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SIEMENS

SIMATIC

# S7-300
# S7-300 Module data

Manual

06/2017
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Siemens AG
Division Digital Factory
Postfach 48 48
90026 NÜRNBERG
GERMANY

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# Preface

## Purpose of the manual

The information contained in this manual can be used as a reference to operating, to functions, and to the technical data of the signal modules, power supply modules and interface modules of the S7-300.

Refer to the relevant S7-300 or ET 200M manuals to find out how to assemble and wire the modules.for system installation.

## Basic knowledge required

This manual presumes general knowledge in the field of automation engineering.

## Range of validity of this manual

The manual describes the components based on the data valid at the time of its release.

SIEMENS reserves the right to include product information for each new module of a later version.

## Changes compared to the previous version

Changes / enhancements compared to the previous version described in this manual:

Comments on the previous version of this manual are included in the current edition.

## Position in the overall documentation structure

The following documentation is part of the S7-300 documentation package. You can find this on the Internet (http://support.automation.siemens.com/WW/view/en/10805159/133300) and the corresponding entry ID.

| Name of the manual | Description |
|---|---|
| **Manual**<br>CPU 31xC and CPU 31x, technical data<br>Entry ID: 12996906 | Control and display elements, communication, memory concept, cycle and reaction times, technical data |
| **Operating Instructions**<br>S7-300, CPU 31xC and CPU 31x: Installation<br>Entry ID: 13008499 | Project design, installation, wiring, addressing, commissioning, maintenance and test functions, diagnostics and troubleshooting. |
| **System Manual**<br>PROFINET system description<br>Entry ID: 19292127 | Basic description of PROFINET:<br>Network components, data exchange and communication, PROFINET IO, Component-based Automation, application example of PROFINET IO and Component-based Automation. |



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| Name of the manual | Description |
|---|---|
| **Programming manual**<br>Migration from PROFIBUS DP to PROFINET IO<br>Entry ID: 19289930 | Guideline for migration from PROFIBUS DP to PROFINET IO. |
| **Manual**<br>• CPU 31xC: Technological functions<br>Entry ID: 12429336<br>• CD containing examples | Description of the technological functions: positioning, counting, point-to-point coupling, loop control.<br>The CD contains examples of the technological functions. |
| **YOU ARE CURRENTLY READING the Manual**<br>S7-300 Automation System: Module Data<br>Entry ID: 8859629 | Description of the functions and technical data of signal/ power supply/ interface modules. |
| **Instructions List**<br>• CPU 31xC, CPU 31x, IM151-7 CPU, IM154-8 CPU, BM 147-1 CPU, BM147-2 CPU<br>Entry ID: 13206730<br>• CPU 312, CPU 314, CPU 315-2 DP CPU 315-2 PN/DP, CPU 317-2 PN/DP, CPU 319-3 PN/DP as of V3.0<br>Entry ID: 31977679 | List of the CPU's instruction set and corresponding execution times. List of executable blocks (OBs, SFCs, SFBs) and their execution times. |
| **Getting Started**<br>Available anthology of Getting Started manuals:<br>• S7-300 Getting Started<br>Entry ID: 15390497<br>• PROFINET Getting Started Collection<br>Entry ID: 19290251 | Using concrete examples, the Getting Started documentation provides step-by-step instructions focused on commissioning a fully functional application. |



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Other manuals on S7-300 and ET 200M

| Name of the manual | Description |
|---|---|
| **Reference Manual**<br>• CPU Data: CPU 312 IFM - 318-2 DP<br>• Entry ID: 8860591 | Control and display elements, communication, memory concept, cycle and reaction times, technical data |
| **Software Installation Manual**<br>S7-300 Automation System: Installation: CPU 312 IFM – 318-2 DP<br>Entry ID: 15390415 | Project design, installation, wiring, addressing, commissioning, maintenance and test functions, diagnostics and troubleshooting. |
| **Configuration manual**<br>ET 200M signal modules for process automation<br>Entry ID: 7215812 | Description of integration in process automation, parameter configuration using SIMATIC PDM, digital input modules, digital output modules. |
| **Manual**<br>Distributed I/O Device ET 200M<br>HART analog modules<br>Entry ID: 22063748 | Description of configuration and commissioning of HART analog modules. |
| **Manual**<br>Distributed I/O Device ET 200M<br>Entry ID: 1142798 | Description of configuration, assembly and wiring. |
| **Manual**<br>SM 335 - High-speed analog mixed module for SIMATIC S7-300<br>Entry ID: 1398483 | Description of how to use the SM 335 module in a SIMATIC S7-300.<br>Overview of operations, descriptions of functions, and technical data relating to the SM 335. |

## Sign posts

The manual contains various features supporting quick access to specific information:

- At the beginning of the manual, you will find a complete table of contents.
- Key terms are explained in the glossary.
- You can use the index to find the key parts of the manual.

## Approvals

See section Standards and approvals (Page 14).

## CE approval

See section Standards and approvals (Page 14).

## RCM (C-Tick) Declaration of conformity for Australia/New Zealand

See section Standards and approvals (Page 14).



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## Standards

See section Standards and approvals (Page 14).

## Recycling and disposal

Since the S7-300 components only contain low levels of harmful substances, they are suitable for recycling. For ecologically compatible recycling and disposal of your old device, contact a certificated disposal service for electronic scrap.

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# General technical data

# 1

## 1.1 Standards and approvals

### Introduction

Contents of general technical data:

- standards and test values satisfied by modules of the S7-300 automation system
- test criteria of S7-300 modules.

**Note**

**Information on the nameplate**

You will find the current labels and approvals on the nameplate of the respective modules.

### Safety guidelines

**WARNING**

Personal injury and damage to property may occur.

In potentially explosive environments, there is a risk of injury or damage if you disconnect any connectors while the S7-300 is in operation.

Always isolate the S7-300 operated in such areas before you disconnect and connectors.

**WARNING**

**Explosion hazard**

If you replace components, compliance with Class I, DIV 2 may become invalid.

**WARNING**

The S7-300 module is only suitable for use in Class I, Div. 2, Group A, B, C, D, or in non-hazardous areas.



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## Test symbols and their significance

The test symbols and their meanings are described in the following section.

## CE Label

The S7-300 automation system satisfies the requirements and protection goals of the following EC directives, and conforms with the harmonized European standards (EN) for programmable logic controllers announced in the Official Journals of the European Community:

- 2014/35/EU "Electrical equipment designed for use within certain voltage limits" (Low-Voltage Directive)
- 2014/30/EU "Electromagnetic Compatibility" (EMC Directive)
- 2014/34/EU "Equipment and protective systems intended for use in potentially explosive atmospheres" (Explosion Protection Directive)
- 2011/65/EU "Restriction of the use of certain hazardous substances in electrical and electronic equipment" (RoHS Directive)

The EC declaration of conformity is held on file available to competent authorities at:

Siemens Aktiengesellschaft
Digital Factory
Factory Automation

DF FA AS SYS
P.O. Box 1963
D-92209 Amberg, Germany

You can also download this under the keyword "Declaration of conformity" on the Internet (http://support.automation.siemens.com/WW/view/en/37217116/134200).

## UL approval

Underwriters Laboratories Inc., complyling with

- UL 508 (Industrial Control Equipment)



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## CSA approval

Canadian Standards Association to

- C22.2 No. 142 (Process Control Equipment)

**or**

## cULus approval

Underwriters Laboratories Inc. complying with

- UL 508 (Industrial Control Equipment)
- CSA C22.2 No. 142 (Process Control Equipment)

**or**

## cULus HAZ. LOC. approval

HAZ. LOC.

Underwriters Laboratories Inc., complying with

- UL 508 (Industrial Control Equipment)
- UL 1604 (Hazardous Location)
- CSA C22.2 No. 142 (Process Control Equipment)
- CSA C22.2 No. 213 (Hazardous Location)

APPROVED for use in
Class I, Division 2, Group A, B, C, D Tx;
Class I, Zone 2, Group IIC Tx



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## FM approval




Factory Mutual Research (FM) in accordance with
Approval Standard Class Number 3611, 3600, 3810
APPROVED for use in

Class I, Division 2, Group A, B, C, D Tx;
Class I, Zone 2, Group IIC Tx

## ATEX approval



In accordance with EN 60079-15 (Electrical Apparatus for Potentially Explosive Atmospheres; Type of Protection "n") and EN 60079-0 (Electrical apparatus for potentially explosive gas atmospheres - Part 0: General Requirements)




## RCM (C-Tick) Declaration of conformity for Australia/New Zealand



The automation system S7-300 fulfills the requirements of the standards

- AS/NZS 61000.6.4
- IEC 61000-6-4.

## IEC 61131

The automation system S7-300 fulfills the requirements and criteria of the IEC 61131-2 standard (Programmable Controllers, Part 2: Equipment requirements and tests).



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## Marine approval

Classification societies:

- ABS (American Bureau of Shipping)
- BV (Bureau Veritas)
- DNV-GL (Det Norske Veritas-Germanischer Lloyd)
- LRS (Lloyds Register of Shipping)
- Class NK (Nippon Kaiji Kyokai)
- CCS (China Classification Society)

## Use in industrial environments

SIMATIC products are designed for industrial applications.

Table 1- 1 Use in industrial environments

| Field of application | Noise emission requirements | Noise immunity requirements |
|---|---|---|
| Industry | EN 61000-6-4: 2007 | EN 61000-6-2: 2005 |

## Use in residential areas / mixed areas

**Note**

The S7-300 automation system is intended for use in industrial areas; use in residential areas / mixed areas may have an impact on radio/TV reception.

If you use the S7-300 in residential areas / mixed areas, you must ensure observance of the Class B radio interference limit in accordance with EN 55022 regarding the emission of radio interferences.

Suitable measures for achieving the required Class B radio interference level include, for example:

- S7-300 installation in grounded switch cabinets / cubicles
- Use of noise filters in the supply lines



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# 1.2 Electromagnetic compatibility

## Definition

Electromagnetic compatibility (EMC) is the ability of an electrical installation to function satisfactorily in its electromagnetic environment without interfering with that environment.

The S7-300 modules also satisfy requirements of EMC legislation for the European domestic market. Compliance of the S7-300 system with specifications and directives on electric design is prerequisite.

## Pulseshaped disturbance

The table below shows the EMC compatibility of S7 modules in areas subject to pulse-shaped disturbance.

| Pulse-shaped disturbance | Test voltage | corresponds with degree of severity |
|---|---|---|
| Electrostatic discharge<br>to IEC 61000-4-2 | Air discharge: ±8 kV<br>Contact discharge ± 4 kV | 3<br>2 |
| Burst pulses (high-speed transient disturbance)<br>to IEC 61000-4-4. | 2 kV (power supply lines)<br>2 kV (signal lines > 3 m)<br>1 kV (signal lines < 3 m) | 3<br>3 |
| High-energy single pulse (surge) to IEC 61000-4-5<br>External protective circuit required<br>(refer to *S7-300 Automation System, Hardware and Installation,* Chapter "Lightning and overvoltage protection") | | 3 |
| • asymmetric coupling | 2 kV (power supply lines) DC with protective elements<br>2 kV (signal/ data line only > 3 m), with protective elements as required | |
| • symmetric coupling | 1 kV (power supply lines) DC with protective elements<br>1 kV (signal/ data line only > 3 m), with protective elements as required | |



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## Sinusoidal disturbance

The table below shows the EMC compatibility of S7-300 modules in areas subject to sinusoidal disturbance.

- HF radiation

| **HF radiation according to IEC 61000-4-3**<br>**Electromagnetic HF field, amplitude-modulated** | | **Corresponds with degree of severity** |
|---|---|---|
| 80 MHz to 1,000 MHz; 1.4 GHz to 2 GHz | 2.0 GHz to 2.7 GHz | 3, 2, 1 |
| 10 V/m | 1 V/m | |
| 80% AM (1 kHz) | | |

- HF coupling

| **HF coupling according to IEC 61000-4-6** | **Corresponds with degree of severity** |
|---|---|
| 0.15 MHz to 80 MHz | 3 |
| 10 $V_{rms}$ unmodulated | |
| 80% AM (1 kHz) | |
| 150 Ω source impedance | |

## Emission of radio interference

Electromagnetic interference to EN 55016: Limit Value Class A (measured at a distance of 10 m).

| **Frequency** | **Noise emission** |
|---|---|
| 30 MHz to 230 MHz | < 40 dB (µV/m)Q |
| 230 MHz to 1000 MHz | < 47 dB (µV/m)Q |
| 1 GHz - 3 GHz | < 76 dB (µV/m) peak < 56 dB (µV/m) average |
| 3 GHz - 6 GHz | < 80 dB (µV/m) peak < 60 dB (µV/m) average |

Noise emission via AC mains to EN 55016: Limit value class A, Group 1.

| **Frequency** | **Noise emission** |
|---|---|
| From 0.15 to 0.5 MHz | < 79 dB (µV/m)Q<br>< 66 dB (µV/m)M |
| 0.5 MHz to 5 MHz | < 73 dB (µV/m)Q<br>< 60 dB (µV/m)M |
| 5 MHz to 30 MHz | < 73 dB (µV/m)Q<br>< 60 dB (µV/m)M |



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# 1.3 Shipping and storage conditions for modules and backup batteries

## Introduction

S7-300 modules exceed the specifications regarding transport and storage conditions pursuant to IEC 61131-2. The following information applies to modules that are transported and stored in their original packaging.

The climatic conditions for temperature and humidity meet:

- IEC 60721-3-3, Class 3K7 for storage.
- IEC 60721-3-2, Class 2K4 for transport.

The mechanical conditions for individual parameters meet IEC 60721-3-2, Class 2M2.

## Shipping and storage conditions for modules

| Type of condition | Permissible range |
|---|---|
| Free fall (in shipping package) | ≤ 1 m |
| Temperature | - 40 °C to + 70 °C |
| Barometric pressure | from 1140 to 660 hPa (corresponds to an elevation of -1000 to 3500 m) |
| Relative humidity | 10% to 95%, no condensation |
| Sinusoidal oscillation to IEC 60068-2-6 | 5 Hz to 9 Hz: 3.5 mm<br>9 Hz to 150 Hz: 9.8 $m/s^2$ |
| Shock to IEC 60068-2-29 | 250 $m/s^2$, 6 ms, 1000 shocks |

## Shipment of backup batteries

Backup batteries should always be shipped in their original package. Note the regulations governing the transport of hazardous goods. The backup battery has a lithium content of approx. 0.25 g.



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## Storing backup batteries

Always store backup batteries in a cool and dry place. The maximum storage period is 5 years

**WARNING**

**Handling backup batteries**

Improper handling of backup batteries can result in injury and damage to property. Improperly handled backup batteries may explode or cause severe burns.

Observe the following rules when handling the backup batteries used in the S7-300 automation system:

- Never charge the batteries
- Never heat the batteries
- Never throw the batteries in an open fire
- Never damage the batteries mechanically (drill, squeeze, etc.)

**Note**

**Backup batteries**

Do not dispose of batteries through household waste! Batteries are recyclable!



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# 1.4 Mechanical and climatic environmental conditions for S7-300 operation

## Operating conditions

S7-300 systems are designed for stationary use in weather-proof locations. The operating conditions are based on the requirements of DIN IEC 60721-3-3:

- Class 3M3 (mechanical requirements)
- Class 3K3 (climatic requirements)

## Use with additional measures

The S7-300 may not be used under the conditions outlined below without taking additional measures:

- at locations with a high degree of ionizing radiation
- in aggressive environments caused, for example, by
  - the development of dust
  - corrosive vapors or gases
  - strong electric or magnetic fields
- in installations requiring special monitoring, for example
  - elevators
  - electrical plants in potentially hazardous areas

## Mechanical environmental conditions

The table below shows the mechanical environmental conditions in the form of sinusoidal oscillations.

| Frequency band | Continuous | Infrequently |
|---|---|---|
| 10 Hz ≤ f ≤ 58 Hz | 0.0375 mm amplitude | 0.75 mm amplitude |
| 58 Hz ≤ f ≤ 150 Hz | 0.5 g constant acceleration | 1 g constant acceleration |

## Reducing vibrations

If your S7-300 modules are exposed to severe shock or vibration, take appropriate measures to reduce acceleration or the amplitude.

We recommend the installation of the S7-300 on damping materials (for example, rubber-bonded-to-metal mounting.)



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## Test of mechanical environmental conditions

The table below provides important information with respect to the type and scope of the test of ambient mechanical conditions.

| Condition tested | Test Standard | Comment |
|---|---|---|
| Vibration | Vibration test to IEC 60068-2-6 (sinusoidal) | Type of oscillation: Frequency sweeps with a rate of change of 1 octave/minute.<br>5 Hz ≤ f ≤ 9 Hz, constant amplitude 3.5 mm<br>9 Hz ≤ f ≤ 150Hz, constant acceleration 1 g<br>Duration of oscillation: 10 frequency sweeps per axis at each of three vertically aligned axes |
| Shock | Shock, tested to IEC 60068-2-27 | Type of shock: half-sine<br>Severity of shock: 15 g peak value, 11 ms duration<br>Direction of shock: 3 shocks in each direction (+/-) at each of three vertically aligned axes |

## Climatic environmental conditions

The S7-300 may be operated on following environmental conditions:

| Environmental conditions | Permitted range | Comments |
|---|---|---|
| Temperature:<br>horizontal mounting position:<br>vertical mounting position: | <br>0°C to 60°C<br>0°C to 40°C | - |
| Relative humidity | 10 % to 95 % | No condensation, corresponds to relative humidity (RH) Class 2 to IEC 61131, Part 2 |
| Barometric pressure | from 1140 to 795 hPa | Corresponds with an altitude of -1000 m to 2000 m |
| Concentration of pollutants | $SO_2$: < 0.5 ppm;<br>RH < 60 %, no condensation<br>$H2_S$: < 0.1 ppm;<br>RH < 60 %, no condensation | Test: 10 ppm; 4 days<br><br>Test: 1 ppm; 4 days |
| | ISA-S71.04 severity level G1; G2; G3 | - |



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# 1.5 Specification of dielectric tests, protection class, degree of protection, and rated voltage of S7-300

### Isolation

The isolation is designed in accordance with the requirements of EN 61131-2.

### Pollution degree/overvoltage category according to IEC 61131-2: 2007

Proof of dielectric strength must be provided in the type test at a test voltage according to IEC 61131-2:

- Pollution degree 2
- Overvoltage category: II

### Protection class in accordance with IEC 61131-2: 2007

The automation system S7-300 meets Protection Class I and contains parts of Protection Classes II and III.

### Degree of protection IP20

Degree of protection IP 20 in accordance with IEC 60529 for all modules of the S7-300 automation system, i.e.:

- Protection against contact with standard test finger
- Protection against foreign objects with diameters greater than 12.5 mm
- No protection against water

# 1.6 Rated voltages of S7-300

### Rated operating voltages

The S7-300 modules operate at different rated voltages. The table shows the rated voltages and corresponding tolerances.

| Rated voltages | Tolerance |
|---|---|
| 24 VDC | 20.4 VDC to 28.8 VDC |
| 120 VAC | 93 VAC to 132 VAC |
| 230 VAC | 187 VAC to 264 VAC |



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# 1.7 SIPLUS S7-300 Modules

## Definition

SIPLUS S7-300 modules can be used under extended environmental conditions. Meaning of "extended environmental conditions":

- Extended temperature range of - 25 °C to + 60 °C/70°C
- Moisture condensation/condensation permissible
- increased mechanical stress permissible

## Comparison with "standard" modules

The functional scope and technical data of SIPLUS S7-300 modules and of "standard" modules are identical, with the exception of the environmental conditions.

SIPLUS S7-300 modules have a separate order number (see the table below.)

The mechanical/climatic environmental conditions and the method of testing these have changed. The SIPLUS S7-300 modules are specified:

- For deployment in harsh environmental conditions,
- For use in hostile environments.
- For extreme temperature ranges.

For more on this, read section Environmental conditions for the operation of SIPLUS S7-300 modules (Page 30).

## Project design in STEP 7

SIPLUS S7-300 modules are not included in the hardware catalog. Please design your plant based on the relevant "standard" modules shown in the table below.



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## SIPLUS S7-300 Modules

This following table contains all SIPLUS S7-300 modules available at the time of publication.

In addition, we included the order numbers of the corresponding "standard" modules to support project design. You can refer to specifications and technical data in the special "standard" module section.

You´ll find more information on SIPLUS and contact partners in the Internet (http://www.siemens.com/siplus-extreme).

Table 1- 2 Comparison of SIPLUS S7-300 modules and S7-300 "Standard" module

| Module type | SIPLUS S7-300 modules for the use under extended environmental conditions | "Standard" modules |
|---|---|---|
| | as of order no. | |
| Power supply | | |
| PS 305; 2A | 6AG1305-1BA80-2AA0 | 6ES7305-1BA80-0AA0 |
| PS 307; 5A | 6AG1307-1EA80-2AA0 | 6ES7307-1EA80-0AA0 |
| PS 307; 10A | 6AG1307-1KA02-7AA0 | 6ES7307-1KA02-0AA0 |
| Interface module | | |
| IM 153-1 | 6AG1153-1AA03-2XB0 | 6ES7153-1AA03-0XB0 |
| IM 365 | 6AG1365-0BA01-2AA0 | 6ES7365-0BA01-0AA0 |
| Separator module | 6AG1195-7KF00-2XA0 | 6ES7195-7KF00-0XA0 |



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| Module type | SIPLUS S7-300 modules for the use under extended environmental conditions | "Standard" modules |
|---|---|---|
| | as of order no. | |
| Central module | | |
| CPU 312C (EN50155) | 6AG1312-5BF04-2AY0 | 6ES7312-5BF04-0AB0 |
| CPU 312C | 6AG1312-5BF04-7AB0 | 6ES7312-5BF04-0AB0 |
| CPU 313C (EN50155) | 6AG1313-5BG04-2AY0 | 6ES7313-5BG04-0AB0 |
| CPU 313C | 6AG1313-5BG04-7AB0 | 6ES7313-5BG04-0AB0 |
| CPU 313C-2DP (EN50155) | 6AG1313-6CG04-2AY0 | 6ES7313-6CG04-0AB0 |
| CPU 313C-2DP | 6AG1313-6CG04-7AB0 | 6ES7313-6CG04-0AB0 |
| CPU 314 (EN50155) | 6AG1314-1AG14-2AY0 | 6ES7314-1AG14-0AB0 |
| CPU 314 | 6AG1314-1AG14-7AB0 | 6ES7314-1AG14-0AB0 |
| CPU 314C | 6AG1314-6BH04-7AB0 | 6ES7314-6BH04-0AB0 |
| CPU 314C-2DP (EN50155) | 6AG1314-6CH04-2AY0 | 6ES7314-6CH04-0AB0 |
| CPU 314C-2DP | 6AG1314-6CH04-7AB0 | 6ES7314-6CH04-0AB0 |
| CPU314C-2PN/DP | 6AG1314-6EH04-7AB0 | 6ES7314-6EH04-0AB0 |
| CPU 315-2DP (EN50155) | 6AG1315-2AH14-2AY0 | 6ES7315-2AH14-0AB0 |
| CPU 315-2DP | 6AG1315-2AH14-7AB0 | 6ES7315-2AH14-0AB0 |
| CPU 315-2PN/DP (EN50155) | 6AG1315-2EH14-2AY0 | 6ES7315-2EH14-0AB0 |
| CPU 315-2PN/DP | 6AG1315-2EH14-7AB0 | 6ES7315-2EH14-0AB0 |
| CPU 315F-2PN/DP | 6AG1315-2FJ14-2AB0 | 6ES7315-2FJ14-0AB0 |
| CPU 315F-2PN/DP (EN50155) | 6AG1315-2FJ14-2AY0 | 6ES7315-2FJ14-0AB0 |
| CPU 315F-2DP | 6AG1315-6FF04-2AB0 | 6ES7315-6FF04-0AB0 |
| CPU 315F-2DP (EN50155) | 6AG1315-6FF04-2AY0 | 6ES7315-6FF04-0AB0 |
| CPU 317-2PN/DP (EN50155) | 6AG1317-2EK14-2AY0 | 6ES7317-2EK14-0AB0 |
| CPU 317-2PN/DP | 6AG1317-2EK14-7AB0 | 6ES7317-2EK14-0AB0 |
| CPU 317F-2PN/DP | 6AG1317-2FK14-2AB0 | 6ES7317-2FK14-0AB0 |
| CPU 317F-2PN/DP (EN50155) | 6AG1317-2FK14-2AY0 | 6ES7317-2FK14-0AB0 |
| CPU 317F-2DP | 6AG1317-6FF04-2AB0 | 6ES7317-6FF04-0AB0 |
| Digital input module | | |
| SM 321; DI 16 x DC 24V | 6AG1321-1BH02-2AA0 | 6ES7321-1BH02-0AA0 |
| SM 321; DI 32 x DC 24V | 6AG1321-1BL00-2AA0 | 6ES7321-1BL00-0AA0 |
| SM 321; DI 16 x DC 24V | 6AG1321-7BH01-2AB0 | 6ES7321-7BH01-0AB0 |
| SM 321; DI 8 x AC 120/230V | 6AG1321-1FF10-7AA0 | 6ES7321-1FF10-0AA0 |
| SM 321; DI 16 x DC 48 V-125V | 6AG1321-1CH20-2AA0 | 6ES7321-1CH20-0AA0 |
| SM 321; DI 8 x AC 120/220 V | 6AG1321-1FF01-2AA0 | 6ES7321-1FF01-0AA0 |
| SM 321; DI 4 NAMUR | 6AG1321-7RD00-4AB0 | 6ES7321-7RD00-0AB0 |
| SM 321; DI 16 x DC 24V | 6AG1321-7TH00-4AB0 | 6ES7321-7TH00-0AB0 |



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| Module type | SIPLUS S7-300 modules for the use under extended environmental conditions | "Standard" modules |
|---|---|---|
| | as of order no. | |
| Digital output module | | |
| SM 322; DO 16 x DC 24V/0.5A | 6AG1322-1BH01-2AA0 | 6ES7322-1BH01-0AA0 |
| SM 322; DO 8 x Rel. 230 V AC / 5A | 6AG1322-1HF10-2AA0 | 6ES7322-1HF10-0AA0 |
| SM 322, DO 8 x DC 48-125 V/1.5 A | 6AG1322-1CF00-7AA0 | 6ES7322-1CF00-0AA0 |
| SM 322; DO 8 x AC 120/230V/2A | 6AG1322-1FF01-7AA0 | 6ES7322-1FF01-0AA0 |
| SM 322; DO 8 x DC 24V/0.5A | 6AG1322-8BF00-2AB0 | 6ES7322-8BF00-0AB0 |
| SM 322; DO 8 x DC 24V | 6AG1322-1BF01-2XB0 | 6ES7322-1BF01-0AA0 |
| SM 322; DO 32 x DC 24 V/0.5 A | 6AG1322-1BL00-2AA0 | 6ES7322-1BL00-0AA0 |
| SM 322; DO 16 x AC 120/230V/1 A | 6AG1322-1FH00-7AA0 | 6ES7322-1FH00-0AA0 |
| SM 322; DO 16 RELAY | 6AG1322-1HH01-2AA0 | 6ES7322-1HH01-0AA0 |
| SM 322; DO 8 x AC 120/230 V, 2 A | 6AG1322-5FF00-4AB0 | 6ES7322-5FF00-0AB0 |
| SM 322; DO 8 RELAY | 6AG1322-5HF00-4AB0 | 6ES7322-5HF00-0AB0 |
| SM 322; DO 16 x DC 24V | 6AG1322-8BH10-7AB0 | 6ES7322-8BH10-0AB0 |
| Digital I/O module | | |
| SM 323; DI8/DO8 x DC 24V/0.5A | 6AG1323-1BH01-2AA0 | 6ES7323-1BH01-0AA0 |
| Analog input module | | |
| SM 331; AI 2 x 12Bit | 6AG1331-7KB02-2AB0 | 6ES7331-7KB02-0AB0 |
| SM 331; AI 8 x 13 Bit | 6AG1331-1KF02-4AB0 | 6ES7331-1KF02-0AB0 |
| SM 331; AI 8 x 13 Bit | 6AG1331-1KF02-7AB0 | 6ES7331-1KF02-0AB0 |
| SM 331; AI 8 x 12 Bit | 6AG1331-7KF02-2AB0 | 6ES7331-7KF02-0AB0 |
| SM 331; AI 8 x 16 Bit | 6AG1331-7NF00-2AB0 | 6ES7331-7NF00-0AB0 |
| SM 331; AI 8 x 16 Bit | 6AG1331-7NF10-2AB0 | 6ES7331-7NF10-0AB0 |
| SM 331; AI 8 x 13 Bit | 6AG1331-7PF11-4AB0 | 6ES7331-7PF11-0AB0 |
| SM 331; AI 8 x 13-bit | 6AG1331-7PF01-4AB0 | 6ES7331-7PF11-0AB0 |
| SM 331; AI 4 x 0/4-20 mA | 6AG1331-7RD00-2AB0 | 6ES7331-7RD00-0AB0 |
| SM 331; AI 8 Thermo / AI 4 PT 100 | 6AG1331-7SF00-4AB0 | 6ES7331-7SF00-0AB0 |
| SM 331; AI 2 HART | 6AG1331-7TB00-7AB0 | 6ES7331-7TB00-0AB0 |
| SM 331; AI 8 x 0/4 to mA HART | 6AG1331-7TF01-7AB0 | 6ES7331-7TF01-0AB0 |
| Analog output module | | |
| SM 332; AO 2 x 12 bit | 6AG1332-5HB01-2AB0 | 6ES7332-5HB01-0AB0 |
| SM 332; AO 4 x 12 bit | 6AG1332-5HD01-7AB0 | 6ES7332-5HD01-0AB0 |
| SM 332; AO 8 x 12 bit | 6AG1332-5HF00-2AB0 | 6ES7332-5HF00-0AB0 |
| SM 332; AO 8 x 0/4 - 20 mA HART | 6AG1332-8TF01-2AB0 | 6ES7332-8TF01-0AB0 |
| SM 332; AO 4 x 16 bit | 6AG1332-7ND02-4AB0 | 6ES7332-7ND02-0AB0 |
| Analog IO module | | |
| SM 334; AI 4/AO 2 x 12 Bit | 6AG1334-0KE00-7AB0 | 6ES7334-0KE00-0AB0 |



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# 1.8 Environmental conditions for the operation of SIPLUS S7-300 modules

## Mechanical environmental conditions

**Application class:** according to IEC 721-3-3, Class 3M4.

## Test of mechanical environmental conditions

The table provides information on the type and scope of the test of mechanical environmental conditions for SIPLUS S7-300 modules.

Table 1- 3 SIPLUS S7-300 Modules: Test of mechanical environmental conditions

| Condition tested | Test Standard | Remarks |
|---|---|---|
| Vibration | Vibration test acc. to IEC 60068-2-6 (sinusoidal) | Type of oscillation: Frequency sweep at a rate of change of 1 octave/minute.<br>5 Hz ≤ f ≤ 9 Hz, constant Amplitude 3.5 mm<br>9 Hz ≤ f ≤ 150 Hz, constant Acceleration<br>1 g duration of oscillation:<br>10 frequency sweeps at each of three vertically aligned axes |
| Shock | Shock, tested acc. to IEC 60068-2-27 | Type of shock: Half-sine<br>Severity of shock: 15 g peak value, 11 ms duration<br>Direction of shock: 3 shocks each in +/– direction in each of the three vertically aligned axes |



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## Environmental conditions

**Operating category:** to IEC 721 -3-3, Class 3K5.

The SIPLUS S7-300 modules may also be used under the following climatic, chemical, biological and mechanical environmental conditions:

Table 1- 4 SIPLUS S7-300 Modules: Environmental conditions

| Environmental conditions | Permitted range |
|---|---|
| Temperature:<br>Horizontal mounting position:<br>Vertical mounting position: | <br>-25 °C to +60 °C/70°C<br>0°C to +40 °C |
| Relative humidity | 5 ... 100 %, condensation / condensation allowed |
| Resistance against biologically active substances | Conformity with EN 60721-3-3, Class 3B2 mildew, fungi and sponge spores (excluding fauna) |
| Resistance against chemically active substances | Conformity with EN 60721-3-3, Class 3C4 incl. salt mist and ISA –S71.04 severity level G1; G2; G3; GX [1)2)] |
| Resistance against mechanically active substances | Conformity with EN 60721-3-3, Class 3S4 incl. conductive sand, dust [2)] |
| Air pressure in relation to<br>ambient temperature - air pressure - installation altitude | - 25 ... +60/70 °C at 1140 ... 795 hPa ≙ -1000 ... +2000 m<br>- 25 ... +50/60°C at 795 ... 658 hPa ≙ +2000 ... +3500 m<br>- 25 ... +40/50°C at 658 ... 540 hPa ≙ +3500 ... +5000 m |
| Certificate of suitability as approval for rail application | --> Partly EN 50155 T1 Cat1 Cl A/B |

1) ISA –S71.04 severity level GX: Dauerbelastung/long-term load: SO2 < 4.8 ppm; H2S < 9.9 ppm; Cl < 0.2 ppm; HCl < 0.66 ppm; HF < 0.12 ppm; NH < 49 ppm; O3 < 0.1 ppm; NOX < 5.2 ppm
limit value (max. 30 min/d): SO2 < 14.8 ppm; H2S < 49.7 ppm; Cl < 1.0 ppm; HCl < 3.3 ppm; HF < 2.4 ppm; NH < 247 ppm; O3 < 1.0 ppm; NOX < 10.4 ppm

2) When operated in harmful gas environments, the supplied plug covers must remain on the non-used port.



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# Power supply modules

# 2

## Introduction

Various 24-VDC power supply modules are available for your S7-300 PLC and the sensors/actuators.

## Power supply modules

This chapter contains the technical data of the S7-300 power supply modules.

In addition to technical data, this chapter describes:

- The characteristics
- Wiring diagram
- Block Diagram
- Line protection
- Reaction to atypical operating conditions



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# 2.1 Power supply module PS 307; 2 A; (6ES7307-1BA01-0AA0)

## Order number

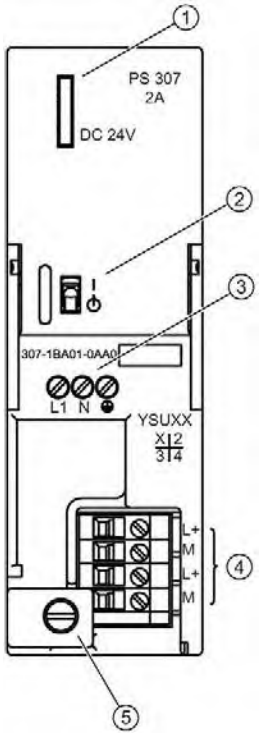
6ES7307-1BA01-0AA0

## Properties

Properties of the PS 307; 2 A power supply module:

- Output current 2 A
- Output voltage 24 V DC; short circuit-proof, open circuit-proof
- Connection to singlephase AC mains
  (rated input voltage 120/230 V AC, 50/60 Hz)
- safe electrical isolation in accordance with EN 60 950 (SELV)
- May be used as load power supply

## Wiring diagram of PS 307; 2 A




① "24 V DC output voltage present" display
② 24 V DC On/Off switch
③ Mains and protective conductor terminals
④ Terminals for 24 V DC output voltage
⑤ Strain-relief



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## Schematic circuit diagram of PS 307; 2 A

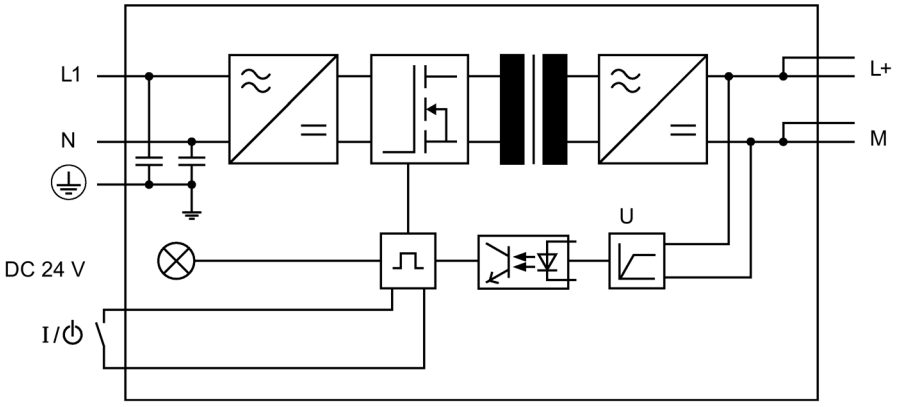



Figure 2-1 Schematic circuit diagram of power supply module PS 307; 2 A

## Line protection

The mains supply of the PS 307; 2A power supply module should be protected with a miniature circuit-breaker (for example Siemens 5SN1 series) of the following rating:

- Rated current at 230 V AC: 3 A
- Tripping characteristics (type): C.

## Reaction to atypical operating conditions

Table 2- 1 Reaction of the PS 307; 2A power supply module to atypical operating conditions

| If ... | ... then ... | 24 V DC LED |
|---|---|---|
| the output circuit is overloaded:<br>• I > 2.6 A (dynamic)<br>• 2 A < I ≤ 2.6 A (static) | Voltage dip, automatic voltage recovery<br>Voltage drop, reduction of service life | Flashing |
| short-circuit at the output | Output voltage 0 V; automatic voltage recovery after short-circuit is eliminated | off |
| overvoltage on primary side | risk of destruction | - |
| undervoltage on primary side | Automatic shutdown; automatic voltage recovery | off |



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## Technical specifications of the PS 307; 2 A (6ES7307-1BA01-0AA0)

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 120 |
| Weight | ca. 400 g |
| **Input parameters** | |
| Input voltage<br>• Rated value<br>Mains frequency<br>• Rated value<br>• Permitted range | <br>120/230 V AC (automatic switching)<br><br>50 Hz or 60 Hz<br>47 Hz to 63 Hz |
| Rated input current<br>• at 230 V<br>• at 120 V | <br>0.5 A<br>0.9 A |
| Inrush current (at 25 °C) | 22 A |
| $I^2t$ (at inrush current) | 1 $A^2s$ |
| **Output parameters** | |
| Output voltage<br>• Rated value<br>• Permitted range<br>• Rampup time | <br>24 V DC<br>24 V ± 3 %, open-circuit test<br>max. 2.5 s |
| Output current<br>• Rated value | <br>2 A,<br>parallel wiring supported |
| Short-circuit protection | electronic, non-latching<br>1.1 to 1.3 x $I_N$ |
| Residual ripple | max. 150 $mV_{pp}$ |
| **Characteristics** | |
| Safety class to IEC 536 (DIN VDE 0106, Part 1) | I, with protective conductor |
| Isolation rating<br>• Rated isolation voltage (24 V to L1)<br>• Test voltage | <br>250 V AC<br>4200 V DC |
| Safety isolation | SELV circuit |
| Buffering of power supply failure (at 93 V or 187 V)<br>• Repeat rate | min. 20 ms<br>min 1 s |
| Efficiency | 84 % |
| Power consumption | 57 W |
| Power loss | Typ. 9 W |
| **Diagnostics** | |
| "Output voltage present" display | yes, green LED |



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# 2.2 Power supply module PS 307; 5 A; (6ES7307-1EA01-0AA0)

## Order number

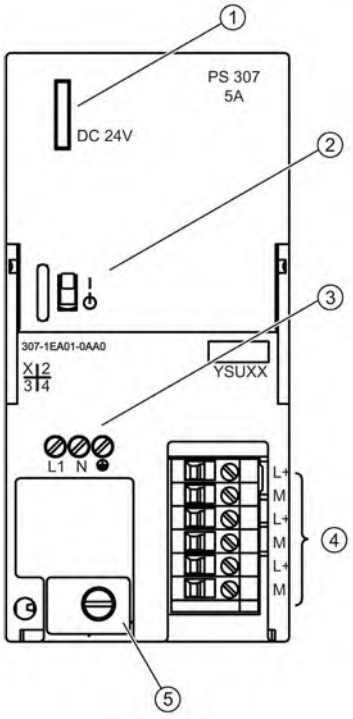
6ES7307-1EA01-0AA0

## Properties

Properties of the PS 307; 5 A power supply module:

- Output current 5 A
- Output voltage 24 V DC; short circuit-proof, open circuit-proof
- Connection to singlephase AC mains
  (rated input voltage 120/230 V AC, 50/60 Hz)
- safe electrical isolation in accordance with EN 60 950 (SELV)
- May be used as load power supply

## Wiring diagram of PS 307; 5 A




① Display for "Output voltage DC 24 V present"
② 24 V DC On/Off switch
③ Mains and protective conductor terminals
④ Terminals for 24 V DC output voltage
⑤ Strain-relief



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## Block diagram PS 307; 5 A

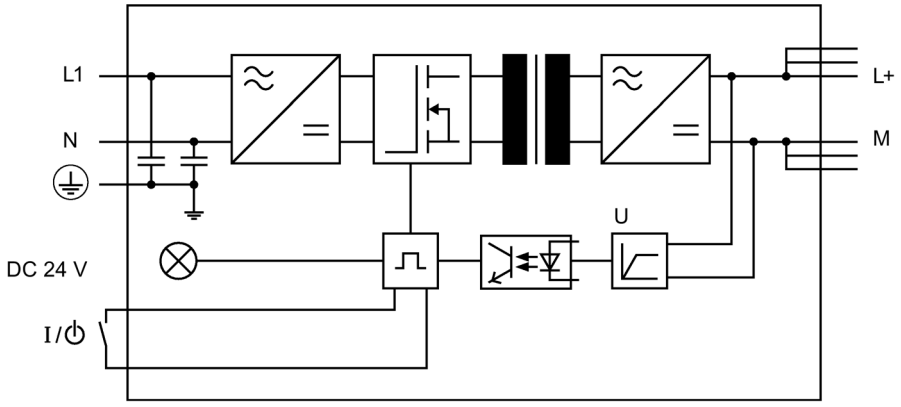



Figure 2-2 Block diagram of the PS 307; 5 A power supply module

## Line protection

The mains supplies of the PS 307; 5 A power supply module should be protected with a miniature circuit-breaker (for example Siemens 5SN1 series) of the following rating:

- Rated current at 230 V AC: 6 A
- Tripping characteristics (type): C.

## Reaction to atypical operating conditions

Table 2- 2 Reaction to atypical operating conditions of the PS 307; 5 A power supply module

| If ... | ... then ... | DisplayDC 24 V |
|---|---|---|
| the output circuit is overloaded:<br>• I > 6.5 A (dynamic)<br>• 5 A < I ≤ 6.5 A (static) | Voltage dip, automatic voltage recovery<br>Voltage drop, reduction of service life | flashes |
| short-circuit at the output | Output voltage 0 V; automatic voltage recovery after short-circuit is eliminated | off |
| overvoltage on primary side | risk of destruction | - |
| undervoltage on primary side | Automatic shutdown; automatic voltage recovery | off |



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## Technical specifications of PS 307; 5 A (6ES7307-1EA01-0AA0)

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 60 x 125 x 120 |
| Weight | ca. 600 g |
| **Input parameters** | |
| Input voltage<br>• Rated value | <br>120/230 V AC (automatic switching) |
| Mains frequency<br>• Rated value<br>• Permitted range | <br>50 Hz or 60 Hz<br>47 Hz to 63 Hz |
| Rated input current<br>• at 120 V<br>• at 230 V | <br>2.3 A<br>1.2 A |
| Inrush current (at 25 °C) | 20 A |
| $I^2t$ (at inrush current) | 1.2 $A^2s$ |
| **Output parameters** | |
| Output voltage<br>• Rated value<br>• Permitted range | <br>24 V DC<br>24 V ± 3 %, open circuit-proof |
| • Rampup time | max. 2.5 s |
| Output current<br>• Rated value | <br>5 A, parallel wiring is available |
| Short-circuit protection | electronic, non-latching<br>1.1 to 1.3 x $I_N$ |
| Residual ripple | max. 150 $mV_{pp}$ |
| **Characteristics** | |
| Safety class to IEC 536 (DIN VDE 0106, Part 1) | I, with protective conductor |
| Isolation rating<br>• Rated isolation voltage (24 V to L1) | <br>250 V AC |
| • Test voltage | 4200 V DC |
| Safety isolation | SELV circuit |
| Buffering of power supply failure (at 93 V or 187 V)<br>• Repeat rate | Min. 20 ms<br>min 1 s |
| Efficiency | 87 % |
| Power consumption | 138 W |
| Power loss | typ. 18 W |
| **Diagnostics** | |
| "Output voltage present" display | yes, green LED |



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# 2.3 Power supply module PS 307; 10 A; (6ES7307-1KA02-0AA0)

## Order number

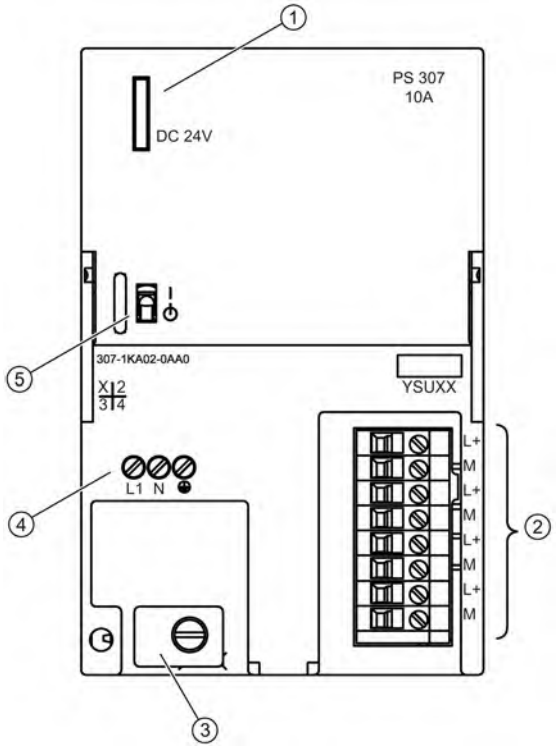
6ES7307-1KA02-0AA0

## Properties

Properties of the PS 307; 10 A power supply module:

- Output current 10 A
- Output voltage 24 V DC; short circuit-proof, open circuit-proof
- Connection to singlephase AC mains
  (rated input voltage 120/230 V AC, 50/60 Hz)
- safe electrical isolation in accordance with EN 60 950 (SELV)
- May be used as load power supply

## Block diagram of PS 307; 10 A




① Display for "Output voltage DC 24 V present"
② Terminals for 24 V DC output voltage
③ Strain-relief
④ Mains and protective conductor terminals
⑤ 24 V DC On/Off switch



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## Block diagram PS 307; 10 A

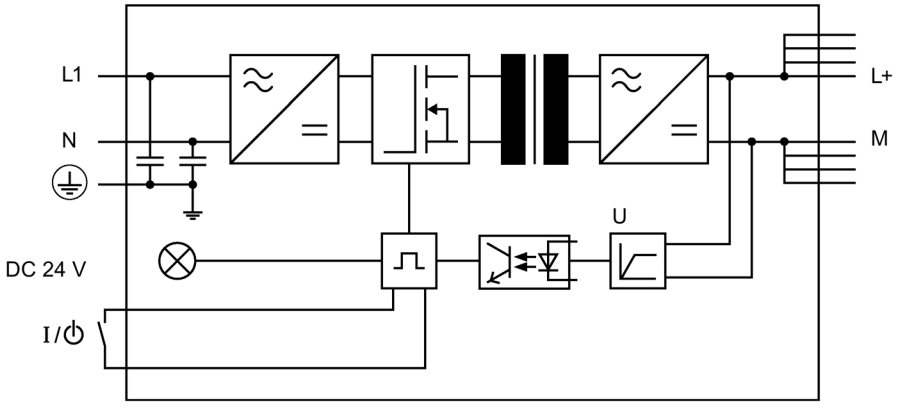



Figure 2-3 Block diagram of the PS 307; 10 A power supply module

## Line protection

The mains supplies of the PS 307;10 A power supply module should be protected with a miniature circuit-breaker (for example Siemens 5SN1 series) of the following rating:

- Rated current at 230 V AC: 10 A
- Tripping characteristics (type): C.

## Reaction to atypical operating conditions

Table 2- 3 Reaction to atypical operating conditions of the PS 307; 10 A power supply module

| If ... | Module reaction | DisplayDC 24 V |
|---|---|---|
| .output circuit is overloaded:<br>• I > 13 A (dynamic)<br>• 10 A < I ≤ 13 A (static) | Voltage dip, automatic voltage recovery<br>Voltage drop (reduction of service life) | flashes |
| short-circuit at the output | Output voltage 0 V; automatic voltage recovery after short-circuit is eliminated | off |
| overvoltage on primary side | risk of destruction | - |
| undervoltage on primary side | Automatic shutdown; automatic voltage recovery | off |



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## Technical specifications of PS 307; 10 A (6ES7307-1KA02-0AA0)

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 80 x 125 x 120 |
| Weight | 800 g |
| Input parameters | |
| Input voltage<br>• Rated value | <br>120/230 V AC (automatic switching) |
| Mains frequency<br>• Rated value<br>• Permitted range | <br>50 Hz or 60 Hz<br>47 Hz to 63 Hz |
| Rated input current<br>• at 230 V<br>• at 120 V | <br>1.9 A<br>4.2 A |
| Inrush current (at 25 °C) | 55 A |
| $I^2t$ (at inrush current) | 3.3 $A^2s$ |
| **Output parameters** | |
| Output voltage<br>• Rated value<br>• Permitted range<br>• Rampup time | <br>24 V DC<br>24 V ± 3 %, open-circuit test<br>max. 2.5 s |
| Output current<br>• Rated value | <br>10 A, parallel wiring is available |
| Short-circuit protection | electronic, non-latching<br>1.1 to 1.3 x $I_N$ |
| Residual ripple | max. 150 $mV_{pp}$ |
| **Characteristics** | |
| Safety class to IEC 536 (DIN VDE 0106, Part 1) | I, with protective conductor |
| Isolation rating<br>• Rated isolation voltage (24 V to L1)<br>• Test voltage | <br>250 V AC<br>4200 V DC |
| Safety isolation | SELV circuit |
| Buffering of power supply failure (at 93 V or 187 V)<br>• Repeat rate | Min. 20 ms<br>min 1 s |
| Efficiency | 90 % |
| Power consumption | 267 W |
| Power loss | typ. 27 W |
| **Diagnostics** | |
| "Output voltage present" display | yes, green LED |



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# 2.4 Power supply module PS 305; 2 A; (6AG1305-1BA80-2AA0)

## Order number "SIPLUS S7-300 module"

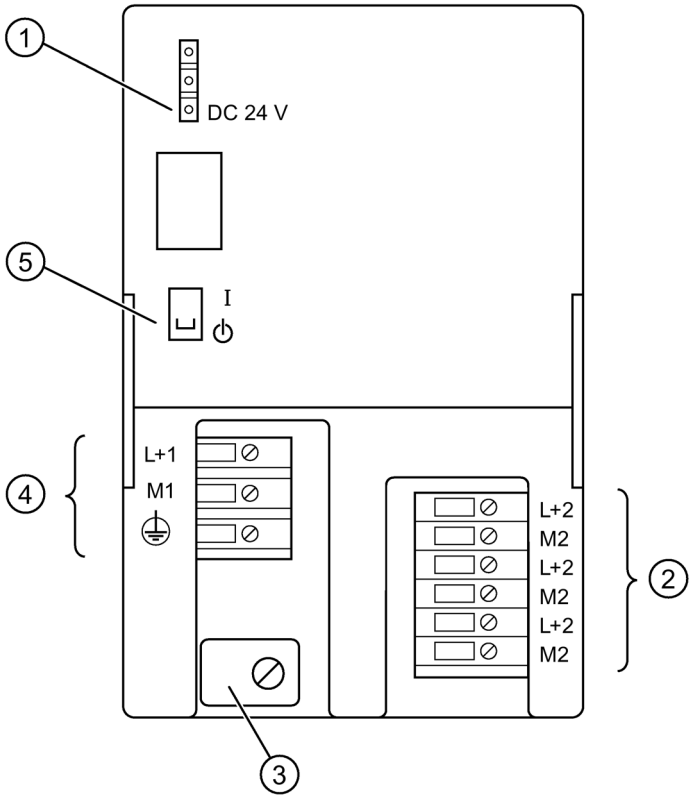
6AG1305-1BA80-2AA0

## Properties

Properties of the PS 305 power supply module (2 A):

- Output current 2 A
- Output voltage 24 V DC; short circuit-proof, open circuit-proof
- Connection to DC power supply
  (rated input voltage 24/48/72/96/110 V DC)
- safe electrical isolation in accordance with EN 60 950 (SELV)
- May be used as load power supply

## Wiring diagram of PS 305; 2 A




① "24 V DC output voltage present" display
② Terminals for 24 V DC output voltage
③ Strain relief
④ Mains and protective conductor terminals
⑤ 24 V DC On/Off switch



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## Schematic circuit diagram of PS 305; 2 A

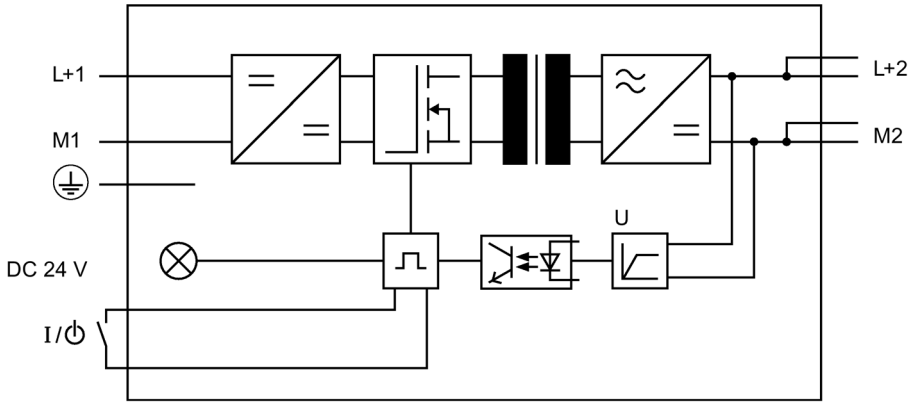



Figure 2-4 Schematic circuit diagram of power supply module PS 305; 2 A

## Line protection

The mains supply of the PS 305 power supply module (2 A) should be protected with a miniature circuit-breaker (for example Siemens 5SN1 series) of the following rating:

- Rated current at 110 V DC: 10 A
- Tripping characteristics (type): C.

## Reaction to atypical operating conditions

Table 2- 4 Reaction of the PS 305;(2 A) power supply module to atypical operating conditions

| If ... | ... then ... | 24 V DC LED |
|---|---|---|
| ... the output circuit is overloaded:<br>• I > 3.9 A (dynamic)<br>• 3 A < I ≤ 3.9 A (static) | Voltage dip, automatic voltage recovery<br>Voltage drop, reduction of service life | Flashing |
| ... short-circuit at the output | Output voltage 0 V; automatic voltage recovery after short-circuit is eliminated | off |
| overvoltage on primary side | risk of destruction | - |
| undervoltage on primary side | Automatic shutdown; automatic voltage recovery | off |



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## Technical specifications of the PS 305; 2 A (6AG1305-1BA80-2AA0)

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 80 x 125 x 120 |
| Weight | ca. 740 g |
| **Input parameters** | |
| Input voltage<br>• Rated value<br>• Voltage range | <br>24/48/72/96/110 V DC<br>16.8 to 138 V DC |
| Rated input current<br>• at 24 V<br>• at 48 V<br>• at 72 V<br>• at 96 V<br>• at 110 V | <br>2.7 A<br>1.3 A<br>0.9 A<br>0.65 A<br>0.6 A |
| Inrush current (at 25 °C) | 20 A |
| $I^2t$ (at inrush current) | 5 $A^2s$ |
| **Output parameters** | |
| Output voltage<br>• Rated value<br>• Permitted range | <br>24 V DC<br>24 V ± 3 %, open circuit-proof |
| • Rampup time | max. 3 s |
| Output current<br>• Rated value | 2 A; [1]<br>parallel connection supported |
| Short-circuit protection | electronic, non-latching, 1.65 to 1.95 x $I_N$ |
| Residual ripple | max. 150 $mV_{pp}$ |
| **Characteristics** | |
| Safety class to IEC 536 (DIN VDE 0106, Part 1) | I, with protective conductor |
| Isolation rating<br>• Rated isolation voltage (24 V to input) | <br>150 V AC |
| • Test voltage | 2800 V DC |
| Safety isolation | SELV circuit |
| Buffering of power supply failure (at 24/48/72/96/110 V) | > 10 ms |
| • Repeat rate | min. 1 s |
| Efficiency | 75% |
| Power consumption | 64 W |
| Power loss | 16 W |
| **Diagnostics** | |
| "Output voltage present" display | yes, green LED |

[1] At a limited input voltage range > 24 V (24 to 138 V DC), PS 305 can be loaded to 3 A.



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# 2.5 Power supply module PS 307; 5 A; (6AG1307-1EA80-2AA0)

## Order number "SIPLUS S7 module"

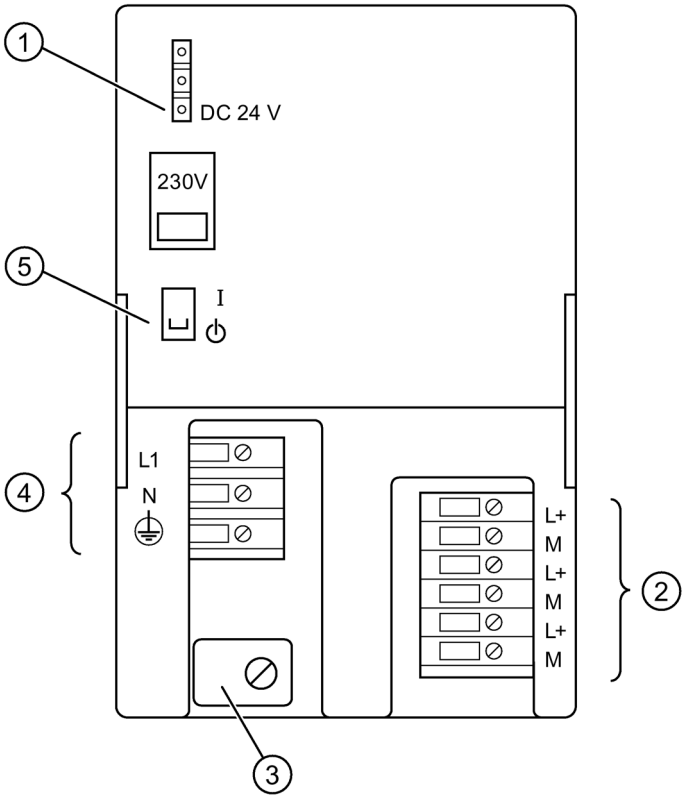
6AG1307-1EA80-2AA0

## Properties

Properties of the PS 307; 5 A power supply module:

- Output current 5 A
- Output voltage 24 V DC; short circuit-proof, open circuit-proof
- Connection to singlephase AC mains
  (rated input voltage 120/230 V AC, 50/60 Hz)
- safe electrical isolation in accordance with EN 60 950 (SELV)
- May be used as load power supply

## Wiring diagram of PS 307; 5 A




① "24 V DC output voltage present" display
② Terminals for 24 V DC output voltage
③ Strain relief
④ Mains and protective conductor terminals
⑤ 24 V DC On/Off switch
⑥ Mains selector switch



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## Schematic circuit diagram of PS 307; 5 A

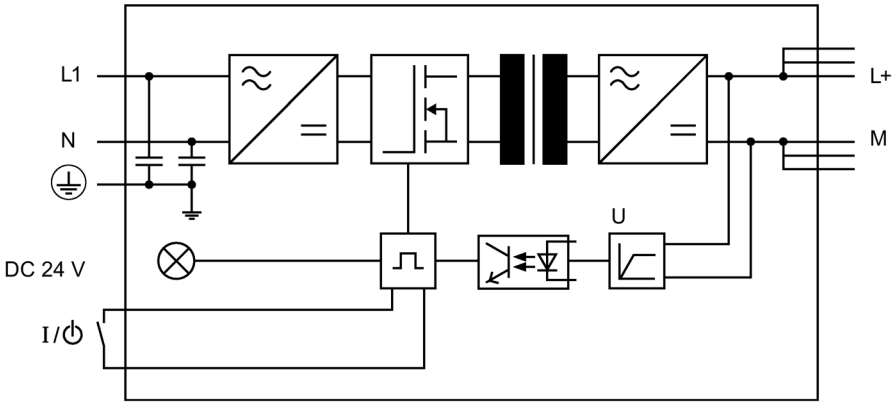



Figure 2-5 Schematic circuit diagram of power supply module PS 307; 5 A

## Line protection

To protect the mains supply line of the PS 307; 5 A power supply module, you should install a miniature circuit-breaker (for example Siemens 5SN1 series) of the following rating:

- Rated current at 230 V AC: 10 A
- Tripping characteristics (type): C.

## Reaction to atypical operating conditions

Table 2- 5 Reaction of the PS 307; 5A power supply module to atypical operating conditions

| If ... | ... then ... | 24 V DC LED |
|---|---|---|
| the output circuit is overloaded:<br>• I > 6.5 A (dynamic)<br>• 5 A < I ≤ 6.5 A (static) | Voltage dip, automatic voltage recovery<br>Voltage drop, reduction of service life | Flashing |
| short-circuit at the output | Output voltage 0 V; automatic voltage recovery after short-circuit is eliminated | off |
| overvoltage on primary side | risk of destruction | - |
| undervoltage on primary side | Automatic shutdown; automatic voltage recovery | off |



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## Technical specifications of the PS 307; 5 A (6AG1307-1EA80-2AA0)

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 80 x 125 x 120 |
| Weight | ca. 570 g |
| **Input parameters** | |
| Input voltage<br>• Rated value | <br>120/230 V DC |
| Mains frequency<br>• Rated value<br>• Permitted range | <br>50 Hz or 60 Hz<br>47 Hz to 63 Hz |
| Rated input current<br>• at 120 V<br>• at 230 V | <br>2.1 A<br>1.2 A |
| Inrush current (at 25 °C) | 45 A |
| $I^2t$ (at inrush current) | 1.8 $A^2s$ |
| **Output parameters** | |
| Output voltage<br>• Rated value<br>• Permitted range<br>• Rampup time | <br>24 V DC<br>24 ± V 3 %<br>max. 3 s |
| Output current<br>• Rated value | <br>5 A; parallel wiring not supported |
| Short-circuit protection | electronic, non-latching<br>1.1 to 1.3 x $I_N$ |
| Residual ripple | max. 150 $mV_{pp}$ |
| **Characteristics** | |
| Safety class to IEC 536 (DIN VDE 0106, Part 1) | I, with protective conductor |
| Isolation rating<br>• Rated isolation voltage (24 V to L1)<br>• Test voltage | <br>250 V AC<br>2800 V DC |
| Safety isolation | SELV circuit |
| Buffering of power supply failure (at 93 V or 187 V)<br>• Repeat rate | min. 20 ms<br>min. 1 s |
| Efficiency | 84 % |
| Power consumption | 143 W |
| Power loss | 23 W |
| **Diagnostics** | |
| "Output voltage present" display | yes, green LED |



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# Digital modules

# 3

## Chapter layout

Topical structure of this chapter:

1. Chapter overview of which modules are available and described here
2. Overview of essential module properties
3. Steps in selecting and commissioning the digital module
4. General information, i.e. global data applicable to all digital modules (parameter assignment and diagnostics, for example)
5. Module-specific information (properties, connection and block diagrams, technical data and special features of the module):

   a) for digital input modules

   b) for digital output modules

   c) for relay output modules

   d) for digital IO modules

## Installation and wiring

For information on installation and wiring, refer to the S7-300, CPU 31xC, and CPU 31x Operating Instructions: Installation. The operating instructions are available on the Internet (http://support.automation.siemens.com/WW/view/en/13008499).

## Further information

The structure of parameter sets (data records 0, 1 and 128) is described in the system data section of the appendix. You must be familiar with this structure if you want to modify module parameters in the STEP 7 user program.

The structure of diagnostic data (data records 0 and 1) is described in the system data section of the appendix. You must be familiar with this structure if you want to analyze diagnostics data of the modules in the STEP 7 user program.

## See also

Principles of programming signal modules in the user program (Page 522)

Evaluating diagnostic data of signal modules in the user program (Page 583)



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# 3.1 Module overview

## Introduction

The tables below summarize the essential properties of the digital modules. This overview supports you in selecting a module to suit your requirements.

## 3.1.1 Digital input modules:

### Overview of properties

The table below shows essential properties of the digital input modules

Table 3- 1 Digital input modules:

| Properties | Module | | | |
|---|---|---|---|---|
| | **SM 321; DI 64 x 24V; Sinking/Sourcing** | **SM 321; DI 32 x DC24V** | **SM 321; DI 32 x AC120V** | **SM 321; DI 16 x DC24V** |
| | **(-1BP00-)** | **(-1BL00-)** | **(-1EL00-)** | **(-1BH02-)** |
| Number of inputs | 64 DO; isolated in groups of 16 | 32 DI; isolated in groups of 16 | 32 DI; isolated in groups of 8 | 16 DI; isolated in groups of 16 |
| Rated input voltage | 24 VDC | 24 VDC | 120 VAC | 24 VDC |
| Suitable for... | - | 2-wire, 3-wire and 4-wire proximity switches (BEROs) | | |
| Supports isochronous mode | No | No | No | No |
| Programmable diagnostics | No | No | No | No |
| Diagnostic interrupt | No | No | No | No |
| Edge-triggered hardware interrupt | No | No | No | No |
| Adjustable input delays | No | No | No | No |
| Special features | - | - | - | - |



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Table 3- 2 Digital input modules (continued)

| Properties | Module | | | | |
|---|---|---|---|---|---|
| | **SM 321; DI 16 x DC24V High Speed** | **SM 321; DI 16 x DC24V with process and diagnostic interrupts** | **SM 321; DI 16 x DC 24V/125V with process and diagnostic interrupts** | **SM 321; DI 16 x DC24V; source input** | **SM 321; DI 16 x UC24/48V** |
| | **(-1BH10-)** | **(-7BH01-)** | **(-7EH00-)** | **(-1BH50-)** | **(-1CH00-)** |
| Number of inputs | 16 DI; electrically isolated in groups of 16 | 16 DI; electrically isolated in groups of 16 | 16 DI; isolated in groups of 16 | 16 DI, source input, electrically isolated in groups of 16 | 16 DI; isolated in groups of 1 |
| Rated input voltage | 24 VDC | 24 VDC | 24 VDC - 125 VDC | 24 VDC | 24 VDC to 48 VDC<br>24 VAC to 48 VAC |
| Suitable for... | Switches;<br>2-wire, 3-wire and 4-wire proximity switches (BEROs) | | | | |
| Supports isochronous mode | Yes | Yes | No | No | No |
| Programmable diagnostics | No | Yes | Yes | No | No |
| Diagnostic interrupt | No | Yes | Yes | No | No |
| Edge-triggered hardware interrupt | No | Yes | Yes | No | No |
| Adjustable input delays | No | Yes | Yes | No | No |
| Special features | Fast module; especially for isochronous mode | 2 short-circuit-proof sensor supplies for 8 channels each;<br>External redundant sensor supply is supported | --- | --- | --- |



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Table 3- 3 Digital input modules (continued)

| Properties | Module | | | | |
|---|---|---|---|---|---|
| | SM 321; DI 16 x DC48-125V | SM 321; DI 16 x AC120/230 V | SM 321; DI 16 x NAMUR | SM 321; DI 8 x AC 120/230V | SM 321; DI 8 x AC 120/230 V ISOL |
| | **(-1CH20-)** | **(-1FH00-)** | **(-7TH00-) *** | **(-1FF01-)** | **(-1FF10-)** |
| Number of inputs | 16 DI; isolated in groups of 4 | 16 DI; isolated in groups of 4 | 16 DI; isolated in groups of 2 | 8 DI; isolated in groups of 2 | 8 DI; isolated in groups of 2 |
| Rated input voltage | 120/230 VAC | 120/230 VAC | 24 VDC | 120/230 VAC | 120/230 VAC |
| Suitable for... | Switches; 2-wire, 3-wire and 4-wire proximity switches (BEROs) | Switches; 2-wire / 3-wire AC proximity switches | NAMUR encoder | Switches; 2-wire / 3-wire AC proximity switches | |
| Supports isochronous mode | No | No | No | No | No |
| Programmable diagnostics | No | No | No | No | No |
| Diagnostic interrupt | No | No | Yes | No | No |
| Edge-triggered hardware interrupt | No | No | No | No | No |
| Adjustable input delays | No | No | No | No | No |
| Special features | --- | --- | Module with single channel diagnostics and extensive control functions | --- | --- |

* This module is described in the ET 200M Signal Modules for Process Automation manual. You can find the manual on the Internet (http://support.automation.siemens.com/WW/view/en/7215812).



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## 3.1.2 Digital output modules

### Overview of properties

The table below shows the essential properties of the digital output modules

Table 3- 4 Digital output modules

| Properties | Module | | | | |
|---|---|---|---|---|---|
| | **SM 322; DO 64 x DC24V/0,3A Sourcing (-1BP00-)** | **SM 322; DO 64 x DC 24V/0,3A Sinking (-1BP50-)** | **SM 322; DO 32 x DC24V/0,5A (-1BL00-)** | **SM 322; DO 32 x AC120/230V/1A (-1FL00-)** | **SM 322; DO 16 x DC24V/0,5A (-1BH01-)** |
| Number of outputs | 64 DO; isolated in groups of 16 | 64 DO; isolated in groups of 16 | 32 DO; isolated in groups of 8 | 32 DO; isolated in groups of 8 | 16 DO; isolated in groups of 8 |
| Output current | 0.3 A | 0.3 A | 0.5 A | 1.0 A | 0.5 A |
| Rated load voltage | 24 V DC | 24 V DC | 24 V DC | 24 V DC | 24 V DC |
| Suitable for... | solenoid valves, DC contactors and signal lamps | | | | |
| Supports isochro-nous mode | no | no | No | No | No |
| Programmable diagnostics | No | No | No | No | no |
| Diagnostic interrupt | No | No | No | No | No |
| Substitute value output | No | No | No | No | No |
| Special features | - | | | | |



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Table 3- 5 Digital output modules (continued)

| Properties | Module | | | | |
|---|---|---|---|---|---|
| | **SM 322; DO 16 x DC24V/0,5A High Speed (-1BH10-)** | **SM 322; DO 16 x UC24/48 V (-5GH00-)** | **SM 322; DO 16 x AC120/230V/1A (-1FH00-)** | **SM 322; DO 16 x DC24V/0,5A (-8BH00-)* (-8BH01-) * (-8BH10-)** | **SM 322; DO 8 x DC24V/2A (-1BF01-)** |
| Number of outputs | 16 DO; isolated in groups of 8 | 16 DO; isolated in groups of 1 | 16 DO; isolated in groups of 8 | 16 DO; isolated in groups of 4 | 8 DO; isolated in groups of 4 |
| Output current | 0.5 A | 0.5 A | 1 A | 0.5 A | 2 A |
| Rated load voltage | 24 V DC | 24 to 48 V DC<br>24 to 48 V AC | 120/230 V AC | 24 V DC | 24 V DC |
| Suitable for... | solenoid valves, DC contactors and signal lamps | | | | |
| Supports isochronous mode | Yes | no | no | no | no |
| Programmable diagnostics | No | Yes | no | yes | no |
| Diagnostic interrupt | no | Yes | No | Yes | No |
| Substitute value output | | | | Yes | No |
| Special features | Fast module; especially for isochronous mode | - | - | Redundant load control is supported; extensive control functions | - |



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Table 3- 6 Digital output modules (continued)

| Properties | Module | | | |
|---|---|---|---|---|
| | **SM 322; DO 8 x DC24V/0,5A with diagnostics interrupt (-8BF00-)** | **SM 322; DO 8 x DC48-125V/1,5A (-1CF00-)** | **SM 322; DO 8 x AC120/230 V/2A (-1FF01-)** | **SM 322;DO 8 x AC120/230 V/ 2A ISOL (-5FF00-)** |
| Number of outputs | 8 DO; isolated in groups of 8 | 8 DO; electrically isolated in groups of 4, with reverse polarity protection | 8 DO; isolated in groups of 4 | 8 DO; isolated in groups of 1 |
| Output current | 0.5 A | 1.5 A | 2 A | 2 A |
| Rated load voltage | 24 V DC | 48 to 125 V DC | 120/230 V AC | 120/230 V AC |
| Suitable for... | solenoid valves, DC contactors and signal lamps | | AC solenoid valves, contactors, motor starters, FHP motors and signal lamps. | |
| Supports isochronous mode | No | No | No | No |
| Programmable diagnostics | Yes | No | no | yes |
| Diagnostic interrupt | Yes | No | no | yes |
| Substitute value output | Yes | No | no | yes |
| Special features | Redundant load control is supported | - | Fuse blown display. Replaceable fuse for each group | - |

* This module is described in the ET 200M Signal Modules for Process Automation manual. You can find the manual on the Internet (http://support.automation.siemens.com/WW/view/en/7215812).



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## 3.1.3 Relay output modules

### Overview of properties

The table below shows the essential properties relay output modules

Table 3- 7 Relay output modules

| Properties | Module | | | |
|---|---|---|---|---|
| | SM 322; DO 16 x Rel. AC 120 V (-1HH01-) | SM 322; DO 8 x Rel. AC 230 V (-1HF01-) | SM 322; DO 8 x Rel. AC 230 V/ 5 A (-5HF00-) | SM 322; DO 8 x Rel. AC 230 V/ 5 A (-1HF10-) |
| Number of outputs | 16 outputs, electrically isolated in groups of 8 | 8 outputs, electrically isolated in groups of 2 | 8 outputs, electrically isolated in groups of 1 | 8 outputs, electrically isolated in groups of 1 |
| Rated load voltage | 24 VDC to 120 VDC, 48 VAC to 230 VAC | 24 VDC to 120 VDC, 48 VAC to 230 VAC | 24 VDC to 120 VDC, 24 VAC to 230 VAC | 24 VDC to 120 VDC, 48 VAC to 230 VAC |
| Suitable for... | AC/DC solenoid valves, contactors, motor starters, FHP motors and signal lamps | | | |
| Supports isochronous mode | no | no | no | no |
| Programmable diagnostics function | no | no | yes | no |
| Diagnostics interrupt | no | no | yes | no |
| Substitution value output | no | no | yes | no |
| Special features | - | | | |



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## 3.1.4 Digital IO modules

### Overview of properties

The table below shows the essential properties of digital IO modules

Table 3- 8 Digital IO modules

| Properties | Module | | |
|---|---|---|---|
| | **SM 323; DI 16/DO 16 x DC 24 V/ 0,5 A (-1BL00-)** | **SM 323; DI 8/DO 8 x DC 24 V/0,5 A (-1BH01-)** | **SM 327; DI 8/DX 8 x DC 24 V/0,5 A, Programmable (-1BH00-)** |
| Number of inputs | 16 inputs, electrically isolated in groups of 16 | 8 inputs, electrically isolated in groups of 8 | 8 digital inputs, plus 8 separately programmable inputs/outputs, electrically isolated in groups of 16 |
| Number of outputs | 16 outputs, electrically isolated in groups of 8 | 8 outputs, electrically isolated in groups of 8 | |
| Rated input voltage | 24 VDC | 24 VDC | 24 VDC |
| Output current | 0.5 A | 0.5 A | 0.5 A |
| Rated load voltage | 24 VDC | 24 VDC | 24 VDC |
| Inputs suitable for... | Switches and 2-/3-/4-wire proximity switches (BEROs). | | |
| Outputs suitable for... | solenoid valves, DC contactors and signal lamps | | |
| Supports isochronous mode | no | no | no |
| Programmable diagnostics | no | no | no |
| Diagnostic interrupt | no | no | no |
| Edge-triggered hardware interrupt | no | no | no |
| Programmable input delay | no | no | no |
| Substitution value output | no | no | no |
| Special features | - | | 8 individually configurable input or outputs;<br>Reading back of inputs is possible, for example, for diagnoses |



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# 3.2 Steps in selecting and commissioning the digital module

## Introduction

The table below contains the steps required to successfully complete commission of digital modules.

You do not strictly have to adhere to this suggested sequence, that is, you can complete other tasks such as installing or commissioning other modules, or program the module at an earlier or later time.

## Step sequence

Table 3- 9 Steps in selecting and commissioning the digital module

| Step | Procedure | See... |
|---|---|---|
| 1. | Selecting the module | Chapter Modules overview (Page 49)and the specific module chapter |
| 2. | Installing the module in the SIMATIC S7 system | *Installation* chapter in the relevant AS Installation Manual:<br>• S7-300 Automation System, Hardware and Installation, or S7-400 / M7-400 Automation System, Hardware and Installation<br>or<br>• Distributed I/O Device ET 200M |
| 3. | Assigning module parameters | Chapter Diagnostics of digital modules (Page 59) |
| 4. | Commission the configuration | *Commissioning* chapter in the relevant installation manual:of the AS used:<br>• S7-300 Automation System, Hardware and Installation, or S7-400 / M7-400 Automation System, Hardware and Installation<br>or<br>• ET 200M distributed I/O device |
| 5. | Analysis the configuration if commissioning was not successful. | Chapter Diagnostics of digital modules (Page 59) |

## See also

Programming digital modules (Page 58)

Parameters of digital output modules (Page 528)

Module overview (Page 49)



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# 3.3 Programming digital modules

## Introduction

Digital modules may have different properties. You can program the properties of certain modules.

All information in this chapter applies only to programmable digital modules:

- Digital input module SM 321; DI 16 x DC 24 V with process and diagnostic interrupts, isochronous; (6ES7321-7BH01-0AB0)
- Digital input module SM 321; DI 16 x DC 24 V/125 V with process and diagnostic interrupts (6ES7321-7EH00-0AB0)
- Digital output module SM 322; DO 16 x DC 24 V/0,5 A (6ES7322-8BH10-0AB0)
- Digital output module SM 322; DO 8 x DC 24 V/0,5 A with diagnostic interrupt (6ES7322-8BF00-0AB0)
- Digital output module SM 322; DO 8 x AC120/230 V /2A ISOL (6ES7322-5FF00-0AB0)
- Digital output module SM 322; DO 8 x Rel. AC230V /5A (6ES7322-5HF00-0AB0)
- Digital input/output module SM 327; DI 8/DO 8 x DC 24 V/0,5 A (6ES7327-1BH00-0AB0)

## Programming tools

Only program the digital modules in STEP 7 while the CPU is in STOP.

After you defined all parameters, download these from your PG to the CPU. During its STOP → RUN transition, the CPU transfers the parameters to the relevant digital modules.

## Static and dynamic parameters

Parameters are organized by static and dynamic properties.

Set the static parameters while the CPU is in STOP, as described earlier.

You may also edit dynamic parameters in the active user program of an S7 PLC using SFCs. However, the parameters set in STEP 7 will be applied again after a RUN → STOP, STOP → RUN transition of the CPU. The appendix Parameter sets of the signal modules (Page 522) describes the assignment of module parameters in the user program.

| Parameters | programmable using | CPU operating state |
|---|---|---|
| static | PG (STEP 7 HW CONFIG) | STOP |
| dynamic | PG (STEP 7 HW CONFIG) | STOP |
| | SFC55 in the user program | RUN |

## Parameters of digital modules

Information on programmable parameters is available in the module-specific chapter.

## See also

Parameters of digital IO modules (Page 524)



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# 3.4 Diagnostics of digital modules

## Introduction

The information provided in this chapter applies only to S7-300 digital modules with diagnostics functions.

- Digital input module SM 321; DI 16 x DC 24 V with process and diagnostic interrupts, isochronous; (6ES7321-7BH01-0AB0)
- Digital input module SM 321; DI 16 x DC 24 V/125 V with process and diagnostic interrupts (6ES7321-7EH00-0AB0)
- Digital output module SM 322; DO 16 × UC 24/48 V (6ES7322-5GH00-0AB0)
- Digital output module SM 322; DO 16 x DC 24 V/0,5 A (6ES7322-8BH10-0AB0)
- Digital output module SM 322; DO 8 x DC 24 V/0,5 A with diagnostic interrupt (6ES7322-8BF00-0AB0)
- Digital output module SM 322; DO 8 x AC120/230 V /2A ISOL (6ES7322-5FF00-0AB0)
- Digital output module SM 322; DO 8 x Rel. AC230V /5A (6ES7322-5HF00-0AB0)

## Programmable and non-programmable diagnostics messages

We distinguish between programmable and non-programmable diagnostics messages.

You only obtain programmable diagnostics messages if you have enabled diagnostics at the relevant parameters. Program the "Diagnostics" parameter block in STEP 7.

Digital modules always return non-programmable diagnostics messages, irrespective of diagnostics being enabled.

## Reactions to diagnostics message in STEP 7

Actions initiated by diagnostics messages:

- The diagnostics message will be entered in the diagnostics data of the digital module, and is then passed to the CPU.
- The SF LED on the digital module is lit.
- When "Enable Diagnostics Interrupt" is set in STEP 7, the system triggers a diagnostics interrupt and calls OB82.

## Reading diagnostics messages

You can read detailed diagnostics messages using SFCs in the user program (refer to the appendix Diagnostics data of signal modules (Page 583)).

In STEP 7, you can view the cause of error by reading the module diagnostics data (refer to the STEP 7 Online Help.)



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## Diagnostics message using the SF LED

Digital modules with diagnostics function indicate errors at their SF LED (group error LED.) The SF LED lights up when the digital module generates a diagnostics message. It goes dark after all error states are cleared.

The SF LED also lights up to indicate external errors (short-circuit at the sensor supply), regardless of the CPU operating state (at POWER ON.)

## Diagnostics messages and interrupt processing of digital modules

For information on diagnostics messages, their possible causes, troubleshooting measures, and possible interrupts refer to the specific module chapter.



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# 3.5 How to protect digital modules from inductive overvoltage

## Inductive overvoltage

Overvoltage occurs when an inductance is deactivated. Examples of this are relay coils and contactors.

## Integrated overvoltage protection

The digital output modules of S7-300 have integrated overvoltage protection equipment.

## Extra overvoltage protection

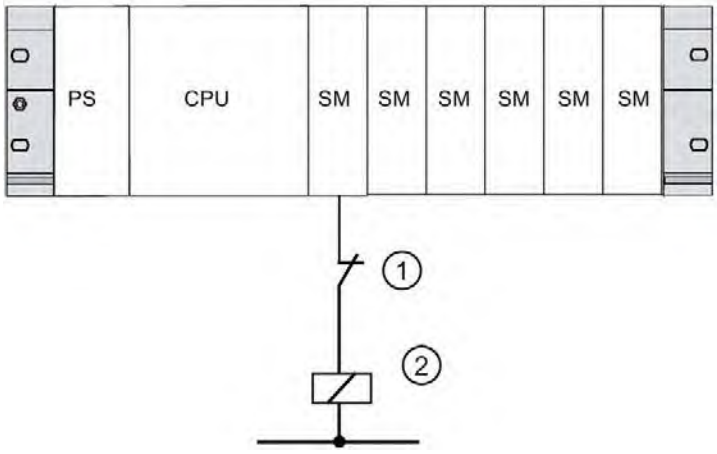
Inductances should only be configured with extra overvoltage protection equipment in the following instances:

- If SIMATIC output current circuits can be deactivated by extra fitted contacts (e.g. relay contacts).
- If the inductive reactances are not activated by SIMATIC modules.

Note: Ask the suppliers of inductive reactances what size of overvoltage protection equipment should be used.

## Example

The following diagram shows an output current circuit which make extra overvoltage protection equipment necessary.




① Contact in output current circuit
② Inductive reactance needs a protective circuit

Figure 3-1 Relay contact for emergency stop in output current circuit



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## Configuration of coils operated with direct current

Coils operated with direct current are shown in the following diagram and configured with diodes or Z diodes.




① with diode
② with Z diode

Figure 3-2 Configuration of coils operated with direct current

Properties of the diode/Z diode circuit:

- Cut-off currents can be avoided. Z diode withstands a higher cut-off voltage.
- High cut-off delay (6 to 9 times higher compared to non-protective cid´rcuits).

Faster cut-off of the Zener diode compared to the diode circuit.

## Connection of AC-operated coils

The operation of AC coils with varistors or RC elements is shown in the diagram.




① with varistor
② with RC element

Figure 3-3 Connection of AC-operated coils

Properties of a circuit with varistor:

- The amplitude of the cut-off current is limited but not attenuated.
- The steepness of the overvoltage remains the same.
- Low cut-off delay.

Properties of acircuit with RC elements:

- Reduction of the amplitude and steepness of the cut-off current.
- Low cut-off delay.



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# 3.6 Digital input module SM 321; DI 64 x DC 24 V, sinking/sourcing; (6ES7321-1BP00-0AA0)

## Order number

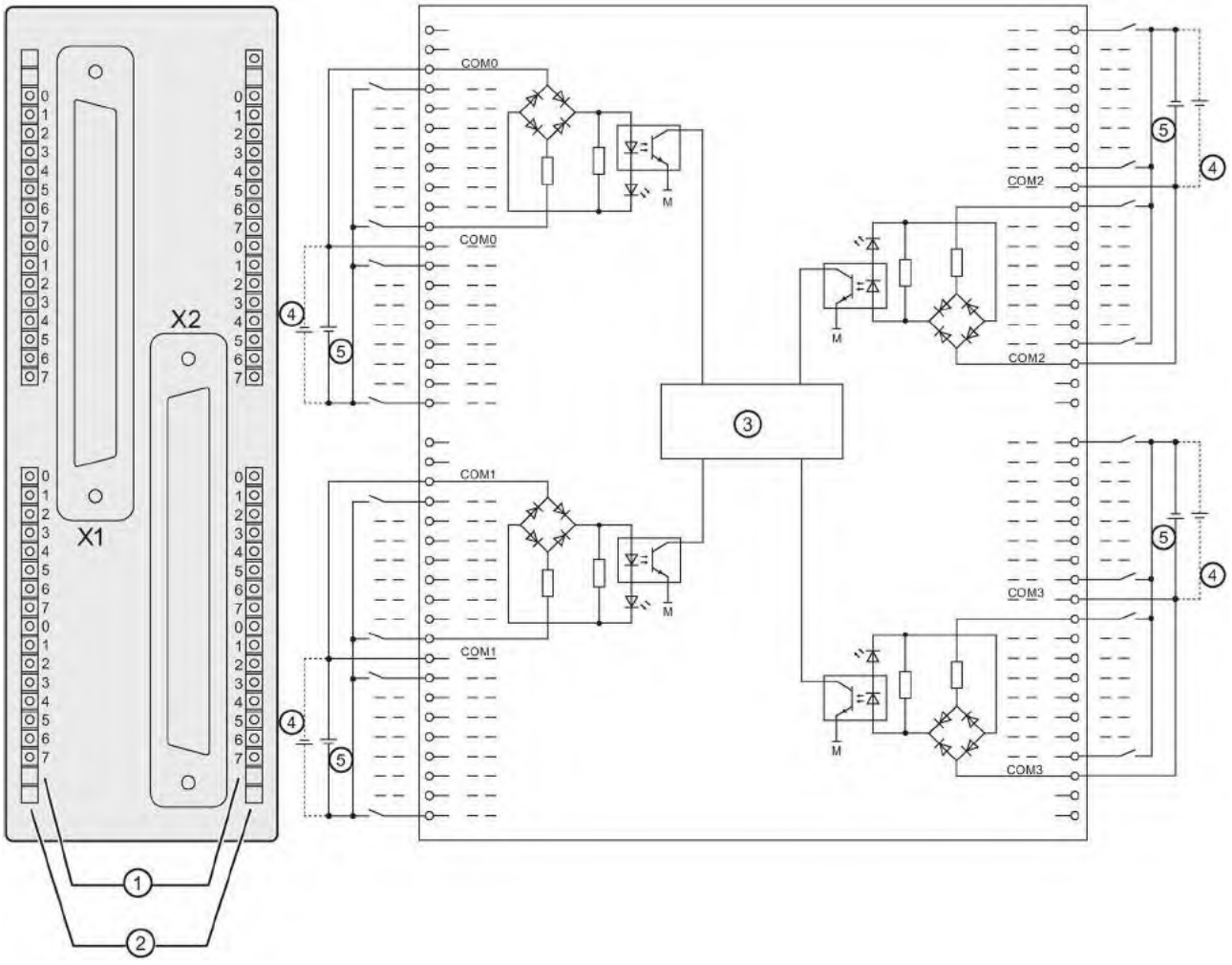
6ES7321-1BP00-0AA0

## Properties

Properties of SM 321; DI 64 x DC 24 V, Sinking/Sourcing:

- 64 inputs, isolated in 4 groups of 16
- Rated input voltage 24 V DC

## Wiring and block diagram of SM 321; DI 64 x DC 24 V, Sinking/Sourcing



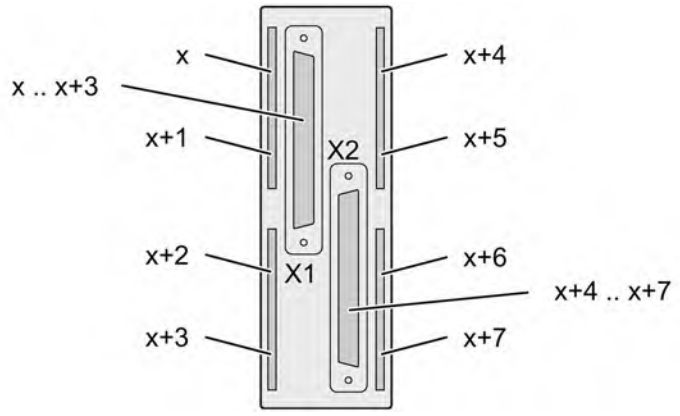

① Channel number
② Status display - green
③ Backplane bus interface
④ Terminal for "sinking" operating mode
⑤ Terminal for "sourcing" operating mode



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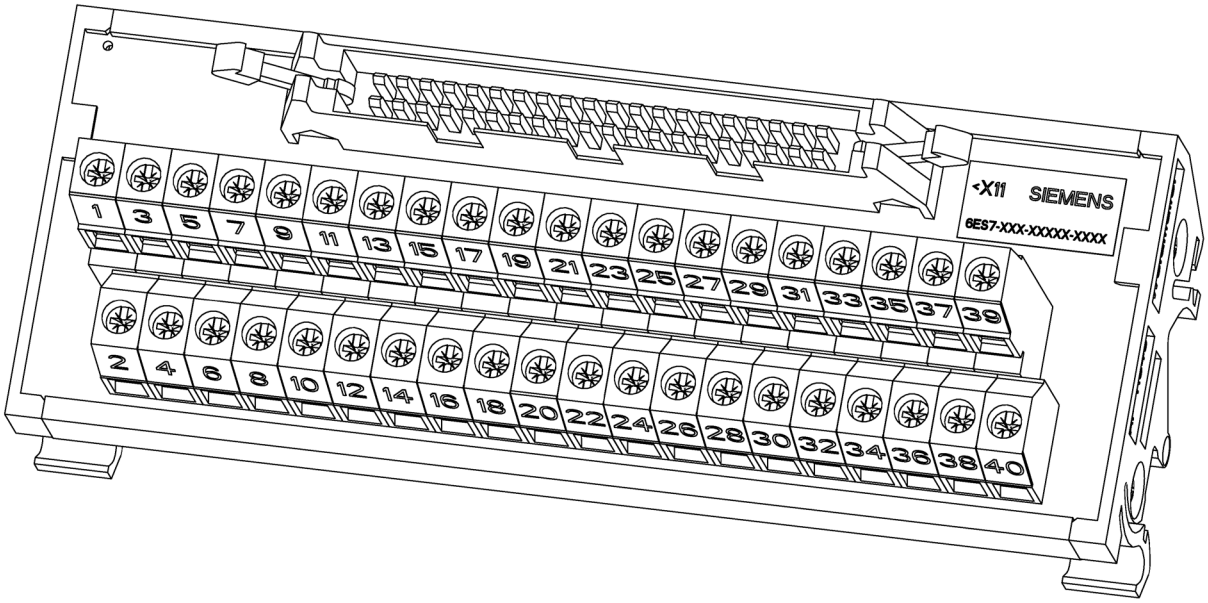
## Terminal assignment of SM 321; DI 64 x DC 24 V, Sinking/Sourcing

The figure below shows how channels are assigned to addresses (input byte x up to input byte x+7).




## 40-pin terminal block

SM321; DI 64 X DC 24 V Sinking/Sourcing features two terminal blocks for connecting actuators and sensors to the module front connector. A connecting cable is used to establish the module connections.






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The table below shows how channel terminals are assigned to the terminal block for module SM321; DI 64 X DC 24 V Sinking/Sourcing.

| Terminal | Function | | Terminal | Function |
|---|---|---|---|---|
| 1 | I x.0 | | 2 | I x+2.0 |
| 3 | I x.1 | | 4 | I x+2.1 |
| 5 | I x.2 | | 6 | I x+2.2 |
| 7 | I x.3 | | 8 | I x+2.3 |
| 9 | I x.4 | | 10 | I x+2.4 |
| 11 | I x.5 | | 12 | I x+2.5 |
| 13 | I x.6 | | 14 | I x+2.6 |
| 15 | I x.7 | | 16 | I x+2.7 |
| 17 | COM 0 | | 18 | COM 1 |
| 19 | I x+1.0 | | 20 | I x+3.0 |
| 21 | I x+1.1 | | 22 | I x+3.1 |
| 23 | I x+1.2 | | 24 | I x+3.2 |
| 25 | I x+1.3 | | 26 | I x+3.3 |
| 27 | I x+1.4 | | 28 | I x+3.4 |
| 29 | I x+1.5 | | 30 | I x+3.5 |
| 31 | I x+1.6 | | 32 | I x+3.6 |
| 33 | I x+1.7 | | 34 | I x+3.7 |
| 35 | COM 0 | | 36 | COM 1 |
| 37 | Not connected | | 38 | Not connected |
| 39 | Not connected | | 40 | Not connected |

**Note**

The COM x terminals must be connected on the terminal block.



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## Technical specifications of SM 321; DI 64 x DC 24 V, Sinking/Sourcing

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions (W x H x D) (mm) | 40 x 125 x 112 (including protective barrier, required for connections which are not in use) |
| Weight | ca. 230 g |
| **Module-specific data** | |
| Supports isochronous mode | No |
| Number of inputs | 64 |
| Cable length<br>• Unshielded<br>• Shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Number of simultaneously controlled inputs<br>• Horizontal installation<br>to 40 °C<br>to 60 °C<br>• Vertical installation<br>to 40 °C | 64<br>32 (50% derating per group)<br><br>32 (50% derating per group) |
| Electrical isolation<br>• between channels and the backplane bus<br>• Between channels<br>in groups of | <br>Yes<br>Yes<br>16 |
| Isolation test voltage | 500 VDC |
| Current consumption<br>• from the backplane bus | <br>Max. <100 mA |
| Power loss of the module | Typ. 7 W |
| **Status, interrupts, diagnostics** | |
| Status display | Green LED (per channel) |
| Interrupts | none |
| Diagnostic functions | none |



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| Technical specifications | |
|---|---|
| **Encoder selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal | <br>24 V DC<br>-13 V to -30 V, 13 V to 30 V<br>- 5 V to + 5 V |
| Input current<br>• "1" signal | <br>Typ. 4.2 mA |
| Input delay<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>1.2 ms to 4.8 ms<br>1.2 ms to 4.8 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs | not supported |
| Input type | Sinking/sourcing input |
| Wiring of the signal transmitters | Two 40-pin terminal blocks |

## STEP 7 integration

64-channel I/O modules are integrated with the HSP 2019 V 1.0. The HSP forms part of STEP 7 V 5.4 SP2 and can be installed from STEP 7 V 5.4 and higher.

## GSD/GSDML files

The 64-channel I/O modules are supported by the ET 200M versions listed below. Download the corresponding GSD/GSDML files from the following link: on the Internet (http://www.siemens.com/automation/service).

- To search for PROFIBUS GSD files, type in the entry ID 113498.
- To search for PROFINET GSDML files, type in the entry ID: 25057900.

## PROFIBUS

- IM 153-1, as of 6ES7153-1AA03-0XB0, E12 with GSD file SI01801D.*, version V 1.5
- IM 153-2, as of 6ES7153-2BA02-0XB0, E01 with GSD file SI04801E.*, version V 1.0

## PROFINET

- IM 153-4 PN, as of 6ES7153-4AA00-0XB0 with GSDML file version V 2.1



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## Using the module in S7-300 and ET 200M

If the station is configured with STEP 7, you can use the SM 321 digital input module with all CPUs in the following tables. Startup cannot be performed if no configuration is loaded.

| C-CPUs (compact CPUs) | Order number |
|---|---|
| CPU 312C | 6ES7312-5BD0x-0AB0 |
| | 6ES7312-5BE03-0AB0 |
| | 6ES7312-5BF04-0AB0 |
| CPU 313C | 6ES7313-5BE0x-0AB0 |
| | 6ES7313-5BF03-0AB0 |
| | 6ES7313-5BG04-0AB0 |
| CPU 313C-2 DP | 6ES7313-6CE0x-0AB0 |
| | 6ES7313-6CF03-0AB0 |
| | 6ES7313-6CG04-0AB0 |
| CPU313C-2 PtP | 6ES7313-6BE0x-0AB0 |
| | 6ES7313-6BF03-0AB0 |
| | 6ES7313-6BG04-0AB0 |
| CPU 314C-2 DP | 6ES7314-6CF0x-0AB0 |
| | 6ES7314-6CG03-0AB0 |
| | 6ES7314-6CH04-0AB0 |
| CPU 314C-2 PtP | 6ES7314-6BF0x--0AB0 |
| | 6ES7314-6BG03--0AB0 |
| | 6ES7314-6BH04-0AB0 |
| CPU314C-2 PN/DP | 6ES7314-6EH04-0AB0 |

| M-CPUs | Order number |
|---|---|
| CPU 312 | 6ES7312-1AD1x-0AB0 |
| | 6ES7312-1AE13-0AB0 |
| | 6ES7312-1AE14-0AB0 |
| CPU 314 | 6ES7314-1AF1x-0AB0 |
| | 6ES7314-1AG13-0AB0 |
| | 6ES7314-1AG14-0AB0 |
| CPU 315-2 DP | 6ES7315-2AF0x-0AB0 |
| | 6ES7315-2AG10-0AB0 |
| | 6ES7315-2AH14-0AB0 |
| CPU 316-2 DP | 6ES7316-2AG00-0AB0 |
| CPU 317-2 DP | 6ES7317-2AJ10-0AB0 |
| | 6ES7317-2AK14-0AB0 |
| CPU 315-2 PN/DP | 6ES7315-2EG10-0AB0 |
| | 6ES7315-2EH13-0AB0 |
| | 6ES7315-2EH14-0AB0 |
| CPU 317-2 PN/DP | 6ES7317-2EJ10-0AB0 |
| | 6ES7317-2EK13-0AB0 |
| | 6ES7317-2EK14-0AB0 |
| CPU 319-3 PN/DP | 6ES7318-3EL00-0AB0 |
| | 6ES7318-3EL01-0AB0 |



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| F-CPUs | Order number |
|---|---|
| CPU 315F-2 DP | 6ES7315-6FF0x-0AB0 |
| CPU 317F-2 DP | 6ES7317-6FF0x-0AB0 |
| CPU 315F-2 PN/DP | 6ES7315-2FH1x-0AB0 |
| | 6ES7315-2FJ14-0AB0 |
| CPU 317F-2 PN/DP | 6ES7317-2FJ10-0AB0 |
| | 6ES7317-2FK13-0AB0 |
| | 6ES7317-2FK14-0AB0 |
| CPU 319F-3 PN/DP | 6ES7318-3FL00-0AB0 |
| | 6ES7318-3FL01-0AB0 |

| T-CPUs | Order number |
|---|---|
| CPU 315T-2 DP | 6ES7315-6TG10-0AB0 |
| CPU315T-3 PN/DP | 6ES7315-7TJ10-0AB0 |
| CPU 317T-2 DP | 6ES7317-6TJ10-0AB0 |
| CPU317TF-2 DP | 6ES7317-6TF14-0AB0 |
| CPU317T-3 PN/DP | 6ES7317-7TK10-0AB0 |
| CPU317TF-3 PN/DP | 6ES7317-7UL10-0AB0 |

| C7-CPUs | Order number |
|---|---|
| C7-613 | 6ES7613-1CA01-0AE3 |
| C7-635 Touch | 6ES7635-2EB01-0AE3 |
| C7-635 Key | 6ES7635-2EC01-0AE3 |
| C7-636 Touch | 6ES7636-2EB00-0AE3 |
| C7-636 Key | 6ES7636-2EC00-0AE3 |

**WARNING**

**Use of the module**

This module must be configured in a STEP 7 project in which the correct address assignment and allocation of the input/output point is ensured. Using the module without having first carried out this configuration work can lead to machines or processes operating in an unexpected manner.

If machines or processes do run in an unexpected manner, this can result in death, serious injury, and/or material damage.



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# 3.7 Digital input module SM 321; DI 32 x DC 24 V; (6ES7321-1BL00-0AA0)

### Order number: "Standard module"

6ES7321-1BL00-0AA0

### Order number: "SIPLUS S7-300 module"

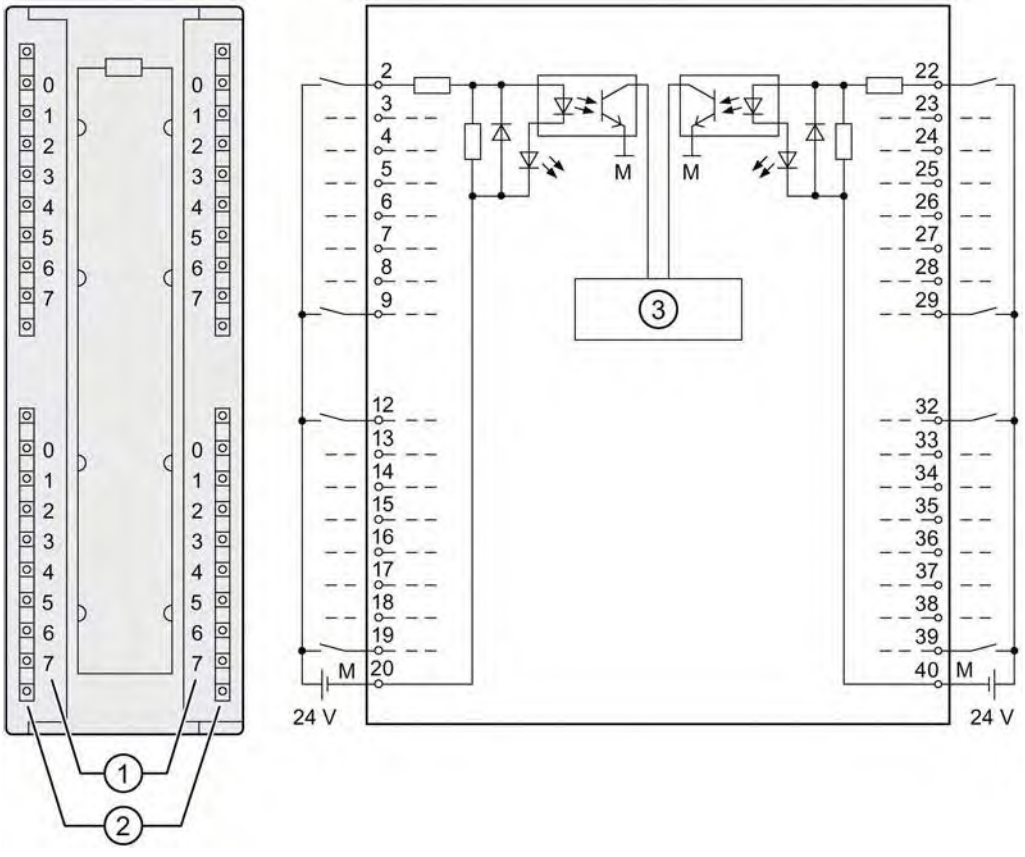
6AG1321-1BL00-2AA0

### Properties

Properties of SM 321; DI 32 x DC 24 V:

- 32 inputs, isolated in groups of 16
- Rated input voltage 24 V DC
- Suitable for switches and 2-/3-/4-wire proximity switches (BEROs)

### Wiring and block diagram of SM 321; DI 32 x DC 24 V



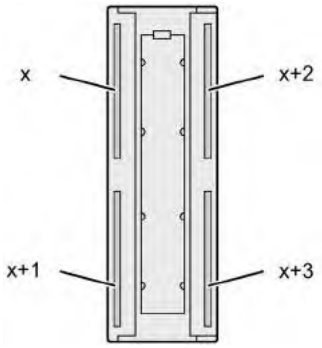

① Channel number
② Status display - green
③ Backplane bus interface



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## Terminal assignment of SM 321; DI 32 x DC 24 V

The figure below shows how channels are assigned to addresses (input byte x up to input byte x+3).




## Technical specifications of SM 321; DI 32 x DC 24 V

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 120 |
| Weight | ca. 260 g |
| **Module-specific data** | |
| Supports isochronous mode | No |
| Number of inputs | 32 |
| Cable length<br>• Unshielded<br>• Shielded | <br>Max. 600 m<br>Max. 1000 m |
| Front connector | 40-pin |
| **Voltages, currents, potentials** | |
| Number of simultaneously controlled inputs<br>• Horizontal mounting position<br>to 40 °C<br>to 60 °C<br>• Vertical arrangement<br>to 40 °C | <br><br>32<br>16<br>32 |
| Electrical isolation<br>• between channels and the backplane bus<br>• Between channels<br>– in groups of | <br>yes<br>Yes<br>16 |
| Isolation test voltage | 500 V DC |



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| **Technical specifications** | |
|---|---|
| Current consumption<br>• From the backplane bus | <br>Max. 15 mA |
| Power loss of the module | Typ. 6.5 W |
| **Status, interrupts, diagnostics** | |
| Status display | Green LED per channel |
| Interrupts | None |
| Diagnostic functions | None |
| **Encoder selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal | <br>24 V DC<br>13 to 30 V<br>- 30 to + 5 V |
| Input current<br>• "1" signal | <br>Typ. 7 mA |
| Input delay<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>1.2 ms to 4.8 ms<br>1.2 ms to 4.8 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | Supported<br>Max. 1.5 mA |
| Connection of the signal transmitters | Using a 40-pin front connector |



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# 3.8 Digital output module SM 321; DI 32 x AC 120 V; (6ES7321-1EL00-0AA0)

## Order number

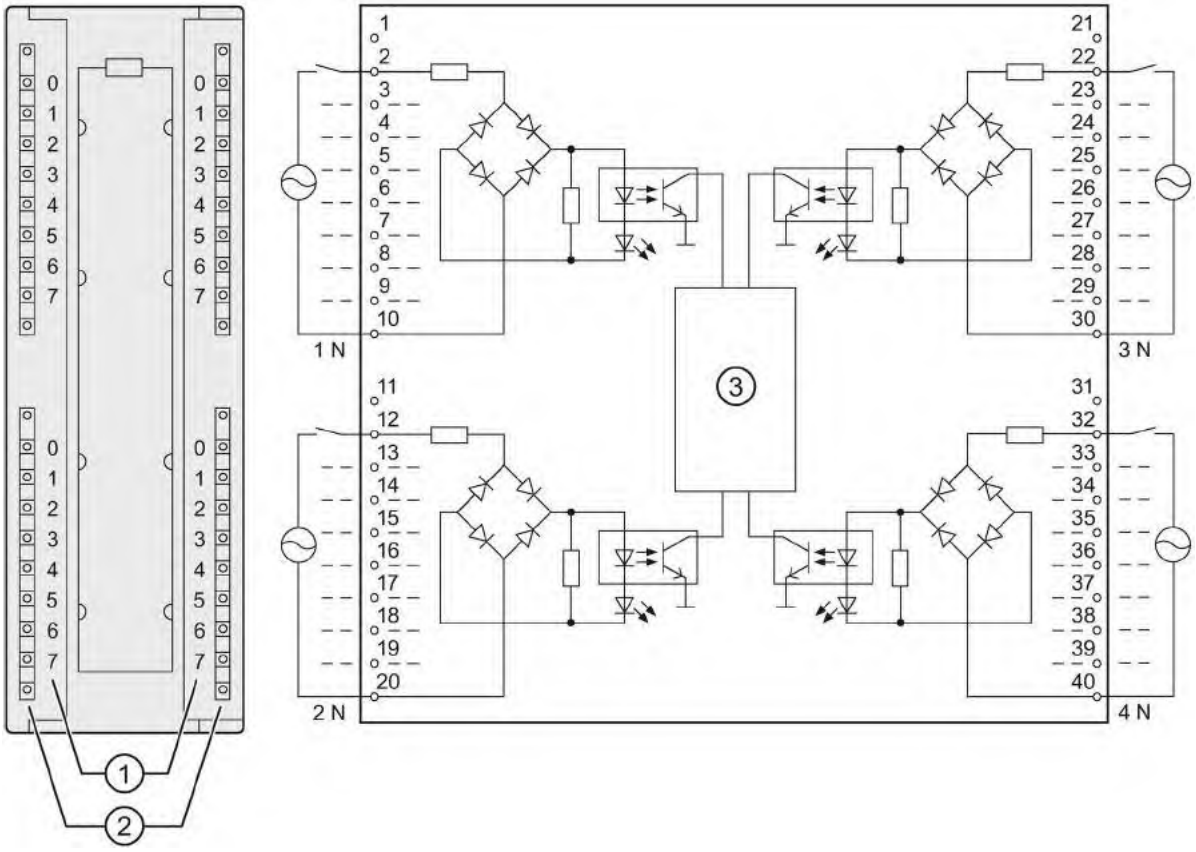
6ES7321-1EL00-0AA0

## Properties

Properties of SM 321; DI 32 x AC 120 V:

- 32 inputs, electrically isolated in groups of 8
- Rated input voltage 120 VAC
- Suitable for switches and 2-/3-wire AC proximity switches

## Wiring and block diagrams SM 321; DI 32 x AC 120 V



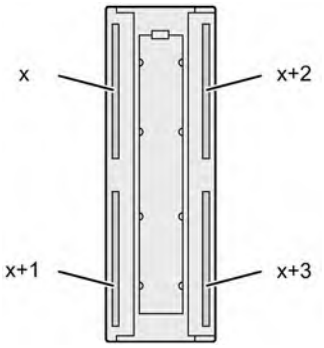

① Channel number
② Status display - green
③ Backplane bus interface



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## Terminal assignment

The figure below shows the channel addressing (input byte x up to input byte x +3).




## Technical specifications of SM 321; DI 32 x AC 120 V

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 300 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of inputs | 32 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Number of simultaneously controlled inputs | |
| • horizontal mounting position<br>to 40 °C<br>to 60 °C | <br>32<br>24 |
| • vertical mounting position<br>to 40 °C | <br>32 |
| Electrical isolation<br>• between channels and the backplane bus | <br>yes |
| • between channels<br>in groups of | yes<br>8 |
| Maximum potential difference | |
| • between $M_{internal}$ and inputs | 120 VAC |
| • between inputs of different groups | 250 VAC |
| Isolation test voltage | 2500 VDC |



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| **Technical specifications** | |
|---|---|
| Current consumption<br>• from the backplane bus | <br>max. 16 mA |
| Power loss of the module | typ. 4 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |
| **Transducer selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal<br>• Frequency band | <br>120 VAC<br>74 V to 132 V<br>0 V to 20 V<br>47 Hz to 63 Hz |
| Input current<br>• "1" signal | <br>typ. 21 mA |
| Input delay<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>max. 15 ms<br>max. 25 ms |
| Input characteristics | to IEC 61131, type 2 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 4 mA |
| Wiring the signal transducers | using a 40pin front connector |



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# 3.9 Digital input module SM 321; DI 16 x DC 24 V; (6ES7321-1BH02-0AA0)

## Order number: "Standard module"

6ES7321-1BH02-0AA0

## Order number: "SIPLUS S7-300 module"

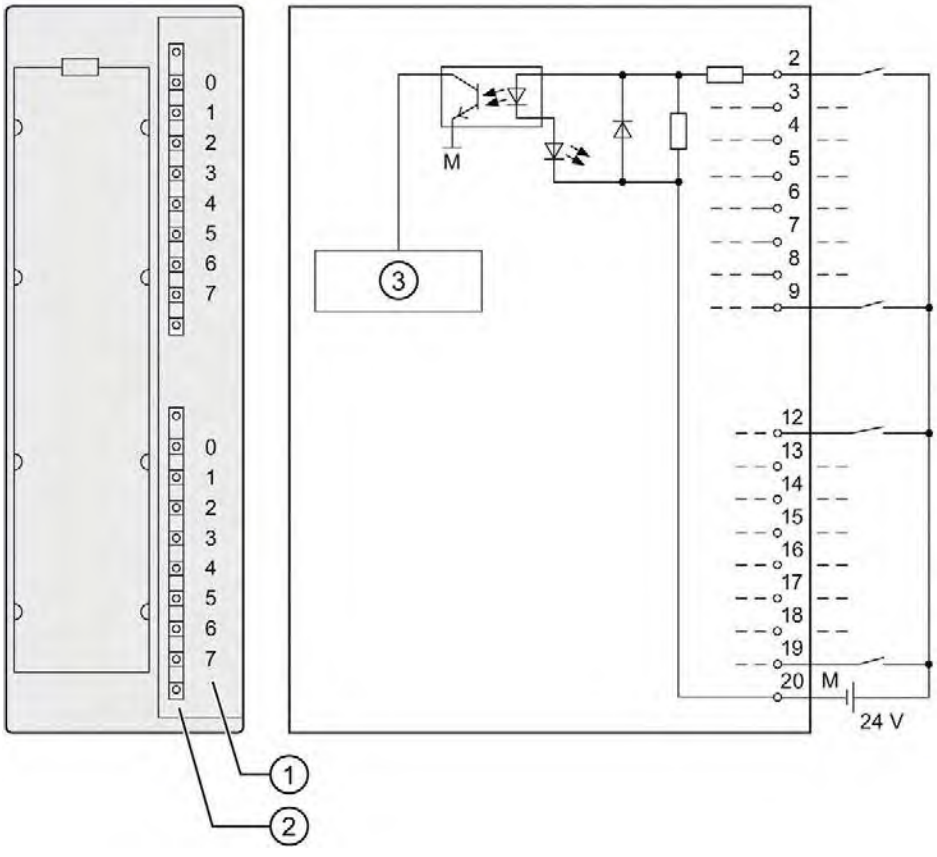
6AG1321-1BH02-2AA0

## Properties

Properties of SM 321; DI 16 x DC 24 V:

- 16 inputs, electrically isolated in groups of 16
- Rated input voltage 24 V DC
- suitable for switches and 2- /3-/4-wire proximity switches (BEROs)

## Wiring and block diagram of SM 321; DI 16 x DC 24 V




① Channel number
② Status display - green
③ Backplane bus interface



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## Technical specifications of SM 321; DI 16 x DC 24 V

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 200 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of inputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Number of simultaneously controlled inputs<br>• horizontal mounting position to 60 °C<br>• vertical mounting position to 40 °C | <br>16<br>16 |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels<br>• in groups of | <br>yes<br>yes<br>16 |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus | <br>max. 10 mA |
| Power loss of the module | typ. 3.5 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |
| **Encoder selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal | <br>24 V DC<br>13 V to 30 V<br>- 30 V to + 5 V |
| Input current<br>• "1" signal | <br>typ. 7 mA |
| Input delay<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>1.2 ms to 4.8 ms<br>1.2 ms to 4.8 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 1.5 mA |
| Wiring of the signal transmitters | using a 20-pin front connector |



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# 3.10 Digital input module SM 321; DI 16 x DC 24 V High Speed; (6ES7321-1BH10-0AA0)

## Order number

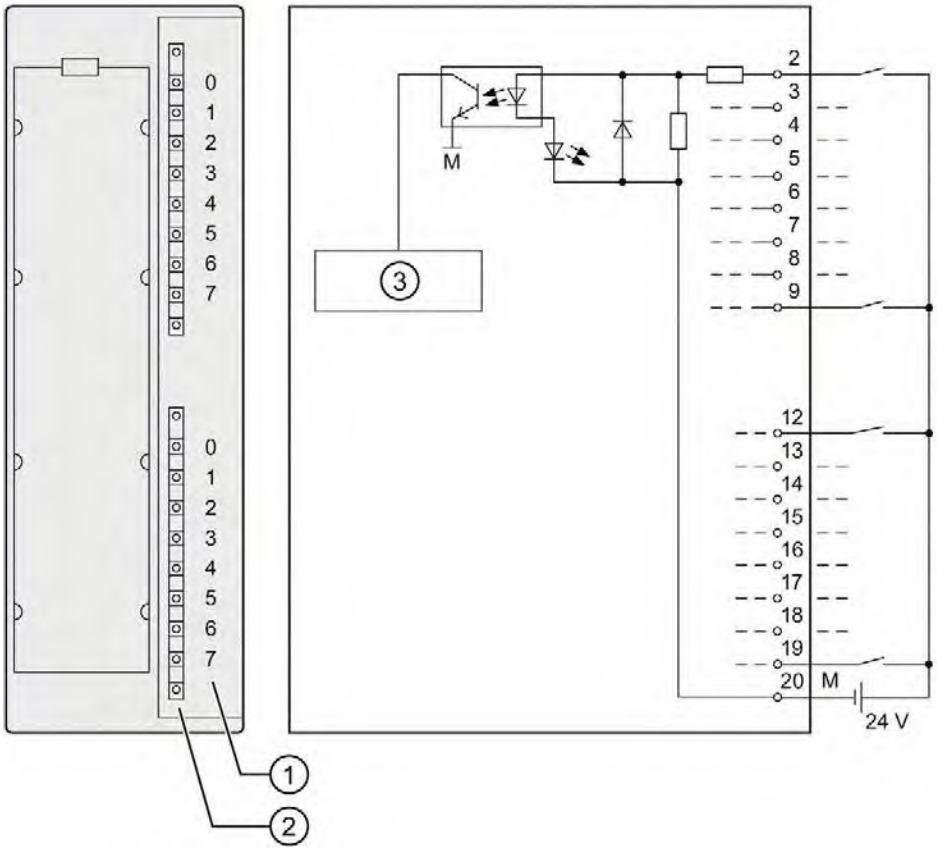
6ES7321-1BH10-0AA0

## Properties

Properties of SM 321; DI 16 x DC 24 V High Speed:

- 16 inputs, electrically isolated in groups of 16
- Rated input voltage 24 V DC
- suitable for switches and 2- /3-/4-wire proximity switches (BEROs)
- Supports isochronous mode

## Wiring and block diagram of SM 321; DI 16 x DC 24 V High Speed




① Channel number
② Status display - green
③ Backplane bus interface



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## Technical specifications of SM 321; DI 16 x DC 24 V High Speed

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 200 g |
| **Module-specific data** | |
| Supports isochronous mode | yes |
| Number of inputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Number of simultaneously controlled inputs<br>• horizontal mounting position<br>to 60 °C<br>• vertical mounting position<br>to 40 °C | <br><br>16<br><br>16 |
| Electrical isolation<br>• between channels and the backplane bus | <br>yes |
| Maximum potential difference<br>• between channels<br>– in groups of | <br>yes<br>16 |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus | <br>max. 110 mA |
| Power loss of the module | typ. 3.8 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |
| **Encoder selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal | <br>24 V DC<br>13 V to 30 V<br>- 30 V to + 5 V |
| Input current<br>• "1" signal | <br>typ. 7 mA |
| Input delay<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>25 µs to 75 µs<br>25 µs to 75 µs |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 1.5 mA |
| Wiring of the signal transmitters | using a 20-pin front connector |



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# 3.11 Digital input module SM 321; DI 16 x 24 VDC; with hardware and diagnostic interrupts (6ES7321-7BH01-0AB0)

### Order number: "Standard module"

6ES7321-7BH01-0AB0

### Order number: "SIPLUS S7-300 module"

6AG1321-7BH01-2AB0

### Properties

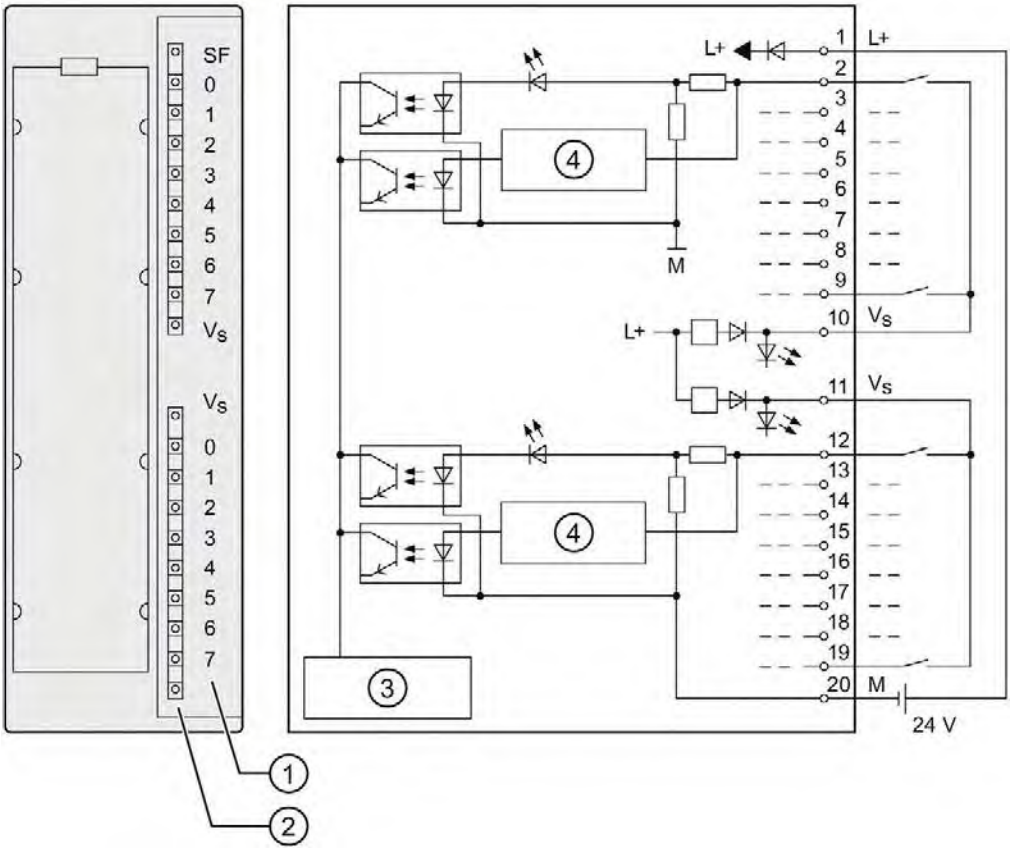
Properties of SM 321; DI 16 x DC 24 V with hardware and diagnostic interrupts:

- 16 inputs, electrically isolated in groups of 16
- Rated input voltage 24 V DC
- Input characteristics to IEC 61131, Type 2
- suitable for switches and 2- /3-/4-wire proximity switches (BEROs)
- 2 short circuitproof sensor supplies for each group of 8 channels
- external redundant sensor supply is supported
- "Sensor supply (Vs)" status display
- Group error display (SF)
- Supports isochronous mode
- Supports parameter reassignment in RUN
- Programmable diagnostics
- Programmable diagnostic interrupt
- Programmable hardware interrupts
- Programmable input delays



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## Wiring and block diagram of SM 321; DI 16 x DC 24 V




① Channel number
② Status displays - green
Error displays - red
Sensor supply $V_S$ -green
③ Backplane bus interface
④ Wire-break detection

## Wiring diagram of the redundant sensor supply

The figure below shows how an additional redundant voltage source can be used to power sensors using Vs.

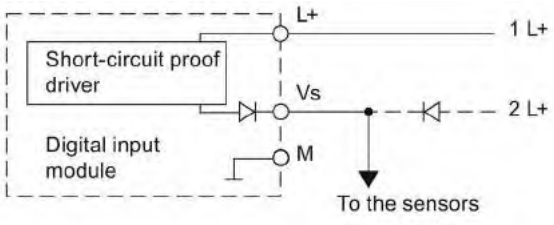



Figure 3-4 Wiring diagram of the redundant supply of sensors of SM 321; DI 16 x DC 24 V



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## Wiring diagram of the shunt circuit of the sensors

For wire-break detection, it is necessary to connect a shunt resistor to the transducer contacts.

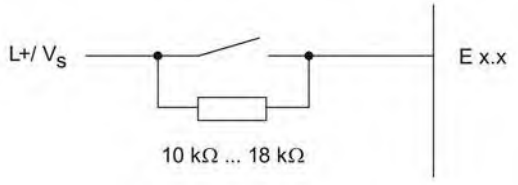



Figure 3-5 Wiring diagram of the shunt circuit of transducers of SM 321; DI 16 x DC 24 V



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## Technical specifications of SM 321; DI 16 x DC 24 V

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 200 g |
| **Module-specific data** | |
| Supports isochronous mode | yes |
| Supports parameter reassignment in RUN | yes |
| • Response of non-programmed inputs | return the process value which was valid before configuration |
| Number of inputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated supply voltage L+ for the electronic system and sensors | 24 V DC |
| • Reverse polarity protection | yes |
| Number of simultaneously controlled inputs | |
| • horizontal mounting position<br>to 60 °C | 16 |
| • vertical mounting position<br>to 40 °C | 16 |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels<br>– In groups of | <br>yes<br>16 |
| Isolation test voltage | 500 V DC |
| Current consumption | |
| • from the backplane bus | max. 130 mA |
| • from load voltage L + (without sensor supply $V_S$) | max. 90 mA |
| Power loss of the module | typ. 4 W |



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| Technical specifications | |
|---|---|
| **Status, interrupts, diagnostics** | |
| Status display<br>• Inputs | <br>green LED per channel |
| • Sensor supplies (Vs) | green LED per output |
| Interrupts<br>• Hardware interrupt<br>• Diagnostic interrupt | <br>programmable<br>programmable |
| Diagnostic functions | programmable |
| • Group error display | red LED (SF) |
| • Reading diagnostic information | supported |
| Monitoring for<br>• wirebreak | <br>yes, sensing I < 1 mA |
| **Sensor supply outputs** | |
| Number of outputs | 2 |
| Output voltage<br>• on load | <br>min. L+ (- 2.5 V) |
| Output current<br>• Rated value<br>• Permitted range | <br>120 mA<br>0 mA to 150 mA |
| Additional (redundant) supply | supported |
| Short-circuit protection | yes, electronic |
| **Encoder selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal | <br>24 V DC<br>13 V to 30 V<br>-30 V to + 5 V |
| Input current<br>• "1" signal | <br>typ. 7 mA |
| Input characteristics | to IEC 61131, type 2 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 2 mA |
| Wiring of the signal transmitters | using a 20-pin front connector |
| Shunt circuit of the sensor for wire-break detection | 10 kohms to 18 kohms |



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| Technical specifications | |
|---|---|
| **Time/frequency** | |
| Internal preparation time for diagnostics (in non-isochronous mode)<br>• Enabling of process and diagnostic interrupts | max. 40 ms |
| Input delay<br>• programmable<br>• Rated value | yes<br>typ. 0.1/0.5/3/15/20 ms |

### Configuration in RUN

Special considerations must be given if you use the Configuration in RUN function.

SF LED is lit:

Status before re-configuration diagnostics on, SF LEDs lit among others (on CPU, IM or module), although diagnostics are no longer pending and the module is operating correctly.

Solution:

- Only change the configuration when no diagnostics are pending for the module or
- Pulling and plugging the module.

## 3.11.1 Isochronous mode

### Properties

Reproducible reaction times (i.e. of the same length) are achieved in a SIMATIC system by means of a constant DP bus cycle, and synchronization of the single cyclic processes outlined below:

- Independent user program cycle. The length of the cycle time may vary due to non-cyclic program branching.
- Independent and variable DP cycle on the PROFIBUS subnet
- Cyclic operation of the backplane bus of the DP slave.
- Cyclic signal conditioning and conversion at the electronic modules of the DP slave.

The constant DP cycle runs in synchronism and at the same length. The CPU run levels (OB61 to OB64) and isochronous IO are synchronized with this cycle. I/O data are therefore transferred at defined and constant intervals (isochronous mode.)

### Requirements

- The DP master and slave must support isochronous mode. STEP 7 V5.2 or higher.



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### Operating mode: Isochronous mode

Conditions of isochronous mode:

| | |
|---|---|
| Filtering and processing time $T_{WE}$ between reading actual values and writing these to the transfer buffer(the value defined for TWE applies, irrespective of the enable status of diagnostics) | 255 µs to 345 µs |
| includes an input delay time of | 100 µs |
| $T_{DPmin}$ | 2.5 ms |
| Diagnostic interrupt | max. 4 x $T_{DP}$ |

**Note**

In "isochronous" mode, the input delay is automatically set to 100 µs, regardless of the input delay setting in STEP 7

### Further information

You can find additional information on isochronous mode in the online help for STEP 7 and in the operating instructions Distributed I/O System ET 200M. (http://support.automation.siemens.com/WW/view/en/1142798)

## 3.11.2 SM 321; DI 16 x DC 24 V - Parameters

### Programming

The general procedure of programming digital modules is described in the chapter Programming digital modules (Page 58).

### Parameters of SM 321; DI 16 x DC 24 V

The table below shows an overview of configurable parameters and their default settings for SM 321; DI 16 x DC 24 V.



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The default settings apply if you have not set any parameters in STEP 7.

Table 3- 10 Parameters of SM 321; DI 16 x DC 24 V

| Parameters | Range of values | Default | Parameter type | Scope |
|---|---|---|---|---|
| Enable<br>• Diagnostic interrupt<br>• Hardware interrupt | <br>Yes/No<br>Yes/No | <br>No<br>No | dynamic | Module |
| Input delay/voltage type | 0.1 ms (DC)<br>0.5 ms (DC)<br>3 ms (DC)<br>15 ms (DC)<br>20 ms (DC/AC) | (DC) | static | Module |
| Diagnosis encoder supply missing<br>• Wire break | <br>Yes/No<br>Yes/No | <br>No<br>No | static | Channel group |
| Hardware interrupt trigger<br>• Positive edge<br>• Negative edge | <br>Yes/No<br>Yes/No | <br>No<br>No | dynamic | Channel group |

## Allocating the sensor supplies to channel groups

The module's two sensor supplies power the two channel groups: Inputs 0 to 7 and inputs 8 to 15. You also configure the diagnostics for the encoder supply in these channel groups.

## Assigning interrupt parameters to channel groups

The table below shows which channels you can group for interrupt processing.

The channel group number is required to program SFC parameters in the user program.

Table 3- 11 Assigning interrupt parameters to the inputs of SM 321; DI 16 x DC 24 V

| Parameters... | Programmable in the following channel groups | Channel group number |
|---|---|---|
| • Hardware interrupt (triggered at the positive, negative, or both edges)<br>• Diagnostic interrupt for wire break | 0 and 1<br>2 and 3<br>4 and 5<br>6 and 7<br>8 and 9<br>10 and 11<br>12 and 13<br>14 and 15 | 0<br>1<br>2<br>3<br>4<br>5<br>6<br>7 |
| • Diagnostic interrupt for missing encoder supply | 0 to 7<br>8 to 15 | - |



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### Tolerances of the programmable input delays

Table 3- 12 Tolerances of the input delays at SM 321; DI 16 x DC 24 V

| Programmed input delay | Tolerance |
|---|---|
| 0.1 ms | 60 µs to 140 µs |
| 0.5 ms | 400 µs to 900 µs |
| 3 ms (default) | 2.6 ms to 3.3 ms |
| 15 ms | 12 ms to 15 ms |
| 20 ms | 17 ms to 23 ms |

## 3.11.3 SM 321; DI 16 x DC 24 V - Diagnostics

### Diagnostic messages of SM 321; DI 16 x DC 24 V

The table below shows an overview of the diagnostic messages of SM 321; DI 16 x DC 24 V.

Table 3- 13 Diagnostic messages of SM 321; DI 16 x DC 24 V

| Diagnostic message | LED | Scope of diagnostics | programmable |
|---|---|---|---|
| Sensor supply missing | SF | Channel group | yes |
| Wire break | SF | Channel group | |
| Module not programmed | SF | Channel group | |
| External auxiliary voltage missing | SF | Module | no |
| Internal auxiliary voltage missing | SF | Module | |
| Fuse blown | SF | Module | |
| Incorrect module parameters | SF | Module | |
| Watchdog time-out | SF | Module | |
| EPROM fault | SF | Module | |
| RAM fault | SF | Module | |
| Hardware interrupt lost | SF | Module | |

**Note**

A prerequisite for detecting faults indicated by programmable diagnostic messages is an appropriate configuration of the digital module in STEP 7.



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**Note**

**Wire break diagnostics**

Wire break diagnostics is always used for one channel group with two channels. It is only possible to determine that one of the two channels has suffered a wire break; it is not possible to identify which one. When operated with PCS7, only one channel of the group can be used at any time for an exact diagnosis.

## Causes of error and troubleshooting

Table 3- 14 Diagnostics Messages of the SM 321; DI 16 x DC 24 V, causes of error and troubleshooting

| Diagnostic message | Possible cause of error | To correct or avoid error |
|---|---|---|
| Sensor supply missing | Overload at sensor supply | Eliminate overload |
| | Short-circuit to M at sensor supply | Eliminate the short-circuit |
| External auxiliary voltage missing | Power supply L+ to module missing | Feed supply L+ |
| Internal auxiliary voltage missing | Power supply L+ to module missing | Feed supply L+ |
| | Fuse blown in module | Replace the module |
| Fuse blown | Fuse blown in module | Replace the module |
| Incorrect module parameters | Implausible parameter or combination thereof | Program the module |
| Watchdog timeout | Infrequent high electromagnetic interference | Eliminate the interference |
| | Module defective | Replace the module |
| EPROM fault | Infrequent high electromagnetic interference | Eliminate interference and cycle the power supply of CPU off/on. |
| | Module defective | Replace the module |
| RAM fault | Infrequent high electromagnetic interference | Eliminate interference and cycle the power supply of CPU off/on. |
| | Module defective | Replace the module |
| Hardware interrupt lost | The module can not output an interrupt, because the previous interrupt was not acknowledged; possibly a configuration error | Change interrupt processing in the CPU, and reprogram the module as required<br>The error persists until the module is assigned new parameters |
| Module not programmed | Startup error | Program the module |



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## 3.11.4 SM 321; DI 16 x DC 24 V - Behavior

### Influence of the operating state and supply voltage on input values

The SM 321; DI 16 x DC 24 input values are determined by the CPU's operating state and the module's power supply.

Table 3- 15 Dependency of input values on the CPU's operating state, and on the L+ power supply of SM 321; DI 16 x DC 24 V

| CPU operating state | | Power supply L+ at digital module | input value of the digital module |
|---|---|---|---|
| POWER ON | RUN | L+ present | Process value |
| | | L+ missing | 0 signal |
| | STOP | L+ present | Process value |
| | | L+ missing | 0 signal |
| POWER OFF | - | L+ present | - |
| | | L+ missing | - |

### Reaction to power failure

Failure of the SM 321; DI 16 x DC 24 power supply is always indicated by the module's SF LED. This information is also available on the module.

The input value is initially held for the duration of 20 ms to 40 ms before the zero signal is transferred to the CPU. Supply voltage dips <20 ms do not influence the process value (see the table above.)

Triggering of diagnostic interrupts is determined by the parameter settings (see chapter Interrupts of SM 321; DO 16 x DC 24 V (Page 91)).

### Power supply failure with redundant external sensor supply

**Note**

When an external redundant power source is connected in parallel to the sensor supply (Vs) and the L+ power supply fails, the module does not report failure of the sensor supply, but rather the failure of the internal and/or external auxiliary voltage, and/or a blown fuse.

### Short-circuit at the sensor supply Vs

The relevant Vs LED goes dark if a short-circuit is detected at the sensor supply Vs, irrespective of parameter settings.



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## 3.11.5 SM 321; DI 16 x DC 24 V - Interrupts

### Introduction

This chapter describes the interrupt reaction of SM 321; DI 16 x DC 24 V. Always distinguish between the following interrupts:

- Diagnostic interrupt
- Hardware interrupt

For detailed information on the OBs and SFCs mentioned below, refer to the STEP 7 Online Help.

### Enabling interrupts

There is no default interrupt setting, i.e. interrupts are disabled if parameters are not set accordingly. You can enable interrupts in STEP 7 (see the chapter Parameters of SM 321; DI 16 x DC 24 V (Page 86)).



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## Diagnostic interrupt

When diagnostic interrupts are enabled, incoming error events (initial occurrence) and outgoing error events (error is cleared) are reported by means of an interrupt.

The CPU interrupts user program execution in order to process diagnostic interrupt OB82.

You can call SFC51 or 59 in OB82 in the user program to view detailed diagnostics data output by the module.

Diagnostics data remain consistent until the program exits OB82. The module acknowledges the diagnostic interrupt when the program exits OB82.

## Hardware interrupt

SM 321; DI 16 x DC 24 V can trigger a hardware interrupt for each channel group at the positive, negative, or both edges of a signal transition.

Program each channel group separately. The parameters can be changed at any time (in RUN mode in the user program.)

Active hardware interrupts trigger hardware interrupt processing in the CPU (OB40) and interrupt execution of the user program or of object classes with lower priority in the CPU.

You can define the response of the AS to signal edge transitions in the user program of hardware interrupt OB40. The module acknowledges the hardware interrupt when the program exits the hardware interrupt OB.

The module can save one interrupt per channel to the stack. If no higher priority classes are pending processing, the CPU processes the buffered interrupts (of all modules) in the order of their occurrence.

## Hardware interrupt lost

A "Hardware interrupt lost" diagnostic interrupt is generated if a successive interrupt is triggered at the channel previously saved to the stack and which has not yet been processed by the CPU.

The CPU does not register any further interrupts at this channel unless it has completed processing of the queued interrupts of the same channel.

## Interrupt-triggering channels

The relevant hardware interrupt-triggering channel is logged in the OB40_POINT_ADDR variable of the start information of OB40. The figure shows the bit assignments of DWORD 8 in the local data.

| Byte | Variable | Data type | | Description |
|---|---|---|---|---|
| 6/7 | OB40_MDL_ADDR | WORD | B#16#0 | Address of the interrupt-triggering module |
| starting at 8 | OB40_POINT_ADDR | DWORD | see the figure below | Indication of the interrupt-triggering inputs |



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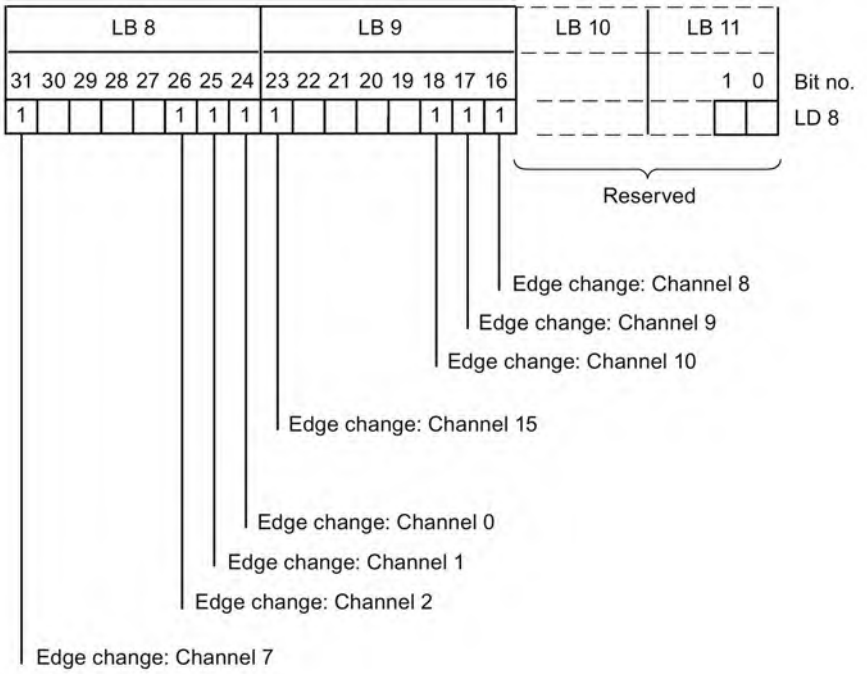



Figure 3-6 Start Information of OB40: which event has triggered the hardware interrupt



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# 3.12 Digital input module SM 321; DI 16 x DC 24/125 V; with hardware and diagnostic interrupts (6ES7321-7EH00-0AB0)

## Order number:

6ES7321-7EH00-0AB0

## Properties

Properties of SM 321; DI 16 x DC 24 V/125 V; with hardware and diagnostic interrupts:

- 16 inputs, electrically isolated in groups of 16
- Rated input voltage 24 to 125 V DC
- Input characteristics to IEC 61131, Type 1
- suitable for switches and 2- /3-/4-wire proximity switches (BEROs)
- Group error display (SF)
- Supports parameter reassignment in RUN
- Channel-based configurable diagnostics
- Programmable diagnostic interrupt
- Channel-based configurable hardware interrupts
- Programmable input delays

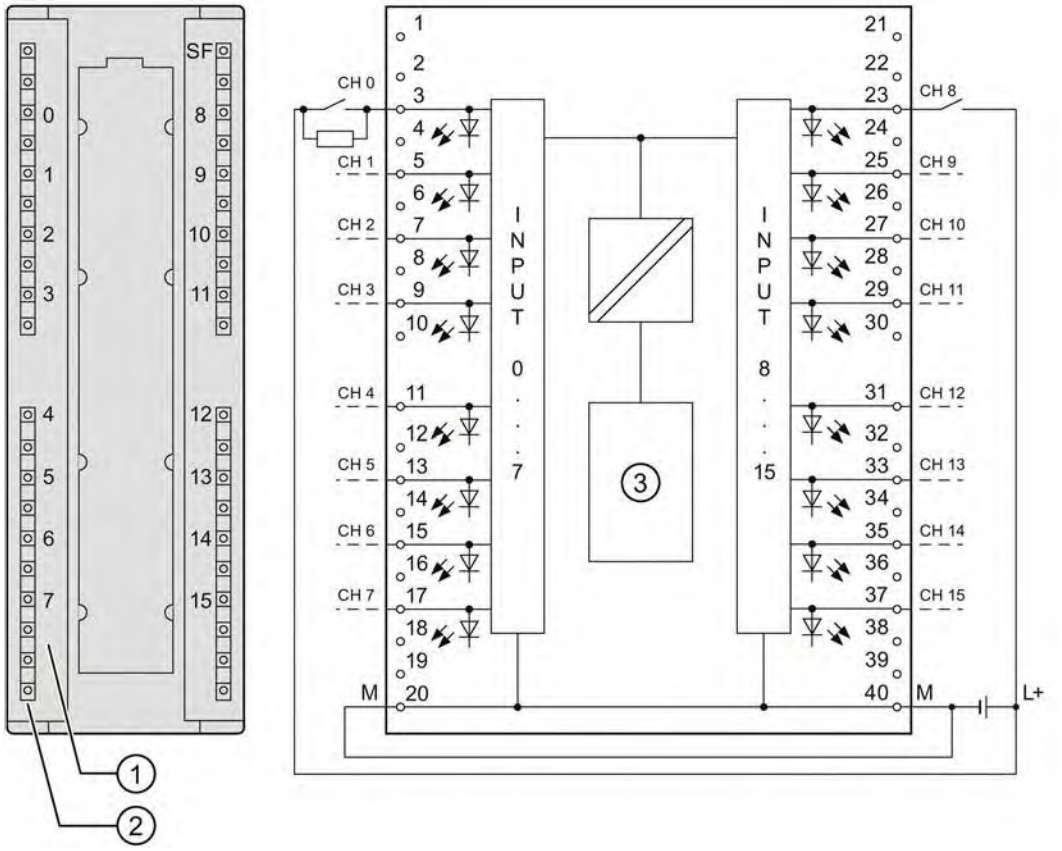
**WARNING**

- Electrical hazard arises with electric circuits operated with voltages
  - >30 $V_{eff}$ and 42.4 $V_{peak}$
  - 60 VDC.
- It is not permitted to mix electrically safe and dangerous contact input voltages on the 16 inputs of the same module.



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## Wiring and block diagram of SM 321; DI 16 x DC 24 V/125 V




① Channel number
② Status displays - green
Error displays - red
③ Backplane bus interface

## Wiring diagram of the shunt circuit of the sensors

For wire-break detection, it is necessary to connect a shunt resistor to the transducer contacts.

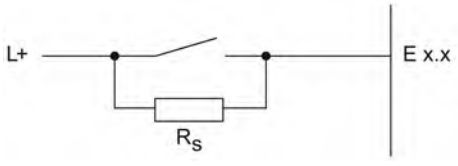



Figure 3-7 Wiring diagram of the shunt circuit of transducers of SM 321; DI 16 x DC 24 V/125 V



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The resistance used depends on the module's rated input voltage

Table 3- 16 Dependence on rated input voltage and resistance

| Rated input voltage L+ | Resistance $R_S$ |
|---|---|
| 24 V DC | 43 kΩ |
| 48 V DC | 100 kΩ |
| 125 V DC | 300 kΩ |

## SM 321; DI 16 x DC 24 V/125V - Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | approx. 200 g |
| **Module-specific data** | |
| Supports isochronous mode | No |
| Supports parameter reassignment in RUN | Yes |
| • Response of non-programmed inputs | return the process value which was valid before configuration |
| Accuracy of the time stamp | > 5 ms* |
| Number of inputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Number of simultaneously controlled inputs | |
| • Horizontal mounting position to 60 °C<br>– L+ = 146 VDC<br>– L+ = 125 VDC<br>– L+ = 100 VDC | <br>8<br>12<br>16 |
| • Vertical mounting position to 40 °C<br>– L+ = 146 VDC<br>– L+ = 125 VDC<br>– L+ = 100 VDC | <br>8<br>12<br>16 |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels | <br>Yes<br>No |
| Maximum potential difference | |
| • between different circuits | 300 V DC / 250 V AC |
| Isolation test voltage | 3500 VDC |



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| Technical specifications | |
|---|---|
| Current consumption | |
| • from the backplane bus | max. 90 mA |
| Power loss of the module<br>• L+ = 24 V<br>• L+ = 100 V | <br>typ. 2 W<br>typ. 6.5 W |
| **Status, interrupts, diagnostics** | |
| Status displays | green LED per channel |
| Interrupts<br>• Hardware interrupt<br>• Diagnostic interrupt<br>• Wire break | <br>programmable<br>programmable<br>programmable |
| Diagnostic functions | programmable |
| • Group error display | red LED (SF) |
| • Reading diagnostics information | supported |
| Monitoring for<br>• Wire break | <br>yes, sensing I < 1 mA |
| **Encoder selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal | <br><br>From 15 to 146 V<br>from -146 V to + 5 V |
| Input current<br>• "1" signal | <br>Typ. 3.5 mA |
| Input characteristics | to IEC 61131, Type 1 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 1 mA |
| Wiring of the signal transmitters | with 40-pin front connector |
| **Time/frequency** | |
| Input delay<br>• programmable<br>• Rated value | <br>Yes<br>typ. 0.1/0.5/3/15/20 ms** |
| Fixed current limitation of the sensor for wire-break detection | See previous table for dependence on rated input voltage and resistance |
| Overvoltage protection | Dehnconnect RK DCO RK ME110; Art. No. 919 923 |

* To obtain a time stamp accuracy of < 1 ms, the input delay must be configured to 0.1 ms.

** To obtain a high immunity to interference, use a shielded cable and set input delay to 0.1 ms.



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### Configuration in RUN

Special considerations must be given if you use the Configuration in RUN function.

SF LED is lit:

Status before re-configuration diagnostics on, SF LEDs lit among others (on CPU, IM or module), although diagnostics are no longer pending and the module is operating correctly.

Solution:

- Only change the configuration when no diagnostics are pending for the module or
- Pulling and plugging the module.

## 3.12.1 Parameters of SM 321; DI 16 x DC 24/125 V

### Programming

The general procedure of programming digital modules is described in the chapter Programming digital modules.

### Parameters of SM 321; DI 16 x DC 24 V/125 V

The table below shows an overview of configurable parameters and their default settings for SM 321; DI 16 x DC 24 V/125V.

The default settings apply if you have not set any parameters in STEP 7.

Table 3- 17 Parameters of SM 321; DI 16 x DC 24 V/125 V

| Parameters | Range of values | Default | Parameter type | Efficiency range |
|---|---|---|---|---|
| Enable<br>• Diagnostic interrupt<br>• Hardware interrupt | <br>Yes/No<br>Yes/No | <br>No<br>No | dynamic | Module |
| Input delay/voltage type | 0.1 ms (DC)<br>0.5 ms (DC)<br>3 ms (DC)<br>15 ms (DC)<br>20 ms (DC/AC) | 3 ms (DC) | static | Module |
| Diagnostics<br>• Wire break | <br>Yes/No | <br>No | static | Channel |
| Hardware interrupt trigger<br>• Positive edge<br>• Negative edge | <br>Yes/No<br>Yes/No | <br>No<br>No | dynamic | Channel |



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### Tolerances of the programmable input delays

Table 3- 18 Tolerances of the input delays of SM 321; DI 16 x DC 24 V/125 V

| Programmed input delay | Tolerance |
|---|---|
| 0.1 ms | 80 µs to 200 µs |
| 0.5 ms | 580 µs to 700 µs |
| 3 ms (default) | 3.1 ms to 3.7 ms |
| 15 ms | 15.1 ms to 18.1 ms |
| 20 ms | 20.1 ms to 24.1 ms |

**Note**

The timers for the input delay are only valid for reading in the status. In the case of wire-break, "Wire-break diagnostics" is only triggered approx. 40 ms after the reading in of the value.

## 3.12.2 Diagnostics of SM 321; DI 16 x DC 24/125 V

### Diagnostic messages of SM 321; DI 16 x DC 24 V/125 V

The table below shows an overview of the diagnostic messages of SM 321; DI 16 x DC 24 V/125 V.

Table 3- 19 Diagnostic messages of SM 321; DI 16 x DC 24 V/125 V

| Diagnostic message | LED | Scope of diagnostics | programmable |
|---|---|---|---|
| Wire break | SF | Channel | Yes |
| No channel parameters | SF | Channel | |
| No/incorrect parameters in module | SF | Module | No |
| Time monitoring activated (watchdog) | SF | Module | |
| EPROM fault | SF | Module | |
| RAM fault | SF | Module | |
| Hardware interrupt lost | SF | Module | |

**Note**

To detect the errors indicated by programmable diagnostic messages, you must have programmed the digital module accordingly in STEP 7.



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### Special features of diagnostics

The SM 321; DI 16 x DC 24 V/125 V supplies 9-byte diagnostic data (diagnostic data set 0 with a length of 4 bytes and the diagnostic data set 1 with a length of 9 bytes).

The wire-break diagnostics is only reported in the channel error vector of the data set 1 (bytes 7 and 8). Each channel that reports an error in the channel errror vector has a wire-break. You can find additional information, in chapter Structure and content of diagnostics data, byte 0 and up (Page 584).

### Causes of error and troubleshooting

Table 3- 20 Diagnostics messages of SM 321; DI 16 x DC 24 V/125V, causes of error and troubleshooting

| Diagnostic message | Possible cause of error | To correct or avoid error |
|---|---|---|
| Incorrect module parameters | Implausible parameter or combination thereof | Program the module |
| Time monitoring activated (watchdog) | Infrequent high electromagnetic interference | Eliminate the interference |
| | Module defective | Replace the module |
| EPROM fault | Infrequent high electromagnetic interference | Eliminate interference and cycle the power supply of CPU off/on. |
| | Module defective | Replace the module |
| RAM fault | Infrequent high electromagnetic interference | Eliminate interference and cycle the power supply of CPU off/on. |
| | Module defective | Replace the module |
| Hardware interrupt lost | The module can not output an interrupt, because the previous interrupt was not acknowledged; possibly a configuration error | Change interrupt processing in the CPU, and reprogram the module as required<br>The error persists until the module is assigned new parameters |
| Module not programmed | Startup error | Program the module |

## 3.12.3 Interrupts of SM 321; DI 16 x DC 24/125 V

### Introduction

This chapter describes the interrupt reaction of SM 321; DI 16 x DC 24 V/125V. Always distinguish between the following interrupts:

- Diagnostic interrupt
- Hardware interrupt

For detailed information on the OBs and SFCs mentioned below, refer to the STEP 7 Online Help.



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## Enabling interrupts

There is no default interrupt setting, i.e. interrupts are disabled if parameters are not set accordingly. You can enable interrupts in STEP 7 (see the chapter Parameters of SM 321; DI 16 x DC 24 V ).

## Diagnostic interrupt

When diagnostic interrupts are enabled, incoming error events (initial occurrence) and outgoing error events (error is cleared) are reported by means of an interrupt.

The CPU interrupts user program execution in order to process diagnostic interrupt OB82.

You can call SFC51 or 59 in OB82 in the user program to view detailed diagnostics data output by the module.

Diagnostics data remain consistent until the program exits OB82. The module acknowledges the diagnostic interrupt when the program exits OB82.

## Hardware interrupt

SM 321; DI 16 x DC 24 V/125V can trigger a hardware interrupt for each channel group at the positive, negative, or both edges of a signal transition.

You perform parameter assignment for each channel separately. The parameters can be changed at any time (in RUN mode in the user program.)

Active hardware interrupts trigger hardware interrupt processing in the CPU (OB40) and interrupt execution of the user program or of object classes with lower priority in the CPU.

You can define the response of the AS to signal edge transitions in the user program of hardware interrupt OB40. The module acknowledges the hardware interrupt when the program exits the hardware interrupt OB.

The module can save one interrupt per channel to the stack. If no higher priority classes are pending processing, the CPU processes the buffered interrupts (of all modules) in the order of their occurrence.

## Hardware interrupt lost

A "Hardware interrupt lost" diagnostic interrupt is generated if a successive interrupt is triggered at the channel previously saved to the stack and which has not yet been processed by the CPU.

The CPU does not register any further interrupts at this channel unless it has completed processing of the queued interrupts of the same channel.



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## Interrupt-triggering channels

The relevant hardware interrupt-triggering channel is logged in the OB40_POINT_ADDR variable of the start information of OB40. The figure shows the bit assignments of DWORD 8 in the local data.

| Byte | Variable | Data type | | Description |
|---|---|---|---|---|
| 6/7 | OB40_MDL_ADDR | WORD | B#16#0 | Address of the interrupt-triggering module |
| starting at 8 | OB40_POINT_ADDR | DWORD | see the figure below | Indication of the interrupt-triggering inputs |

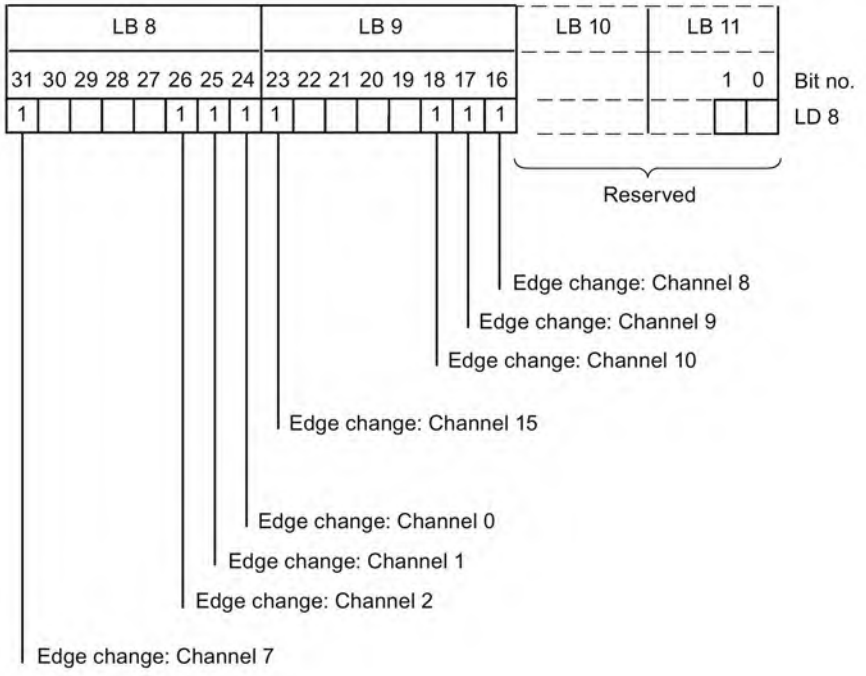



Figure 3-8 Start Information of OB40: which event has triggered the hardware interrupt



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# 3.13 Digital input module SM 321; DI 16 x DC 24 V; source input; (6ES7321-1BH50-0AA0)

## Order number

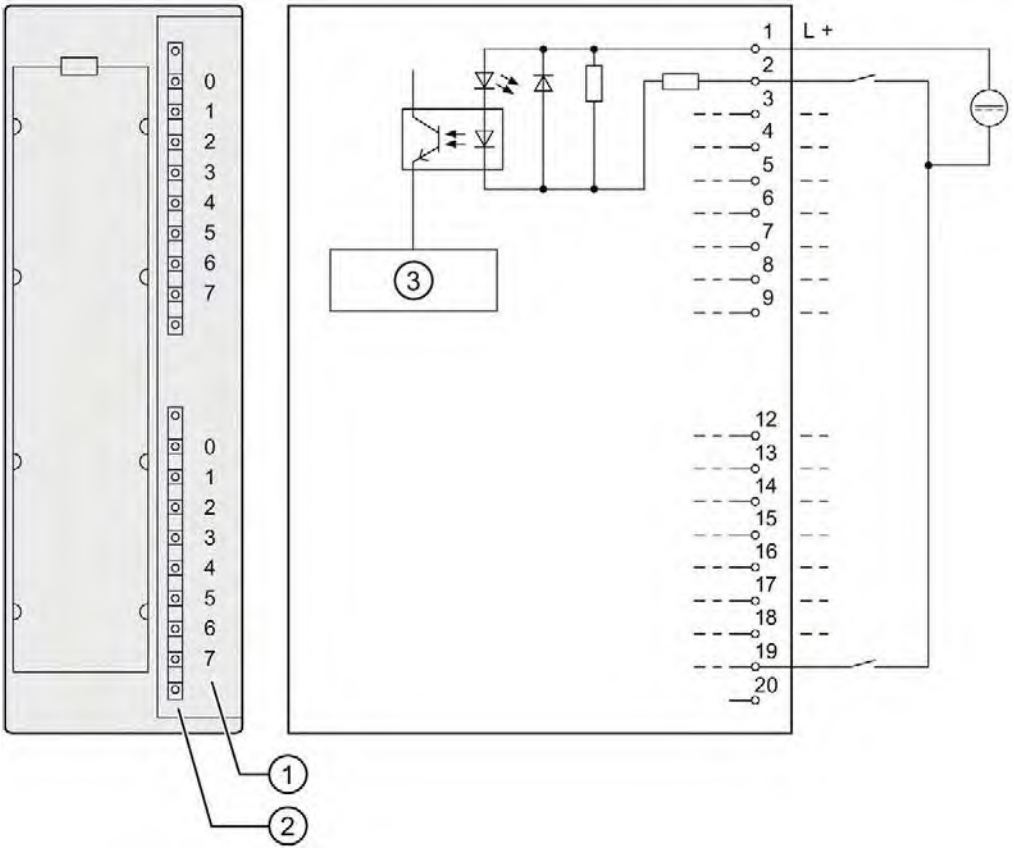
6ES7321-1BH50-0AA0

## Properties

Properties of SM 321; DI 16 x DC 24 V; source input:

- 16 inputs, source input, electrically isolated in groups of 16
- Rated input voltage 24 V DC
- Suitable for switches and 2- /3-/4-wire proximity switches (BEROs)

## Wiring and block diagram of SM 321; DI 16 x DC 24 V




① Channel number
② Status display - green
③ Backplane bus interface



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## SM 321; DI 16 x DC 24 V - Technical specifications

| | |
|---|---|
| **Technical specifications** | |
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 200 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of inputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Number of simultaneously controlled inputs | |
| • horizontal mounting position<br>to 60 °C | 16 |
| • vertical mounting position<br>to 40 °C | 16 |
| Electrical isolation<br>• between channels and the backplane bus | <br>yes |
| • between channels<br>in groups of | yes<br>16 |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus | <br>max. 10 mA |
| Power loss of the module | typ. 3.5 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |
| **Encoder selection data** | |
| Input voltage (reference potential L+) | |
| • Rated value<br>• "1" signal<br>• "0" signal | 24 V DC<br>-13 V to -30 V<br>+30 V to -5 V |
| Input current<br>• "1" signal | <br>typ. 7 mA |
| Input delay<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>1.2 ms to 4.8 ms<br>1.2 ms to 4.8 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 1.5 mA |
| Wiring of the signal transmitters | using a 20-pin front connector |



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# 3.14 Digital input module SM 321; DI 16 x UC 24/48 V; (6ES7321-1CH00-0AA0)

## Order number

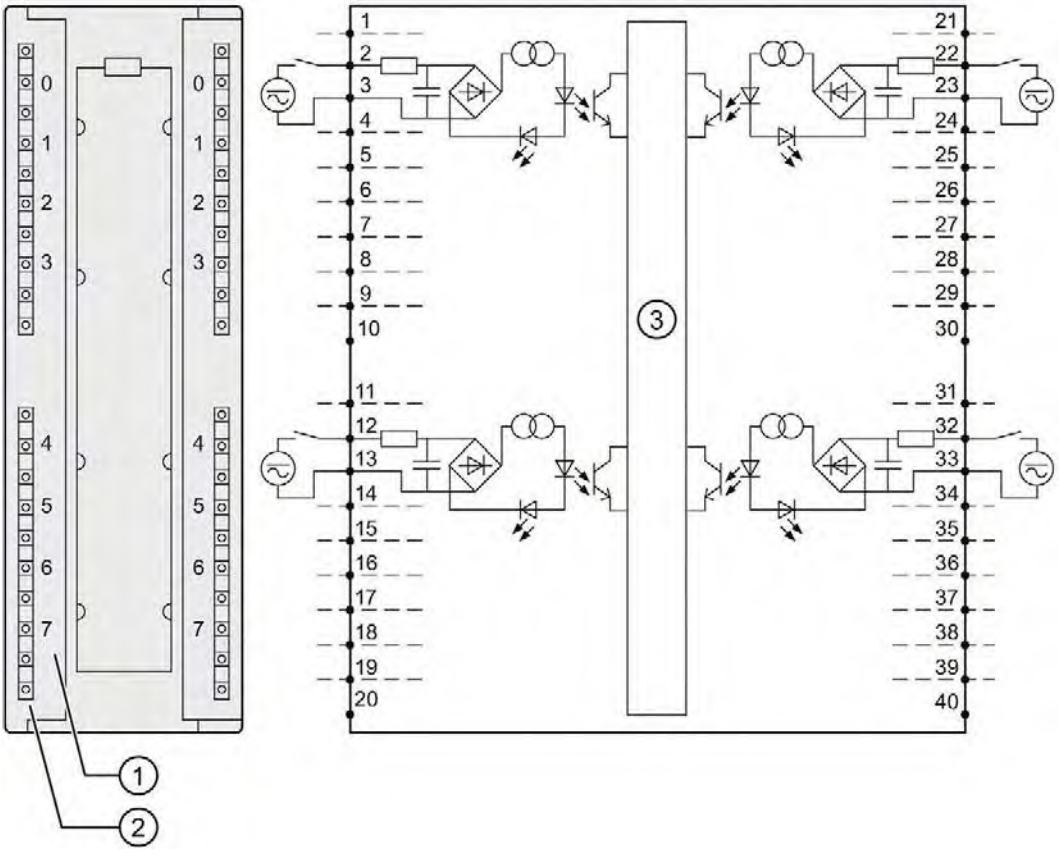
6ES7321-1CH00-0AA0

## Properties

Properties of SM 321; DI 16 x UC24/48 V:

- 16 inputs, electrically isolated
- Electrical isolation between channels of 120 V AC
- Rated input voltage 24 VDC/VAC to 48 VDC/VAC
- Inputs are autarkic and can be wired to suit any configuration

## Wiring and block diagram of SM 321; DI 16 x UC 24/48 V




① Channel number
② Status display - green
③ Backplane bus interface



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## SM 321; DI 16 x UC 24/48 V - Technical specifications

| | |
|---|---|
| **Technical specifications** | |
| **Dimensions and weight** | |
| Dimensions W x H x D | 40 x 125 x 117 |
| Weight | ca. 260 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of inputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Number of simultaneously controlled inputs<br>• horizontal mounting position up to 60 °C | <br>16 |
| • other mounting positions up to 40 °C | 16 |
| Electrical isolation | |
| • Between channels and the backplane bus | Yes |
| • between channels<br>In groups of | Yes<br>1 |
| Maximum potential difference | |
| • Between channels and the backplane bus | 170 VDC, 120 VAC |
| • between inputs of different groups | 170 VDC, 120 VAC |
| Isolation test voltage | |
| • Between channels and the backplane bus | 1500 VAC |
| • between inputs of different groups | 1500 VAC |
| Current consumption | |
| • from the backplane bus | 100 mA max. |
| Power loss of the module | |
| • Operation with 24 V<br>• Operation with 48 V | typ. 1.5 W<br>typ. 2.8 W |
| **Status, interrupts, diagnostics** | |
| Status display<br>Interrupts<br>Diagnostic functions | green LED per channel<br>none<br>none |



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| **Technical specifications** | |
|---|---|
| **Sensor selection data** | |
| Input voltage<br>• Rated value | <br>24 VDC/VAC or 48 VDC/VAC |
| • "1" signal<br>• "0" signal<br>• Frequency band | 14 V to 60 V<br>-5 V to 5 V<br>0 Hz to 63 Hz |
| Input current | |
| • "1" signal<br>• "0" signal | typ. 2.7 mA<br>-1 mA to +1 mA |
| Input delay | |
| • "0" to "1" transition<br>• "1" to "0" transition | max. 16 ms<br>max. 16 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs | supported |
| • Permissible quiescent current | max. 1 mA |
| Wiring of the signal sensors | using a 40-pin front connector |



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# 3.15 Digital input module SM 321; DI 16 x DC 48-125 V; (6ES7321-1CH20-0AA0)

### Order number: "Standard module"

6ES7321-1CH20-0AA0

### Order number: "SIPLUS S7-300 module"

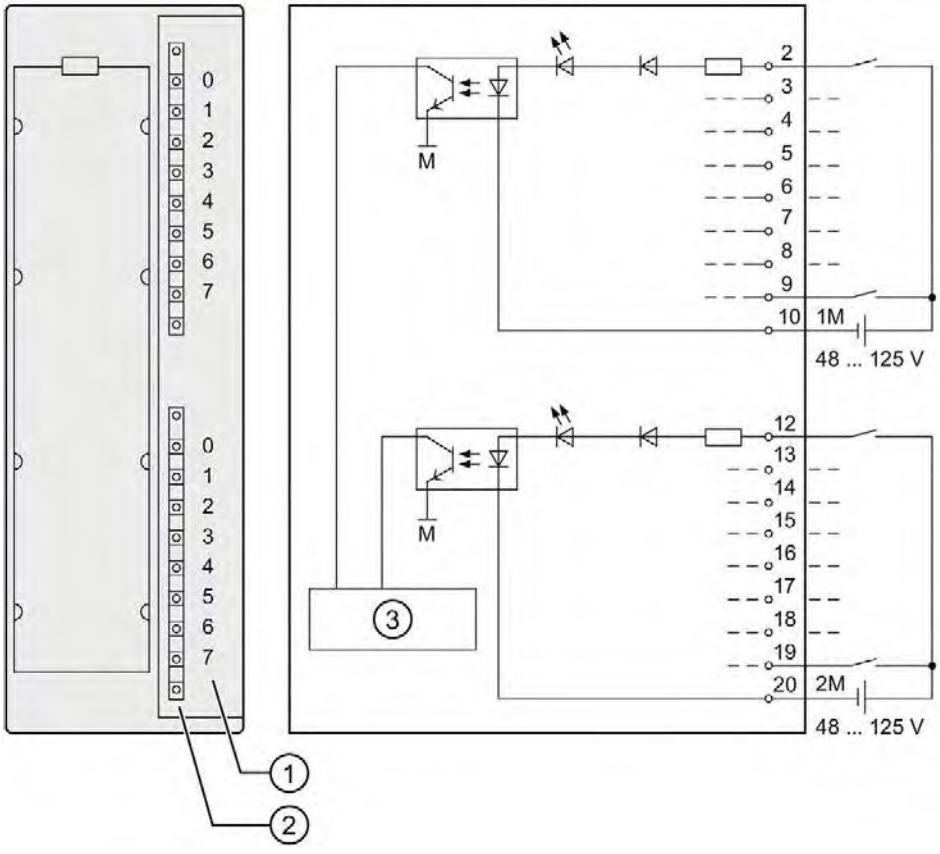
6AG1321-1CH20-2AA0

### Properties

Properties of SM 321; DI 16 x DC 48-125 V:

- 16 inputs, electrically isolated in groups of 8
- Rated input voltage 48 VDC to 125 VDC
- suitable for switches and 2- /3-/4-wire proximity switches (BEROs)

### Wiring and block diagram of SM 321; DI 16 x DC 48-125 V




① Channel number
② Status display - green
③ Backplane bus interface



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## SM 321; DI 16 x DC 48-125 V - Technical specifications

| **Technical specifications** | | |
|---|---|---|
| **Dimensions and weight** | | |
| Dimensions W x H x D (mm) | 40 x 125 x 120 | |
| Weight | ca. 200 g | |
| **Module-specific data** | | |
| Supports isochronous mode | no | |
| Number of inputs | 16 | |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m | |
| **Voltages, currents, electrical potentials** | | |
| Number of simultaneously controlled inputs **per group** at $U_I$ | to 60 V | to 146 V |
| • horizontal mounting position<br>to 50 °C<br>to 60 °C | <br>8<br>8 | <br>8<br>6 |
| • vertical mounting position<br>to 40 °C | 8 | 8 |
| Electrical isolation | | |
| • between channels and the backplane bus | yes | |
| • between channels<br>in groups of | yes<br>8 | |
| Maximum potential difference<br>• between different circuits | <br>146 VDC / 132 VAC | |
| Isolation test voltage | 1500 VDC | |
| Current consumption<br>• from the backplane bus | <br>max. 40 mA | |
| Power loss of the module | typ. 4.3 W | |
| **Status, interrupts, diagnostics** | | |
| Status display | green LED per channel | |
| Interrupts | none | |
| Diagnostic functions | none | |



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| **Technical specifications** | |
|---|---|
| **Sensor selection data** | |
| Input voltage | |
| • Rated value | 48 VDC to 125 VDC |
| • "1" signal | 30 V to 146 V |
| • "0" signal | -146 V to 15 V |
| Input current<br>• "1" signal | <br>typ. 3.5 mA |
| Input delay<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>0.1 ms to 3.5 ms<br>0.7 ms to 3.0 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 1 mA |
| Wiring the signal transducers | using a 20-pin front connector |



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# 3.16 Digital input module SM 321; DI 16 x AC 120/230 V; (6ES7321-1FH00-0AA0)

## Order number

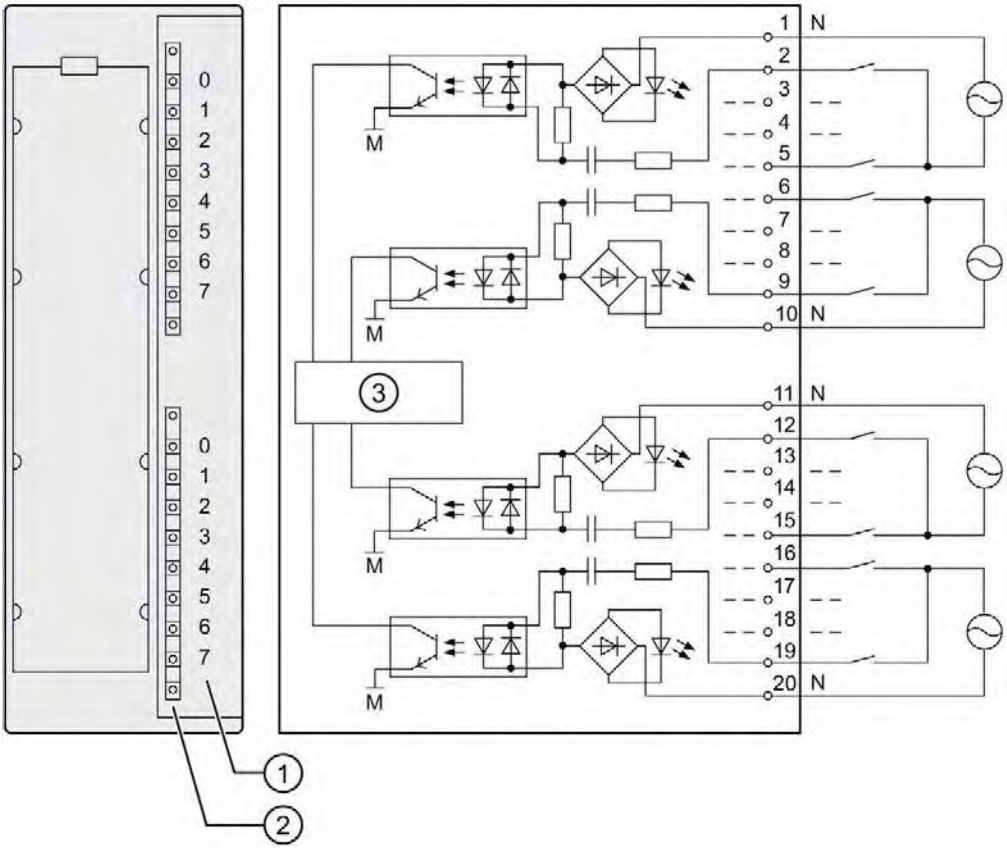
6ES7321-1FH00-0AA0

## Properties

Properties of SM 321, DI 16 x AC 120/230 V:

- 16 inputs, electrically isolated in groups of 4
- Rated input voltage 120/230 VAC
- Suitable for switches and 2-/3-wire proximity switches (AC)

## Wiring and block diagrams of SM 321; DI 16 x AC 120/230 V




① Channel number
② Status display - green
③ Backplane bus interface



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## SM 321; DI 16 x AC 120/230 V- Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D | 40 x 125 x 117 |
| Weight | ca. 240 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of inputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L1<br>All load voltages must be connected to a common phase | 120/230 V |
| Number of simultaneously controlled inputs | |
| • Horizontal mounting position to 60 °C | 16 |
| • Vertical mounting position to 40 °C | 16 |
| Electrical isolation | |
| • Between channels and the backplane bus | Yes |
| • between channels<br>in groups of | Yes<br>4 |
| Maximum potential difference | |
| • between $M_{internal}$ and inputs | 230 VAC |
| • between inputs of different groups | 500 VAC |
| Isolation test voltage | 4000 VDC |
| Current consumption | |
| • from the backplane bus | max. 29 mA |
| Power loss of the module | typ. 4.9 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |



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| **Technical specifications** | |
|---|---|
| **Sensor selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal<br>• Frequency band | <br>120/230 VAC<br>79 V to 264 V<br>0 V to 40 V<br>47 Hz to 63 Hz |
| Input current<br>• "1" signal<br>120 V, 60 Hz<br>230 V, 50 Hz | <br><br>typ. 6.5 mA<br>typ. 16.0 mA |
| Input delay<br>• "0" to "1" transition<br>• "0" to "1" transition | <br>max. 25 ms<br>max. 25 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 2 mA |
| Wiring the signal transducers | using a 20-pin front connector |



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# 3.17 Digital input module SM 321; DI 8 x AC 120/230 V; (6ES7321-1FF01-0AA0)

### Order number: "Standard module"

6ES7321-1FF01-0AA0

### Order number: "SIPLUS S7-300 module"

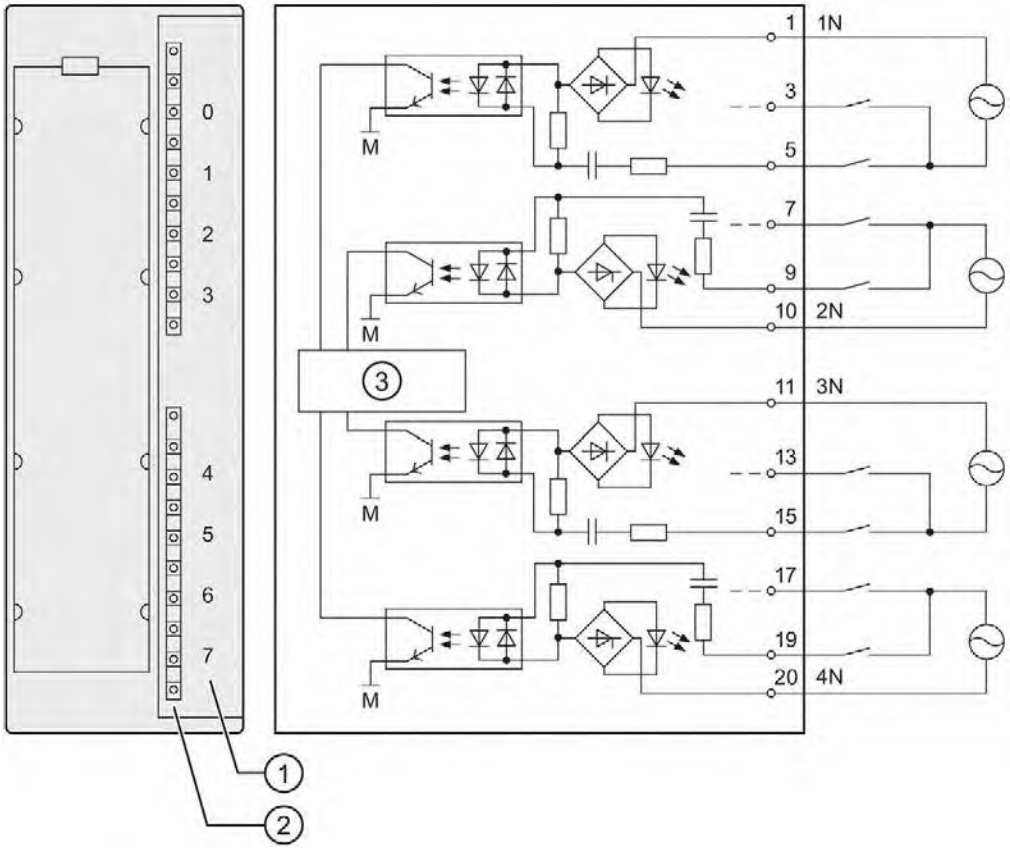
6AG1321-1FF01-2AA0

### Properties

Properties of SM 321, DI 8 x AC 120/230 V:

- 8 inputs, electrically isolated in groups of 2
- Rated input voltage 120/230 VAC
- suitable for switches and 2-/3-wire AC proximity switches

### Wiring and block diagram of SM 321; DI 8 x AC 120/230 V




① Channel number
② Status display - green
③ Backplane bus interface



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## SM 321; DI 8 x AC 120/230 V - Technical specifications

| | |
|---|---|
| **Technical specifications** | |
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 240 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of inputs | 8 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Number of simultaneously controlled inputs | |
| • horizontal mounting position<br>to 60 °C | 8 |
| • vertical mounting position<br>to 40 °C | 8 |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels<br>in groups of | yes<br>2 |
| Maximum potential difference | |
| • between $M_{internal}$ and inputs | 230 VAC |
| • between inputs of different groups | 500 VAC |
| Isolation test voltage | 4000 VDC |
| Current consumption<br>• from the backplane bus | <br>max. 29 mA |
| Power loss of the module | typ. 4.9 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |



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| **Technical specifications** | |
|---|---|
| **Sensor selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal<br>• Frequency band | <br>120/230 VAC<br>79 V to 264 V<br>0 V to 40 V<br>47 Hz to 63 Hz |
| Input current<br>• "1" signal<br>120 V, 60 Hz<br>230 V, 50 Hz | <br><br>typ. 6.5 mA<br>typ. 11 mA |
| Input delay<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>max. 25 ms<br>max. 25 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 2 mA |
| Wiring of the signal transducers | using a 20-pin front connector |



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# 3.18 Digital input module SM 321; DI 8 x AC 120/230 V ISOL; (6ES7321-1FF10-0AA0)

## Order number

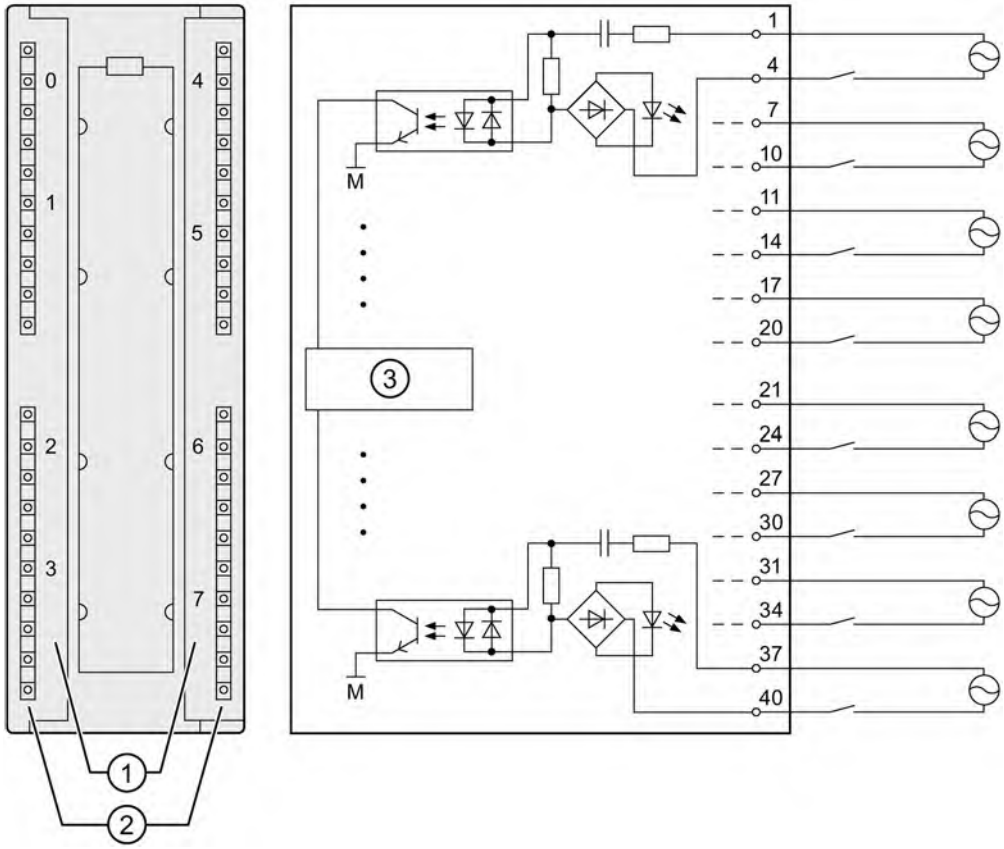
6ES7321-1FF10-0AA0

## Properties

Properties of the digital input module SM 321; DI 8 x AC 120/230 V ISOL:

- 8 inputs, electrically isolated in groups of 1
- Rated input voltage 120/230 VAC
- Suitable for switches and 2-/3-/4-wire AC proximity switches

## Wiring and block diagrams of SM 321; DI 8 x AC 120/230 V ISOL




① Channel number
② Status display - green
③ Backplane bus interface



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## SM 321; DI 8 x AC 120/230 V ISOL - Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W × H × D | 40 × 125 × 117 |
| Weight | ca. 240 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of inputs | 8 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L1<br>All load voltages must be connected to a common phase | 120/230 VAC |
| Number of simultaneously controlled inputs | |
| • Horizontal mounting position to 60 °C | 8 |
| • Vertical mounting position to 40 °C | 8 |
| Electrical isolation | |
| • Between channels and the backplane bus | Yes |
| • between channels<br>in groups of | Yes<br>1 |
| Maximum potential difference | |
| • between $M_{internal}$ and inputs | 230 VAC |
| • between inputs of different groups | 500 VAC |
| Isolation test voltage | |
| • between $M_{internal}$ and inputs | 1500 VAC |
| • between inputs of different groups | 2000 VAC |
| Current consumption | |
| • from the backplane bus | max. 100 mA |
| Power loss of the module | typ. 4.9 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |



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| **Technical specifications** | |
|---|---|
| **Sensor selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal<br>• Frequency band | <br>120/230 VAC<br>79 V to 264 V<br>0 V to 40 V<br>47 Hz to 63 Hz |
| Input current<br>• "1" signal<br>120 V, 60 Hz<br>230 V, 50 Hz | <br><br>typ. 7.5 mA<br>typ. 17.3 mA |
| Input delay<br>• "0" to "1" transition<br>• "0" to "1" transition | <br>max. 25 ms<br>max. 25 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs | supported |
| • Permissible quiescent current | max. 2 mA |
| Wiring of the signal sensors | using a 40-pin front connector |



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# 3.19 Digital output module SM 322; DO 64 x DC 24 V/0.3 A sourcing; (6ES7322-1BP00-0AA0)

## Order number

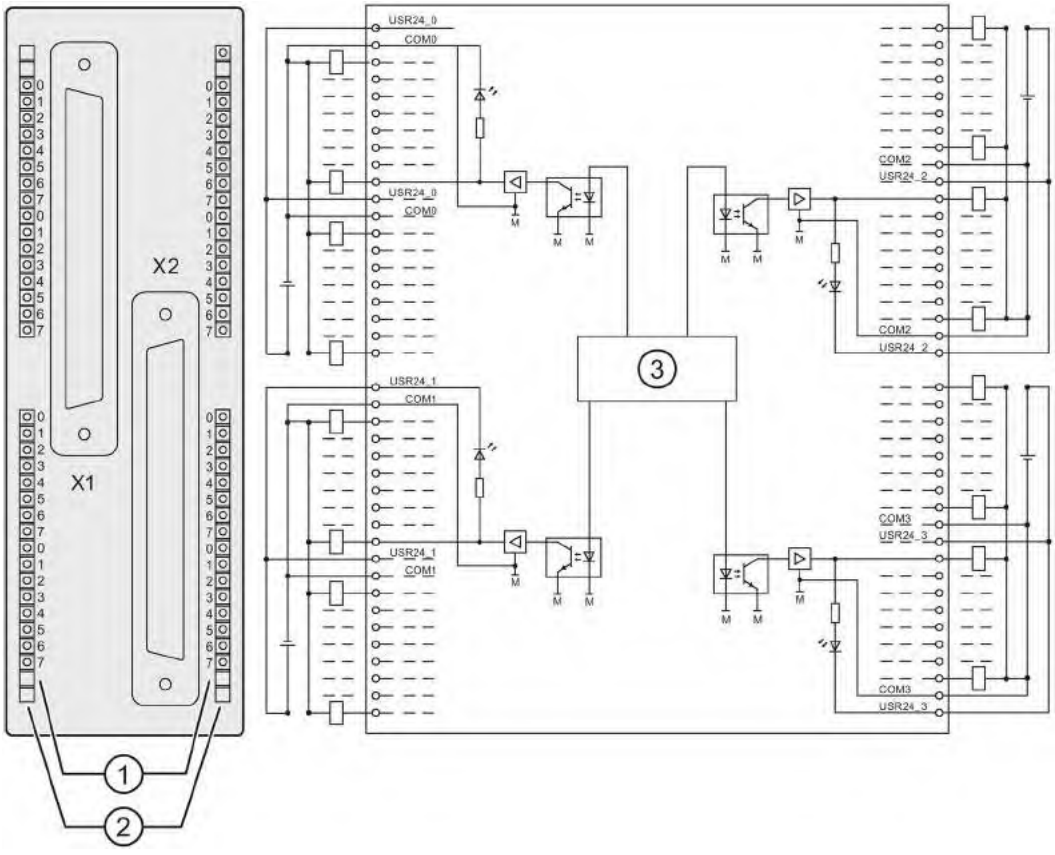
6ES7322-1BP00-0AA0

## Properties

Properties of SM 322; DO 64 x DC 24 V/0,3 A Sourcing:

- 64 outputs, isolated in 4 groups of 16
- Rated load voltage 24 V DC

## Wiring and block diagram of SM 322; DO 64 x DC 24 V/0,3 A Sourcing



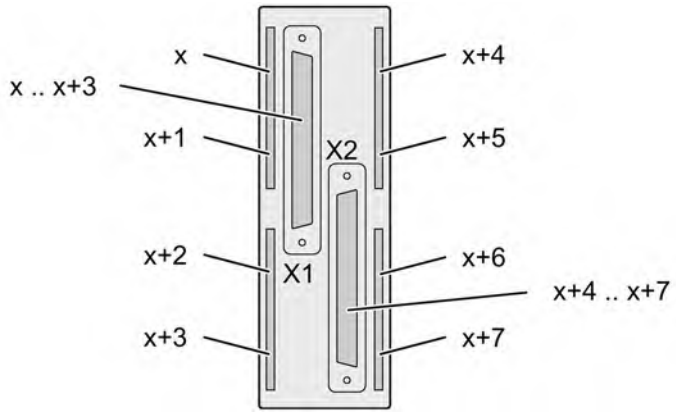

① Channel number
② Status display - green
③ Backplane bus interface



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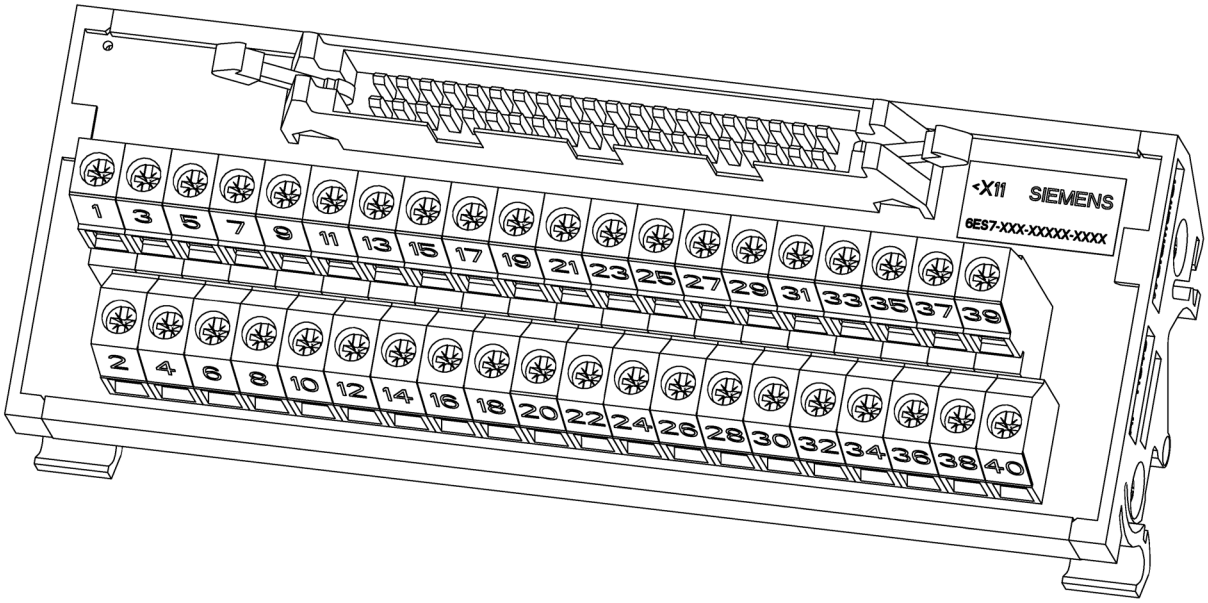
## Terminal assignment of SM 322; DO 64 x DC 24 V/0,3 A Sourcing

The figure below shows how channels are assigned to addresses (output byte x up to output byte x+7).




## 40-pin terminal block

SM 322; DO 64 x DC 24 V/0,3 A Sourcing features two terminal blocks for connecting actuators and sensors to the module front connector. A connecting cable is used to establish the module connections.






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The table below shows how channel terminals are assigned to the connector for module SM 322; DO 64 x DC 24 V/0,3 A Sourcing.

| Terminal | Function | | Terminal | Function |
|---|---|---|---|---|
| 1 | O x.0 | | 2 | O x+2.0 |
| 3 | O x.1 | | 4 | O x+2.1 |
| 5 | O x.2 | | 6 | O x+2.2 |
| 7 | O x.3 | | 8 | O x+2.3 |
| 9 | O x.4 | | 10 | O x+2.4 |
| 11 | O x.5 | | 12 | O x+2.5 |
| 13 | O x.6 | | 14 | O x+2.6 |
| 15 | O x.7 | | 16 | O x+2.7 |
| 17 | 1M | | 18 | 2M |
| 19 | 1L+ | | 20 | 2L+ |
| 21 | O x+1.0 | | 22 | O x+3.0 |
| 23 | O x+1.1 | | 24 | O x+3.1 |
| 25 | O x+1.2 | | 26 | O x+3.2 |
| 27 | O x+1.3 | | 28 | O x+3.3 |
| 29 | O x+1.4 | | 30 | O x+3.4 |
| 31 | O x+1.5 | | 32 | O x+3.5 |
| 33 | O x+1.6 | | 34 | O x+3.6 |
| 35 | O x+1.7 | | 36 | O x+3.7 |
| 37 | 1M | | 38 | 2M |
| 39 | 1L+ | | 40 | 2L+ |

**Note**

Connections x M and x L+ must be connected to a channel group.



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## Technical specifications of SM 322, DO 64 x DC 24 V, 0,3 A Sourcing

| | |
|---|---|
| **Technical specifications** | |
| **Dimensions and weight** | |
| Dimensions (W x H x D) (mm) | 40 x 125 x 112 (including protective barrier, required for connections which are not in use) |
| Weight | ca. 260 g |
| **Module-specific data** | |
| Supports isochronous mode | No |
| Number of outputs | 64 |
| Cable length<br>• Unshielded<br>• Shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+ | 24 V DC |
| Total current of outputs (per group) | |
| For horizontal installation<br>• Up to 25 °C<br>• to 40 °C<br>• to 60 °C | <br>max. 2.0 A<br>max. 1.6 A<br>max. 1.2 A |
| For vertical installation<br>• to 40 °C<br>• Up to 25 °C | <br>max. 1.6 A<br>max. 2.0 A |
| Electrical isolation | |
| • Between channels and the backplane bus<br>• Between channels<br>– In groups of | Yes<br>Yes<br>16 |
| Isolation test voltage | 500 VDC |
| Current consumption<br>• From the backplane bus<br>• From the user 24 V (L+) (separately for each group; no load) | <br>Max. 100 mA<br>Max. 75 mA |
| Power loss of the module | Typ. 6.0 W |



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| **Technical specifications** | |
|---|---|
| **Status, interrupts, diagnostics** | |
| Status display | Green LED per channel |
| Interrupts | None |
| Diagnostic functions | None |
| Actuator selection data | |
| Output type<br>Output voltage<br>• "1" signal | M switching<br>24 V DC<br>L+ (-0.5 V) |
| Output current<br>• "1" signal<br>– Rated value<br>– Permitted range<br>• "0" signal (residual current) | <br><br>Typ. 0.3 A<br>2.4 mA to 0.36 A<br><100 µA |
| Output delay (resistive load)<br>• "0" to "1" transition<br>• "1" to "0" transition | <br><550 µs<br><550 µs |
| Load resistance range | 80 Ω to 10 kΩ |
| Lamp load | Max. <5 W |
| Wiring two outputs in parallel<br>• For redundant load control<br>• For performance increase | <br>supported (with external diode)<br>not supported |
| Control of a digital input | supported |
| Switching frequency<br>• with resistive load<br>• With inductive load to IEC 947-5-1, DC 13[1]<br>• With lamp load | <br>Max. <100 Hz<br>Max. <0.5 Hz<br>Max. <10 Hz |
| Internal limiting of the inductive shutdown voltage to: | 53 V typ. |
| Short-circuit-proof output<br>• Response threshold: | Yes, electronic<br>0.7 A to 1.9 A typ. |
| Wiring of the actuators | Two 40-pin terminal blocks |
| [1] For loads above 200 mA, a terminal diode is required for the inductive load. | |

## STEP 7 integration

64-channel I/O modules are integrated with the HSP 2019 V 1.0. The HSP forms part of STEP 7 V 5.4 SP2 and can be installed from STEP 7 V 5.4 and higher.



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## GSD/GSDML files

The 64-channel I/O modules are supported by the ET 200M versions listed below. Download the corresponding GSD/GSDML files from the following link: on the Internet (http://www.siemens.com/automation/service).

- To search for PROFIBUS GSD files, type in the entry ID 113498.
- To search for PROFINET GSDML files, type in the entry ID: 25057900.

## PROFIBUS

- IM 153-1, as of 6ES7153-1AA03-0XB0, E12 with GSD file SI01801D.*, version V 1.5
- IM 153-2, as of 6ES7153-2BA02-0XB0, E01 with GSD file SI04801E.*, version V 1.0

## PROFINET

- IM 153-4 PN, as of 6ES7153-4AA00-0XB0 with GSDML file version V 2.1
- IM153-4 PN IO HF, as of 6ES7153-4BA00-0XB0 with GSDML file version V2.1

## Using the module in S7-300 and ET 200M

If the station is configured with STEP 7, you can use the digital output module SM 322 with all CPUs in the following table. Startup cannot be performed if no configuration is loaded.

| C-CPUs (compact CPUs) | Order number |
|---|---|
| CPU 312C | 6ES7312-5BD0x-0AB0 |
| | 6ES7312-5BE03-0AB0 |
| | 6ES7312-5BF04-0AB0 |
| CPU 313C | 6ES7313-5BE0x-0AB0 |
| | 6ES7313-5BF03-0AB0 |
| | 6ES7313-5BG04-0AB0 |
| CPU 313C-2 DP | 6ES7313-6CE0x-0AB0 |
| | 6ES7313-6CF03-0AB0 |
| | 6ES7313-6CG04-0AB0 |
| CPU313C-2 PtP | 6ES7313-6BE0x-0AB0 |
| | 6ES7313-6BF03-0AB0 |
| | 6ES7313-6BG04-0AB0 |
| CPU 314C-2 DP | 6ES7314-6CF0x-0AB0 |
| | 6ES7314-6CG03-0AB0 |
| | 6ES7314-6CH04-0AB0 |
| CPU 314C-2 PtP | 6ES7314-6BF0x--0AB0 |
| | 6ES7314-6BG03--0AB0 |
| | 6ES7314-6BH04-0AB0 |
| CPU314C-2 PN/DP | 6ES7314-6EH04-0AB0 |



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| M-CPUs | Order number |
|---|---|
| CPU 312 | 6ES7312-1AD1x-0AB0 |
| | 6ES7312-1AE13-0AB0 |
| | 6ES7312-1AE14-0AB0 |
| CPU 314 | 6ES7314-1AF1x-0AB0 |
| | 6ES7314-1AG13-0AB0 |
| | 6ES7314-1AG14-0AB0 |
| CPU 315-2 DP | 6ES7315-2AF0x-0AB0 |
| | 6ES7315-2AG10-0AB0 |
| | 6ES7315-2AH14-0AB0 |
| CPU 316-2 DP | 6ES7316-2AG00-0AB0 |
| CPU 317-2 DP | 6ES7317-2AJ10-0AB0 |
| | 6ES7317-2AK14-0AB0 |
| CPU 315-2 PN/DP | 6ES7315-2EG10-0AB0 |
| | 6ES7315-2EH13-0AB0 |
| | 6ES7315-2EH14-0AB0 |
| CPU 317-2 PN/DP | 6ES7317-2EJ10-0AB0 |
| | 6ES7317-2EK13-0AB0 |
| | 6ES7317-2EK14-0AB0 |
| CPU 319-3 PN/DP | 6ES7318-3EL00-0AB0 |
| | 6ES7318-3EL01-0AB0 |

| F-CPUs | Order number |
|---|---|
| CPU 315F-2 DP | 6ES7315-6FF0x-0AB0 |
| CPU 317F-2 DP | 6ES7317-6FF0x-0AB0 |
| CPU 315F-2 PN/DP | 6ES7315-2FH1x-0AB0 |
| | 6ES7315-2FJ14-0AB0 |
| CPU 317F-2 PN/DP | 6ES7317-2FJ10-0AB0 |
| | 6ES7317-2FK13-0AB0 |
| | 6ES7317-2FK14-0AB0 |
| CPU 319F-3 PN/DP | 6ES7318-3FL00-0AB0 |
| | 6ES7318-3FL01-0AB0 |



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| T-CPUs | Order number |
|---|---|
| CPU 315T-2 DP | 6ES7315-6TG10-0AB0 |
| CPU315T-3 PN/DP | 6ES7315-7TJ10-0AB0 |
| CPU 317T-2 DP | 6ES7317-6TJ10-0AB0 |
| CPU317TF-2 DP | 6ES7317-6TF14-0AB0 |
| CPU317T-3 PN/DP | 6ES7317-7TK10-0AB0 |
| CPU317TF-3 PN/DP | 6ES7317-7UL10-0AB0 |

| C7-CPUs | Order number |
|---|---|
| C7-613 | 6ES7613-1CA01-0AE3 |
| C7-635 Touch | 6ES7635-2EB01-0AE3 |
| C7-635 Key | 6ES7635-2EC01-0AE3 |
| C7-636 Touch | 6ES7636-2EB00-0AE3 |
| C7-636 Key | 6ES7636-2EC00-0AE3 |

**WARNING**

**Use of the module**

This module must be configured in a STEP 7 project in which the correct address assignment and allocation of the input/output point is ensured. Using the module without having first carried out this configuration work can lead to machines or processes operating in an unexpected manner.

If machines or processes do run in an unexpected manner, this can result in death, serious injury, and/or material damage.



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# 3.20 Digital output module SM 322; DO 64 x DC 24 V/0.3 A Sinking (6ES7322-1BP50-0AA0)

## Order number

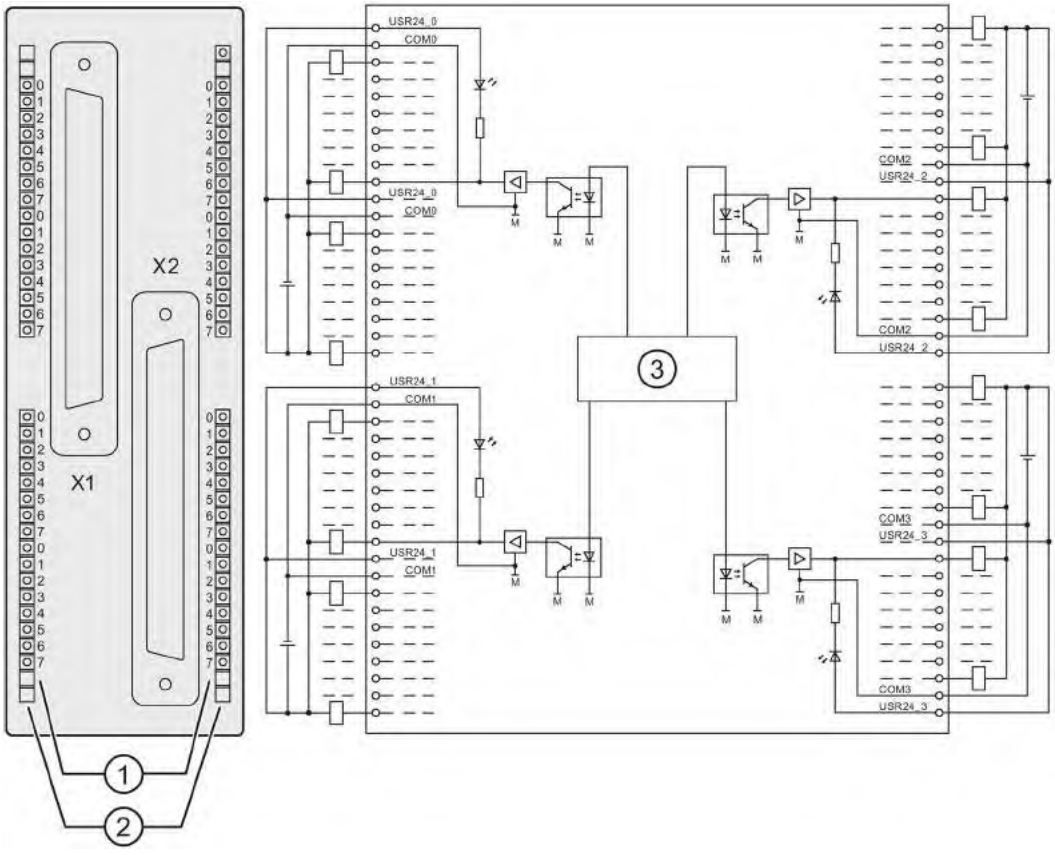
6ES7322-1BP50-0AA0

## Properties

Characteristics of the SM 322; DO 64 x DC 24 V, 0,3 A Sinking digital output module:

- 64 outputs, isolated in 4 groups of 16
- Rated load voltage 24 V DC

## Wiring and block diagram of SM 322; DO 64 x DC 24 V, 0,3 A Sinking



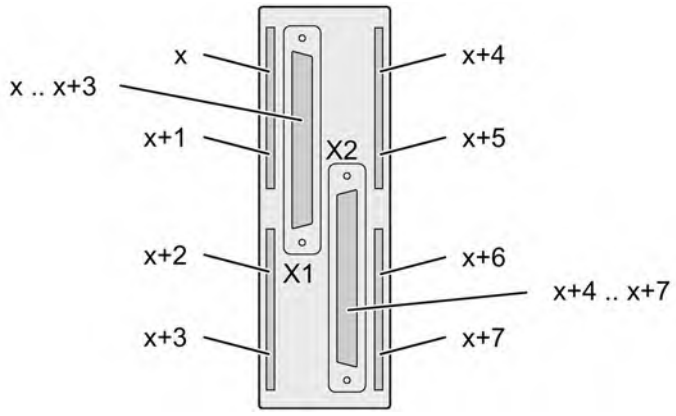

① Channel number
② Status display - green
③ Backplane bus interface



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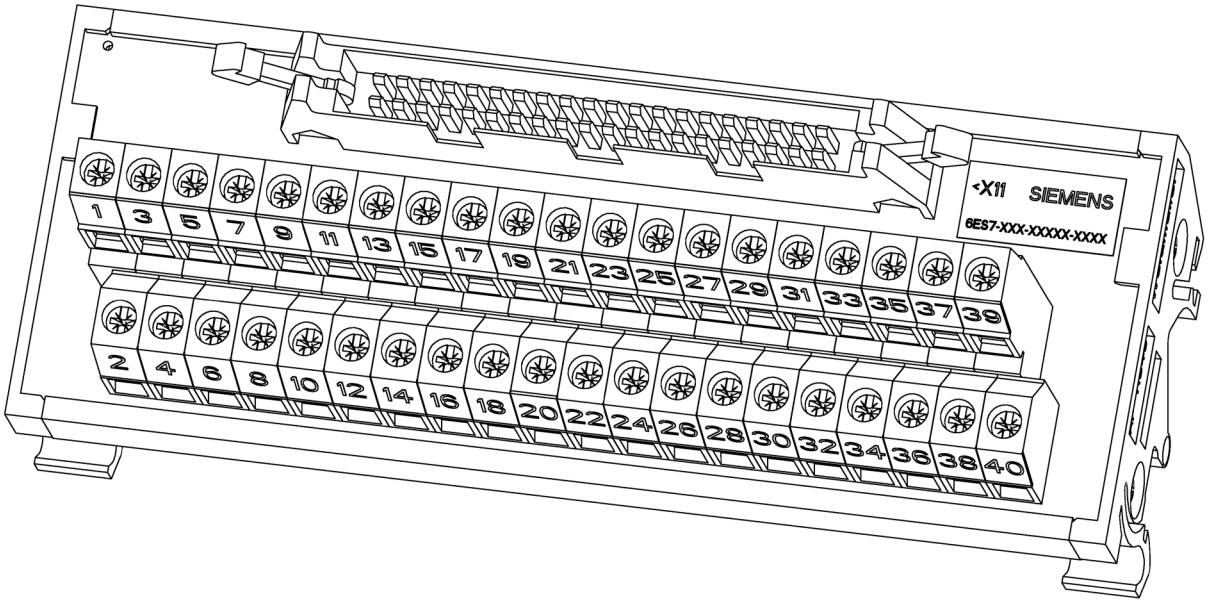
## Terminal assignment of SM 322; DO 64 x DC 24 V, 0,3 A Sinking

The figure below shows how channels are assigned to addresses (output byte x to output byte x+7).




## 40-pin terminal block

SM 322; DO 64 x DC 24 V/0,3 A Sinking features two terminal blocks for connecting actuators and sensors to the module front connector. A connecting cable is used to establish the module connections.






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The table below shows how channel terminals are assigned to the terminal block for module SM 322; DO 64 x DC 24 V/0,3 A Sinking..

| Terminal | Function | | Terminal | Function |
|---|---|---|---|---|
| 1 | O x.0 | | 2 | O x+2.0 |
| 3 | O x.1 | | 4 | O x+2.1 |
| 5 | O x.2 | | 6 | O x+2.2 |
| 7 | O x.3 | | 8 | O x+2.3 |
| 9 | O x.4 | | 10 | O x+2.4 |
| 11 | O x.5 | | 12 | O x+2.5 |
| 13 | O x.6 | | 14 | O x+2.6 |
| 15 | O x.7 | | 16 | O x+2.7 |
| 17 | 1M | | 18 | 2M |
| 19 | 1L+ | | 20 | 2L+ |
| 21 | O x+1.0 | | 22 | O x+3.0 |
| 23 | O x+1.1 | | 24 | O x+3.1 |
| 25 | O x+1.2 | | 26 | O x+3.2 |
| 27 | O x+1.3 | | 28 | O x+3.3 |
| 29 | O x+1.4 | | 30 | O x+3.4 |
| 31 | O x+1.5 | | 32 | O x+3.5 |
| 33 | O x+1.6 | | 34 | O x+3.6 |
| 35 | O x+1.7 | | 36 | O x+3.7 |
| 37 | 1M | | 38 | 2M |
| 39 | 1L+ | | 40 | 2L+ |

**Note**

Terminals x M and x L+ must be connected on the terminal block.

## Technical specifications of SM 322, DO 64 x DC 24 V, 0,3 A (Sinking)

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions (W x H x D) (mm) | 40 x 125 x 112 (including protective barrier, required for connections which are not in use) |
| Weight | ca. 260 g |
| **Module-specific data** | |
| Supports isochronous mode | No |
| Number of outputs | 64 |
| Cable length<br>• Unshielded<br>• Shielded | <br>Max. 600 m<br>Max. 1000 m |



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| **Technical specifications** | |
|---|---|
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+ | 24 V DC |
| Total current of outputs (per group) | |
| For horizontal installation<br>• Up to 25 °C<br>• to 40 °C<br>• to 60 °C | <br>max. 2.0 A<br>max. 1.6 A<br>max. 1.2 A |
| For vertical installation<br>• to 40 °C<br>• Up to 25 °C | <br>max. 1.6 A<br>max. 2.0 A |
| Electrical isolation<br>• Between channels and the backplane bus<br>• Between channels<br>In groups of | <br>Yes<br>Yes<br>16 |
| Isolation test voltage | 500 VDC |
| Current consumption<br>• From the backplane bus<br>• From load voltage L+ (no load) | <br>max. 100 mA<br>max. 75 mA |
| Power loss of the module | Typ. 6.0 W |
| **Status, interrupts, diagnostics** | |
| Status display | Green LED per channel |
| Interrupts | None |
| Diagnostic functions | None |
| Actuator selection data | |
| Output type<br>Output voltage<br>• "1" signal | Sinking<br>24 V DC<br>M+ (0.5 V) at full load |
| Output current<br>"1" signal<br>• Rated value<br>• Permitted range<br>"0" signal (residual current) | <br><br>Typ. 0.3 A<br>2.4 mA to 0.36 A<br><100 µA |
| Output delay (resistive load)<br>• "0" to "1" transition<br>• "1" to "0" transition | <br><450 µs<br><450 µs |
| Load resistance range | 80 Ω to 10 kΩ |
| Lamp load | Max. 5 W |
| Wiring two outputs in parallel<br>• for redundant load control<br>• for performance increase | <br>supported (with external diode)<br>not supported |



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| Technical specifications | |
|---|---|
| Control of a digital input | supported |
| Switching frequency<br>• With resistive load<br>• With inductive load to IEC 947-5-1, DC 13[1]<br>• With lamp load | <br>Max. 100 Hz<br>Max. 0.5 Hz<br>Max. 10 Hz |
| Internal limiting of the inductive shutdown voltage to: | Typ. 45 V |
| Short-circuit protection of the output<br>• Response threshold | Yes, electronic<br>1.7 A to 3.5 A typ. |
| Wiring of the actuators | Two 40-pin terminal blocks |
| [1] For loads above 200 mA, a terminal diode is required for the inductive load. | |

## Recommended fuse

Groups of outputs must be protected by a 4 A/125 V fast-blow fuse (recommended: Littelfuse 235 004P 125 V 4 A). If the fuse is installed in a danger zone in accordance with the National Electric Code (NEC), you must always use a suitable tool to remove it. Before removing or replacing the fuse, you must determine whether or not you are dealing with a danger zone.

## STEP 7 integration

64-channel I/O modules are integrated with the HSP 2019 V 1.0. The HSP forms part of STEP 7 V 5.4 SP2 and can be installed from STEP 7 V 5.4 and higher.

## GSD/GSDML files

The 64-channel I/O modules are supported by the ET 200M versions listed below. Download the corresponding GSD/GSDML files from the following link: on the Internet (http://www.siemens.com/automation/service).

- To search for PROFIBUS GSD files, type in the entry ID 113498.
- To search for PROFINET GSDML files, type in the entry ID: 25057900.

## PROFIBUS

- IM 153-1, as of 6ES7153-1AA03-0XB0, E12 with GSD file SI01801D.*, version V 1.5
- IM 153-2, as of 6ES7153-2BA02-0XB0, E01 with GSD file SI04801E.*, version V 1.0

## PROFINET

- IM 153-4 PN, as of 6ES7153-4AA00-0XB0 with GSDML file version V 2.1
- IM153-4 PN IO HF, as of 6ES7153-4BA00-0XB0 with GSDML file version V2.1



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## Using the module in S7-300 and ET 200M

If the station is configured with STEP 7, you can use the digital output module SM 322 with all CPUs in the following table. Startup cannot be performed if no configuration is loaded.

| C-CPUs (compact CPUs) | Order number |
|---|---|
| CPU 312C | 6ES7312-5BD0x-0AB0 |
| | 6ES7312-5BE03-0AB0 |
| | 6ES7312-5BF04-0AB0 |
| CPU 313C | 6ES7313-5BE0x-0AB0 |
| | 6ES7313-5BF03-0AB0 |
| | 6ES7313-5BG04-0AB0 |
| CPU 313C-2 DP | 6ES7313-6CE0x-0AB0 |
| | 6ES7313-6CF03-0AB0 |
| | 6ES7313-6CG04-0AB0 |
| CPU313C-2 PtP | 6ES7313-6BE0x-0AB0 |
| | 6ES7313-6BF03-0AB0 |
| | 6ES7313-6BG04-0AB0 |
| CPU 314C-2 DP | 6ES7314-6CF0x-0AB0 |
| | 6ES7314-6CG03-0AB0 |
| | 6ES7314-6CH04-0AB0 |
| CPU 314C-2 PtP | 6ES7314-6BF0x--0AB0 |
| | 6ES7314-6BG03--0AB0 |
| | 6ES7314-6BH04-0AB0 |
| CPU314C-2 PN/DP | 6ES7314-6EH04-0AB0 |

| M-CPUs | Order number |
|---|---|
| CPU 312 | 6ES7312-1AD1x-0AB0 |
| | 6ES7312-1AE13-0AB0 |
| | 6ES7312-1AE14-0AB0 |
| CPU 314 | 6ES7314-1AF1x-0AB0 |
| | 6ES7314-1AG13-0AB0 |
| | 6ES7314-1AG14-0AB0 |
| CPU 315-2 DP | 6ES7315-2AF0x-0AB0 |
| | 6ES7315-2AG10-0AB0 |
| | 6ES7315-2AH14-0AB0 |
| CPU 316-2 DP | 6ES7316-2AG00-0AB0 |
| CPU 317-2 DP | 6ES7317-2AJ10-0AB0 |
| | 6ES7317-2AK14-0AB0 |
| CPU315-2 PN/DP | 6ES7315-2EG10-0AB0 |
| | 6ES7315-2EH13-0AB0 |
| | 6ES7315-2EH14-0AB0 |
| CPU317-2 PN/DP | 6ES7317-2EJ10-0AB0 |
| | 6ES7317-2EK13-0AB0 |
| | 6ES7317-2EK14-0AB0 |
| CPU 319-3 PN/DP | 6ES7318-3EL00-0AB0 |
| | 6ES7318-3EL01-0AB0 |



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| F-CPUs | Order number |
|---|---|
| CPU 315F-2 DP | 6ES7315-6FF0x-0AB0 |
| CPU 317F-2 DP | 6ES7317-6FF0x-0AB0 |
| CPU315F-2 PN/DP | 6ES7315-2FH1x-0AB0 |
| | 6ES7315-2FJ14-0AB0 |
| CPU 317F-2 PN/DP | 6ES7317-2FJ10-0AB0 |
| | 6ES7317-2FK13-0AB0 |
| | 6ES7317-2FK14-0AB0 |
| CPU 319F-3 PN/DP | 6ES7318-3FL00-0AB0 |
| | 6ES7318-3FL01-0AB0 |

| T-CPUs | Order number |
|---|---|
| CPU 315T-2 DP | 6ES7315-6TG10-0AB0 |
| CPU315T-3 PN/DP | 6ES7315-7TJ10-0AB0 |
| CPU317T-2 DP | 6ES7317-6TJ10-0AB0 |
| CPU317TF-2 DP | 6ES7317-6TF14-0AB0 |
| CPU317T-3 PN/DP | 6ES7317-7TK10-0AB0 |
| CPU317TF-3 PN/DP | 6ES7317-7UL10-0AB0 |

| C7-CPUs | Order number |
|---|---|
| C7-613 | 6ES7613-1CA01-0AE3 |
| C7-635 Touch | 6ES7635-2EB01-0AE3 |
| C7-635 Key | 6ES7635-2EC01-0AE3 |
| C7-636 Touch | 6ES7636-2EB00-0AE3 |
| C7-636 Key | 6ES7636-2EC00-0AE3 |

**WARNING**

**Use of the module**

This module must be configured in a STEP 7 project in which the correct address assignment and allocation of the input/output point is ensured. Using the module without having first carried out this configuration work can lead to machines or processes operating in an unexpected manner.

If machines or processes do run in an unexpected manner, this can result in death, serious injury, and/or material damage.



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# 3.21 Digital output module SM 322; DO 32 x DC 24 V/ 0.5 A; (6ES7322-1BL00-0AA0)

## Order number

6ES7322-1BL00-0AA0

## Properties

Properties of SM 322; DO 32 **x** DC 24 V/0.5 A:

- 32 outputs, electrically isolated in groups of 8
- Output current 0.5 A
- Rated load voltage 24 V DC
- Suitable for solenoid valves, DC contactors and signal lamps

## Use of the module with high-speed counters

Please note when using the module in combination with high-speed counters:

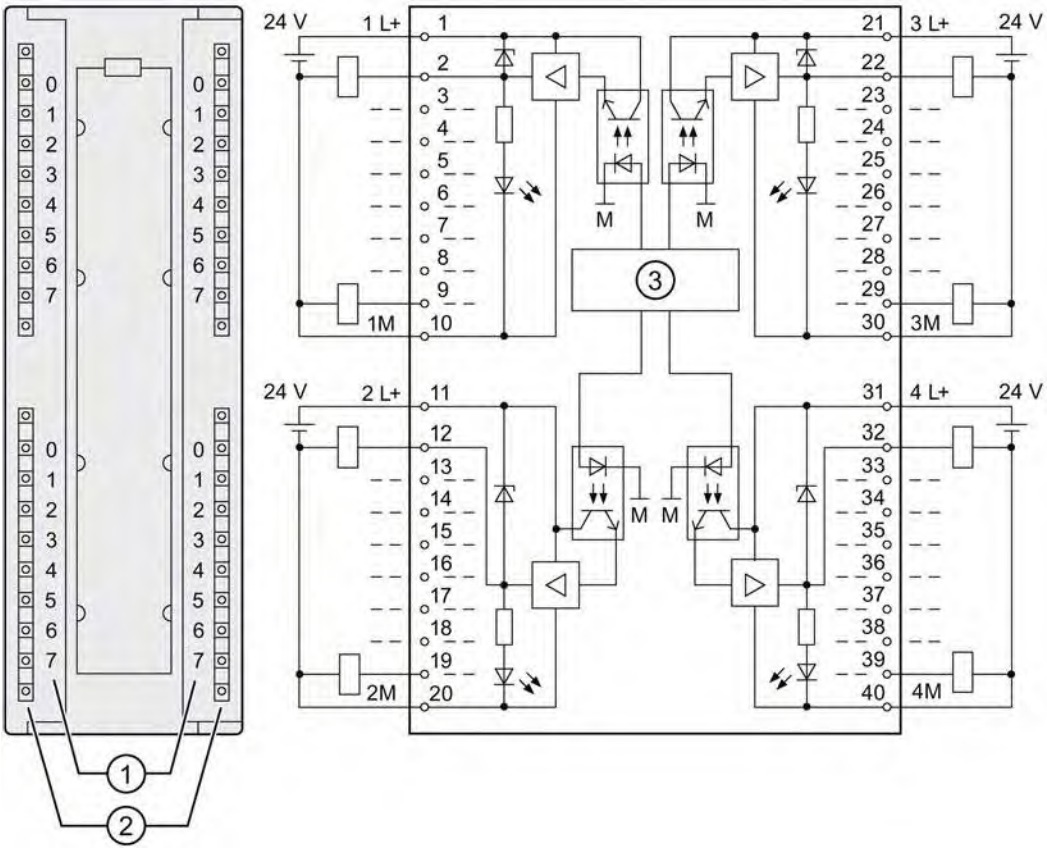
**Note**

When using a mechanical contact to switch on the 24-V power supply to SM 322; DO 32 x DC 24 V/0.5 A, its outputs will carry "1" signal for the duration of ca. 50 µs due to the circuit structure.



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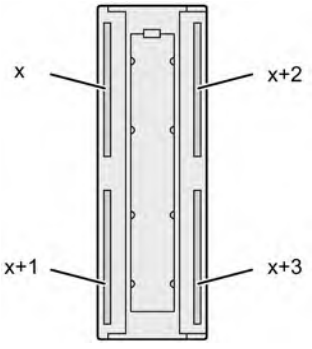
## Wiring and block diagram of SM 322; DO 32 x DC 24 V/ 0.5 A




① Channel number
② Status display - green
③ Backplane bus interface

## Terminal assignment

The figure below shows the channel addressing (output byte x to output byte x+3).






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## SM 322; DO 32 x DC 24 V/ 0.5 A - Technical specifications

| | |
|---|---|
| **Technical specifications** | |
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 260 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of outputs | 32 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+ | 24 V DC |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 40 °C<br>to 60 °C | <br>max. 4 A<br>max. 3 A |
| • vertical mounting position<br>to 40 °C | max. 2 A |
| Electrical isolation<br>• between channels and the backplane bus | <br>yes |
| • between channels<br>in groups of | yes<br>8 |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 110 mA<br>max. 160 mA |
| Power loss of the module | typ. 6.6 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |



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| **Technical specifications** | |
|---|---|
| **Actuator selection data** | |
| Output voltage<br>• "1" signal | <br>min. L + (- 0.8 V) |
| Output current | |
| • "1" signal<br>Rated value<br>Permitted range | <br>0.5 A<br>5 mA to 0.6 A |
| • "0" signal (residual current) | max. 0.5 mA |
| Output delay (resistive load) | |
| • "0" to "1" transition | max. 100 µs |
| • "1" to "0" transition | max. 500 µs |
| Load resistance range | 48 Ω to 4 kΩ |
| Lamp load | max. 5 W |
| Wiring two outputs in parallel | |
| • For redundant load control | supported (only outputs of the same group) |
| • For performance increase | Not supported |
| Control of a digital input | Supported |
| Switching frequency | |
| • with resistive load | max. 100 Hz |
| • with inductive load to IEC 947-5-1, DC 13 | max. 0.5 Hz |
| • with lamp load | max. 10 Hz |
| Internal limiting of the inductive shutdown voltage to | typ. L + (-53 V) |
| Short-circuit protection of the output | yes, electronic |
| • Threshold | typ. 1 A |
| Wiring of the actuators | using a 40-pin front connector |



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# 3.22 Digital output module SM 322; DO 32 x AC 120/230 V/1 A; (6ES7322-1FL00-0AA0)

## Order number

6ES7322-1FL00-0AA0

## Properties

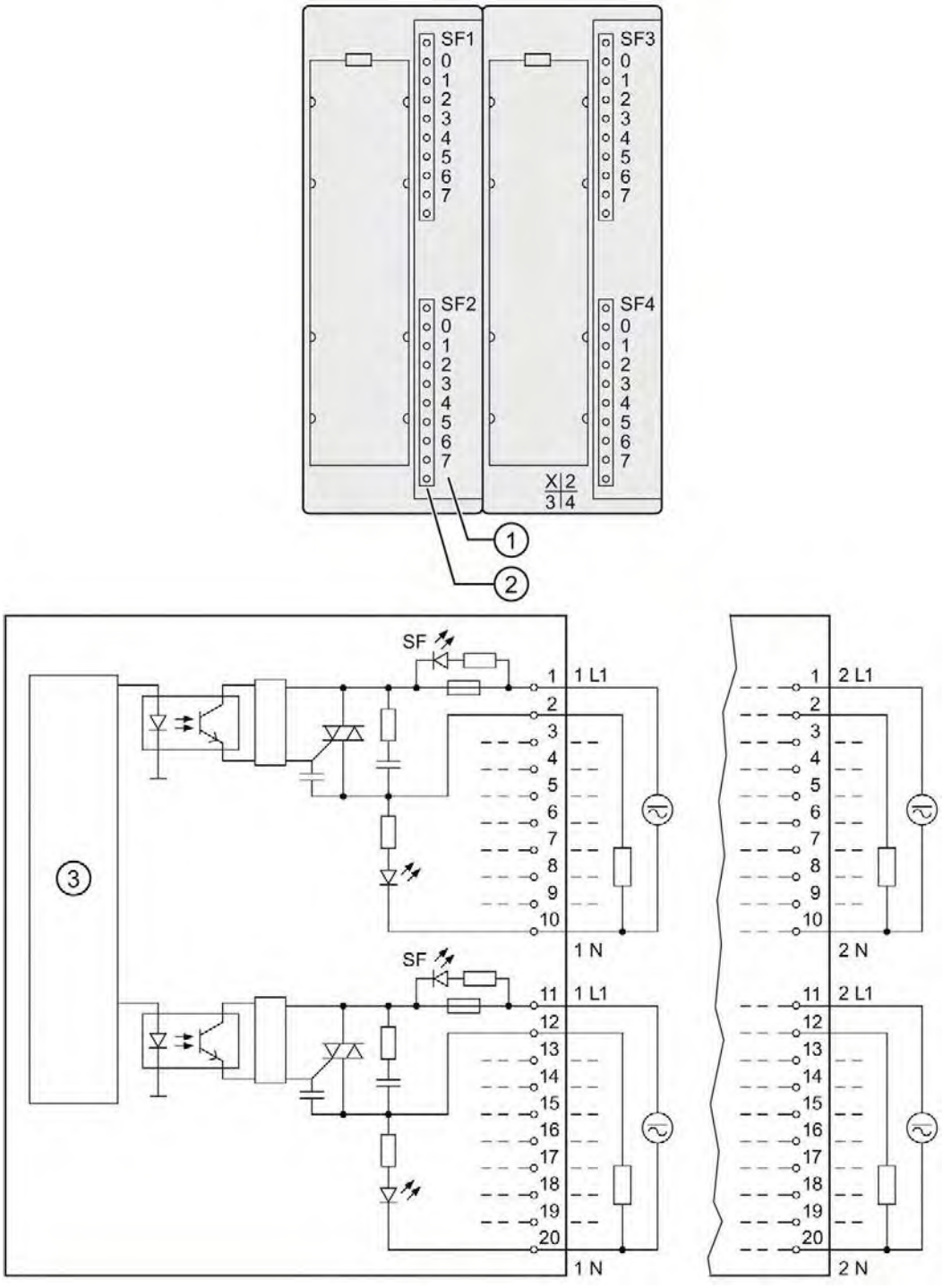
Properties of SM 322; DO 32 x AC 120/230 V/1 A:

- 32 outputs, fused and electrically isolated in groups of 8
- Output current 1.0 A
- Rated load voltage 120/230 VAC
- Blown fuse indicator for each group
- Suitable for AC solenoids, contactors, starters, FHP motors and signal lamps
- Group error display (SF)



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## Wiring and block diagram of SM 322; DO 32 x AC 120/230 V/1 A



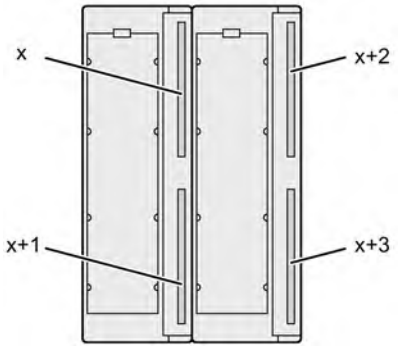

① Channel numbers
② Status display - green
Error LED - red
③ Backplane bus interface



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## Terminal assignment

The figure below shows the channel addressing (output byte x to output byte x+3).




## SM 322; DO 32 x AC 120/230 V/1 A - Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 80 x 125 x 117 |
| Weight | ca. 500 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of outputs | 32 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L1 | 120/230 VAC |
| • Maximum frequency range | 47 Hz to 63 Hz |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 60 °C<br>to 40 °C | <br>max. 3 A<br>max. 4 A |
| • vertical mounting position<br>• to 40 °C | <br>max. 4 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels<br>in groups of | yes<br>8 |
| Maximum potential difference | |
| • between $M_{internal}$ and outputs | 250 VAC |
| • between outputs of different groups | 250 VAC |



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| **Technical specifications** | |
|---|---|
| Isolation test voltage | 4000 VDC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L1 (no-load) | <br>max. 190 mA<br>max. 10 mA |
| Power loss of the module | typ. 25 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | no |
| Diagnostic functions<br>• Group error display | yes<br>red LED (SF) |
| **Actuator selection data** | |
| Output voltage<br>• "1" signal | <br>min. L1 (-0.8 V) |
| Output current<br>• "1" signal<br>Rated value<br>Permitted range<br>Maximum inrush current (per group) | <br><br>1 A<br>10 mA to 1 A<br>10 A (for two AC cycles) |
| • "0" signal (residual current) | max. 2 mA |
| Output delay (resistive load) | |
| • "0" to "1" transition | 1 AC cycle |
| • "1" to "0" transition | 1 AC cycle |
| Blocking voltage<br>zero transition | <br>max. 60 V |
| Size of the motor starter | max. size 4 to NEMA |
| Lamp load | max. 50 W |
| Wiring two outputs in parallel | |
| • for redundant load control | supported (only outputs of the same group) |
| • for performance increase | not supported |
| Control of a digital input | supported |
| Switching frequency<br>• with resistive load<br>• with inductive load to IEC 947-5-1, AC 15<br>• with lamp load | <br>max. 10 Hz<br>max. 0.5 Hz<br>1 Hz |
| Short-circuit protection of the output | no |
| Wiring of the actuators | using a 20-pin* front connector |

*Requires two front connectors of the appropriate version



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# 3.23 Digital output module SM 322; DO 16 x DC 24 V/ 0.5 A; (6ES7322-1BH01-0AA0)

### Order number: "Standard module"

6ES7322-1BH01-0AA0

### Order number: "SIPLUS S7-300 module"

6AG1322-1BH01-2AA0

### Properties

Properties of SM 322; DO 16 x DC 24 V/0.5 A:

- 16 outputs, electrically isolated in groups of 8
- Output current 0.5 A
- Rated load voltage 24 V DC
- Suitable for solenoid valves, DC contactors and signal lamps

### Use of the module with high-speed counters

Please note when using the module in combination with high-speed counters:

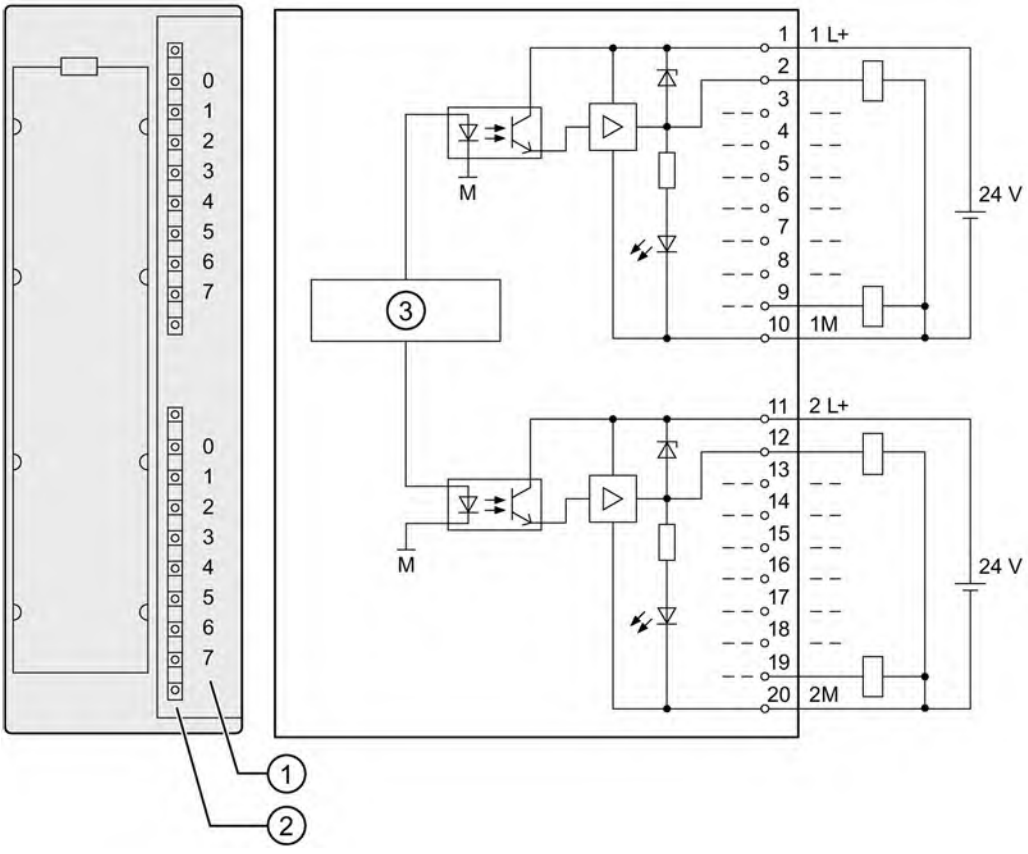
**Note**

When using a mechanical contact to switch on the 24-V power supply to SM 322; DO 16 x DC 24 V/0.5 A, its outputs will carry "1" signal for the duration of ca. 50 µs, due to the circuit structure.



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## Wiring and block diagram of SM 322; DO 16 x DC 24 V/ 0.5 A




① Channel number
② Status display - green
③ Backplane bus interface



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## SM 322; DO 16 x DC 24 V/0.5 A - Technical specifications

Table 3- 21

| | |
|---|---|
| **Technical specifications** | |
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 190 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of outputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+ | 24 V DC |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 40 °C<br>to 60 °C | <br>max. 4 A<br>max. 3 A |
| • vertical mounting position<br>to 40 °C | <br>max. 2 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels<br>in groups of | yes<br>8 |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 80 mA<br>max. 80 mA |
| Power loss of the module | typ. 4.9 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |



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| **Technical specifications** | |
|---|---|
| **Actuator selection data** | |
| Output voltage<br>• "1" signal | min. L + (- 0.8 V) |
| Output current | |
| • "1" signal<br>Rated value<br>Permitted range | <br>0.5 A<br>5 mA to 0.6 A |
| • "0" signal (residual current) | Max. 0.5 mA |
| Output delay (resistive load) | |
| • "0" to "1" transition | max. 100 µs |
| • "1" to "0" transition | max. 500 µs |
| Load resistance range | 48 Ω to 4 kΩ |
| Lamp load | max. 5 W |
| Wiring two outputs in parallel | |
| • For redundant load control | Supported (only outputs of the same group) |
| • For performance increase | Not supported |
| Control of a digital input | Supported |
| Switching frequency | |
| • with resistive load | max. 100 Hz |
| • with inductive load to IEC 947-5-1, DC 13 | max. 0.5 Hz |
| • with lamp load | max. 10 Hz |
| Internal limiting of the inductive shutdown voltage to | typ. L + (-53 V) |
| Short-circuit protection of the output | yes, electronic |
| • Threshold | typ. 1 A |
| Wiring of the actuators | using a 20-pin front connector |



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# 3.24 Digital output module SM 322; DO 16 x DC 24 V/0.5 A: (6ES7322-8BH10-0AB0)

## Order number

6ES7322-8BH10-0AB0

## Order number: "SIPLUS S7-300 module"

6AG1322-8BH10-7AB0

## Properties

The digital output module SM 322; DO 16 x DC24 V/0.5 A is distinguished by the following properties:

- 16 outputs, electrically isolated in groups of 4 channels
- A nominal load voltage of 24 V DC
- Configurable diagnostics
- Programmable diagnostic interrupt
- Redundant
- Wire break at "0" and "1" signal
- Identification Data
- Firmware update possible

## Use of the module with high-speed counters

Please note when using the module in combination with high-speed counters.

**Note**

When using a mechanical contact to switch on the 24-V power supply to SM 322; DO 16 x DC 24 V/0.5 A, its outputs will carry "1" signal for the duration of ca. 50 µs, due to the circuit structure.



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## Using the module

For the use of the SM 322; DO 16 x DC24V/0.5A, the following hardware and software requirements must be fulfilled:

- For the central use in S7-300, the module can be used with all available CPUs.
- For the decentral use in ET 200M, the module can be used with the following IM 153-modules and compatible successor modules:
  - IM 153-2; as of 6ES7153-2BA02-0XB0, (PROFIBUS).
  - IM 153-2; as of 6ES7153-2BA82-0XB0; (PROFIBUS, OUTDOOR).
  - IM 153-4; as of 6ES7153-4BA0x-0XB0; (PROFINET).
- Requirement: STEP 7 V5.5 (HSP0217) or higher.
- A GSD file or a GSDML file must be used if the module is part of a distributed and controlled by a master produced by a third-party manufacturer. The corresponding file for the selected IM 153 is available for download from the Internet (http://www.siemens.com/automation/service&support).
- Module diagnosis and identification data (I&M) are available through STEP 7 and with SIMATIC PDM as of V6.0 + SP5 (HSP0217) or SIMATIC PDM V7.0 or higher and EDD for ET 200M "DP_IOSystem_Siemens_ET200M_Module.Device" as of V1.1.12.

## Compatible use of the module 6ES7322-8BH0x-0AB0

You can repalce the digital output module 6ES7322-8BH**0x**-0AB0 without changing your settings through a digital output module 6ES7322-8B**10**-0AB0.

In this case, the module does not offer discrepancy failure monitoring.

If a STEP 7 version before STEP 7 V5.1 SP3 is used, the replacement value behavior will only be entered through the parameter dialog from HW config and transferred to the module during system startup.

In this case, all other settings must be transferred through SIMATIC PDM or in the user program through datasets to the module.

These settings are not saved retentively on the digital output module 6ES7322-8BH**10**-0AB0 and are reset after restarting the module.

**Note**

A setting through SIMATIC PDM is only possible with the use of a 6ES7322-8BH**10**-0AB0 as a replacement for a 6ES7322-8BH**0x**-0AB0 as long as the device label (6ES7322-8BH**0x**-0AB0) in SIMATIC PDM was not updated with the actual device label through Device -> Load in PC/PG.

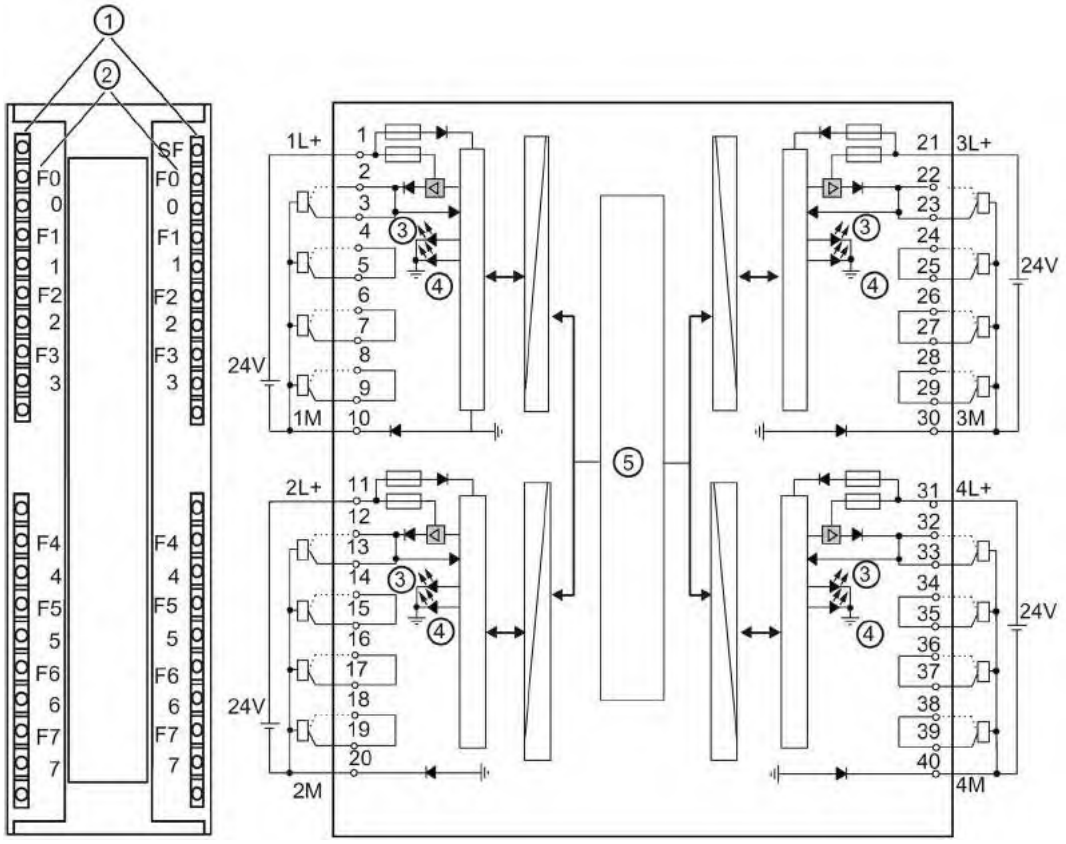
## Redundant use of the module

A redundant use of the module is only permissible if the 6ES7322-8BH**10**-0AB0 is used and configured for both modules. No short-circuit monitoring occurs according to L+ in redundant use.



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## Wiring and block diagram




① Status displays - green
Error - red

② Channel numbers
Numbers 0 to 7 on the right side correspond to channel numbers 8 to 15

③ Channel status

④ Channel fault

⑤ Backplane bus interface

## Redundant Output Signals

Two clamps are on each channel. Both connections are similar and can be used for a redundant control of an actuator. Redundant control can take place from 2 different modules without an external circuit. Both signal modules must be connected to the common reference potential M.



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## Technical specifications

Table 3- 22 Technical specifications SM 322; DO 16 x DC 24V/0.5A

| **Technical specifications** | |
|---|---|
| **Dimensions and Weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 120 |
| Weight | approx. 300 g |
| **Module-specific data** | |
| Supports isochronous mode | No |
| Number of outputs | 16 |
| Cable length | |
| • Unshielded | Max. 600 m |
| • Shielded | Max. 1000 m |
| **Voltages, Currents, Potentials** | |
| Nominal load voltage L+ | 24 V DC |
| • Reverse polarity protection | Yes |
| Total current of outputs (per group) | |
| • Horizontal mounting position to 60 °C | Max. 2 A |
| • Vertical mounting position to 40 °C | Max. 2 A |
| Electrical isolation | |
| • Between channels and the backplane bus | Yes |
| • between channels<br>in groups of | yes<br>4 |
| Insolation tested with | DC 500 V |
| Power consumption | |
| • From the backplane bus | Max. 100 mA |
| • From load voltage L+ (without load) | Max. 100 mA |
| Power dissipation of the module | Typically 6 W |
| **Status, Interrupts, Diagnostics** | |
| Status LEDs | Green LED per channel |
| Interrupts | |
| • Diagnostic interrupt | Programmable |
| Diagnostic functions | Programmable |
| • Group error display | Red LED (SF) |
| • Channel error display | red LED, per channel |
| • Diagnostic information readable | supported |



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| **Technical specifications** | |
|---|---|
| **Actuator selection data** | |
| Output voltage | |
| • "1" signal | Min. L + (- 0.7 V) |
| • "0" signal | 0.7 mA * $R_L$ ($R_L$ = load resistance value)<br>max. 31 V for $R_L$ = infinite |
| Output current | |
| • At signal "1"<br>Nominal value<br>Permitted range | <br>0.5 A<br>5 mA up to 600 mA |
| • "0" signal (residual current) | Max. 0.7mA |
| Output delay (with resistive load) | |
| • At "1" to "0" | Max. 2.7 ms (including module cycle time) |
| • At "1" to "0" | Max. 2.7 ms (including module cycle time) |
| Load resistor range | 48 Ω bis 4kΩ |
| Lamp load | Max. 5 W |
| Connecting 2 outputs in parallel | |
| • For redundant triggering of a load | supported |
| • To increase performance | Not possible |
| Control of a digital input | supported |
| Operating frequency | |
| • with resistive load | Max. 100 Hz |
| • With inductive load, to IEC 947-5-1, DC 13 | Max. 2 Hz |
| • With lamp load | Max. 10 Hz |
| Limit (internal) of the inductive circuit interruption voltage to | Typical L+ (-68 V) |
| Short-circuit of an output | Yes, electronic |
| • Response threshold | Typical 1.4 A |



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### Load resistances of the actuators

The load resistances of the actuators must be in the range from 48 Ω to 4 Ω. For larger values, a suitable resistance must be switched directly on the connection clamps of the actuator (observe the maximum power loss with signal "1").

The permissible rated voltage of the actuator must be greater than 28.2 V.

The lower response threshold of the actuator must be known in the operating temperature range or be determined experimentally. The output voltage of the module with signal "0" can be influenced through parallel switching of a resistance directly on the actuator connection clamps. With the selection of the resistance, the maximum power loss with signal "1" must be observed.

- Load resistances between 10 kΩ and 1 MΩ can be reported as short-circuits after L+.
- Unwired outputs or loads greater than 1 MΩ are reporeted as "wire-break".

## 3.24.1 Parameters of digital output modules

### Programming

For general information on programming digital modules, refer to the chapter Programming digital modules (Page 58).

The table below describes the programmable parameters of SM 322; DO 16 x DC 24 V/0.5 A, including defaults.

**Note**

A setting of the module through SIMATIC PDM is not possible.

Table 3- 23 Setting for the digital output module SM 322; 6ES7322-8BH10-0AB0

| Parameters | Value range | Default setting | Applicability |
|---|---|---|---|
| Diagnostics | | | |
| • Group diagnostics | Yes/no | no | Channel |
| • Load voltage L+ missing | Yes/no | No | Channel group |
| • Discrepancy error | Yes/no | No | Channel group |
| Diagnostics interrupt | yes/no | no | Module |
| Response at CPU-STOP | Substitute a value/ Keep last value | Substitute a value | Module |
| Substitute value | 0/1 | 0 | Channel |

### See also

Settings from the digital output module SM 322; DO 16 x DC 24 V/0.5 A (6ES7322-8BH10-0AB0) (Page 530)



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## 3.24.2 Diagnosis of digital output modules

### Introduction

General information in regards to the evaluation of the diagnosis messages can be found in the chapter Diagnosis of digital modules (Page 59) and the design and content of the individual bytes in the chapter Diagnosis data from the SM 322; DO 16 x DC24 V/0.5 A (6ES7322-8BH10-0AB0) (Page 590).

Channel errors are signaled with the channel error display (red LED per channel) and reported in the data record 1. As soon as at least one channel error display is lit, the group error display (SF) is also lit.

Module errors are signaled via the diagnostic data record 0/1 and only displayed via the the group error display (SF).

### Group diagnostics

Through the "Group diagnositcs" setting, the message from the channel-specific fields, with the exception of "external load voltage L+", for "Setting error" and the recognition of a discrepancy error can be turned off.

### Load voltage L+ missing

The approval of the channel diagnositcs "external load point L+" occurs in channel groups through the diagnostics setting "Missing load voltage L+". This means that if the load voltage fails, the error will be reported to all four channels of a channel group. Additionally, the module-specific message occurs in the byte 0 of the diagnostics dataset 0 / 1, "external auxiliary voltage missing". Even if the diagnostics of "Missing load voltage L+" is turned off for all channels/channel groups, the recognition within the module remains active. This means that if there is a failure of at least one load voltage, the module error will always be reported in the byte 0 of the diagnostics data set 0 / 1 "External auxiliary voltage missing".

### Fuse blown

If a fuse is blown, it will always be reported to all four channels of a channel group. In addition to the channel message, there is always the module-specific message in the byte 3 of the diagnostics dataset 0 / 1 "Fuse defect". Even if the "Group diagnostics" setting is disabled by all channels, a defective fuse will always be reported as module error in the byte 3 of the diagnostics dataset 0 / 1 "Fuse defect".



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### Discrepancy error monitoring

For project engineering with the MLFB 6ES7322-8BH10-0AB0, the SM 322 DO 16 x DC24 V / 0.5A offers a discrepancy error monitoring.

The approval of the channel discrepancy error monitoring occurs in channel groups through the "Discrepancy error" diagnostics settings. With an approved discrepancy error monitoring, the module constantly checks the set and actual status of the corresponding digital outputs. With a recognized discrepancy, for example, due to a component defect on the digital module, the corresponding channel group will be turned off and the "Fuse defect" error will be reported to all affected channels in the channel group. After removal/insertion or restart of the module, the digital outputs will be reactivated and the discrepancy test runs again.

A discrepancy error is exclusively reported through the "Fuse defect" error. An additional indication through the byte 3 "Fuse defect" does not occur. Thus, a differentiation between the actual fuse blown and a discrepancy error is possible.

### Description of the Diagnostic Evaluation

You can find a detailed description of how to evaluate diagnostic information in the STEP 7 online help.

## 3.24.3 Firmware update via HW Config

### Introduction

The SM 322; DO 16 x DC 24V/0.5 A can be updated to the newest firmware version depending on the available compatible functional updates.

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

### Preconditions / Requirements

- STEP 7 V5.5 +(HSP0217) or higher
- With a central use of the module in a S7-300, the firmware update must occur in the CPU-operating mode STOP. If the CPU is in the operating mode RUN, it may lead to unexpected behavior and the module is only available after a network off/network on.
- If the module is used in a distributed IO device ET 200M with active backplane bus modules (removal and insertion allowed), the a firmware update is also possible in the RUN CPU state.
- With a distributed use without active backplane bus modules, the firmware update is also possible in the RUN CPU state. Please observe that during the firmware update, the distributed IO device will be turned off shortly.



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### Firmware update

This is how you update the firmware of a central or distributed module:

1. Select the module SM 322; DO 16 x DC 24V/0.5 A in HW-config.
2. Select PLC > Update Firmware.
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.
5. You can find additional information in the STEP 7 Online Help.

**Note**

- During the firmware update, the OB 83 (alarm due to removing and inserting modules), the OB 85 (program execution error) and the OB 86 (error due to module rack failure) are opened. If the diagnostics alarm of the module is approved, the OB 82 (diagnostics alarm) will also be opened during the firmware update. Make sure that the OB is set correspondingly.
- If the red LED (SF) on the module blinks, an error occurred during the firmware update and the update must be repeated. In this case, the bootloader version Ex.x.x is displayed in the online diagnostics.
- A firmware update through HW-config is not permitted if the module is in redundant mode.

### Identification of the firmware version

After the firmware update, you must label the firmware version on the module.

## 3.24.4 I&M identification data

### Properties

I data: Information about the module, which is normally found on the module casing. I-data is write-protected. They include:

- Hardware release status
- Firmware release status
- Serial number

M data: System-dependent information (e.g. plant designation).

M data is created during configuration.



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All identification data (I&M) is stored retentively in a module and supports you with the following tasks:

- Error search and repair in the system
- Testing the system configuration
- Finding changes to the system hardware.

The SM 322; DO 16 x DC 24V/0.5 A supports:

- I&M 0 (identification)
- I&M 1 (system identification / location identification)
- I&M 2 (installation date)
- I&M 3 ( additional information)

## Reading and writing the identification data with STEP 7

System-dependent information (M-data) is configured in the properties dialog of the module.

You obtain information on the module (I data) from the module status dialog. The system-dependent information on the module is displayed here too.

**Note**

Identification data can only be written for modules if the CPU is in the STOP operating mode.

## Reading and writing the identification data with PDM

Through the "Identification" flap, the identification data is evaluated and transferred to the module. Location identification is not available in PDM.

**Note**

Identification data can only be written for modules if the CPU is in the STOP operating mode.

It is recommended to change at most one entry per download, if applicable, the transferring of the identification data must be activated multiple times.



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# 3.25 Digital output module SM 322; DO 16 x DC 24 V/0.5 A High Speed; (6ES7322-1BH10-0AA0)

## Order number

6ES7322-1BH10-0AA0

## Properties

Properties of SM 322; DO 16 **x** DC 24 V/0.5 A High Speed:

- 16 outputs, electrically isolated in groups of 8
- Output current 0.5 A
- Rated load voltage 24 V DC
- Suitable for solenoid valves, DC contactors and signal lamps
- Supports isochronous mode

## Use of the module with high-speed counters

Please note when using the module in combination with high-speed counters:

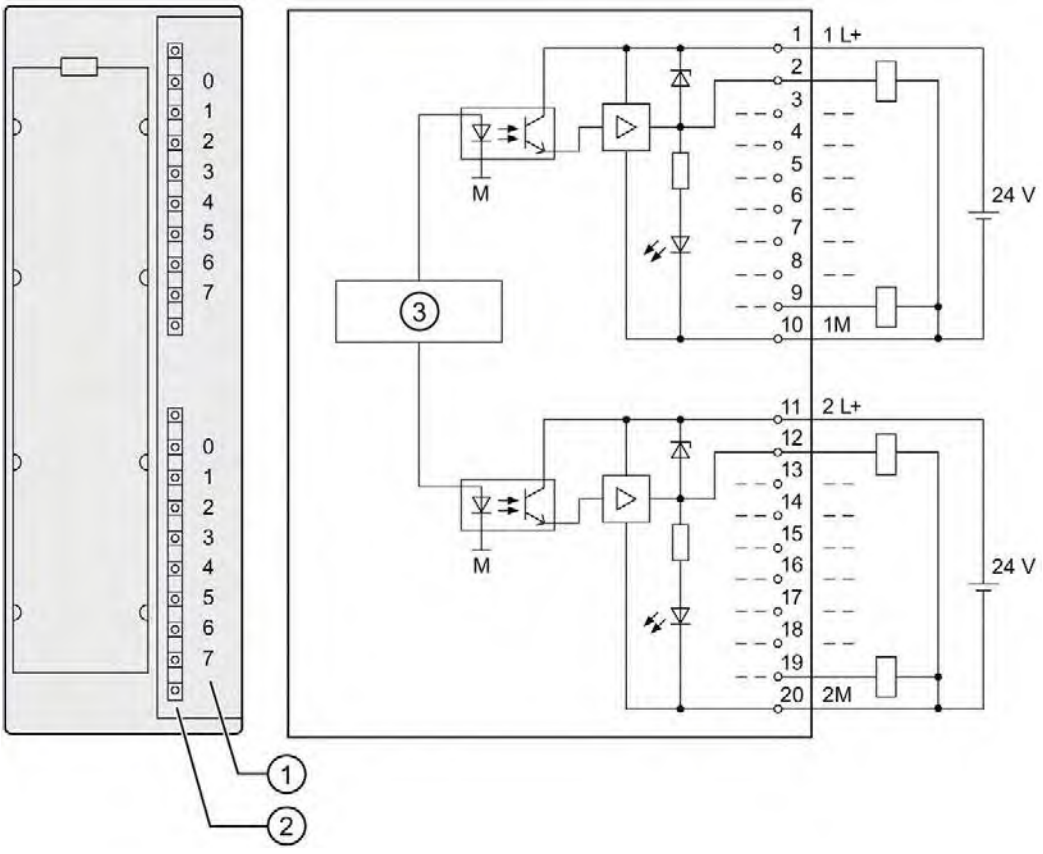
**Note**

When using a mechanical contact to switch on the 24-V power supply to SM 322; DO 16 x DC 24 V/0.5 A High Speed, its outputs will carry "1" signal for the duration of ca. 50 µs, due to the circuit structure.



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## Wiring and block diagram of SM 322; DO 16 x DC 24 V/0.5 A High Speed




① Channel number
② Status display - green
③ Backplane bus interface



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## Technical specifications of SM 322; DO 16 x DC 24 V/0.5 A High Speed

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 200 g |
| **Module-specific data** | |
| Supports isochronous mode | yes |
| Number of outputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+ | 24 V DC |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 40 °C<br>to 60 °C | <br>max. 4 A<br>max. 3 A |
| • vertical mounting position<br>to 40 °C | max. 2 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels<br>in groups of | yes<br>8 |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 70 mA<br>max. 110 mA |
| Power loss of the module | typ. 5 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |



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| **Technical specifications** | |
|---|---|
| **Actuator selection data** | |
| Output voltage<br>• "1" signal | min. L + (- 0.8 V) |
| Output current | |
| • "1" signal<br>Rated value<br>Permitted range | <br>0.5 A<br>5 mA to 0.6 A |
| • "0" signal (residual current) | Max. 0.5 mA |
| Output delay (resistive load) | |
| • "0" to "1" transition | max. 100 µs |
| • "1" to "0" transition | max. 200 µs |
| Internal module cycle time between the backplane bus and the output driver input | |
| • "0" to "1" transition | 0.1 µs to 20 µs |
| • "1" to "0" transition | 0.1 µs to 20 µs |
| Load resistance range | 48 Ω to 4 kΩ |
| Lamp load | max. 5 W |
| Wiring two outputs in parallel | |
| • For redundant load control | Supported (only outputs of the same group) |
| • For performance increase | Not supported |
| Control of a digital input | Supported |
| Switching frequency | |
| • with resistive load | max. 1000 Hz |
| • with inductive load to IEC 947-5-1, DC 13 | max. 0.5 Hz |
| • with lamp load | max. 10 Hz |
| Internal limiting of the inductive shutdown voltage to | typ. L + (-53 V) |
| Short-circuit protection of the output | yes, electronic |
| • Threshold | typ. 1 A |
| Wiring of the actuators | using a 20-pin front connector |



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# 3.26 Digital output module SM 322; DO 16 x UC 24/48 V; (6ES7322-5GH00-0AB0)

## Order number

6ES7322-5GH00-0AB0

## Properties

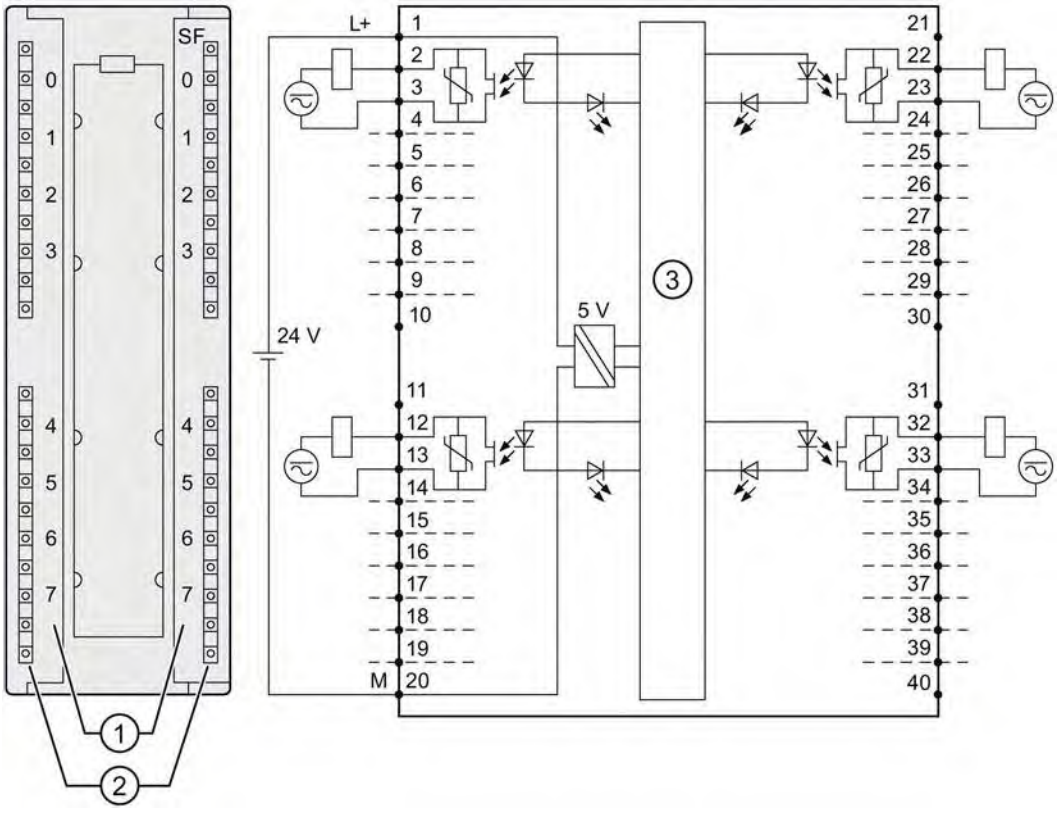
Performance features of the SM 322; DO 16 x UC24/48 V digital output module:

- 16 electrically isolated semiconductor relay outputs
- Electrical isolation between channels of 120 V
- Switching characteristics: $R_{DS}$ ON is typically 0.25 Ohm, and $R_{DS}$ OFF is typically greater than 100 GOhm
- Designed for load voltages up to 48 V AC or DC, no minimum load voltage
- Designed for output loads up to 0.5 A, no minimum load current
- Outputs are fully independent and support any wiring configuration
- Set substitution values or "Hold last values" can be programmed at the outputs for CPU STOP.
- The module supports diagnostics of programming errors and of external power failure
- Suitable for AC solenoids, actuators, motor starters, FHP motors and signal lamps
- Supports parameter reassignment in RUN



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## Wiring and block diagram of SM 322; DO 16 x UC 24/48 V




① Channel number
② Status LEDs - green
③ Backplane bus interface

## Technical specifications of SM 322; DO 16 x UC 24/48 V

| | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 260 g |
| **Module-specific data** | |
| Supports parameter reassignment in RUN | Yes |
| • Reaction of non-programmed outputs | Return the output value which was valid before the parameterization |
| Supports isochronous mode | no |
| Number of outputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |



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| | |
|---|---|
| **Dimensions and weight** | |
| **Voltages, currents, electrical potentials** | |
| Rated electronics supply voltage L + | 24 V DC |
| • Reverse polarity protection<br>• Power failure buffering | yes<br>min. 5 ms |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>up to 60 °C | max. 0.5 A |
| • other mounting positions<br>to 40 °C | max. 0.5 A |
| Cumulated current of outputs (per module) | |
| • horizontal mounting position<br>to 60 °C | max. 8 A |
| • other mounting positions<br>to 40 °C | max. 8 A |
| **Electrical isolation** | |
| • between channels and the backplane bus | yes |
| • between channels and electronics power supply | yes |
| • between channels<br>in groups of | yes<br>1 |
| Maximum potential difference | |
| • between channels and the backplane bus | 170 V DC, 120 V AC |
| • between channels and electronics power supply | 170 V DC, 120 V AC |
| • between outputs of different groups | 170 V DC, 120 V AC |
| Isolation test voltage | |
| • between channels and the backplane bus | 1500 V AC |
| • between channels and electronics power supply | 1500 V AC |
| • between outputs of different groups | 1500 V AC |
| Current consumption | |
| • from the backplane bus<br>• from supply voltage L+ | max. 100 mA<br>max. 200 mA |
| Power loss of the module | typ. 2.8 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Diagnostic functions | |
| • Group error display | red LED (SF) |
| Interrupts | |
| • Diagnostic interrupt<br>• Reading diagnostics information | programmable<br>supported |



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| | |
|---|---|
| **Dimensions and weight** | |
| **Actuator selection data** | |
| Output voltage | |
| • "1" signal | min. L+ (-0.25 V) |
| Output current | |
| • Rated inrush current (per group) with "1" signal<br>• "0" signal (residual current) | 0.5 A max. 1.5 A (max. 50 ms)<br>max. 10 µA |
| Output delay (resistive load) | |
| • "0" to "1" transition<br>• "1" to "0" transition | max. 6 ms<br>max. 3 ms |
| External fuse for relay outputs | Fuse, $I^2t$ :1 $A^2s$, fast-blow fuse* |
| Lamp load | max. 2.5 W |
| Internal parallel wiring of 2 outputs | Varistor, 85 V |
| • for redundant load control<br>• for performance increase | supported<br>not supported |
| Control of a digital input | supported |
| Switching frequency | |
| • with resistive load | max. 10 Hz |
| • with inductive load to IEC 947-5-1; DC 12 AC/12 | max. 0.5 Hz |
| • with lamp load | max. 0.5 Hz |
| Wiring of the actuators | using a 40pin front connector |

* Outputs must be protected by a 250 V fast-blow fuse (recommended fuses: Wickman 194-1100 1.1 A and Littlefuse 0217-800 V 800 mA.)

When mounted in a hazardous area to National Electric Code (NEC), always remove the fuse when the module is outside of the potentially explosive atmosphere, and use a suitable tool.

## Configuration in RUN

Special considerations must be given if you use the Configuration in RUN function.

SF LED is lit:

Status before re-configuration diagnostics on, SF LEDs lit among others (on CPU, IM or module), although diagnostics are no longer pending and the module is operating correctly.

Solution:

- Only change the configuration when no diagnostics are pending for the module or
- Pulling and plugging the module.



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## 3.26.1 Parameters of digital output module SM 322 DO 16 x UC24/48 V

### Programming

The tables below show data record numbers for static and dynamic parameters.

Table 3- 24 Data record 0 (static parameters):

| Parameters | Comment |
|---|---|
| Enable diagnostics | Enabling an interrupt as a reaction to module failure caused by faulty parameter, hardware error, or voltage error. |

Table 3- 25 Data record 1 (dynamic parameters):

| Parameters | Comment |
|---|---|
| **Reaction to CPU STOP** | |
| Hold last value | |
| Substitute value output | |
| **Substitute value** | |
| Substitute value | Each bit represents an output |

This module supports fail state/substitution value outputs when the CPU changes from RUN to STOP.

### Status displays

Each output of this module is equipped with a green LED to indicate the relay state. In addition, a red LED (SF) indicates the diagnostics status of the module.

### Diagnostics, troubleshooting

Diagnostics data are assigned according to the technical data listed below.

The four system diagnostics data bytes can be read in the additional interrupt information as data record 0, or in the first 4 bytes of data record 1.

### Structure of the data record and system diagnostics for SM 322 DO 16x UC 24/48V

Structure of data record 1:

Table 3- 26 Structure of the data record for SM 322 DO 16 x UC 24/48 V

| Data record 1 byte address | Available information | Contents |
|---|---|---|
| 0..3 | System-specific diagnostics data | 4 bytes |



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System diagnostics for SM 322;DO 16 x UC24/48 V:

Table 3- 27 System diagnostics for SM 322 DO 16 x UC 24/48 V

| **System diagnostics byte 1:** | | **Technical data** |
|---|---|---|
| D0: | Module fault | yes |
| D1: | Internal fault | yes |
| D2: | External fault | yes |
| D3: | Channel fault | no |
| D4: | External auxiliary voltage missing | yes |
| D5: | Front connector missing | no |
| D6: | Module not programmed | yes |
| D7: | Incorrect parameters | yes |
| **System diagnostics byte 2:** | | |
| D0..D3: | Module class | 1111 |
| D4: | Channel information available | no |
| D5: | User information available | no |
| D6: | Diagnostics interrupt from substitute | no |
| D7: | Reserve | |
| **System diagnostics byte 3:** | | |
| D0: | Wrong/missing memory module | no |
| D1: | Communication error | no |
| D2: | RUN/STOP operating state | no |
| D3: | Watchdog timeout | yes |
| D4: | Internal power failure | no |
| D5: | Battery 1 low | no |
| D6: | Backup system failure | no |
| D7: | Reserve | |
| **System diagnostics byte 4:** | | |
| D0: | Rack failure | no |
| D1: | Processor failure | yes |
| D2: | EPROM fault | yes |
| D3: | RAM fault | yes |
| D4: | DAC error | no |
| D5: | Fuse blown | no |
| D6: | Process interrupt lost | no |
| D7: | Reserve | |



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# 3.27 Digital output module SM 322; DO 16 x AC 120/230 V/1 A; (6ES7322-1FH00-0AA0)

## Order number

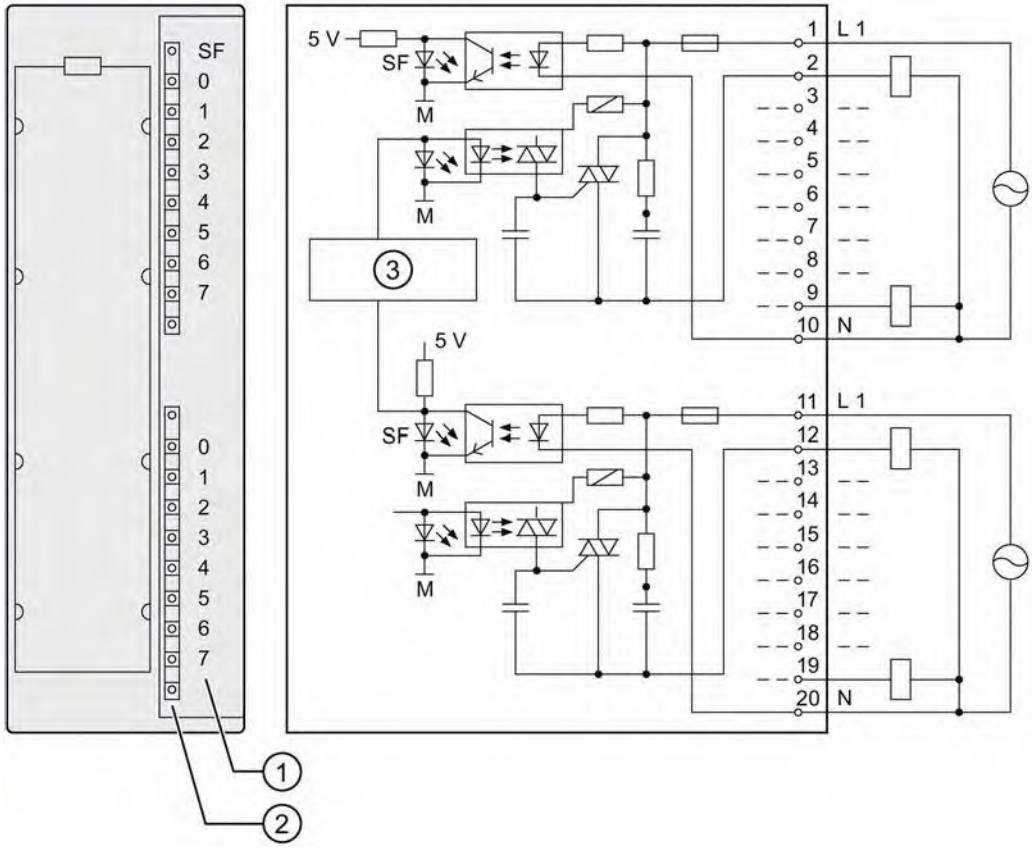
6ES7322-1FH00-0AA0

## Properties

Properties of digital output module SM 322; DO 16 x AC120/230 V/1 A:

- 16 outputs, fused and electrically isolated in groups of 8
- Output current 1 A
- Rated load voltage 120/230 VAC
- Suitable for AC solenoids, actuators, motor starters, FHP motors and signal lamps

## Wiring and block diagram of SM 322 DO 16 x AC120/230 V/1 A




① Channel number
② Status LEDs - green
Error LED - red
③ Backplane bus interface



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## SM 322; DO 16 x AC 120/230 V/1 A - Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D | 40 x 125 x 117 |
| Weight | ca. 275 g |
| **Module-specific data** | |
| Supports isochronous mode | No |
| Number of outputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Load voltage L1<br>All load voltages must be connected to the same phase | 120/230 VAC |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 40 °C<br>to 60 °C | <br>max. 4 A<br>max. 2 A |
| • vertical mounting position<br>to 40 °C | max. 2 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels<br>in groups of | yes<br>8 |
| Maximum potential difference<br>• between $M_{internal}$ and outputs | <br>230 VAC |
| • between outputs of different groups | 500 VAC |
| Isolation test voltage | 4000 VDC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 200 mA<br>max. 2 mA |
| Power loss of the module | typ. 8.6 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts<br>• Diagnostic interrupt | <br>no |
| Diagnostic functions<br>• Group error display | red LED (SF)<br>(fuse or no L1/N) |



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| **Technical specifications** | |
|---|---|
| **Actuator selection data** | |
| Output voltage<br>• "1" signal<br>– At maximum current<br>– At minimum current | <br>min. L 1 (- 1.5 V)<br>min. L 1 (- 8.5 V) |
| Output current | |
| • "1" signal<br>Rated value<br>Permitted range at 0 °C to 40 °C<br>Permitted range at 0°C to 60°C<br>Maximum inrush current (per group) | <br>1 A<br>10 mA to 1 A<br>10 mA to 0.5 A<br>20 A (two half-waves) |
| • with "0" signal (residual current) | max. 2 mA |
| Blocking voltage | max. 60 V |
| Zero transition | |
| Size of the motor starter | max. size 4 to NEMA |
| Lamp load | max. 50 W |
| Wiring two outputs in parallel | |
| • for redundant load control | supported (only outputs of the same group) |
| • for performance increase | no |
| Control of a digital input | supported |
| Switching frequency | |
| • with resistive load<br>• with inductive load to IEC 947-5-1, AC 15 | max. 10 Hz<br>max. 0.5 Hz |
| • with lamp load | max. 1 Hz |
| Short-circuit protection of the output | Fuse 8 A,<br>250 V; per group |
| • Fuse-tripping current | min. 40 A |
| • Response time | max. 300 ms |
| Replacement fuses | 8 A fuse, fast-blowing |
| • Wickman<br>• Schurter<br>• Littlefuse | 19 194-8 A<br>SP001.1014<br>217.008 |
| Fuse holder | |
| • Wickman | 19 653 |
| Wiring of the actuators | using a 20-pin front connector |



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# 3.28 Digital output module SM 322; DO 8 x DC 24 V/2 A; (6ES7322-1BF01-0AA0)

## Order number

6ES7322-1BF01-0AA0

## Properties

Properties of SM 322; DO 8 x DC 24 V/2 A:

- 8 outputs, electrically isolated in groups of 4
- Output current 2 A
- Rated load voltage 24 V DC
- Suitable for solenoid valves, DC contactors and signal lamps

## Use of the module with high-speed counters

Please note when using the module in combination with high-speed counters:

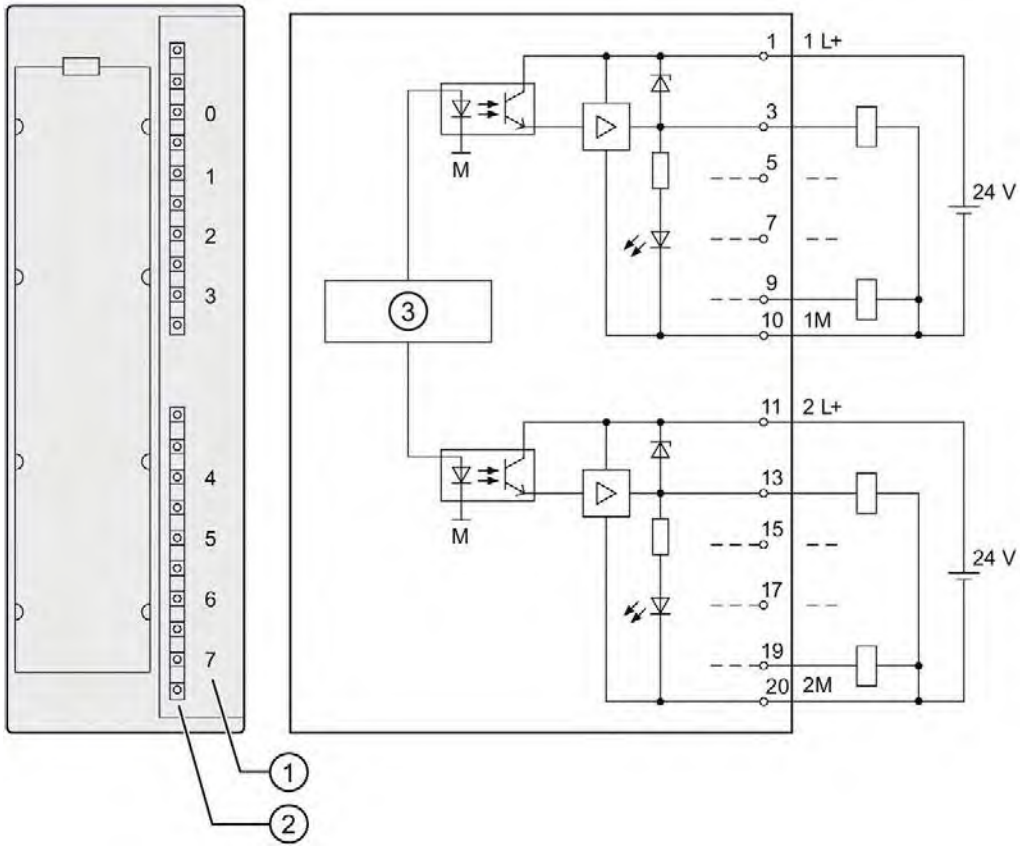
**Note**

When using a mechanical contact to switch on the 24-V power supply to SM 322; DO 8 x DC 24 V/2 A, the module outputs will carry a "1" signal for the duration of ca. 50 µs due to the circuit structure.



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## Wiring and block diagram of SM 322; DO 8 x DC 24 V/2 A




① Channel number
② Status display - green
③ Backplane bus interface

## SM 322; DO 8 x DC 24 V/2 A - Technical specifications

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 190 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of outputs | 8 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |



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| **Technical specifications** | |
|---|---|
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+ | 24 V DC |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 60 °C | max. 4 A |
| • vertical mounting position<br>to 40 °C | max. 4 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels<br>in groups of | yes<br>4 |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 40 mA<br>max. 60 mA |
| Power loss of the module | typ. 6.8 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |
| **Actuator selection data** | |
| Output voltage<br>• "1" signal | min. L+ (- 0.8 V) |
| Output current | |
| • "1" signal<br>Rated value<br>Permitted range | <br>2 A<br>5 mA to 2.4 A |
| • with "0" signal (residual current) | max. 0.5 mA |
| Output delay (with resistance load) | |
| • "0" to "1" transition | max. 100 µs |
| • "1" to "0" transition | max. 500 µs |
| Load resistance range | 12 Ω to 4 kΩ |
| Lamp load | max. 10 W |
| Wiring two outputs in parallel | |
| • for redundant load control | supported (only outputs of the same group) |
| • for performance increase | not supported |
| Control of a digital input | supported |



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| **Technical specifications** | |
|---|---|
| Switching frequency | |
| • with resistive load | max. 100 Hz |
| • with inductive load to IEC 947-5-1, DC 13 | max. 0.5 Hz |
| • with lamp load | max. 10 Hz |
| Internal limiting of the inductive shutdown voltage to | typ. L + (-48 V) |
| Short-circuit protection of the output | yes, electronic |
| • Threshold | typ. 3 A |
| Wiring of the actuators | using a 20-pin front connector |



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# 3.29 Digital output module SM 322; DO 8 x DC 24 V/ 0.5 A; with diagnostics interrupt; (6ES7322-8BF00-0AB0)

### Order number: "Standard module"

6ES7322-8BF00-0AB0

### Order number: "SIPLUS S7-300 module"

6AG1322-8BF00-2AB0

### Properties

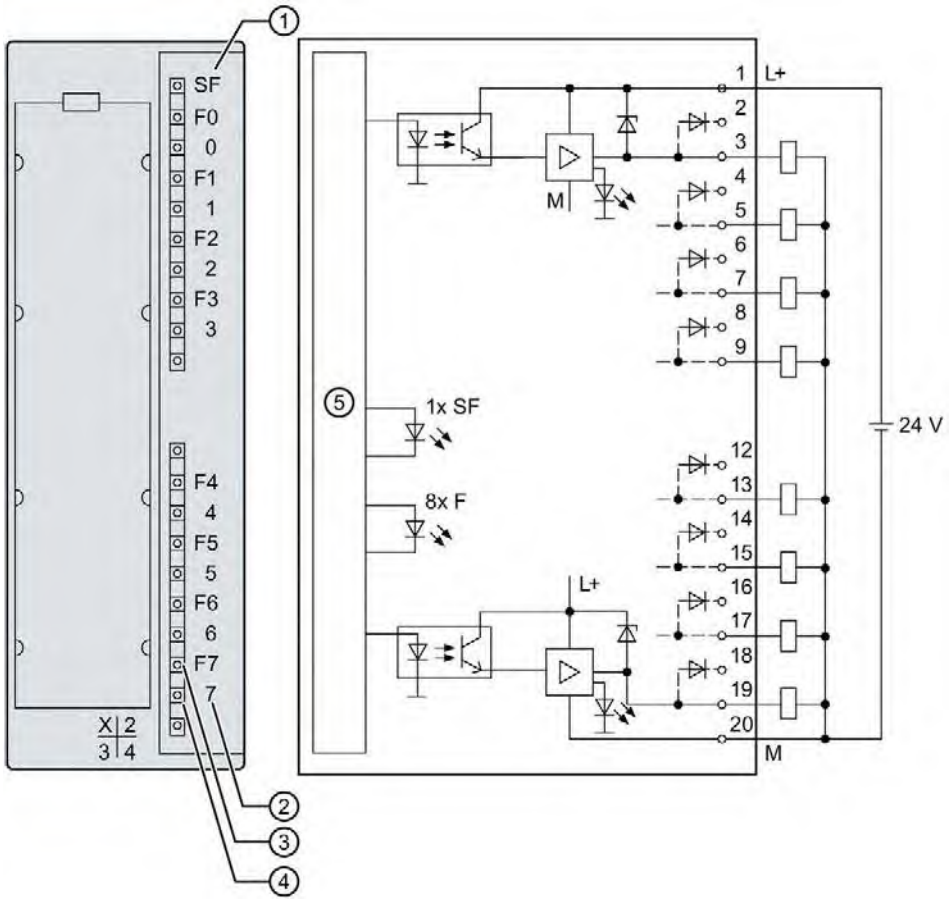
Properties of SM 322; DO 8 x DC 24 V/0.5 A:

- 8 outputs, electrically isolated in groups of 8
- Output current 0.5 A
- Rated load voltage 24 V DC
- Suitable for solenoid valves, DC contactors and signal lamps
- 2 terminals per output
  - Output without series diode
  - Output with series diode (for redundant load control)
- Group error display (SF)
- Channel-specific status and error LEDs
- Programmable diagnostics
- Programmable diagnostic interrupt
- Programmable substitute value output
- Supports parameter reassignment in RUN



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## Wiring and block diagram of SM 322; DO 8 x DC 24 V/ 0.5 A




① Group error display -red-
② Channel number (0 ... 7)
③ Channel fault display -red- (F0 ... F7)
④ Status display -green-
⑤ Backplane bus interface

Figure 3-9 Wiring and block diagram of SM 322; DO 8 x 24 V DC / 0.5

## Redundant load control

The output with series diode can be used for redundant load control. Redundant control without external circuitry is possible using two different signal modules. Both modules must be connected to the common reference potential M.

**Note**

It is not possible to detect external short-circuits to L+ at output with series diode.



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## SM 322; DO 8 x DC 24 V/0.5 A - Technical specifications

| | |
|---|---|
| **Technical specifications** | |
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 210 g |
| **Module-specific data** | |
| Supports parameter reassignment in RUN | Yes |
| • Reaction of non-programmed outputs | Return the output value which was valid before the parameterization |
| Supports isochronous mode | no |
| Number of outputs | 8 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+ | 24 V DC |
| Total current (per group) of outputs without series diode | |
| • horizontal mounting position<br>to 40 °C<br>to 60 °C | <br>max. 4 A<br>max. 3 A |
| • vertical mounting position<br>to 40 °C | max. 4 A |
| Total current of outputs (per group) with series diode | |
| • horizontal mounting position<br>to 40 °C<br>to 60 °C | <br>max. 3 A<br>max. 2 A |
| • vertical mounting position<br>to 40 °C | max. 3 A |
| Electrical isolation<br>• between channels and the backplane bus | <br>yes |
| • between channels<br>in groups of | yes<br>8 |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 70 mA<br>max. 90 mA |
| Power loss of the module | typ. 5 W |



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| **Technical specifications** | |
|---|---|
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts<br>• Diagnostic interrupt | programmable |
| Diagnostic functions<br>• Group error display<br>• Channel error display (F)<br>• Reading diagnostics data | programmable<br>red LED (SF)<br>red LED (F) per channel<br>supported |
| **Actuator selection data** | |
| Output voltage<br>• "1" signal<br>without series diode<br>with series diode | <br><br>min. L + (- 0.8 V)<br>min. L+ (-1.6 V) |
| Output current | |
| • "1" signal<br>Rated value<br>Permitted range | <br>0.5 A<br>10 mA to 0.6 A[1)] |
| • "0" signal (residual current) | max. 0.5 mA |
| Output delay (resistive load)<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>max. 180 µs<br>max. 245 µs |
| Load resistance range | 48 Ω to 3 kΩ |
| Lamp load | max. 5 W |
| Wiring two outputs in parallel | |
| • for redundant load control | Only outputs with series diode and common reference potential |
| • for performance increase | not supported |
| Control of a digital input | supported<br>1 binary input to IEC 61131, Type 2;<br>Type 1, with disabled wire-break monitoring |
| Switching frequency<br>• with resistive load<br>• with inductive load to IEC 947-5-1, DC 13<br>• with lamp load | <br>max. 100 Hz<br>max. 2 Hz<br>max. 10 Hz |
| Internal limiting of the inductive shutdown voltage to | typ. L + (-45 V) |
| Short-circuit protection of the output | yes, electronic |
| • Threshold | typ. 0.75 A to 1.5 A |
| Wiring of the actuators | using a 20-pin front connector |
| 1) 5 mA to 0.6 A, with disabled wire-break monitoring | |



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### Configuration in RUN

Special considerations must be given if you use the Configuration in RUN function.

SF LED is lit:

Status before re-configuration diagnostics on, SF LEDs lit among others (on CPU, IM or module), although diagnostics are no longer pending and the module is operating correctly.

Solution:

- Only change the configuration when no diagnostics are pending for the module or
- Pulling and plugging the module.

## 3.29.1 SM 322; DO 8 x DC 24 V/0.5 A - Parameters

### Programming

The general procedure of programming digital modules is described in the chapter Programming digital modules (Page 58).

### SM 322; DO 8 x DC 24 V/0.5 A - Parameters

The table below lists the programmable parameters of SM 322; DO 8 x DC 24 V/0.5 A, including defaults.

The defaults apply if you have not set any parameters in **STEP 7**.

Table 3- 28 Parameters of SM 322; DO 8 x DC 24 V/0.5 A

| Parameters | Range of values | Default | Parameter type | Scope |
|---|---|---|---|---|
| Enable<br>• Diagnostics interrupt | yes/no | no | dynamic | Module |
| Reaction to CPU STOP | Set substitute value (SSV)<br>Hold last value (HLV) | SSV | | |
| Diagnostics<br>• Wirebreak<br>• No load voltage L<br>• Short-circuit to M<br>• Short-circuit to L | yes/no<br>yes/no<br>yes/no<br>yes/no | no<br>no<br>no<br>no | static | Channel |
| Set substitute value "1" | yes/no | no | dynamic | Channel |



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## 3.29.2 SM 322; DO 8 x DC 24 V/0.5 A - Diagnostics

### Diagnostics messages of SM 322; DO 8 x DC 24 V/0.5 A

The table provides an overview of the diagnostic messages of SM 322; DO 8 x DC 24 V/0.5 A

Table 3- 29 Diagnostics messages of SM 322; DO 8 x DC 24 V/0.5 A

| Diagnostics message | LED | Scope of diagnostics | programmable |
|---|---|---|---|
| Wire-break* | SF | Channel | yes |
| Load voltage missing | SF | Channel | yes |
| Short-circuit to M | SF | Channel | yes |
| Short-circuit to L+ | SF | Channel | yes |
| External auxiliary voltage missing | SF | Module | no |
| Internal auxiliary voltage missing | SF | Module | no |
| Fuse blown | SF | Module | no |
| Watchdog time-out | SF | Module | no |
| EPROM fault | SF | Module | no |
| RAM fault | SF | Module | no |
| * The module detects a wire-break at a current < 1 mA. If configured accordingly, the SF LED and corresponding channel error LED light up when a wire-break is detected. | | | |

**Note**

Prerequisite for the detection of errors indicated by programmable diagnostic messages is an appropriate configuration of the digital module in *STEP 7*.



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## Causes of error and troubleshooting

Table 3- 30 Diagnostic messages of SM 322; DO 8 x DC 24 V/0.5 A, causes of error and troubleshooting

| Diagnostics message | Error detection condition ... | Possible cause of error | To correct or avoid error |
|---|---|---|---|
| Wirebreak | Only when output = "1" | Wire-break between the module and actuator | Connect the cable |
| | | Channel not connected (open) | Disable the "wire-break diagnostics" parameter for the channel in *STEP 7* |
| Load voltage missing | Only when output = "1" | Defective output | Replace the module |
| Short-circuit to M | Only when output = "1" | Overload at output | Eliminate overload |
| | | Short-circuit of output to M | Eliminate the short-circuit |
| Short-circuit to L+ | generally | Short-circuit at output to L+ of the module power supply | Eliminate the short-circuit |
| External auxiliary voltage missing | generally | Power supply L+ to module missing | Feed supply L+ |
| Internal auxiliary voltage missing | generally | Power supply L+ to module missing | Feed supply L+ |
| | | Fuse blown in module | Replace the module |
| Fuse blown | generally | Fuse blown in module | Replace the module |
| Watchdog timeout | generally | Infrequent high electromagnetic interference | Eliminate the interference |
| | | Defective module | Replace the module |
| EPROM fault | generally | Infrequent high electromagnetic interference | Eliminate interference and cycle the power supply of CPU off/on. |
| | | Defective module | Replace the module |
| RAM fault | generally | Infrequent high electromagnetic interference | Eliminate interference and cycle the power supply of CPU off/on. |
| | | Defective module | Replace the module |



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## 3.29.3 SM 322; DO 8 x DC 24 V/0.5 A - Behavior

### Influence of the operating state and supply voltage on output values

The output values of SM 322; DO 8 x DC 24V/0.5 A are determined by the CPU's operating state and the module's power supply.

Table 3- 31 Influence of the CPU operating state and of the supply voltage L+ of SM 322; DO 8 24 VDC/0.5 A on output values.

| CPU operating state | | Power supply L+ at digital module | Output value of the digital module |
|---|---|---|---|
| POWER ON | RUN | L+ present | CPU value |
| | | L+ missing | 0 signal |
| | STOP | L+ present | Substitute value/last value (default = 0 signal) |
| | | L+ missing | 0 signal |
| POWER OFF | - | L+ present | 0 signal |
| | | L+ missing | 0 signal |

### Reaction to power failure

Failure of the power supply to SM 322; DO 8 x DC 24V/0.5 A is always indicated at the module's SF LED. This information is also available on the module (entry in diagnostics data.)

Triggering of diagnostics interrupts is determined by the parameter settings (see the next chapter Interrupts of SM 322; DO 8 x DC 24/0.5 A (Page 182)).

### See also

SM 322; DO 8 x DC 24 V/0.5 A - Parameters (Page 178)



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## 3.29.4 SM 322; DO 8 x DC 24 V/0.5 A - Interrupts

### Introduction

The SM 322; DO 8 x DC 24 V/0.5 A can trigger diagnostic interrupts.

For detailed information on the OBs and SFCs mentioned below, refer to the *STEP 7* Online Help.

### Enabling interrupts

There is no default interrupt setting, i.e. interrupts are disabled if parameters are not set accordingly. Program the interrupt enable parameter in **STEP 7**.

### Diagnostics interrupt

Incoming error events (initial occurrence) and outgoing error events (error is cleared) are reported by means of diagnostics interrupt, if this interrupt is enabled.

The CPU interrupts user program execution in order to process diagnostics interrupt OB82.

You can call SFC51 or 59 in OB82 in the user program to view detailed diagnostics data output by the module.

Diagnostics data remain consistent until the program exits OB82. The module acknowledges the diagnostics interrupt when the program exits OB82.

### See also

SM 322; DO 8 x DC 24 V/0.5 A - Parameters (Page 178)



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# 3.30 Digital output module SM 322; DO 8 x DC 48-125 V/1.5 A; (6ES7322-1CF00-0AA0)

### Order number: "Standard module"

6ES7322-1CF00-0AA0

### Order number: "SIPLUS S7-300 module"

6AG1322-1CF00-2AA0

### Properties

Properties of SM 322; DO 8 x DC 48-125 V/1.5 A:

- 8 outputs, with reverse polarity protection, and electrically isolated in groups of 4
- Output current 1.5 A
- Rated load voltage 48 VDC to 125 VDC
- Suitable for solenoid valves, DC contactors and signal lamps
- Group error display (SF)

### Use of the module with high-speed counters

Please note when using the module in combination with high-speed counters:

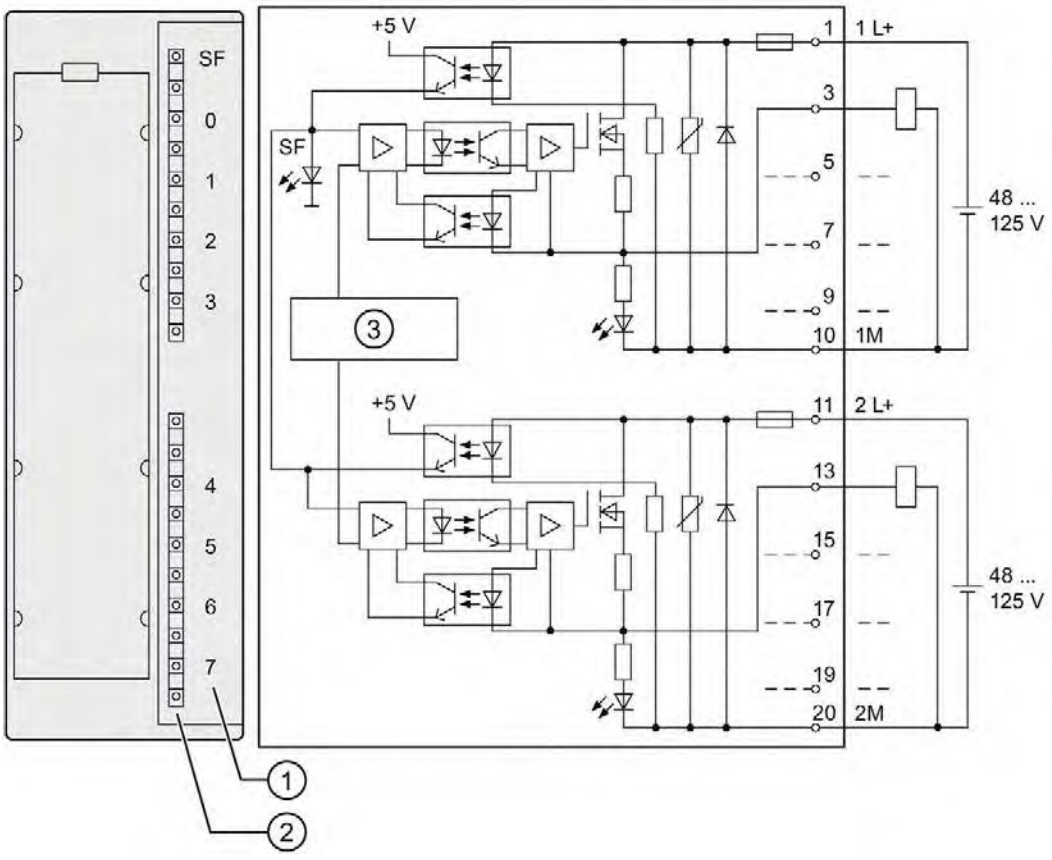
**Note**

When using a mechanical contact to switch on the power supply, the outputs of SM 322; DO 8 x DC 48-125 V/1.5 A will carry a "1" signal for the duration of ca. 50 µs due to the circuit structure.



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## Wiring and block diagrams of SM 322; DO 8 x DC 48-125 V/1.5 A




① Channel number
② Status display - green
Error LED - red
③ Backplane bus interface



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## Technical specifications of M 322; DO 8 x DC 48-125 V/1.5 A

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 250 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of outputs | 8 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+ | 48 VDC to 125 VDC |
| • Reverse polarity protection | yes, by fusing[1)] |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 40 °C<br>to 50 °C<br>to 60 °C | <br>max. 6 A<br>max. 4 A<br>max. 3 A |
| • vertical mounting position<br>to 40 °C | max. 4 A |
| Electrical isolation<br>• between channels and the backplane bus | yes |
| • between channels<br>in groups of | yes<br>4 |
| Maximum potential difference<br>• between different circuits | <br>146 VDC / 132 VAC |
| Isolation test voltage | 1500 VAC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 100 mA<br>max. 2 mA |
| Power loss of the module | typ. 7.2 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions<br>• Group error display | <br>red LED (SF) [2)] |



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| **Technical specifications** | |
|---|---|
| **Actuator selection data** | |
| Output voltage<br>• "1" signal | <br>min. L+ (-1.2 V) |
| Output current<br>• "1" signal<br>Rated value<br>Permitted range | <br><br>1.5 A<br>10 mA to 1.5 A |
| • Permitted surge current | max. 3 A for a duration of 10 ms |
| • with "0" signal (residual current) | max. 0.5 mA |
| Output delay (resistive load) | |
| • "0" to "1" transition<br>• "1" to "0" transition | max. 2 ms<br>max. 15 ms |
| Lamp load | max. 15 W at 48 V<br>max. 40 W at 125 V |
| Wiring two outputs in parallel | |
| • for redundant load control | supported (only outputs of the same group) |
| • for performance increase | not supported |
| Control of a digital input | supported |
| Switching frequency<br>• with resistive load<br>• with inductive load<br>• with lamp load | <br>max. 25 Hz<br>max. 0.5 Hz<br>max. 10 Hz |
| Internal limiting of the inductive shutdown voltage to | typ. M (-1V) |
| Short-circuit protection of the output<br>• Threshold | yes, electronic[3)]<br>typ. 4.4 A |
| Replacement fuses | Fuse 6.3 A/250 V, fast-blow, 5 x 20 mm |
| • Schurter<br>• Wickman | SP0001.1012<br>194-1630-0 |
| Fuse holder<br>• Wickman | <br>653 0000 040 |
| Wiring of the actuators | using a 20-pin front connector |

1) Fuses on this module are only supplementary. External surge current protection (suitable for tap circuits conforming to local regulations for electrical engineering) is required in the supply lines of the load circuit.

2) Possible errors:

- no load voltage
- defective fuse
- output overload

3) If an overload condition is detected, the output is disabled for the duration of ca. 2.4 s.



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# 3.31 Digital output module SM 322;DO 8 x AC 120/230 V/2 A; (6ES7322-1FF01-0AA0)

### Order number: "Standard module"

6ES7322-1FF01-0AA0

### Order number: "SIPLUS S7-300 module"

6AG1322-1FF01-2AA0

### Properties

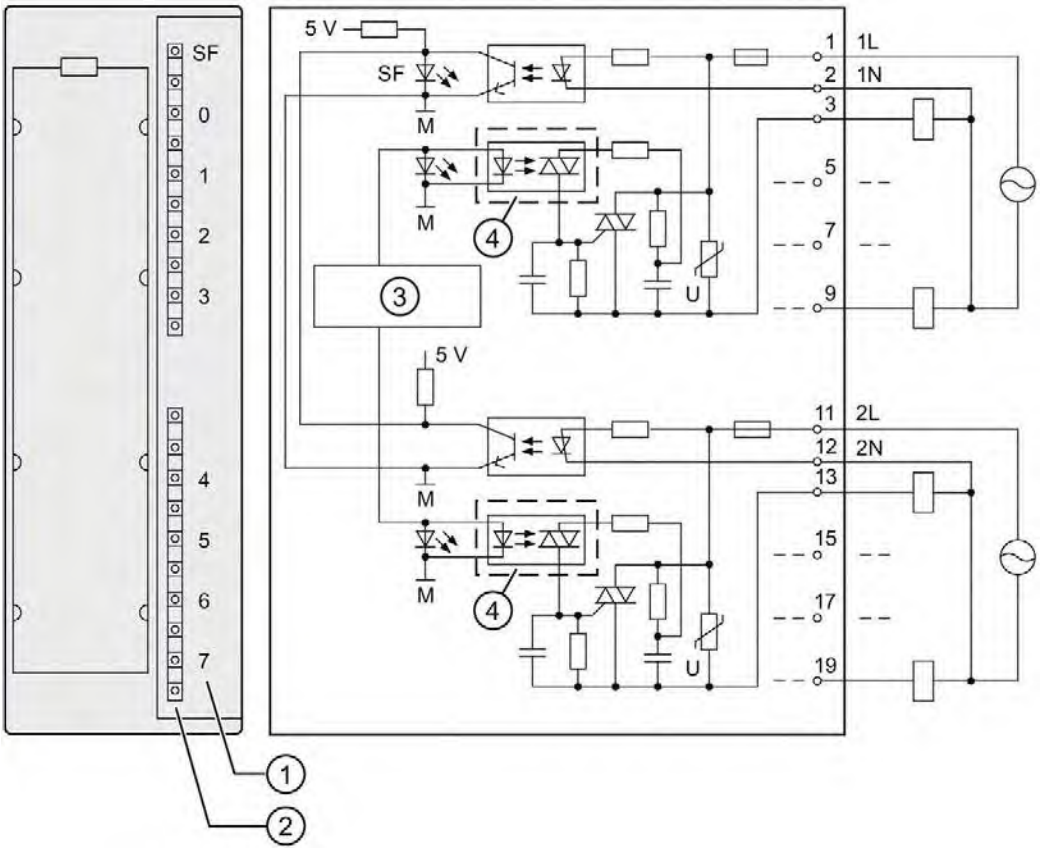
Properties of SM 322; DO 8 x AC 120/230 V/2 A:

- 8 outputs, fused and electrically isolated in groups of 4
- Output current 2 A
- Rated load voltage 120/230 VAC
- Suitable for AC solenoid valves, contactors, motor starters, FHP motors and signal lamps.
- Group error display (SF)



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## Wiring and block diagram of SM 322; DO 8 x AC 120/230 V/2 A




① Channel number
② Status display - green
Error LED - red
③ Backplane bus interface
④ Optotriac



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## SM 322; DO 8 x AC 120/230 V/2 A - Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 275 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of outputs | 8 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L1<br>• Maximum frequency range | 120/230 VAC<br>47 Hz to 63 Hz |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 40 °C<br>to 60 °C | <br>max. 4 A<br>max. 2 A |
| • vertical mounting position<br>to 40 °C | <br>max. 2 A |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels<br>in groups of | <br>yes<br>yes<br>4 |
| Maximum potential difference | |
| • between $M_{internal}$ and outputs | 230 VAC |
| • between outputs of different groups | 500 VAC |
| Isolation test voltage | 1500 VAC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L1 (no-load) | <br>max. 100 mA<br>max. 2 mA |
| Power loss of the module | typ. 8.6 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions<br>• Group error display | yes<br>red LED (SF) [2)] |



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| **Technical specifications** | |
|---|---|
| **Actuator selection data** | |
| Output voltage<br>• "1" signal<br>– At maximum current<br>– At minimum current | <br><br>min. L1 (-1.5 V)<br>min. L1 (-8.5 V) |
| Output current<br>• "1" signal<br>Rated value<br>permissible range at 0 °C to 40 °C<br>permissible range at 40 °C to 60 °C<br>Maximum inrush current (per group) | <br><br>AC 2 A[1)]<br>10 mA to 2 A<br>10 mA to 1 A<br>max. 20 A (max. 1 AC cycle) |
| • "0" signal (residual current) | max. 2 mA |
| Output delay (resistive load) | |
| • "0" to "1" transition | max. 1 AC cycle |
| • "1" to "0" transition | max. 1 AC cycle |
| Minimum load current | 10 mA |
| Zero transition | max. 60 V |
| Size of the motor starter | max. size 5 to NEMA |
| Lamp load | max. 50 W |
| Wiring two outputs in parallel | |
| • for redundant load control | supported (only outputs of the same group) |
| • for performance increase | not supported |
| Control of a digital input | supported |
| Switching frequency<br>• with resistive load<br>• with inductive load to IEC 947-5-1, AC 15<br>• with lamp load | <br>max. 10 Hz<br>max. 0.5 Hz<br>max. 1 Hz |
| Short-circuit protection of the output | Fuse, 8 A/250 V; per group |
| • Fuse-tripping current | min. 40 A |
| • Response time | max. 300 ms |
| Replacement fuses<br>• Wickman<br>• Schurter<br>• Littlefuse | 8 A fuse/fast-blow<br>194-1800-0<br>SP001.1013<br>217.008 |
| Fuse holder<br>• Wickman | <br>653 07 |
| Wiring of the actuators | using a 20-pin front connector |

1) The load current must not be half-wave

2) Possible errors:

- no load voltage
- defective fuse



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# 3.32 Digital output module SM 322; DO 8 x AC 120/230 V/2 A ISOL (6ES7322-5FF00-0AB0)

## Order number

6ES7322-5FF00-0AB0

## Properties

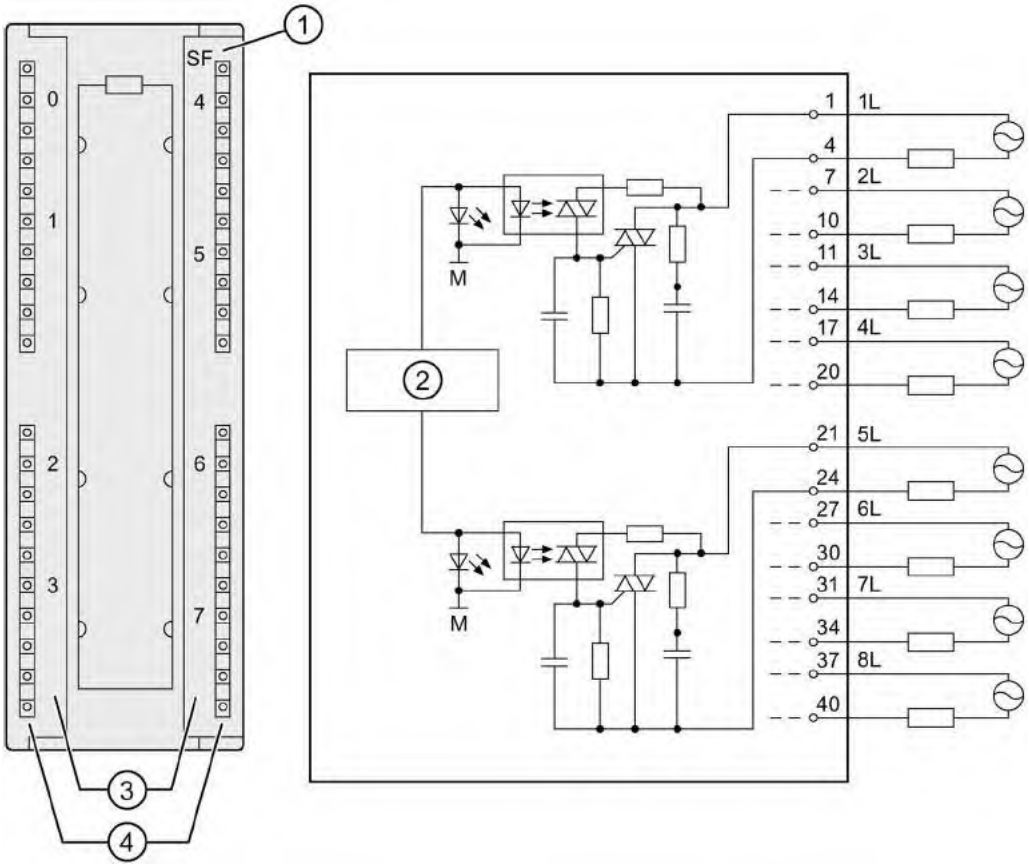
Properties of digital output module SM 322; DO 8 x AC 120/230 V/2 A ISOL:

- 8 outputs, electrically isolated
- Group error display
- Channelspecific status LEDs
- Configurable diagnostics
- Programmable diagnostic interrupt
- Programmable substitute value output
- Output current 2 A
- Rated load voltage 120/230 V AC
- Suitable for AC solenoid valves, contactors, motor starters, FHP motors and signal lamps
- Supports parameter reassignment in RUN



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## Wiring and block diagram of SM 322; DO 8 x AC 120/230 V/2 A ISOL




① Group error display - red
② Backplane bus interface
③ Channel number
④ Status display - green



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## SM 322; DO 8 x AC 120/230 V/2 A ISOL - Technical specifications

| | |
|---|---|
| **Technical specifications** | |
| **Dimensions and weight** | |
| Dimensions W x H x D | 40 x 125 x 117 |
| Weight | approx. 275 g |
| **Module-specific data** | |
| Supports parameter reassignment in RUN | Yes |
| • Reaction of non-programmed outputs | Return the output value which was valid before the parameterization |
| Supports isochronous mode | No |
| Number of outputs | 8 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L1 | 120/230 V AC |
| Total current of outputs (module) | |
| • Horizontal mounting position<br>to 40 °C<br>to 60 °C | <br>max. 8 A<br>max. 4 A |
| • vertical mounting position<br>to 40 °C | max. 4 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels<br>in groups of | yes<br>1 |
| Maximum potential difference | |
| • between $M_{internal}$ and outputs | 230 V AC |
| • between outputs | 500 V AC |
| Isolation test voltage | |
| • between $M_{internal}$ and outputs | 1500 V AC |
| • between outputs of different groups | 2000 V AC |
| Current consumption | |
| • from the backplane bus<br>• from load voltage L1 (no-load) | max. 100 mA<br>max. 2 mA |
| Power loss of the module | typ. 8.6 W |



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| **Technical specifications** | |
|---|---|
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts<br>• Diagnostic interrupt | <br>programmable |
| Diagnostic functions<br>• Group error display | <br>red LED (SF) |
| **Actuator selection data** | |
| Output voltage<br>• "1" signal<br>– At maximum current<br>– At minimum current | <br><br>min. L1 (-1.5 V)<br>min L1 (-8.5 V) |
| Output current | |
| • "1" signal<br>Rated value<br>permissible range at 0 °C to 40 °C<br>permissible range at 40 °C to 60 °C<br>Maximum inrush current (per group) | <br>2 A<br>10 mA to 2 A<br>10 mA to 1 A<br>20 A (with two half-waves) |
| • "0" signal (residual current) | max. 2 mA |
| Zero transition | max. 60 V |
| Size of the motor starter | max. size 5 to NEMA |
| Lamp load | max. 50 W |
| Wiring two outputs in parallel | |
| • for redundant load control | supported |
| • for performance increase | not supported |
| Control of a digital input | supported |
| Switching frequency | |
| • with resistive load | max. 10 Hz |
| • with inductive load to IEC 947-5-1, AC 15 | max. 0.5 Hz |
| • with lamp load | max. 1 Hz |
| Short circuit-proof output | yes, 3.15 A / 250 V fuse, fast-blow |
| Wiring of the actuators | Using a 40-pin front connector |

**Note**

The outputs must be protected by a high-speed, fast-blow 3.15 A 250 V AC fuse. Hazardous areas to National Electric Code must be determined safe before you remove/replace the fuse. Removal and replacement may only be possible using a suitable tool.



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### Configuration in RUN

Special considerations must be given if you use the Configuration in RUN function.

SF LED is lit:

Status before re-configuration diagnostics on, SF LEDs lit among others (on CPU, IM or module), although diagnostics are no longer pending and the module is operating correctly.

Solution:

- Only change the configuration when no diagnostics are pending for the module or
- Pulling and plugging the module.

## 3.32.1 Parameters of SM 322; DO 8 x AC 120/230 V/2 A ISOL

### Parameters of SM 322; DO 8 x AC 120/230 V/2 A ISOL

The table below lists the configurable parameters of SM 322; DO 8 x AC120/230 V/2 A ISOL, including defaults.

The defaults apply if you have not set any parameters in *STEP 7*.

Table 3- 32 Parameters of SM 322; DO 8 x AC 120/230 V/2 A ISOL

| Parameters | Range of values | Defaults | Parameter type | Scope |
|---|---|---|---|---|
| Enable<br>• Diagnostic interrupts | yes/no | no | dynamic | Module |
| Reaction to CPU STOP | Set substitute value (SSV)<br>Hold last value (HLV) | SSV | dynamic | Channel |
| Set substitute value "1" | yes/no | no | dynamic | Channel |

### Programming

For detailed information on parameters of the digital output module, refer to the appendix Settings for the digital output modules (Page 528).

### See also

Programming digital modules (Page 58)



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## 3.32.2 SM 322; DO 8 x AC 120/230 V/2 A ISOL - Diagnostics

### Diagnostic messages of SM 322; DO 8 x AC 120/230 V/2 A ISOL

The table below provides an overview of the diagnostic messages of SM 322; DO 8 x 120/230 VAC/2 A ISOL.

Table 3- 33 Diagnostic messages of SM 322; DO 8 x AC 120/230 V/2 A ISOL

| Diagnostics message | LED | Scope of diagnostics | programmable |
|---|---|---|---|
| Watchdog timeout | SF | Module | no |
| EPROM fault | SF | Module | no |
| RAM fault | SF | Module | no |

### Causes of error and troubleshooting

The following table shows the diagnostic messages of SM 322; DO 8 x AC 120/230V/2 A ISOL, causes of error and troubleshooting.

Table 3- 34 Diagnostic messages of SM 322; DO 8 x AC 120/230V/2 A ISOL, error causes and troubleshooting

| Diagnostics message | Error detection | Possible cause of error | To correct or avoid errors |
|---|---|---|---|
| Watchdog timeout | Always | Transient high electromagnetic interference | Eliminate interference and cycle the CPU power supply off and on |
| | | Defective module | Replace the module |
| EPROM fault | Always | Transient high electromagnetic interference | Eliminate interference and cycle the CPU power supply off and on |
| | | Defective module | Replace the module |
| RAM fault | Always | Transient high electromagnetic interference | Eliminate interference and cycle the CPU power supply off and on |
| | | Defective module | Replace the module |

## 3.32.3 SM 322; DO 8 x AC 120/230 V/2 A ISOL - Interrupts

### Introduction

The SM 322; DO 8 x AC 120/230 V/2 A ISOL can trigger diagnostic interrupts.

For detailed information on the OBs and SFCs mentioned below, refer to the *STEP 7* Online Help.

### Enabling interrupts

There is no default interrupt setting, i.e. interrupts are disabled if not set accordingly. Program the interrupt enable parameter in **STEP 7**.



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## Diagnostic interrupt

When diagnostic interrupts are enabled, incoming error events (initial occurrence) and outgoing error events (error is cleared) are reported by means of interrupt.

The CPU interrupts user program execution in order to process diagnostics interrupt OB82.

You can call SFC51 or 59 in OB82 in the user program to obtain detailed diagnostics data from the module.

Diagnostics data remain consistent until the program exits OB82. The module acknowledges the diagnostic interrupt when the program exits OB82.

## Load restrictions in horizontal mounting position

In horizontal mounting position, the module loads must be restricted so that two adjacent inputs or outputs do not exceed their rated load.

## Load restrictions in vertical mounting position

In vertical mounting position, the module loads must be restricted so that four adjacent inputs or outputs do not exceed their rated load.



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# 3.33 Relay output module SM 322; DO 16 x Rel. AC 120/230 V; (6ES7322-1HH01-0AA0)

## Order number

6ES7322-1HH01-0AA0

## Properties

The SM 322; DO 16 x Rel. 120/230 V AC is characterized by the following properties:

- 16 outputs, electrically isolated in groups of 8
- Load voltage 24 to 120 V DC; 24 to 230 V AC
- Suitable for AC/DC solenoid valves, contactors, motor starters, FHP motors and signal lamps.

## Reaction to a shutdown of the power supply

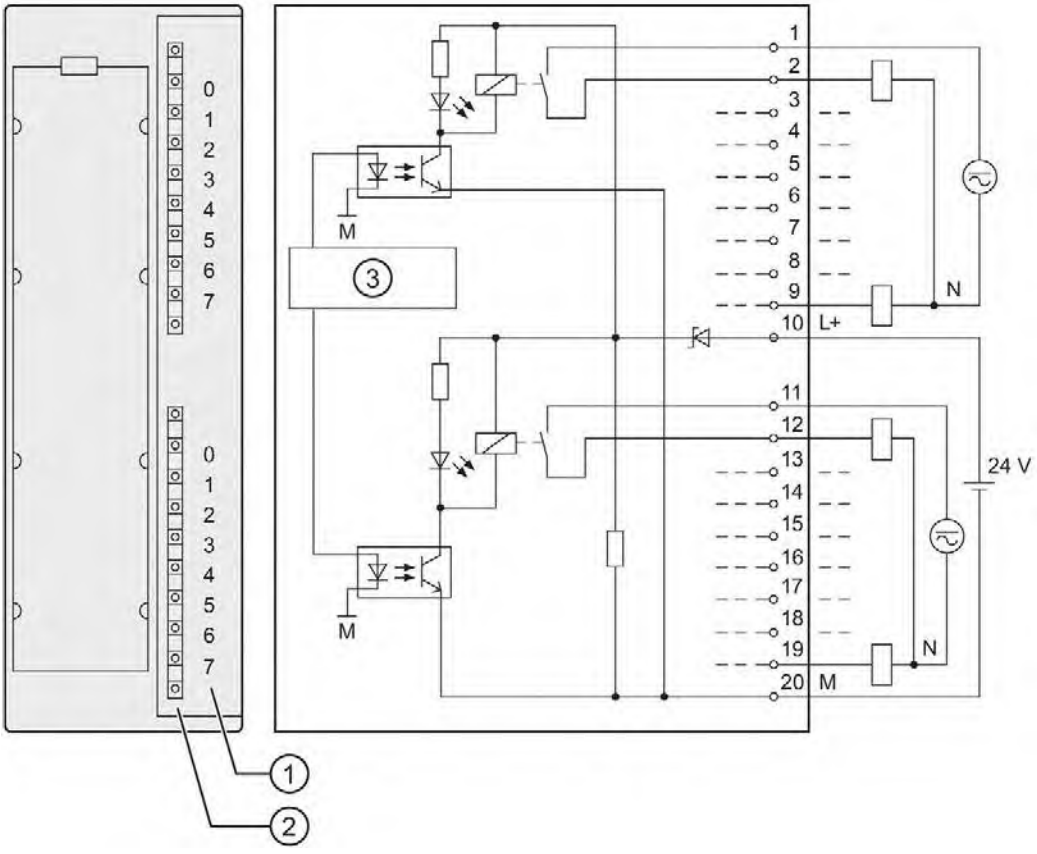
**Note**

The internal 200-ms buffer capacitance discharges sufficient power after power off to allow the user program to set a defined relay state.



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## Wiring and block diagram of SM 322; DO 16 x Rel. 120/230 V AC




① Channel number
② Status display - green
③ Backplane bus interface



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## Technical specifications of the SM 322; DO 16 x Rel. 120/230 V AC

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 250 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of outputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated power supply L+ to the relays | 24 V DC |
| Total current of outputs (per group) | max. 8 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels<br>in groups of | yes<br>8 |
| Maximum potential difference | |
| • Between $M_{internal}$ and the power supply to relays and outputs | 230 V AC |
| • Between outputs of different groups | 500 V AC |
| Isolation test voltage | |
| • between $M_{internal}$ and the power supply to relays | 500 V DC |
| • between $M_{internal}$ and the power supply to relays and outputs | 1500 V AC |
| • between outputs of different groups | 2000 V AC |
| Current consumption<br>• from the backplane bus<br>• from power supply L+ | <br>max. 100 mA<br>max. 250 mA |
| Power loss of the module | typ. 4.5 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |



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| **Technical specifications** | | |
|---|---|---|
| **Actuator selection data** | | |
| Thermal current, continuous | max. 2 A | |
| Minimum load voltage / current | 10 V / 10 mA | |
| Short-circuit current to IEC 947-5-1 | 200 A, with B10/B16 circuit breaker | |
| Switching capacity and service life of contacts | | |
| • with resistive load | | |
| Voltage | Current | No. of switching cycles (typical) |
| 24 V DC | 2.0 A | 0.1 million |
| | 1.0 A | 0.2 million |
| | 0.5 A | 1.0 million |
| 60 V DC | 0.5 A | 0.2 million |
| 120 V DC | 0.2 A | 0.6 million |
| 24 V AC | 1.5 A | 1.5 million |
| 48 V AC | 1.5 A | 1.5 million |
| 60 V AC | 1.5 A | 1.5 million |
| 120 V AC | 2.0 A | 1.0 million |
| | 1.0 A | 1.5 million |
| | 0.5 A | 2.0 million |
| 230 V AC | 2.0 A | 1.0 million |
| | 1.0 A | 1.5 million |
| | 0.5 A | 2.0 million |
| • with inductive load to IEC 947-5-1 DC13/AC15 | | |
| Voltage | Current | No. of switching cycles (typical) |
| 24 V DC | 2.0 A | 0.05 million |
| | 1.0 A | 0.1 million |
| | 0.5 A | 0.5 million |
| DC 60 V | 0.5 A | 0.1 million |
| DC 120 V | 0.2 A | 0.3 million |
| 24 V AC | 1.5 A | 1 million |
| 48 V AC | 1.5 A | 1 million |
| AC 60 V | 1.5 A | 1 million |
| AC 120 V | 2.0 A | 0.7 million |
| | 1.0 A | 1.0 million |
| | 0.5 A | 1.5 million |
| 230 V AC | 2.0 A | 0.7 million |
| | 1.0 A | 1.0 million |
| | 0.5 A | 1.5 million |
| An external protective circuit will increase the service life of contacts. | | |
| Size of the motor starter | max. size 5 to NEMA | |
| Lamp load | 50 W / 230 V AC<br>5 W / 24 V DC | |
| Contact protection (internal) | none | |



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| **Technical specifications** | |
|---|---|
| Wiring two outputs in parallel | |
| • for redundant load control | supported (only outputs of the same group) |
| • for performance increase | not supported |
| Control of a digital input | supported |
| Switching frequency | |
| • Mechanical | max. 10 Hz |
| • with resistive load | max. 1 Hz |
| • with inductive load to IEC 947-5-1, DC13/AC15 | max. 0.5 Hz |
| • with lamp load | max. 1 Hz |
| Wiring of the actuators | using a 20-pin front connector |



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# 3.34 Relay output module SM 322; DO 8 x Rel. AC 230 V; (6ES7322-1HF01-0AA0)

## Order number

6ES7322-1HF01-0AA0

## Properties

The SM 322; DO 8 x Rel. 230 V AC is characterized by the following properties:

- 8 outputs, electrically isolated in groups of 2
- Rated load voltage 24 to 120 V DC, 48 V to 230 V AC
- Suitable for AC/DC solenoid valves, contactors, motor starters, FHP motors and signal lamps.

## Reaction to a shutdown of the power supply

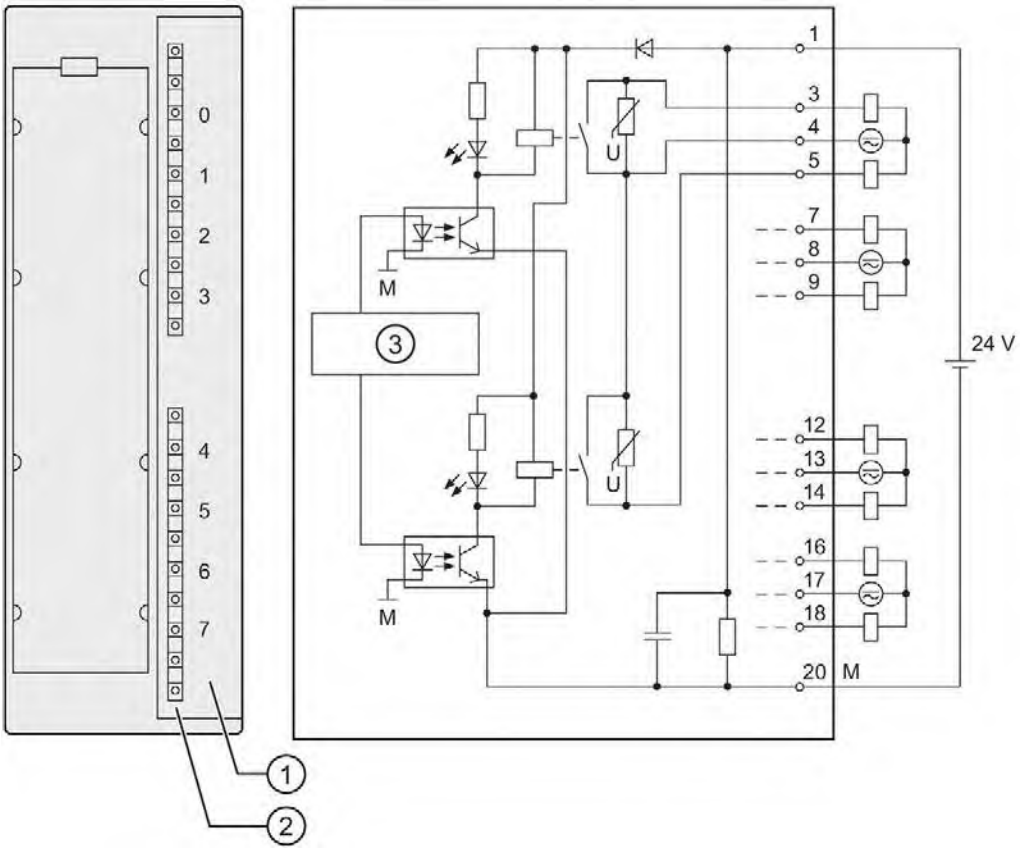
**Note**

The following only applies to SM 322; DO 8 x Rel. 230 V AC with product version 1: The internal backup capacitor provides power for the duration of ca. 200 ms. This backup time is sufficient to briefly control the relay in the user program.



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## Wiring and block diagram of SM 322; DO 8 x Rel. 230 V AC




① Channel number
② Status display - green
③ Backplane bus interface

## Technical specifications of the SM 322; DO 8 x Rel. 230 V AC

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 190 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of outputs | 8 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |



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| **Technical specifications** | |
|---|---|
| **Voltages, currents, electrical potentials** | |
| Rated power supply L+ to the relays | 24 V DC |
| Total current of outputs (per group) | max. 4 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels<br>in groups of | yes<br>2 |
| Maximum potential difference | |
| • Between $M_{internal}$ and the power supply to relays and outputs | 230 V AC |
| • Between outputs of different groups | 500 V AC |
| Isolation test voltage | |
| • between $M_{internal}$ and the power supply to relays | 500 V DC |
| • between $M_{internal}$ and the power supply to relays and outputs | 2000 V AC |
| • between outputs of different groups | 2000 V AC |
| Current consumption<br>• from the backplane bus<br>• from power supply L+ | <br>max. 40 mA<br>max. 160 mA |
| Power loss of the module | typ. 3.2 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |
| **Actuator selection data** | |
| Thermal current, continuous | max. 3 A |
| Minimum load voltage / current | 10 V / 5 mA |
| Short circuit-proof to IEC 947-5-1 [2)] | With circuit-breaker, characteristics B, for:<br>cos Φ 1.0: 600 A<br>cos Φ 0.5...0.7: 900 A<br>With 8 A Diazed fuse: 1000 A |



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| **Technical specifications** | | |
|---|---|---|
| Switching capacity and useful life of contacts | | |
| • with resistive load | | |
| Voltage | Current | No. of switching cycles (typical) |
| 24 V DC | 2.0 A | 0.7 million |
| | 1.0 A | 1.6 million |
| | 0.5 A | 4 million |
| 60 V DC | 0.5 A | 1.6 million |
| 120 V DC | 0.2 A | 1.6 million |
| 48 V AC | 2.0 A | 1.6 million |
| 60 V AC | 2.0 A | 1.2 million |
| 120 V AC | 2.0 A | 0.5 million 2) |
| | 1.0 A | 0.7 million 2) |
| | 0.5 A | 1.5 million 2) |
| 230 V AC | 2.0 A | 0.5 million 2) |
| | 1.0 A | 0.7 million 2) |
| | 0.5 A | 1.5 million |
| • with inductive load to IEC 947-5-1 DC13/AC15 | | |
| Voltage | Current | No. of switching cycles (typical) |
| 24 V DC | 2.0 A | 0.3 million |
| | 1.0 A | 0.5 million |
| | 0.5 A | 1.0 million |
| 60 V DC | 0.5 A | 0.5 million |
| | 0.2 A | 0.3 million 2) |
| 120 V DC | 1.5 A | 1 million |
| 48 V AC | 1.5 A | 1 million |
| 60 V AC | 2.0 A | 0.2 million |
| 120 V AC | 1.0 A | 0.7 million |
| | 0.7 A | 1 million |
| | 0.5 A | 2.0 million |
| 230 V AC | 2.0 A | 0.3 million 2) |
| | 1.0 A | 0.7 million 2) |
| | 0.5 A | 2 million 2) |
| Contact protection (internal) | Varistor SIOV-CU4032 K275 G | |
| An external protective circuit extends the useful life of contacts. | | |
| **Actuator selection data [continued]** | | |
| Lamp load 1) | max. 50 W | |
| | Power | No. of switching cycles (typical) |
| Lamp load (230 V AC) 2) | 700 W | 25000 |
| | 1500 W | 10000 |
| Energy-saving lamps/fluorescent lamps with electronic ballast2) | 10 x 58 W | 25000 |



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| **Technical specifications** | | |
|---|---|---|
| Fluorescent lamps, conventionally compensated [2] | 1 x 58 W | 25000 |
| Fluorescent lamps, non-compensated [2] | 10 x 58 W | 25000 |
| Wiring two outputs in parallel | | |
| • for redundant load control | supported (only outputs of the same group) | |
| • for performance increase | not supported | |
| Control of a digital input | supported | |
| Switching frequency<br>• Mechanical | max. 10 Hz | |
| • with resistive load | max. 2 Hz | |
| • with inductive load to IEC 947-5-1, DC13/AC15 | max. 0.5 Hz | |
| • with lamp load | max. 2 Hz | |
| Wiring of the actuators | using a 20-pin front connector | |

1) Product version 1

2) Product version 2 or higher



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# 3.35 Relay output module SM 322; DO 8 x Rel. 230VAC/5A; (6ES7322-5HF00-0AB0)

## Order number

6ES7322-5HF00-0AB0

## Properties

The relay output module SM 322; DO 8 x Rel. 230 V AC / 5A is characterized by the following properties:

- 8 outputs, electrically isolated
- Load voltage 24 to 120 V DC, 24 to 230 V AC
- Suitable for AC solenoid valves, contactors, motor starters, FHP motors and signal lamps
- You can protect the contacts with an RC quenching element by setting a jumper (SJ.)
- Group error display
- Channel-specific status displays
- Programmable diagnostic interrupt
- Programmable substitute value output
- Supports parameter reassignment in RUN

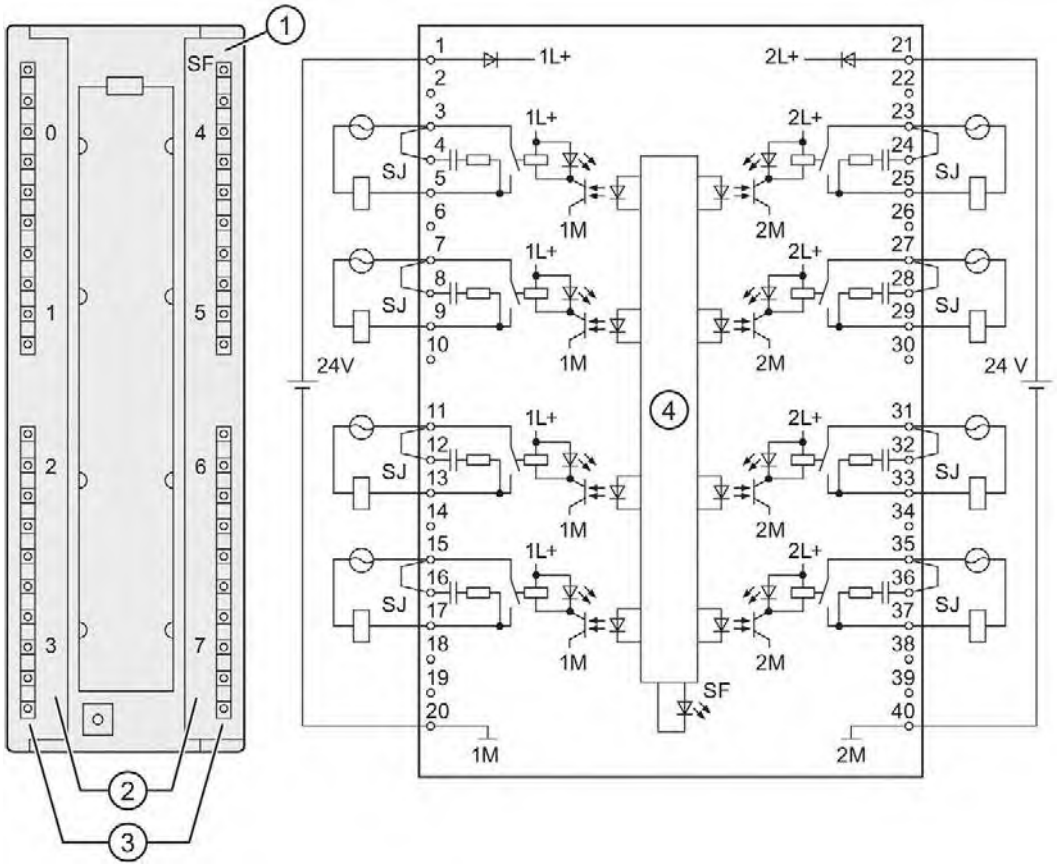
## Overvoltage protection of contacts

You can protect the contacts against overvoltage by bridging (SJ) the module terminals 3 and 4, 7 and 8, 12 and 13 etc. (see the diagram below).



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## Wiring and block diagram of SM 322; DO 8 x Rel. 230 V AC / 5A




① Error LED - red
② Channel number
③ Status display - green
④ Backplane bus interface

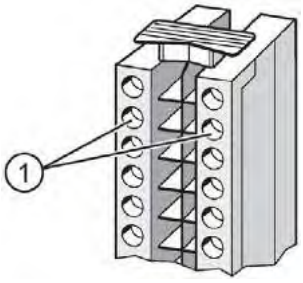


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## Operation on safety extra-low voltage (SELV)

Make allowances for the special feature outlined below when operating the 6ES7322-5HF00-0AB0 relay output module on SELV:

The horizontally adjacent terminal of a terminal operated on SELV may not be operated at a rated voltage higher than 120 VUC. When operated at voltages higher than 120 VUC, the creepage distances and air gaps in the 40-pin front connector do not meet SIMATIC requirements of safe electrical separation.




① If one of two horizontally adjacent terminals is operated on SELV, the other terminal may not be operated at more than 120 VUC.

## Technical specifications of the SM 322; DO 8 x Rel. 230 V AC / 5A

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 320 g |
| **Module-specific data** | |
| Supports parameter reassignment in RUN | Yes |
| • Reaction of non-programmed outputs | Return the output value which was valid before the parameterization |
| Supports isochronous mode | no |
| Number of outputs | 8 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |



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| **Technical specifications** | |
|---|---|
| **Voltages, currents, electrical potentials** | |
| Rated electronics supply voltage L+ | 24 V DC |
| • Reverse polarity protection | yes |
| Total current of outputs (per group) | |
| • horizontal mounting position up to 60° | max. 5 A |
| • vertical mounting position up to 40° | max. 5 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels and the power supply to relays | yes |
| • between channels<br>in groups of | yes<br>1 |
| Maximum potential difference | |
| • Between $M_{internal}$ and the power supply to relays and outputs | 250 V AC |
| • Between outputs of different groups | 500 V AC |
| Isolation test voltage | |
| • between $M_{internal}$ and the power supply to relays | 500 V DC |
| • between $M_{internal}$ and the power supply to relays and outputs | 1500 V AC |
| • between outputs of different groups | 2000 V AC |
| Current consumption<br>• from the backplane bus<br>• from power supply L+ | <br>max. 100 mA<br>max. 160 mA |
| Power loss of the module | typ. 3.5 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | |
| • Diagnostic interrupt | programmable |
| Diagnostic functions | programmable |
| • Group error display | red LED (SF) |
| • Reading diagnostics information | supported |



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| **Technical specifications** | | |
|---|---|---|
| **Actuator selection data** | | |
| Thermal current, continuous | max. 5 A | |
| Minimum load voltage / current | 10 V /10 mA[1)] | |
| Residual current | 11.5 mA [2)] | |
| Short circuit-proof to IEC 947-5-1 | With circuit-breaker, characteristics B, for:<br>cos Φ 1.0: 600 A<br>cos Φ 0.5...0.7: 900 A<br>With 8 A Diazed fuse: 1000 A | |
| Switching capacity and useful life of contacts | | |
| • with resistive load | | |
| Voltage | Current | No. of switching cycles (typical) |
| 24 V DC | 5.0 A | 0.2 million |
| 24 V DC | 2.5 A | 0.4 million |
| 24 V DC | 1.0 A | 0.9 million |
| 24 V DC | 0.2 A | 1.7 million |
| 24 V DC | 0.1 A | 2 million |
| 120 V DC | 0.2 A | 1.7 million |
| 120 V DC | 0.1 A | 2 million |
| 230 V AC | 5.0 A | 0.2 million |
| 230 V AC | 2.5 A | 0.4 million |
| 230 V AC | 1.0 A | 0.9 million |
| 230 V AC | 0.2 A | 1.7 million |
| 230 V AC | 0.1 A | 2 million |
| • with inductive load | | |
| Voltage | Current | No. of switching cycles (typical) |
| 24 V DC | 5.0 A | 0.1 million |
| 24 V DC | 2.5 A | 0.25 million |
| 24 V DC | 1.0 A | 0.5 million |
| 24 V DC | 0.2 A | 1 million |
| 24 V DC | 0.1 A | 1.2 million |
| 120 V DC | 0.1 A | 1.2 million |
| 230 V AC | 5.0 A | 0.1 million |
| 230 V AC | 2.5 A | 0.25 million |
| 230 V AC | 1.0 A | 0.5 million |
| 230 V AC | 0.2 A | 1 million |
| 230 V AC | 0.1 A | 1.2 million |



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| Technical specifications | | |
|---|---|---|
| An RC quenching element (jumper "SJ" inserted) or an external protection circuit extend the service life of contacts. | | |
| Size of the motor starter | max. size 5 to NEMA | |
| | Power | No. of switching cycles (typical) |
| Lamp load (230 V AC) | 1000 W<br>1500 W | 25000<br>10000 |
| Energy-saving lamps/fluorescent lamps with electronic ballast[3)] | 10 x 58 W | 25000 |
| Fluorescent lamps, conventionally compensated | 1 x 58 W | 25000 |
| Fluorescent lamps, non-compensated | 10 x 58 W | 25000 |
| Contact protection | RC quenching element; 330 Ω, 0.1 µF | |
| Wiring two outputs in parallel | | |
| • for redundant load control | supported (only outputs with the same load voltage) | |
| • for performance increase | not supported | |
| Control of a digital input | supported | |
| Switching frequency<br>• Mechanical | max. 10 Hz | |
| • with resistive load | max. 2 Hz | |
| • with inductive load to IEC 947-5-1, DC13/AC15 | max. 0.5 Hz | |
| • with lamp load | max. 2 Hz | |
| Wiring of the actuators | using a 40-pin front connector | |

[1)] Without inserted jumper (SJ).

[2)] With AC load voltage and inserted jumper (SJ). No residual current if the jumper (SJ) is not installed.

[3)] The sum of all inrush currents on a ballast connected to an output must not exceed 5 A.

**Note**

The residual current of an RC quenching element connected to IEC Type 1 inputs may cause unwanted signal states. Remove the SJ jumper to rectify this fault.

## Configuration in RUN

Special considerations must be given if you use the Configuration in RUN function.

SF LED is lit:

Status before re-configuration diagnostics on, SF LEDs lit among others (on CPU, IM or module), although diagnostics are no longer pending and the module is operating correctly.

Solution:

- Only change the configuration when no diagnostics are pending for the module or
- Pulling and plugging the module.



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## 3.35.1 Parameters of SM 322; DO 8 x Rel. AC 230V/5A

### Parameters of SM 322; DO 8 x Rel. AC 230V/5A

The table below provides an overview of configurable parameters and defaults for SM 322; DO 8 x Rel. AC 230V/5A.

The defaults apply if you have not set any parameters in **STEP 7**.

Table 3- 35 Parameters of SM 322; DO 8 x Rel. AC 230V/5A

| Parameters | Range of values | Defaults | Parameter type | Scope |
|---|---|---|---|---|
| Enable<br>• Diagnostic interrupts | yes/no | no | Dynamic | Module |
| Reaction to CPU STOP | Set substitution value (SSV)<br>Hold last value (HLV) | SSV | Dynamic | Channel |
| Set substitution value "1" | yes/no | no | Dynamic | Channel |

### See also

Programming digital modules (Page 58)

## 3.35.2 SM 322; DO 8 x Rel. AC 230V/5A - Diagnostics

### Diagnostics messages of SM 322; DO 8 x Rel. AC 230V/5A

The table below provides an overview of the diagnostic messages of SM 322; DO 8 x Rel. AC 230V/5A.

Table 3- 36 Diagnostics messages of SM 322; DO 8 x Rel. AC 230V/5A

| Diagnostics message | LED | Scope of diagnostics | programmable |
|---|---|---|---|
| Watchdog time-out | SF | Module | no |
| EPROM error | SF | Module | no |
| RAM error | SF | Module | no |



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### Causes of error and troubleshooting

Table 3- 37 Diagnostic messages of SM 322; DO 8 x Rel. AC230V/5A, cause of error and troubleshooting

| Diagnostics message | Error detection | Possible cause of error | To correct or avoid errors |
|---|---|---|---|
| Watchdog time-out | generally | infrequent high level of electro-magnetic interference | Eliminate interference and cycle the CPU power supply off and on |
| | | Defective module | Replace the module |
| EPROM error | generally | infrequent high level of electro-magnetic interference | Eliminate interference and cycle the CPU power supply off and on |
| | | Defective module | Replace the module |
| RAM error | generally | transient high electromagnetic interference | Eliminate interference and cycle the CPU power supply off and on |
| | | Defective module | Replace the module |

## 3.35.3 SM 322; DO 8 x Rel. AC 230V/5A - Interrupts

### Introduction

The SM 322; DO 8 x Rel. AC 230V/5A can trigger diagnostic interrupts.

For detailed information on the OBs and SFCs mentioned below, refer to the *STEP 7* Online Help.

### Enabling interrupts

There is no default interrupt setting, i.e. interrupts are disabled if not set accordingly. Program the interrupt enable parameter in **STEP 7**.

### Diagnostic interrupt

Incoming error events (initial occurrence) and outgoing error events (error is cleared) are reported by means of diagnostics interrupt, if this interrupt is enabled.

The CPU interrupts user program execution in order to process diagnostics interrupt OB82.

You can call SFC51 or 59 in OB82 in the user program to obtain detailed diagnostics data from the module.

Diagnostics data remain consistent until the program exits OB82. The module acknowledges the diagnostics interrupt when the program exits OB82.



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# 3.36 Relay output module SM 322; DO 8 x Rel. AC 230 V/5 A; (6ES7322-1HF10-0AA0)

### Order number: "Standard module"

6ES7322-1HF10-0AA0

### Order number: "SIPLUS S7-300 module"

6AG1322-1HF10-2AA0

### Properties

The SM 322; DO 8 x Rel. 230 V AC / 5 A is characterized by the following properties:

- 8 outputs, electrically isolated in groups of 1
- Rated load voltage 24 to 120 V DC, 48 V to 230 V AC
- Suitable for AC/DC solenoid valves, contactors, motor starters, FHP motors and signal lamps.

### Measures to take for switching currents > 3 A

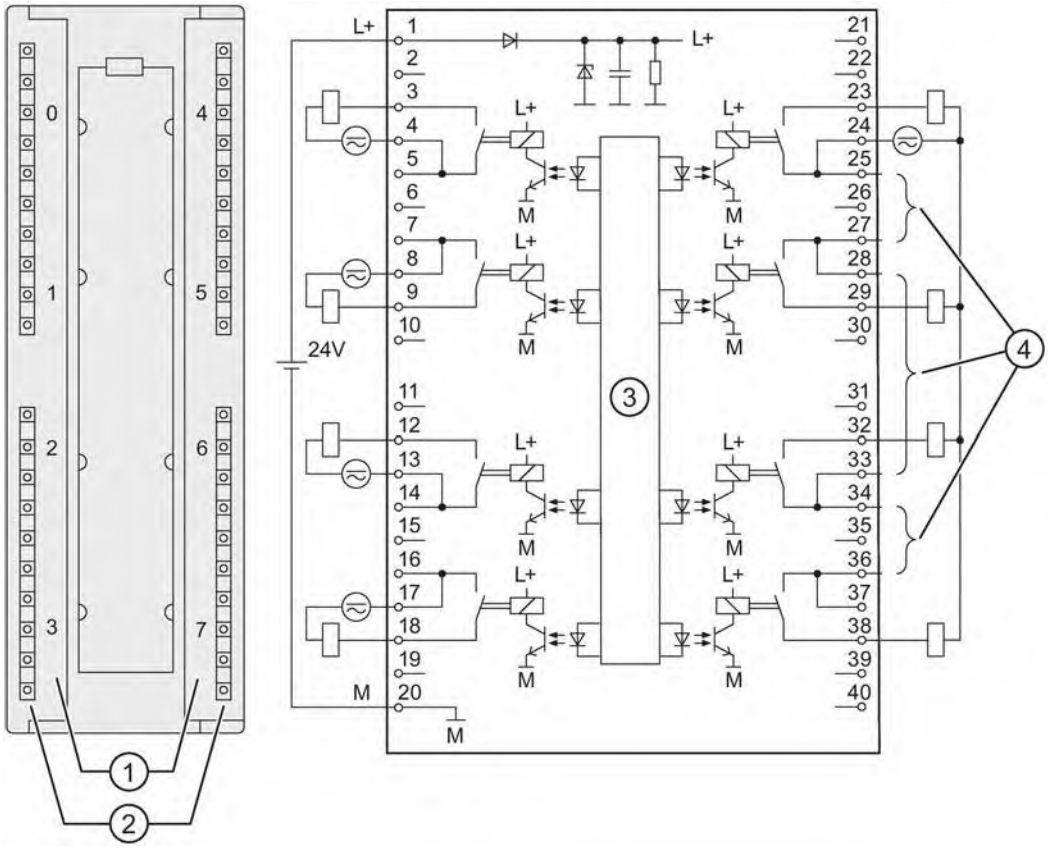
**Note**

Always use connecting cables with a cross-section of 1.5 $mm^2$ when operating with switching currents > 3 A in order to reduce any temperature rise in the connector area of the module to a minimum.



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## Wiring and block diagram of SM 322; DO 8 x Rel. 230 V AC / 5 A




① Channel number
② Status displays - green
③ Backplane bus interface
④ Options of looping the power supply to contacts
$I_{Accumulated\ current}$ ≦ 8 A at $T_U$ ≦ 30 °C
$I_{Accumulated\ current}$ ≦ 5 A at $T_U$ ≦ 60 °C

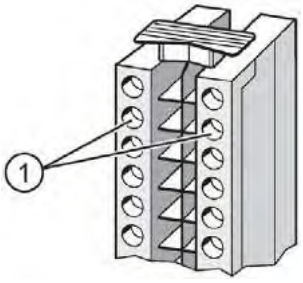


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## Operation on safety extra-low voltage (SELV)

Make allowances for the special feature outlined below when operating relay output module 322-1HF10 on SELV:

To operate a terminal on SELV, the horizontally adjacent terminal may not be operated at a rated voltage higher than 120 VUC. The creepage distances and air gaps of the 40-pin front connector do not meet SIMATIC requirements in terms of safe electrical separation if operated with voltages above 120 VUC.




① If one of two horizontally adjacent terminals is operated on SELV, the other terminal may not be operated at more than 120 VUC.

## Technical specifications of the SM 322; DO 8 x Rel. 230 V AC / 5 A

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 120 |
| Weight | ca. 320 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of outputs | 8 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |



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| **Technical specifications** | |
|---|---|
| **Voltages, currents, electrical potentials** | |
| Rated power supply L+ to the relays | 24 V DC |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 30 °C<br>to 60 °C<br>• vertical mounting position<br>to 40 °C | <br>max. 8 A<br>max. 5 A<br><br>max. 5 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels<br>in groups of | yes<br>1 |
| Maximum potential difference | |
| • Between $M_{internal}$ and the power supply to relays and outputs | 250 V AC |
| • Between outputs of different groups | 500 V AC |
| Isolation test voltage | |
| • between $M_{internal}$ and the power supply to relays | 500 V DC |
| • between $M_{internal}$ and the power supply to relays and outputs | 1500 V AC |
| • between outputs of different groups | 2000 V AC |
| Current consumption<br>• from the backplane bus<br>• from power supply L+ | <br>max. 40 mA<br>max. 125 mA |
| Power loss of the module | typ. 3.2 W |
| **Status, interrupts, diagnostics** | |
| Status display<br>Interrupt<br>Diagnostic functions | green LED per channel<br>none<br>none |



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| **Technical specifications** | | |
|---|---|---|
| **Actuator selection data** | | |
| Thermal current, continuous | max. 8 A | |
| Minimum load voltage / current | 10 V / 5 mA | |
| Short-circuit current to IEC 947-5-1 | With circuit-breaker, characteristics B, for:<br>cos Φ 1.0: 600 A<br>cos Φ 0.5...0.7: 900 A<br>With 8 A Diazed fuse: 1000 A | |
| Switching capacity and useful life of contacts | | |
| • with resistive load | | |
| Voltage | Current | No. of switching cycles (typical) |
| 24 V DC | 8.0 A<br>4.0 A<br>2.0 A<br>0.5 A | 0.1 million<br>0.3 million<br>0.7 million<br>4.0 million |
| 60 V DC | 0.5 A | 4 million |
| 120 V DC | 0.2 A | 1.6 million |
| 48 V AC | 8.0 A<br>2.0 A | 0.1 million<br>1.6 million |
| 60 V AC | 8.0 A<br>2.0 A | 0.1 million<br>1.2 million |
| 120 V AC | 8.0 A<br>4.0 A<br>2.0 A<br>1.0 A<br>0.5 A | 0.1 million<br>0.3 million<br>0.5 million<br>0.7 million<br>1.5 million |
| 230 V AC | 8.0 A<br>4.0 A<br>2.0 A<br>1.0 A<br>0.5 A | 0.1 million<br>0.3 million<br>0.5 million<br>0.7 million<br>1.5 million |
| Switching capacity and useful life of contacts | | |
| • with inductive load to IEC 947-5-1 DC13/AC15 | | |



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| **Technical specifications** | | |
|---|---|---|
| Voltage | Current | No. of switching cycles (typical) |
| 24 V DC | 2.0 A<br>1.0 A<br>0.5 A | 0.3 million<br>0.5 million<br>1 million |
| 60 V DC | 0.5 A<br>0.3 A | 0.5 million<br>1 million |
| 120 V DC | 0.2 A | 0.5 million |
| 48 V AC | 3.0 A<br>1.5 A | 0.5 million<br>1 million |
| 60 V AC | 3.0 A<br>1.5A | 0.3 million<br>1 million |
| 120 V AC | 3.0 A<br>2.0 A<br>1.0 A<br>0.5 A | 0.2 million<br>0.3 million<br>0.7 million<br>2 million |
| 230 V AC | 3.0 A<br>2.0 A<br>1.0 A<br>0.5 A | 0.1 million<br>0.3 million<br>0.7 million<br>2.0 million |
| • Aux. contactors Size 0 (3TH28) | | 30 million |
| An external protective circuit extends the useful life of contacts. | | |
| | Power | No. of switching cycles (typical) |
| Lamp load (230 V AC) | 1000 W<br>1500 W | 25000<br>10000 |
| Energy-saving lamps/fluorescent lamps with electronic ballast | 10 x 58 W | 25000 |
| Fluorescent lamps, conventionally compensated | 1 x 58 W | 25000 |
| Fluorescent lamps, non-compensated | 10 x 58 W | 25000 |
| Contact protection (internal) | none | |
| Wiring two outputs in parallel | | |
| • For redundant load control | supported | |
| • for performance increase | not supported | |
| Control of a digital input | supported | |
| Switching frequency<br>• Mechanical | <br>max. 10 Hz | |
| • with resistive load | max. 2 Hz | |
| • with inductive load to IEC 947-5-1, DC13/AC15 | max. 0.5 Hz | |
| • with lamp load | max. 2 Hz | |
| Wiring of the actuators | using a 40-pin front connector | |



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# 3.37 Digital IO module SM 323; DI 16/DO 16 x DC 24 V/0.5 A; (6ES7323-1BL00-0AA0)

## Order number

6ES7323-1BL00-0AA0

## Properties

Properties of SM 323; DI 16/DO 16 x DC 24 V/0.5 A:

- 16 inputs, electrically isolated in groups of 16
- 16 outputs, electrically isolated in groups of 8
- Rated input voltage 24 V DC
- Rated load voltage 24 V DC
- Inputs suitable for switches and 2-/3-/4-wire proximity switches (BEROs)
- Outputs capable of driving solenoid valves, DC contactors and indicator lights

## Use of the module with high-speed counters

Please note when using the module in combination with high-speed counters:

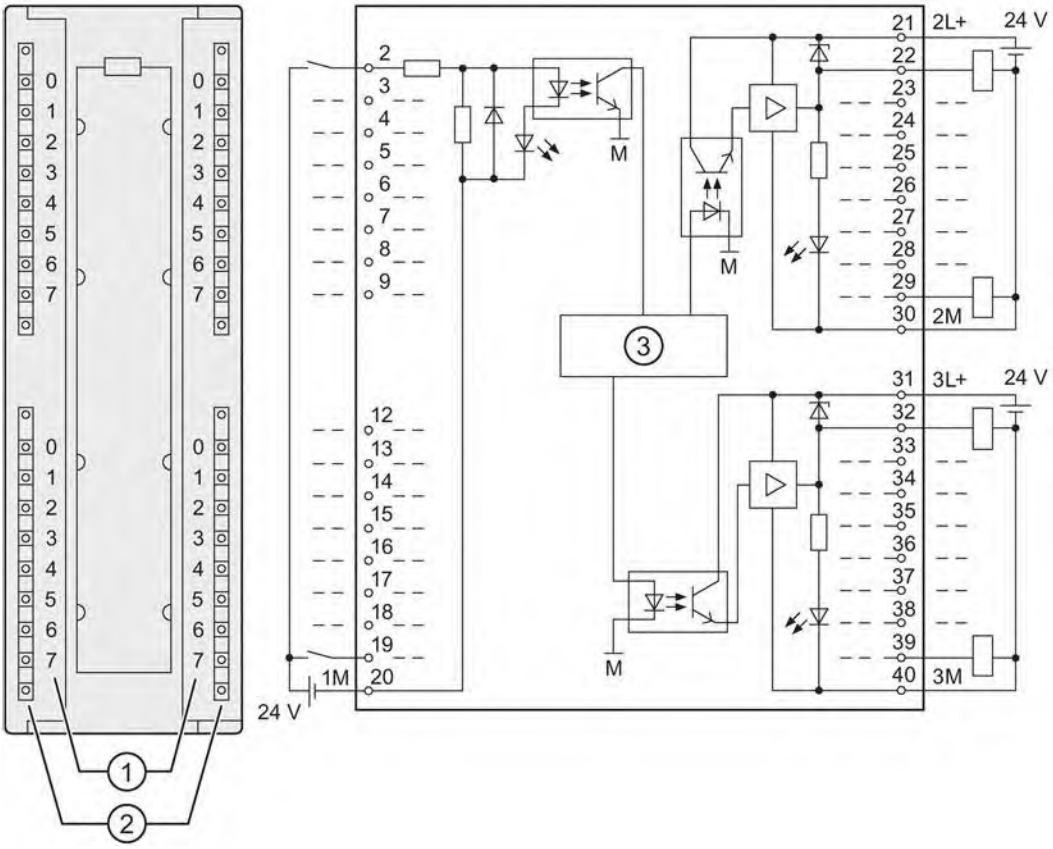
**Note**

When using a mechanical contact to switch on the 24-V power supply to SM 323; DI 16/DO 16 x DC 24 V/0.5 A, its outputs will carry "1" signal for the duration of ca. 50 µs, due to the circuit structure.



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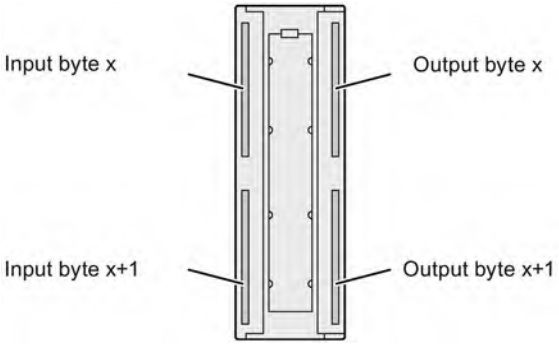
## Wiring and block diagram of SM 323; DI 16/DO 16 x DC 24 V/0.5 A




① Channel number
② Status displays - green
③ Backplane bus interface

## Terminal assignment

The diagram below shows the IO addressing of channels.






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## SM 323; DI 16/DO 16 x DC 24 V/0.5 A - Technical specifications

| | |
|---|---|
| **Technical specifications** | |
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 260 g |
| **Module-specific data** | |
| Isochronous | no |
| Number of inputs | 16 |
| Number of outputs | 16 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+ | 24 V DC |
| Number of simultaneously controlled inputs | |
| • horizontal mounting position<br>to 40 °C<br>to 60 °C | <br>16<br>8 |
| • vertical mounting position<br>to 40 °C | 16 |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 40 °C<br>to 60 °C | <br>max. 4 A<br>max. 3 A |
| • vertical mounting position<br>to 40 °C | max. 2 A |
| Electrical isolation<br>• between channels and the backplane bus | <br>yes |
| • between channels<br>Inputs in groups of<br>Outputs in groups of | yes<br>16<br>8 |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | max. 80 mA<br>max. 80 mA |
| Power loss of the module | typ. 6.5 W |



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| **Technical specifications** | |
|---|---|
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |
| **Encoder selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal | <br>24 V DC<br>13 V to 30 V<br>- 30 V to + 5 V |
| Input current<br>• "1" signal | <br>typ. 7 mA |
| Input delay<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>1.2 ms to 4.8 ms<br>1.2 ms to 4.8 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 1.5 mA |
| Wiring of the signal transmitters | using a 40-pin front connector |
| **Actuator selection data** | |
| Output voltage<br>• "1" signal | <br>min. L + (- 0.8 V) |
| Output current | |
| • "1" signal<br>Rated value<br>Permitted range | <br>0.5 A<br>5 mA to 0.6 A |
| • "0" signal (residual current) | max. 0.5 mA |
| Output delay (resistive load) | |
| • "0" to "1" transition<br>• "1" to "0" transition | Max. 100 µs<br>Max. 500 µs |
| Load resistance range | 48 Ω to 4 kΩ |
| Lamp load | Max. 5 W |
| Wiring two outputs in parallel | |
| • for redundant load control | supported (only outputs of the same group) |
| • for performance increase | not supported |



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| **Technical specifications** | |
|---|---|
| Control of a digital input | supported |
| Switching frequency<br>• with resistive load<br>• with inductive load to IEC 947-5-1, DC 13<br>• with lamp load | <br>max. 100 Hz<br>max. 0.5 Hz<br>max. 10 Hz |
| Internal limiting of the inductive shutdown voltage to | typ. L + (- 53 V) |
| Short circuit-proof output | yes, electronic |
| • Threshold | typ. 1 A |
| Wiring of the actuators | using a 40-pin front connector |



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# 3.38 Digital IO module SM 323; DI 8/DO 8 x DC 24 V/0.5 A; (6ES7323-1BH01-0AA0)

### Order number: "Standard module"

6ES7323-1BH01-0AA0

### Order number: "SIPLUS S7-300 module"

6AG1323-1BH01-2AA0

### Properties

Properties of SM 323; DI 8/DO 8 x DC 24 V/0.5 A:

- 8 inputs, electrically isolated in groups of 8
- 8 outputs, electrically isolated in groups of 8
- Rated input voltage 24 V DC
- Rated load voltage 24 V DC
- Inputs suitable for switches and 2-/3-/4-wire proximity switches (BEROs)
- Outputs capable of driving solenoid valves, DC contactors and indicator lights

### Use of the module with high-speed counters

Please note when using the module in combination with high-speed counters:

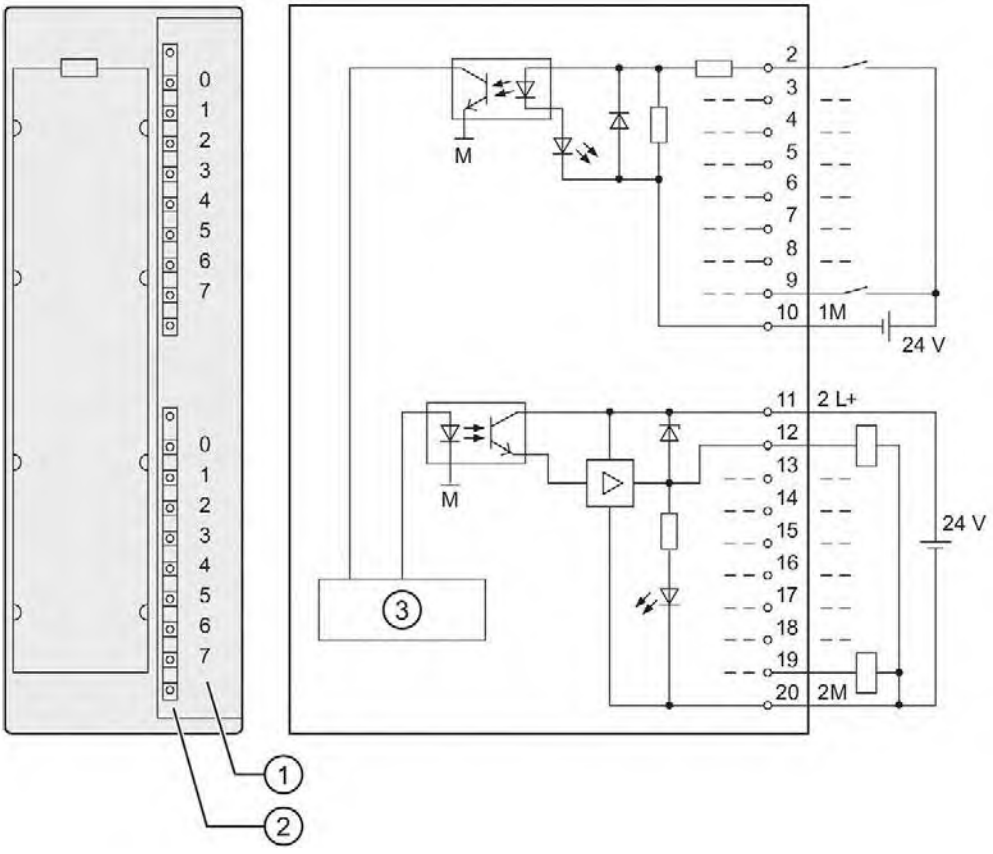
**Note**

When using a mechanical contact to switch on the 24-V power supply to SM 323; DI 8/DO 8 x DC 24 V/0.5 A, its outputs will carry "1" signal for the duration of ca. 50 µs, due to the circuit structure.



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## Wiring and block diagram of SM 323; DI 8/DO 8 x DC 24 V/0.5 A




① Channel number
② Status displays - green
③ Backplane bus interface

## SM 323; DI 8/DO 8 x DC 24 V/0.5 A - Technical specifications

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 200 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of inputs | 8 |
| Number of outputs | 8 |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |



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| **Technical specifications** | |
|---|---|
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+ | 24 V DC |
| Number of simultaneously controlled inputs | |
| • horizontal mounting position<br>to 60 °C<br>• vertical mounting position<br>to 40 °C | <br>8<br><br>8 |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 60 °C<br>• vertical mounting position<br>to 40 °C | <br>max. 4 A<br><br>max. 4 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels<br>Inputs in groups of<br>Outputs in groups of | yes<br>8<br>8 |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 40 mA<br>max. 40 mA |
| Power loss of the module | typ. 3.5 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |
| **Encoder selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal | <br>24 V DC<br>13 V to 30 V<br>- 30 V to + 5 V |
| Input current<br>• "1" signal | <br>typ. 7 mA |
| Input delay<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>1.2 ms to 4.8 ms<br>1.2 ms to 4.8 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 1.5 mA |
| Wiring of the signal transmitters | using a 20-pin front connector |



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| **Technical specifications** | |
|---|---|
| **Actuator selection data** | |
| Output voltage<br>• "1" signal | <br>min. L + (- 0.8 V) |
| Output current | |
| • "1" signal<br>Rated value<br>Permitted range | <br>0.5 A<br>5 mA to 0.6 A |
| • "0" signal (residual current) | Max. 0.5 mA |
| Output delay (resistive load) | |
| • "0" to "1" transition<br>• "1" to "0" transition | Max. 100 µs<br>Max. 500 µs |
| Load resistance range | 48 Ω to 4 kΩ |
| Lamp load | Max. 5 W |
| Wiring two outputs in parallel | |
| • for redundant load control | supported (only outputs of the same group) |
| • for performance increase | not supported |
| Control of a digital input | supported |
| Switching frequency<br>• with resistive load<br>• with inductive load to IEC 947-5-1, DC 13<br>• with lamp load | <br>max. 100 Hz<br>max. 0.5 Hz<br>max. 10 Hz |
| Internal limiting of the inductive shutdown voltage to | typ. L + (- 53 V) |
| Short circuit-proof output | yes, electronic |
| • Threshold | typ. 1 A |
| Wiring of the actuators | using a 20-pin front connector |



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# 3.39 Programmable digital IO module SM 327; DI 8/DO 8 x DC 24 V/0.5 A (6ES7327-1BH00-0AB0)

## Order number

6ES7327-1BH00-0AB0

## Properties

Properties of SM 327; DI 8/DO 8 x DC 24 V/0.5 A:

- 8 digital inputs and 8 individually configurable inputs or outputs, isolated in groups of 16
- Rated input voltage 24 V DC
- Inputs suitable for switches and 2-/3-/4-wire proximity switches (BEROs)
- Output current 0.5 A
- Rated load voltage 24 V DC
- Outputs capable of driving solenoid valves, DC contactors and indicator lights
- Dynamic change of parameters in RUN (CiR-compatible), separately at each channel.
- Readback of outputs.

## Use of the module with high-speed counters

Please note when using the module in combination with high-speed counters:

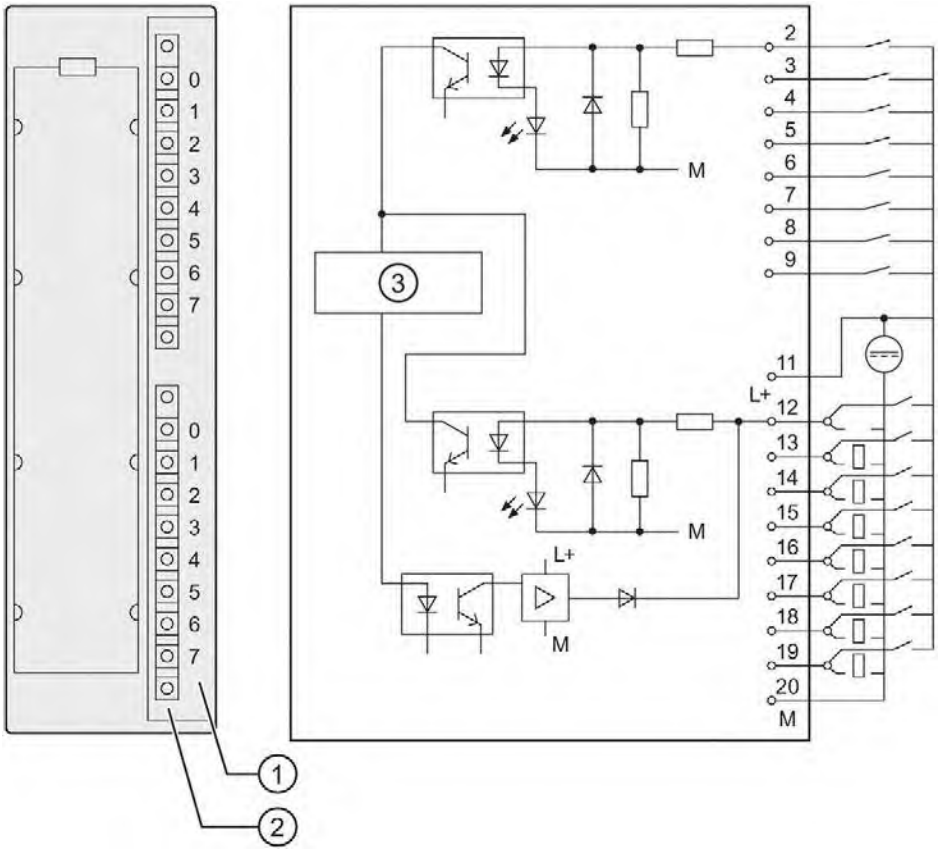
**Note**

When using a mechanical contact to switch on the 24-V power supply to SM 327; DI 8/DO 8 x DC 24 V/0.5 A, its outputs will carry "1" signal for the duration of ca. 50 µs, due to the circuit structure.



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## Wiring and block diagram of SM 327; DI 8/DO 8 x DC 24 V/0.5 A, programmable




① Channel number
② Status display - green
③ Backplane bus interface

## Technical specifications of SM 327; DI 8/DO 8 x DC 24 V/0.5 A, programmable

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 120 |
| Weight | ca. 200 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of inputs | 8 digital |
| Number of inputs/outputs | 8, can be programmed separately |
| Cable length<br>• unshielded<br>• shielded | <br>max. 600 m<br>max. 1000 m |



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| **Technical specifications** | |
|---|---|
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+ | 24 V DC |
| Number of simultaneously controlled inputs | |
| • horizontal mounting position<br>to 60 °C<br>• vertical mounting position<br>to 40 °C | <br>16<br><br>16 |
| Total current of outputs (per group) | |
| • horizontal mounting position<br>to 40 °C<br>to 60 °C<br>• vertical mounting position<br>to 40 °C | <br>max. 4 A<br>max. 3 A<br><br>max. 2 A |
| Electrical isolation | |
| • between channels and the backplane bus | yes |
| • between channels | no |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 60 mA<br>max. 20 mA |
| Power loss of the module | typ. 3 W |
| **Status, interrupts, diagnostics** | |
| Status display | green LED per channel |
| Interrupts | none |
| Diagnostic functions | none |
| **Encoder selection data** | |
| Input voltage<br>• Rated value<br>• "1" signal<br>• "0" signal | <br>24 V DC<br>15 V to 30 V<br>- 30 V to + 5 V |
| Input current<br>• "1" signal | <br>typ. 6 mA |
| Input delay<br>• "0" to "1" transition<br>• "1" to "0" transition | <br>1.2 ms to 4.8 ms<br>1.2 ms to 4.8 ms |
| Input characteristics | to IEC 61131, type 1 |
| Connection of 2-wire BEROs<br>• Permissible quiescent current | supported<br>max. 1.5 mA |
| Wiring of the signal transmitters | using a 20pin front connector |



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| **Technical specifications** | |
|---|---|
| **Actuator selection data** | |
| Output voltage<br>• "1" signal | <br>min. L+ (-1.5 V) |
| Output current | |
| • "1" signal<br>Rated value<br>Permitted range | <br>0.5 A<br>5 mA to 0.6 A |
| • "0" signal (residual current) | Max. 0.5 mA |
| Output delay (resistive load) | |
| • "0" to "1" transition<br>• "1" to "0" transition | max. 350 µs<br>max. 500 µs |
| Load resistance range | 48 Ω to 4 kΩ |
| Lamp load | max. 5 W |
| Wiring two outputs in parallel | |
| • for redundant load control | supported |
| • for performance increase | not supported |
| Control of a digital input | supported |
| Switching frequency<br>• with resistive load<br>• with inductive load to IEC 947-5-1, DC 13<br>• with lamp load | <br>max. 100 Hz<br>max. 0.5 Hz<br>max. 10 Hz |
| Internal limiting of the inductive shutdown voltage to | typ. L + (-54 V) |
| Short circuit-proof output | yes, electronic |
| • Threshold | typ. 1 A |
| Wiring of the actuators | using a 20pin front connector |



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## 3.39.1 Parameters of SM 327; DI 8/DO 8 x 24 VDC/0.5 A

### Programming

The general procedure of programming digital modules is described in the chapter Programming digital modules (Page 58).

### Parameters of SM 327; DI 8/DO 8 x DC 24 V/0.5 A, programmable

The table below lists the programmable parameters of SM 327; DI 8/DO 8 x DC 24 V/0.5 A, including defaults.

The defaults apply if you have not set any parameters in *STEP 7*.

The comparison illustrates the parameters you can edit:

- in*STEP 7*
- using SFC55 "WR_PARM"
- using SFB53 "WRREC" (for GSD, for example).

Parameters set in *STEP 7* may also be transferred to the module using SFCs 56 and 57, and SFB 53 (refer to the *STEP 7*) Online Help).

Table 3- 38 Parameters of SM 327; DI 8/DO 8 x DC 24 V/0.5 A

| Parameters | Range of values | Default | Parameter type | Scope | Data record number | Programmable using ... | |
|---|---|---|---|---|---|---|---|
| | | | | | | SFC55, SFB53 | PG |
| Digital output | yes/no | no | dynamic | Channel | 1 | yes | yes |



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### 3.39.1.1 Structure of data record 1 of SM 327; DI 8/DO 8 x DC 24 V/0.5 A

## Structure of data record 1

The figure below shows the structure of data record 1 of the dynamic parameters of SM 327; DI 8/DO 8 x DC 24 V/0.5 A.

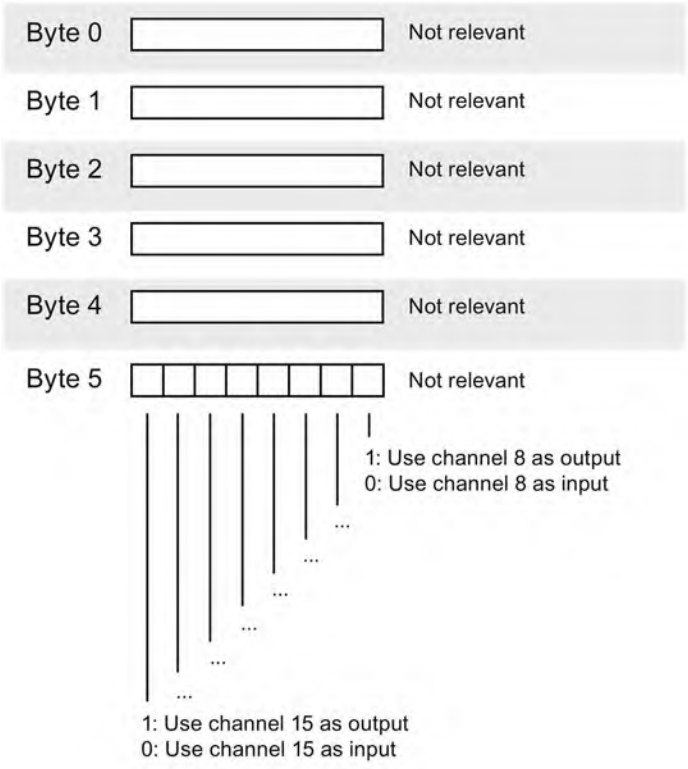



Figure 3-10 Structure of data record 1 of SM 327; DI 8/DO 8 x DC 24 V/0.5 A



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## Readback of outputs

The readback function is a simple form of diagnostics. You can use this to determine whether the information output to the process ("1" or "0") actually arrives there.

The digital outputs can be read back to the user data area: When Q11.3 is configured as an output, for example, it can be read back at I11.3. See the figure below

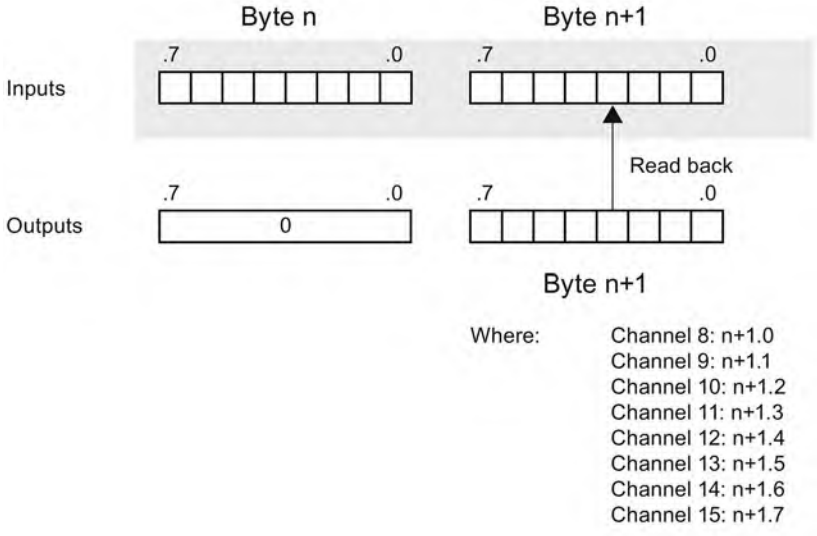



Figure 3-11 Readback of the outputs of SM 327; DI 8/DO 8 x DC 24 V/0.5 A



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# Principles of analog value processing

# 4

## 4.1 Overview

### Introduction

This chapter describes the basic procedure in wiring and connecting signal sensors to analog inputs and analog outputs and corresponding items to observe.

The diagrams below do not show the connecting lines required to connect the electrical potentials of the analog input module and sensors.

Always adhere to the general information on sensor wiring and connecting.

Special wiring and connecting options are described in the corresponding module data.

### Installation and wiring

For information on installation and wiring, refer to the S7-300, CPU 31xC, and CPU 31x Operating Instructions: Installation The operating instructions are available on the Internet (http://support.automation.siemens.com/WW/view/en/13008499).



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# 4.2 Wiring and connecting transducers to analog inputs

## Transducers which can be wired and connected to analog inputs

You can wire and connect the following transducers to the analog input modules, depending on the type of measurement:

- Voltage transducers
- Current transducers
  - As 2-wire transducer
  - As 4-wire transducer
- Resistors
- Thermocouples

## Cables for analog signals

Always use shielded twisted-pair cables to wire analog signals. This reduces interference. Connect both ends of the analog cable shield to ground.

Any potential difference between the cable ends may cause an equipotential current on the shield and disturbance on analog signals. Avoid this effect by means of low-impedance equipotential bonding. Ground only one end of the shielding.

## Electrically isolated analog input modules

Electrically isolated analog input modules are not electrically interconnected at the reference point of the measuring circuit ($M_{ANA}$ and/or M) and the M terminal of the CPU/IM153.

Always use electrically isolated analog input modules if there is any risk of potential difference $V_{ISO}$ developing between the reference point of measuring circuit (MANA and/or M-) and the M terminal of the CPU/IM153 .

You can prevent the potential difference $V_{ISO}$ from exceeding limits by means of equipotential interconnection of terminals $M_{ANA}$ and M of the CPU/IM153.

## Non-isolated analog input modules

Non-isolated analog input modules require a low-impedance connection between the reference point of measuring circuit $M_{ANA}$ and the M terminal of the CPU or interface module IM 153. Interconnect terminals $M_{ANA}$ with M of the CPU or interface module IM 153. Any potential difference between $M_{ANA}$ and M of the CPU or interface module IM 153 may corrupt the analog signal.

## Limited potential difference CMV

The permissible potential difference $U_{CM}$ (CMV/Common Mode) may not be exceeded. A CMV fault may develop between

- the measurement inputs (M+ / M-) and the reference potential of measuring circuit $M_{ANA}$
- between the measuring inputs.

The following diagrams show the measures to be taken when wiring transducers.



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## 4.2.1 Wiring and connecting electrically isolated transducers

### Electrically isolated transducers

Electrically isolated transducers are not connected to local ground potential. They can be operated in electrically isolated mode.

Potential differences may develop between electrically isolated sensors. These potential differences may be caused by interference, or may develop as a result of the local distribution of transducers.

In environments with a high level of EMC interference, it is advisable to interconnect M- with $M_{ANA}$ in order to prevent the permissible CMV value from being exceeded.

**Note**

For modules where $V_{CM} \leq 2.5$ V, interconnect M- and $M_{ANA}$ (see the diagrams below).

### Wiring and connecting electrically isolated transducesr to an electrically isolated AI

The CPU / IM 153 can be operated in grounded mode or ungrounded mode.

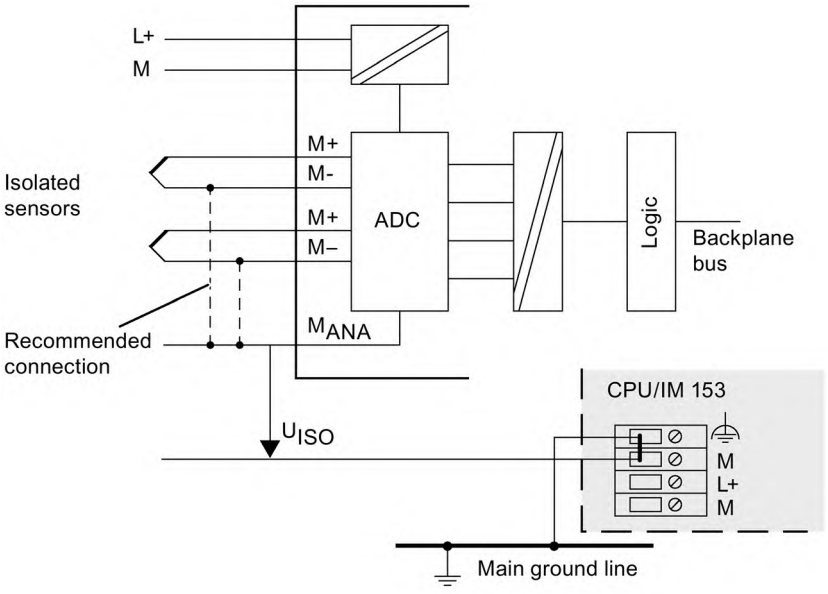



Figure 4-1 Wiring and connecting electrically isolated transducers to electrically isolated AI



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### Wiring and connecting electrically isolated transducers to a non-isolated AI

The CPU / IM 153 can be operated in grounded mode or ungrounded mode.

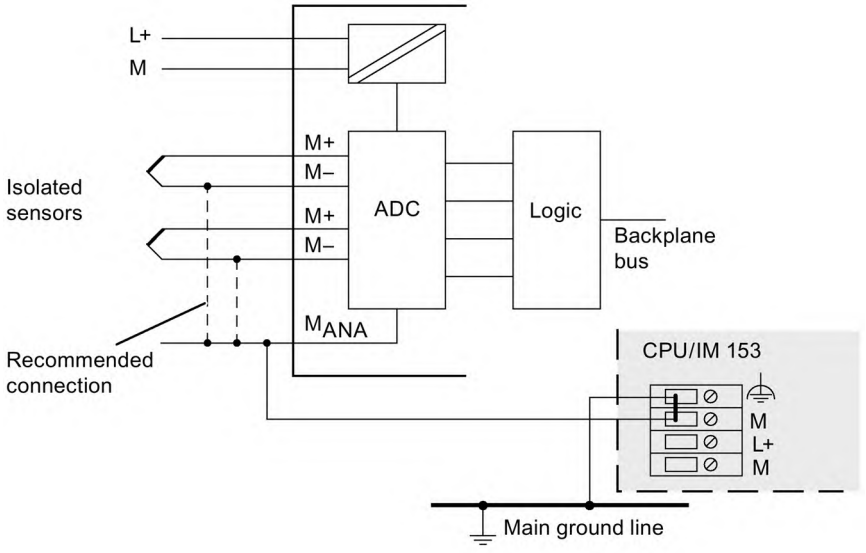



Figure 4-2 Wiring and connecting electrically isolated transducers to a non-isolated AI

**Note**

Do not interconnect M- with $M_{ANA}$ when wiring and connecting 2-wire transducers and resistance transducers. An equalization current develops at the interconnection of M- with $M_{ANA}$ and corrupts the measured value. This also applies to unused inputs which are programmed accordingly.

## 4.2.2 Wiring non-isolated transducers

### Non-isolated transducer

Non-isolated transducers are interconnected with local ground potential. Always interconnect $M_{ANA}$ with local ground when using non-isolated transducers.

Local conditions or interference may cause potential differences CMV (static or dynamic) between locally distributed measuring points. If the maximum CMV value is exceeded, interconnect the measuring points by means of equipotential conductors.



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## Wiring non-isolated transducer to electrically isolated AI

When connecting non-isolated transducers to electrically isolated modules, the CPU / IM 153 can be operated in grounded or ungrounded mode.

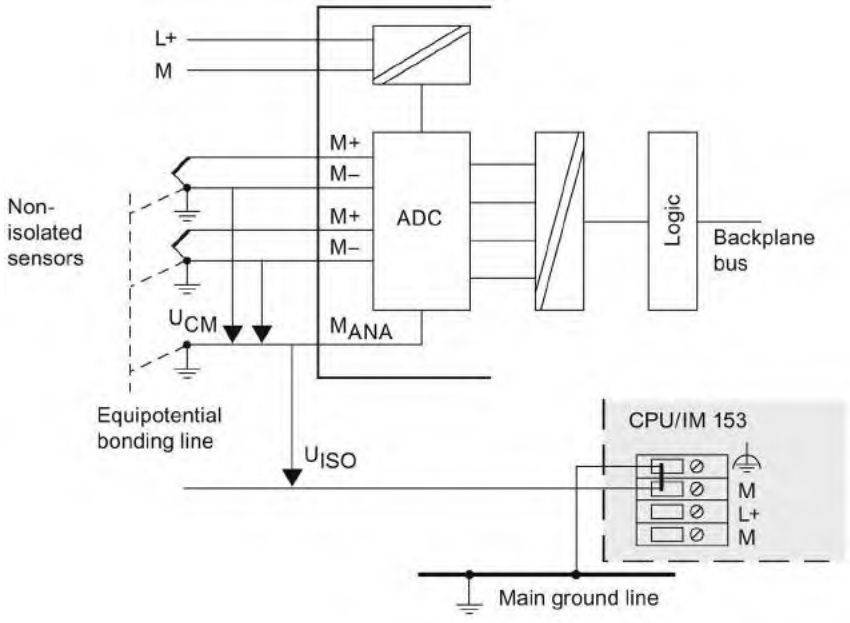



Figure 4-3 Wiring non-isolated transducer to electrically isolated AI



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## Wiring non-isolated transducer to a non-isolated AI

Always operate the CPU / IM 153 in grounded mode if you connect non-isolated transducers to non-isolated modules.

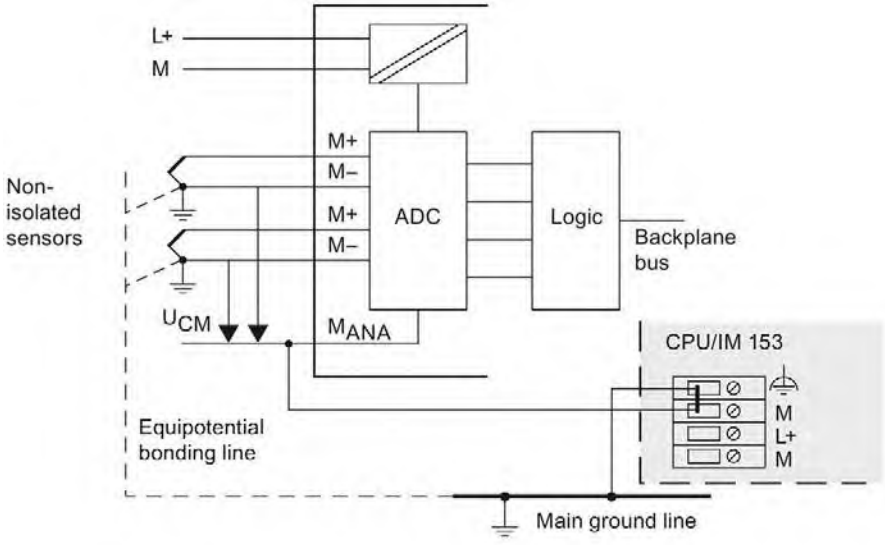



Figure 4-4 Wiring non-isolated transducers to a non-isolated AI

**Note**

You may not connect non-isolated 2-wire transducers/resistive transducers to non-isolated analog inputs!



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# 4.3 Wiring and connecting voltage transducers

## Introduction

This chapter describes how to wire and connect voltage transducers and and the corresponding items to be observed.

## Wiring and connecting voltage transducers

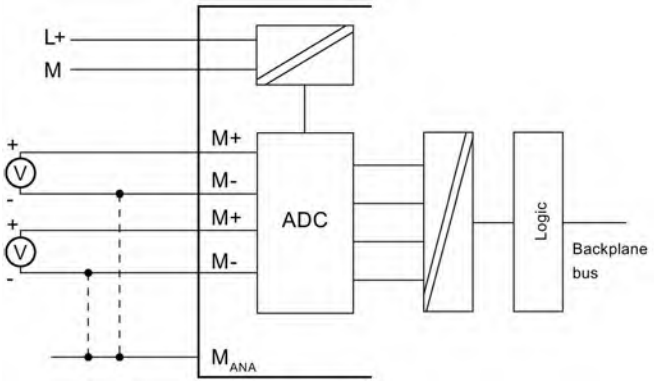



Figure 4-5 Wiring and connecting voltage transducers to electrically isolated AI



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# 4.4 Wiring and connecting current transducers

## Introduction

This chapter describes the wiring and connecting of current transducers and rules to be observed.

## Supported current transducers

- As 2-wire transducer
- As 4-wire transducer

## Wiring and connecting 2-wire transducers with power supply from the module

The 2-wire transducer is wired to the short circuit-proof supply voltage at the terminals of the analog input module.

The 2-wire transducer converts the process variable into a current. 2-wire transducers must be electrically isolated.

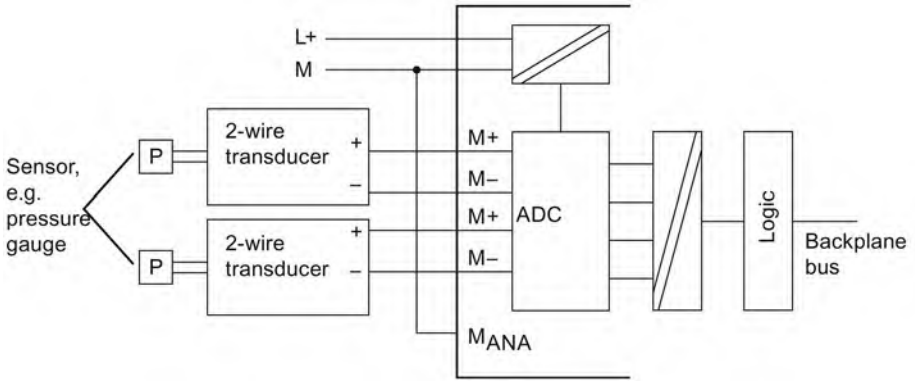



Figure 4-6 Wiring and connecting 2-wire transducers to electrically isolated AI



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## Wiring and connecting 2-wire transducers with power supply from L+

Configure the 2-wire as a 4-wire transducer in *STEP 7* if it is connected to supply voltage L+.

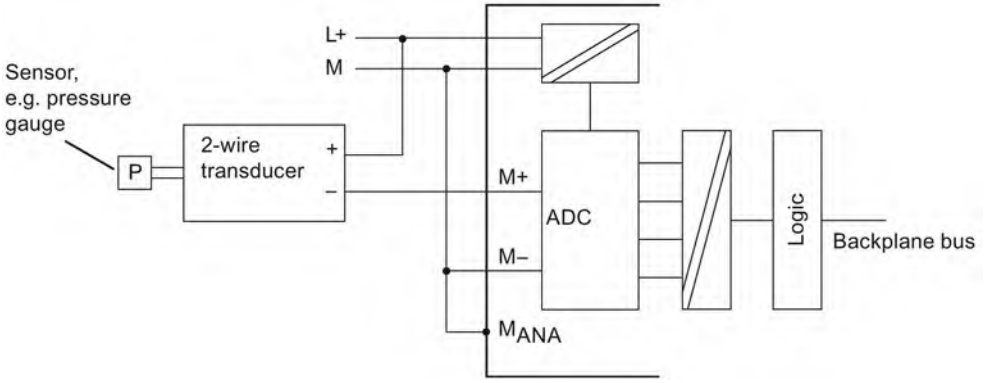



Figure 4-7 Wiring and connecting a 2-wire transducer with supply from L + to an electrically isolated AI

## Wiring and connecting 4-wire transducers

4-wire transducers are connected to a separately power supply.

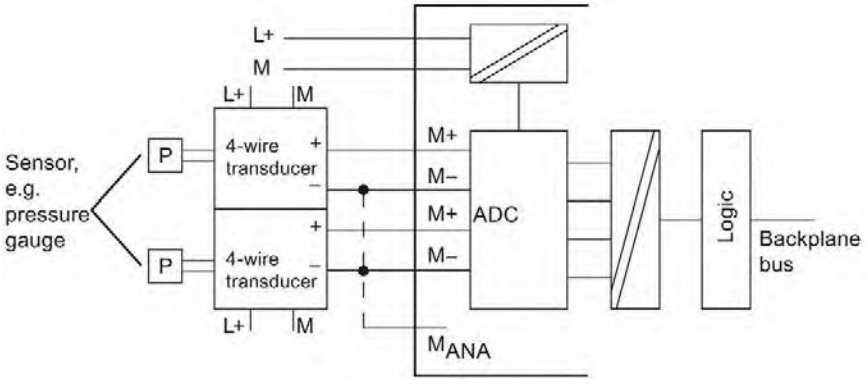



Figure 4-8 Wiring and connecting 4-wire transducers to electrically isolated AI



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# 4.5 Wiring and connecting resistance thermometers and resistors

## Introduction

This chapter describes the wiring and connecting of resistance thermometers and resistors and rules to be observed.

## Supported resistance transducers

- With 4-wire connection
- With 3-wire connection
- With 2-wire connection

## Wiring and connecting resistance thermometers and resistors

The module provides a constant current at terminals $I_{C+}$ and $I_{C-}$ for current measurements. The constant current is fed to the resistance for measuring its voltage potential. The constant current cables must be wired directly to the resistance thermometer/resistor.

Measurements programmed for 4-or 3-wire connections compensate for line resistance and return considerably higher precision compared to 2-wire connections.

Measurements with programmed 2-wire connections also record line impedance in addition to their internal resistance.

## 4-wire connection of a resistance thermometer

The voltage generated at the resistance thermometer is measured across the $M_+$ and M- terminals. Observe the correct polarity when wiring and connecting the devices ($I_{C+}$ and $M_+$, and $I_{C-}$ and M- at the resistance thermometer).

Always wire and connect the **$I_{C}$+, M+**, **$I_{C}$- and M-** lines directly to the resistance thermometer.

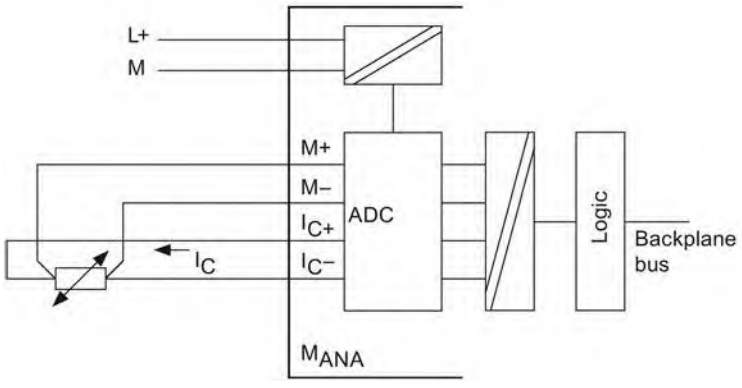



Figure 4-9 4-wire connection of resistance thermometers to an electrically isolated analog input



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## 3-wire connection of a resistance thermometer (not for 6ES7331-7PF01-0AB0)

When connecting 3-wire devices to modules equipped with four terminals, you should generally **bridge M- and $I_C$-**. Always wire and connect the connected $_C$+ and M+ lines directly to the resistance thermometer.

The image shows the basic wiring. Please observe the notes in the description about the respective module.

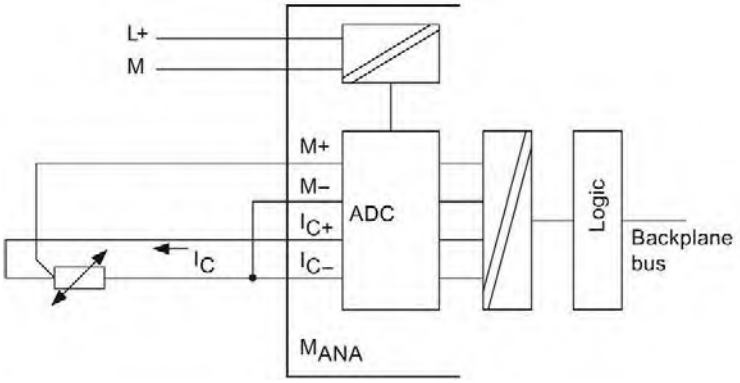



Figure 4-10 3-wire connection of resistance thermometers to an electrically isolated analog input

## 2-wire connection of a resistance thermometerError! Bookmark not defined.

For 2-wire connections, insert a bridge between the $M_+$ and $I_{C+}$ and between the **M- and $I_C$-** terminals of the module. The line impedance is included in the measurement.

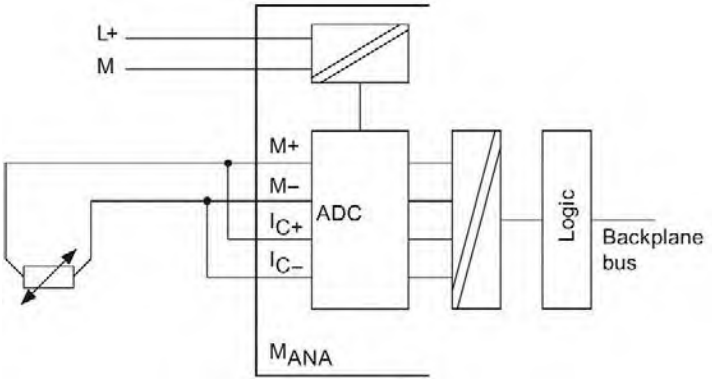



Figure 4-11 2-wire connection of resistance thermometers to an electrically isolated analog input



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# 4.6 Wiring and connecting thermocouples

## Introduction

This chapter describes the wiring and connecting of thermocouples and corresponding rules to be observed.

## Supported thermocouples (depending on module)

- B; C; E; J; K; L; N; R; S; T; U;
- TXK / XKL GOST

## Thermocouple selection

The figure below shows several thermocouples and their temperature ranges.

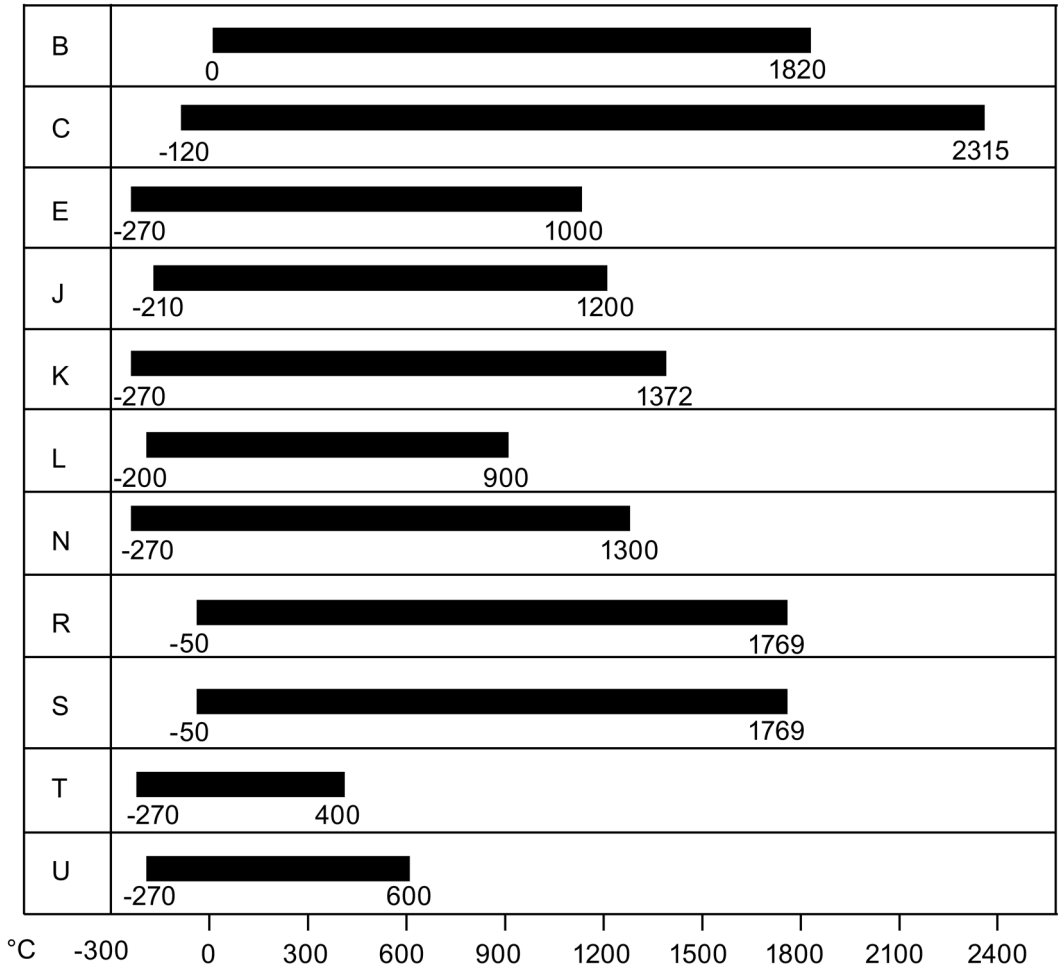



Figure 4-12 Thermocouples and their ranges

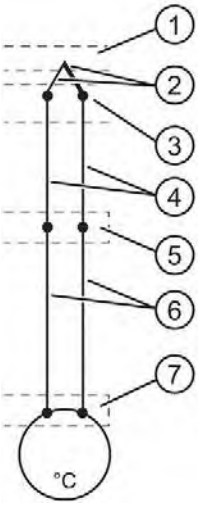


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## Thermocouple structure

Thermocouples consist of a pair of thermal probes and all necessary installation and connecting parts. The thermocouple pair consists of two wires made of different metals, or of metal alloys soldered or welded together at their ends.

The different thermocouple types, for example, K, J or N, are derived from different material compositions. The measuring principle of all thermocouples is the same, irrespective of their type.




① Measurement point
② Thermocouple with positive and negative thermal elements
③ Terminal
④ Compensating line
⑤ Reference junction
⑥ Supply line
⑦ Thermal voltage acquisition point

Figure 4-13 Fig. 4-22 Structure of thermocouples



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## Operating principle of thermocouples

Any temperature difference between the measuring point and the free ends of the thermocouple (point of connection) generates a thermoelectric voltage. The thermoelectric voltage is a function of the temperature difference between the measuring point and the free ends, and is also determined by the material composition of the thermal elements.

As thermocouples always sense temperature differences, it is essential to maintain the free ends at the known temperature of a reference junction in order to be able to determine the temperature at the measuring point.

The thermocouples can be extended from their point of connection to the reference junction by means of compensating lines. These compensating lines are made of the same materials as the thermocouple wires. The supply lines from the reference junction to the module are made of copper.

**Note**

Make sure of the correct polarity in order to avoid serious measuring errors.

## Compensation for the reference junction temperature

You can compensate for the influence of temperature fluctuation at the reference junction by means of a compensating circuit.

You have several options of measuring the reference junction temperature in order to obtain an absolute temperature value as a function of the temperature difference between the reference junction and the measuring point.

You can use either an internal or an external compensating circuit, depending on the required location of the reference junction.



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## Options of compensating for the reference junction temperature

Table 4- 1 Options of compensating for the reference junction temperature

| Option | Explanations |
|---|---|
| No compensation | To record only the temperature difference between the measuring point and reference junction. |
| Internal compensation<br>(for wiring and connecting, see *Connecting thermocouples with internal compensation box to electrically isolated analog inputs*) | The internal compensation is based on a comparison using the internal temperature (thermocouple internal comparison) of the module. |
| External compensation with compensation box in the feed lines of each thermocouple (the wiring and connecting is shown in the diagram *Wiring and connecting of thermocouples with compensation box to electrically isolated analog inputs* and *Wiring and connecting of thermocouples with reference junction (order no. M72166-xxx00) to electrically isolated analog inputs*) | You have already measured and compensated for the reference junction temperature (thermocouple external comparison) using an interconnected compensating box in the feed lines of each thermocouple.<br>Further signal processing is not required at the module. |
| Only for SM 331; AI 8 x TC:<br>External compensation with resistance thermometer for recording the reference junction temperature | You can measure the reference temperature using a (platinum or nickel) resistance thermometer, and compute it in the module for any thermocouple. |

## See also

Wiring and connecting thermocouples with internal compensation (Page 253)
Wiring and connecting thermocouples with external compensation (Page 254)
Wiring and connecting transducers to analog inputs (Page 239)



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## 4.6.1 Wiring and connecting thermocouples with internal compensation

### Function principle of internal compensation

Internal compensation allows you to form the reference point at the terminals of the analog input module. In this case, route the compensating lines directly to the analog module. The internal temperature sensor measures the module's temperature and returns a compensation voltage.

Note that internal compensation is not as accurate as external compensation.

### Wiring and connecting thermocouples with internal compensation

Wire the thermocouples either directly to the inputs of the module, or indirectly via compensating lines. Each channel group can use any type of thermocouple supported by the analog module, independently of other channel groups.

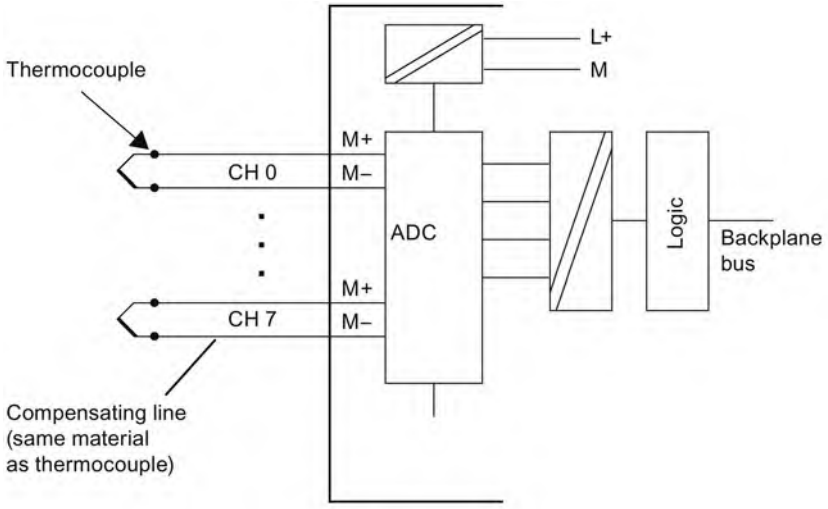



Figure 4-14 Wiring and connecting thermocouples with internal compensation to electrically isolated analog inputs



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## 4.6.2 Wiring and connecting thermocouples with external compensation

### Function principle of external compensation with compensating box

With external compensation, the temperature at the reference junction of the thermocouples is evaluated using a compensating box.

The compensating box contains a bridge circuit which is calibrated to a defined reference junction temperature /calibrating temperature.) The reference junction is formed by the connecting ends of the thermocouple's equalizing conductor.

The resistance of the temperature-sensitive bridge changes as a function of the difference between the actual reference temperature and calibrating temperature. This difference induces a positive or negative compensating voltage, which is added to the thermoelectrical voltage.

### Wiring and connecting the compensating box

Terminate the compensating box at the COMP terminals of the module; the compensating box must be installed at the reference junction of the thermocouples. The compensating box be supplied with an electrically isolated voltage. The power supply module must provide adequate noise filtering, for example, by means of grounded cable shielding.

The terminals for the connection of the thermocouple on the compensating box are not required and must therefore be jumpered (for example, see figure *Connection of thermocouples to reference junction)*

Restrictions:

- The channel group parameters always apply to the all its channels (for example, input voltage, integrating time etc.)
- External compensation with connection of the compensating box to the COMP connections of the module can only be made for one thermocouple type. That is, all channels that work with external compensation must use the same type.



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## Wiring and connecting thermocouples via compensating box

If all thermocouples connected to the module's inputs share a common reference junction, compensate the circuit as follows:

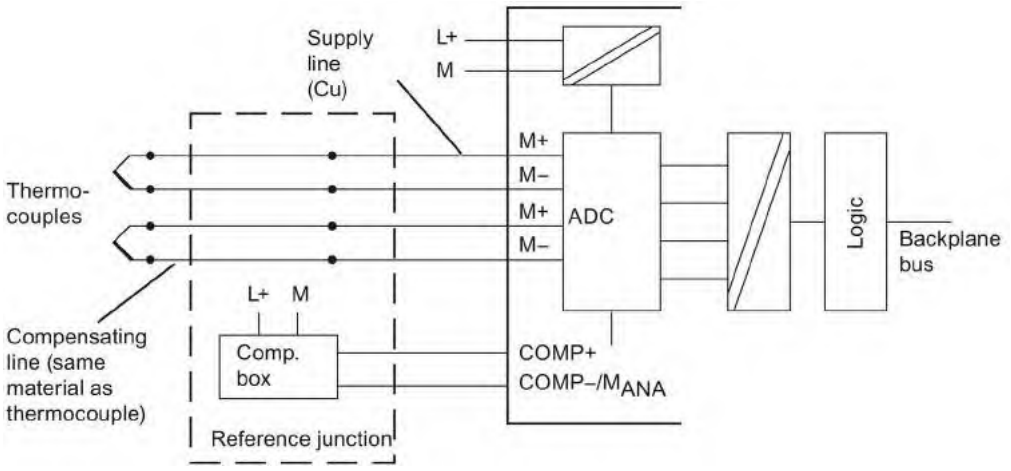



Figure 4-15 Wiring and connecting thermocouples to electrically isolated analog inputs via compensation box

**Note**

To compensate the analog input modules, always use compensation boxes with a **reference junction temperature of 0 °C**.

## Recommended compensating box

Use a compensating box with a reference junction. You must order compensating box from external companies. Contact your Siemens representative or Industry Online Support on the Internet (https://support.industry.siemens.com/cs/ww/en/).



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## Connection of the reference junction

If all thermocouples connected to the module's inputs share a common reference junction, compensate the circuit as follows:

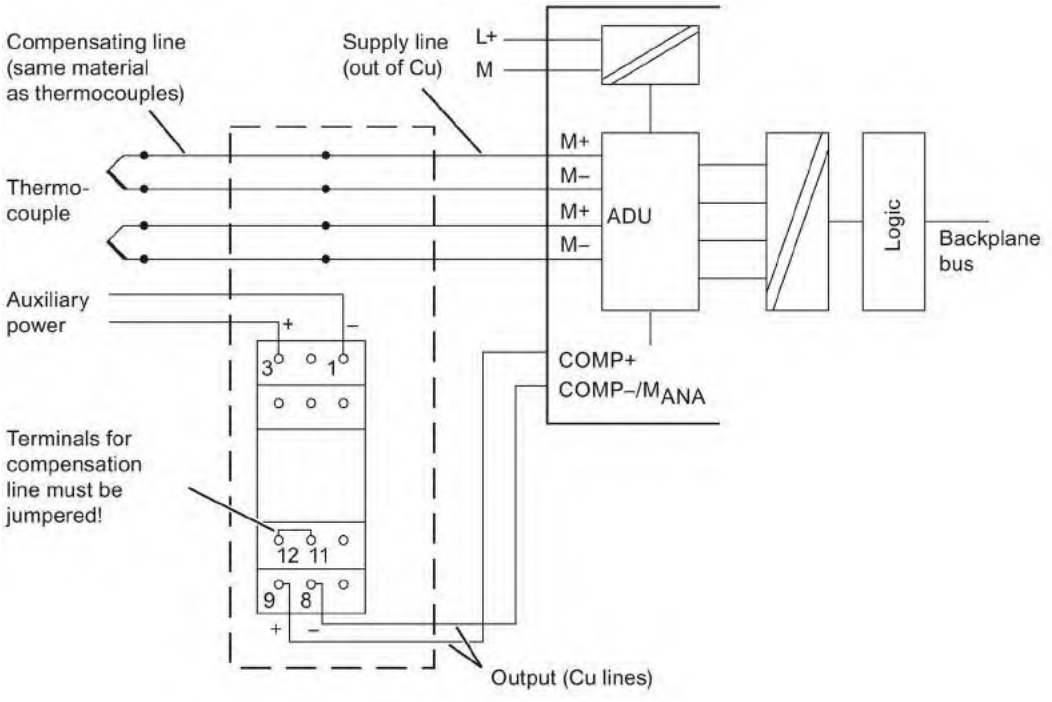



Figure 4-16 Connection of thermocouples to reference junction

## Additional information

You can find additional information on the compensating box and connection to an analog module on the Internet. (https://support.industry.siemens.com/cs/ww/en/view/18272332)



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# 4.7 Wiring and connecting loads/actuators to analog outputs

## Wiring and connecting loads/actuators to analog outputs

The analog output modules can be used as current or voltage source for loads and actuators.

## Cables for analog signals

Always use shielded twisted-pair cables to wire analog signals. Form two twisted pairs of the $Q_V$ and S+, and M and S- signals in order to reduce interference. Connect both ends of the analog cable shield to ground.

Any potential difference between the cable ends may cause an equipotential current on the shield and disturbance on analog signals. Avoid this situation by grounding only one end of the shielding.

## Electrically isolated analog output modules

Electrically isolated analog output modules do not have a galvanic interconnection between the reference point of measuring circuit $M_{ANA}$ and the CPU's M terminal.

Always use electrically isolated analog input modules if there is any risk of potential difference $V_{iso}$ developing between the reference point of measuring circuit $M_{ANA}$ and the M terminal of the CPU. Use an equipotential bonding conductor to interconnect the $M_{ANA}$ terminal and the M terminal of the CPU, in order to prevent $V_{iso}$ from exceeding the permitted value.

## Non-isolated analog output modules

When using on-isolated analog output modules, always interconnect the reference point $M_{ANA}$ of the of measuring circuit with terminal M of the CPU. Wire the $M_{ANA}$ terminal to the M terminal of the CPU. Any potential difference between $M_{ANA}$ and the M terminal of the CPU could otherwise corrupt the analog signal.



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## 4.7.1 Wiring and connecting loads/actuators to voltage outputs

### Wiring and connecting loads to a voltage output

The voltage outptus support the wiring and connecting of 2-wire and 4-wire loads. Certain analog output modules, however, do not support both types of wiring and connecting.

### Wiring 4-wire loads to the voltage output of an electrically isolated module

The 4-wire load circuit returns high precision. Wiring and connecting the S- and S+ sense lines directly to the load. This allows direct measurement and correction of the load voltage.

Interference or voltage dips may lead to potential differences between the sense line S- and the reference loop of analog circuit $M_{ANA}$. This potential difference may not exceed set limits. Any potential difference above limits has a negative impact on analog signal precision.

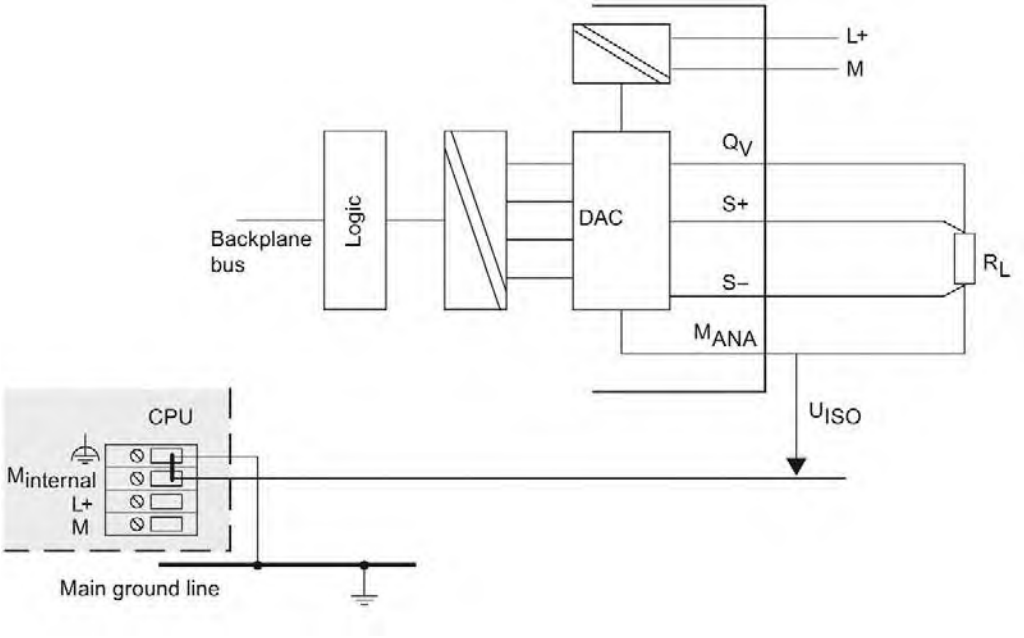



Figure 4-17 4-wire connection of loads to the voltage output of an electrically isolated analog output module



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## Wiring 2-wire loads to the voltage output of non-isolated module

Wire the loads to the $Q_V$ terminals and to the reference point of measuring circuit $M_{ANA}$. Interconnect terminal S+ to $Q_V$ with terminal S to $M_{ANA}$ in the front connector.

A 2-wire circuit does not provide for compensation of line impedance.

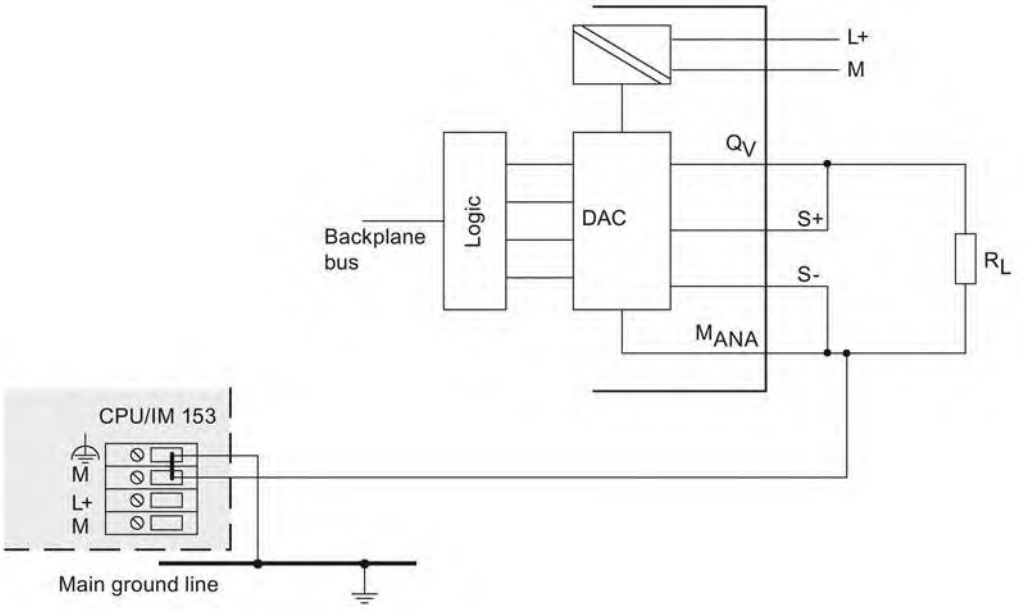



Figure 4-18 2-wire connection of loads to the voltage output of a non-isolated analog module

## See also

Wiring and connecting loads/actuators to analog outputs (Page 257)



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## 4.7.2 Wiring and connecting loads/actuators to current outputs

### Wiring and connecting loads to a current output

Wire and connect the loads to $Q_I$ and to the reference point of analog circuit $M_{ANA}$ of a current output.

### Wiring and connecting loads to a current output of an electrically isolated module

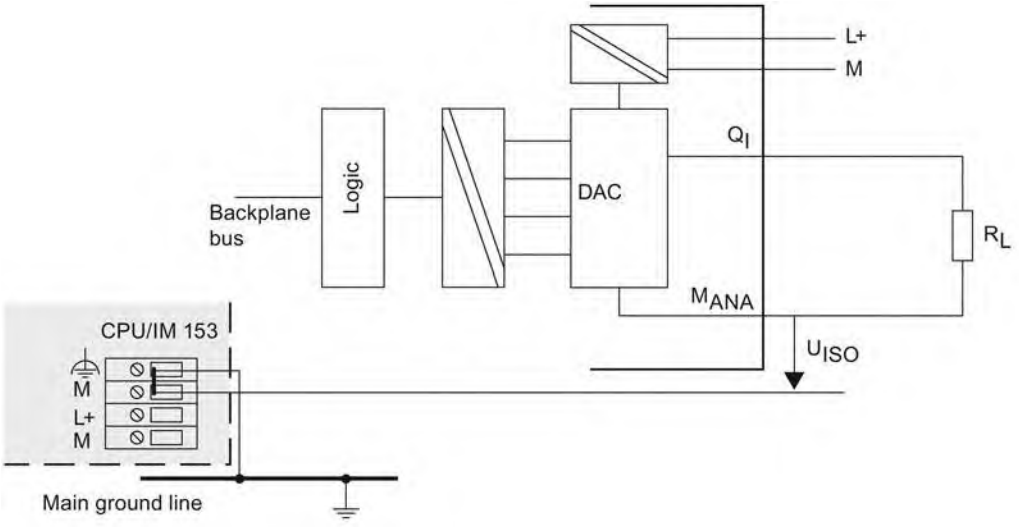



Figure 4-19 Wiring and connecting loads to a current output of an electrically isolated analog output module

### Wiring and connecting loads to a current output of a non-isolated analog output module

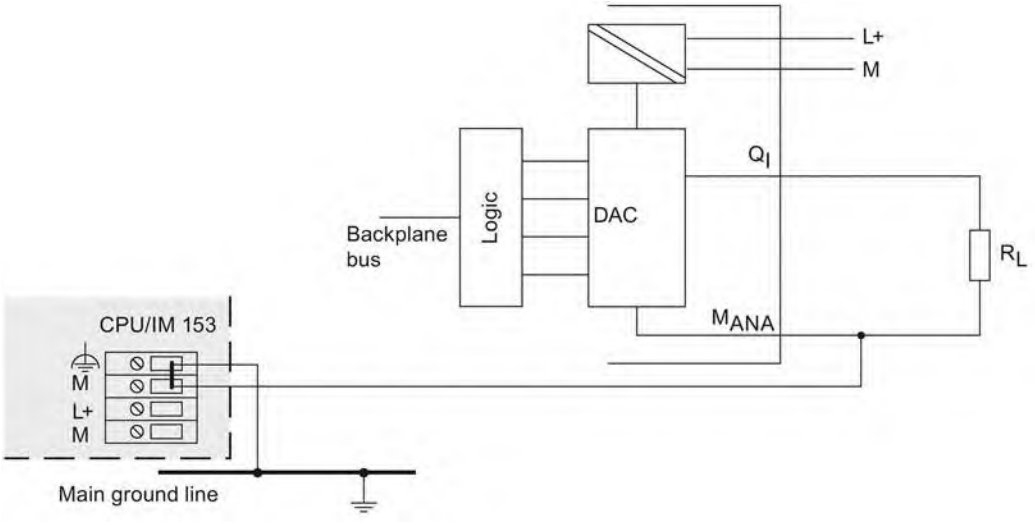



Figure 4-20 Wiring and connecting loads to a current output of a non-isolated analog output module

### See also

Wiring and connecting loads/actuators to analog outputs (Page 257)



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# Principles of analog modules

# 5

## Introduction

This chapter describes the analog values for all measuring or output ranges supported by the analog modules.

## Analog value conversion

The CPU always processes the analog values in binary format.

Analog input modules convert the analog process signal to a digital format.

Analog output modules convert digital output values to analog signals.

## Representation of analog values at a resolution of 16 bits

The digitized analog value applies to input and output values of the same rated range. Analog values are output as fixed point numbers with two's complement. The resultant assignment:

| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit values | $2^{15}$ | $2^{14}$ | $2^{13}$ | $2^{12}$ | $2^{11}$ | $2^{10}$ | $2^{9}$ | $2^{8}$ | $2^{7}$ | $2^{6}$ | $2^{5}$ | $2^{4}$ | $2^{3}$ | $2^{2}$ | $2^{1}$ | $2^{0}$ |

## Sign

The sign of the analog value is always set at bit 15:

- "0" → +
- "1" → -

## Resolution < 16 bits

On analog modules with a resolution of < 16 bits, the analog value is stored left-aligned. The unused least significant bit positions are padded with zeros ("0".)

## Example

The example below demonstrates the zero padding of unused bit positions for low resolution values.

Table 5- 1 Example: Bit pattern of a 16-bit and 13-bit analog value

| **Resolution** | **Analog value** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 16-bit analog value | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| 13-bit analog value | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |



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# 5.1 Representation of the values for analog input channels

## Measured value resolution

The resolution of the analog values may differ, based on the analog module and module parameters. At resolutions < 15 bits, all bits identified by "x" are set to "0".

**Note**

This resolution does not apply to temperature values. Converted temperature values are the result of a conversion in the analog module.

Table 5- 2 Supported analog value resolutions

| Resolution in bits (+ sign) | Units | | Analog value | |
|---|---|---|---|---|
| | dec | hex | high byte | low byte |
| 8 | 128 | $80_H$ | Sign 0 0 0 0 0 0 0 | 1 x x x x x x x |
| 9 | 64 | $40_H$ | Sign 0 0 0 0 0 0 0 | 0 1 x x x x x x |
| 10 | 32 | $20_H$ | Sign 0 0 0 0 0 0 0 | 0 0 1 x x x x x |
| 11 | 16 | $10_H$ | Sign 0 0 0 0 0 0 0 | 0 0 0 1 x x x x |
| 12 | 8 | $8_H$ | Sign 0 0 0 0 0 0 0 | 0 0 0 0 1 x x x |
| 13 | 4 | $4_H$ | Sign 0 0 0 0 0 0 0 | 0 0 0 0 0 1 x x |
| 14 | 2 | $2_H$ | Sign 0 0 0 0 0 0 0 | 0 0 0 0 0 0 1 x |
| 15 | 1 | $1_H$ | Sign 0 0 0 0 0 0 0 | 0 0 0 0 0 0 0 1 |

## Binary representation of input ranges

Table 5- 3 Bipolar input ranges

| Units | Measured value in % | Data word | | | | | | | | | | | | | | | | Range |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $2^{15}$ | $2^{14}$ | $2^{13}$ | $2^{12}$ | $2^{11}$ | $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | |
| 32767 | >118.515 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Overflow |
| 32511 | 117.589 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Overshoot range |
| 27649 | >100.004 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 27648 | 100.000 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Rated range |
| 1 | 0.003617 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| -1 | -0.003617 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| -27648 | -100.000 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| -27649 | ≤-100.004 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Undershoot range |
| -32512 | -117.593 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| -32768 | ≤-117.596 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Underflow |



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Table 5- 4 Unipolar input ranges

| Units | Measured value in % | Data word | | | | | | | | | | | | | | | | Range |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $2^{15}$ | $2^{14}$ | $2^{13}$ | $2^{12}$ | $2^{11}$ | $2^{10}$ | $2^{9}$ | $2^{8}$ | $2^{7}$ | $2^{6}$ | $2^{5}$ | $2^{4}$ | $2^{3}$ | $2^{2}$ | $2^{1}$ | $2^{0}$ | |
| 32767 | ≥118.515 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Overflow |
| 32511 | 117.589 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Overshoot |
| 27649 | ≥100.004 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | range |
| 27648 | 100.000 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | range |
| 1 | 0.003617 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Rated range |
| 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| -1 | -0.003617 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Undershoot |
| -4864 | -17.593 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | range |
| | | | | | | | | | | | | | | | | | | range |
| -32768 | ≤-17.596 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Underflow |

## Representation of analog values in voltage measuring ranges

Table 5- 5 Representation of analog values in the ±1 V to ±10 V voltage measuring range

| System | | Voltage measuring range | | | | |
|---|---|---|---|---|---|---|
| dec | hex | ±10 V | ±5 V | ±2.5 V | ±1 V | |
| 32767 | 7FFF | 11.851 V | 5.926 V | 2.963 V | 1.185 V | Overflow |
| 32512 | 7F00 | | | | | |
| 32511 | 7EFF | 11.759 V | 5.879 V | 2.940 V | 1.176 V | Overshoot range |
| 27649 | 6C01 | | | | | |
| 27648 | 6C00 | 10 V | 5 V | 2.5 V | 1 V | Rated range |
| 20736 | 5100 | 7.5 V | 3.75 V | 1.875 V | 0.75 V | |
| 1 | 1 | 361.7 µV | 180.8 µV | 90.4 µV | 36.17 µV | |
| 0 | 0 | 0 V | 0 V | 0 V | 0 V | |
| -1 | FFFF | | | | | |
| -20736 | AF00 | -7.5 V | -3.75 V | -1.875 V | -0.75 V | |
| -27648 | 9400 | -10 V | -5 V | -2.5 V | -1 V | |
| -27649 | 93FF | | | | | Undershoot range |
| -32512 | 8100 | -11.759 V | -5.879 V | -2.940 V | -1.176 V | |
| -32513 | 80FF | | | | | Underflow |
| -32768 | 8000 | -11.851 V | -5.926 V | -2.963 V | -1.185 V | |



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Table 5- 6 Representation of analog values in the ±80 mV to ±500 mV voltage measuring ranges

| System | | Voltage measuring range | | | |
|---|---|---|---|---|---|
| **dec** | **hex** | **±500 mV** | **±250 mV** | **±80 mV** | |
| 32767 | 7FFF | 592.6 mV | 296.3 mV | 94.8 mV | Overflow |
| 32512 | 7F00 | | | | |
| 32511 | 7EFF | 587.9 mV | 294.0 mV | 94.1 mV | Overshoot range |
| 27649 | 6C01 | | | | |
| 27648 | 6C00 | 500 mV | 250 mV | 80 mV | Rated range |
| 20736 | 5100 | 375 mV | 187.5 mV | 60 mV | |
| 1 | 1 | 18.08 µV | 9.04 µV | 2.89 µV | |
| 0 | 0 | 0 mV | 0 mV | 0 mV | |
| -1 | FFFF | | | | |
| -20736 | AF00 | -375 mV | -187.5 mV | -60 mV | |
| -27648 | 9400 | -500 mV | -250 mV | -80 mV | |
| -27649 | 93FF | | | | Undershoot range |
| -32512 | 8100 | -587.9 mV | -294.0 mV | -94.1 mV | |
| -32513 | 80FF | | | | Underflow |
| -32768 | 8000 | -592.6 mV | -296.3 mV | -94.8 mV | |

Table 5- 7 Representation of analog values in the 1 V to 5 V and 0 V to 10 V voltage measuring ranges

| System | | Voltage measuring range | | |
|---|---|---|---|---|
| **dec** | **hex** | **1 V to 5 V** | **0 V to 10 V** | |
| 32767 | 7FFF | 5.741 V | 11.852 V | Overflow |
| 32512 | 7F00 | | | |
| 32511 | 7EFF | 5.704 V | 11.759 V | Overshoot range |
| 27649 | 6C01 | | | |
| 27648 | 6C00 | 5 V | 10 V | Rated range |
| 20736 | 5100 | 4 V | 7.5 V | |
| 1 | 1 | 1 V + 144.7 µV | 0 V + 361.7 µV | |
| 0 | 0 | 1 V | 0 V | |
| -1 | FFFF | | Negative values are not supported | Undershoot range |
| -4864 | ED00 | 0.296 V | | |
| -4865 | ECFF | | | Underflow |
| -32768 | 8000 | | | |



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## Representation of analog values in the current measuring ranges

Table 5- 8 Representation of analog values in the ±3.2 mA to ±20 mA current measuring ranges

| System | | Current measuring range | | | |
|---|---|---|---|---|---|
| dec | hex | ±20 mA | ±10 mA | ±3.2 mA | |
| 32767 | 7FFF | 23.70 mA | 11.85 mA | 3.79 mA | Overflow |
| 32512 | 7F00 | | | | |
| 32511 | 7EFF | 23.52 mA | 11.76 mA | 3.76 mA | Overshoot range |
| 27649 | 6C01 | | | | |
| 27648 | 6C00 | 20 mA | 10 mA | 3.2 mA | Rated range |
| 20736 | 5100 | 15 mA | 7.5 mA | 2.4 mA | |
| 1 | 1 | 723.4 nA | 361.7 nA | 115.7 nA | |
| 0 | 0 | 0 mA | 0 mA | 0 mA | |
| -1 | FFFF | | | | |
| -20736 | AF00 | -15 mA | -7.5 mA | -2.4 mA | |
| -27648 | 9400 | -20 mA | -10 mA | -3.2 mA | |
| -27649 | 93FF | | | | Undershoot range |
| -32512 | 8100 | -23.52 mA | -11.76 mA | -3.76 mA | |
| -32513 | 80FF | | | | Underflow |
| -32768 | 8000 | -23.70 mA | -11.85 mA | -3.79 mA | |

Table 5- 9 Representation of analog values in the 0 mA to 20 mA and 4 mA to 20 mA current measuring ranges

| System | | Current measuring range | | |
|---|---|---|---|---|
| dec | hex | 0 mA to 20 mA | 4 mA to 20 mA | |
| 32767 | 7FFF | 23.70 mA | 22.96 mA | Overflow |
| 32512 | 7F00 | | | |
| 32511 | 7EFF | 23.52 mA | 22.81 mA | Overshoot range |
| 27649 | 6C01 | | | |
| 27648 | 6C00 | 20 mA | 20 mA | Rated range |
| 20736 | 5100 | 15 mA | 16 mA | |
| 1 | 1 | 723.4 nA | 4 mA + 578.7 nA | |
| 0 | 0 | 0 mA | 4 mA | |
| -1 | FFFF | | | Undershoot range |
| -4864 | ED00 | -3.52 mA | 1.185 mA | |
| -4865 | ECFF | | | Underflow |
| -32768 | 8000 | | | |



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## Representation of the analog values of resistive transducers

Table 5- 10 Representation of the analog values of 6 kΩ; 10 kΩ and from 150 Ω to 600 Ω resistive transducers

| System | | Resistive transducer range | | | | | |
|---|---|---|---|---|---|---|---|
| dec | hex | 6kΩ | 10 kΩ | 150 Ω | 300 Ω | 600 Ω | |
| 32767 | 7FFF | 7.111 kΩ | 11.852 kΩ | 177.77 Ω | 355.54 Ω | 711.09 Ω | Overflow |
| 32512 | 7F00 | | | 176.39 Ω | 352.78 Ω | 705.55 Ω | |
| 32511 | 7EFF | 7.055 kΩ | 11.759 kΩ | 176.38 Ω | 352.77 Ω | 705.53 Ω | Overshoot range |
| 27649 | 6C01 | | | | | | |
| 27648 | 6C00 | 6.0 kΩ | 10 kΩ | 150 Ω | 300 Ω | 600 Ω | Rated range |
| 20736 | 5100 | 4.5 kΩ | 7.5 kΩ | 112.5 Ω | 225 Ω | 450 Ω | |
| 1 | 1 | 217.0 mΩ | 361.7 mΩ | 5.43 mΩ | 10.85 mΩ | 21.70 mΩ | |
| 0 | 0 | 0 Ω | 0 Ω | 0 Ω | 0 Ω | 0 Ω | |
| | | (negative values are physically impossible) | | | | | Undershoot range |

## Representation of analog values for resistance thermometers Pt x00 and Pt x00 GOST (0.003850) standard

Table 5- 11 Representation of analog values for resistance thermometers PT 100, 200, 500,1000 and PT 10, 50,100, 500 GOST (0.003850) standard

| Pt x00 Standard / GOST in °C (1 digit = 0.1°C) | Units | | Pt x00 Standard/ GOST in °F (1 digit = 0.1 °F) | Units | | Pt x00 Standard/ GOST in K (1 digit = 0.1 K) | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 1000.0 | 32767 | $7FFF_H$ | > 1832.0 | 32767 | $7FFF_H$ | > 1273.2 | 32767 | $7FFF_H$ | Overflow |
| 1000.0<br>:<br>850.1 | 10000<br>:<br>8501 | $2710_H$<br>:<br>$2135_H$ | 1832.0<br>:<br>1562.1 | 18320<br>:<br>15621 | $4790_H$<br>:<br>$3D05_H$ | 1273.2<br>:<br>1123.3 | 12732<br>:<br>11233 | $31BC_H$<br>:<br>$2BE1_H$ | Overshoot range |
| 850.0<br>:<br>-200.0 | 8500<br>:<br>-2000 | $2134_H$<br>:<br>$F830_H$ | 1562.0<br>:<br>-328.0 | 15620<br>:<br>-3280 | $3D04_H$<br>:<br>$F330_H$ | 1123.2<br>:<br>73.2 | 11232<br>:<br>732 | $2BE0_H$<br>:<br>$2DC_H$ | Rated range |
| -200.1<br>:<br>-243.0 | -2001<br>:<br>-2430 | $F82F_H$<br>:<br>$F682_H$ | -328.1<br>:<br>-405.4 | -3281<br>:<br>-4054 | $F32F_H$<br>:<br>$F02A_H$ | 73.1<br>:<br>30.2 | 731<br>:<br>302 | $2DB_H$<br>:<br>$12E_H$ | Undershoot range |
| < - 243.0 | -32768 | $8000_H$ | < - 405.4 | -32768 | $8000_H$ | < 30.2 | 32768 | $8000_H$ | Underflow |



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## Representation of the analog values of Pt x00 GOST (0.003910) standard resistance thermometers

Table 5- 12 Representation of the analog values of Pt 10, 50, 100, 500 GOST (0.003910) standard resistance thermometers

| Pt x00 GOST Standard in °C (1 digit = 0.1°C) | Units | | Pt x00 GOST Standard in °F (1 digit = 0.1 °F) | Units | | Range |
|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | |
| > 1295.0 | 32767 | 7FFF$_H$ | > 2363.0 | 32767 | 7FFF$_H$ | Overflow |
| 1295.0<br>:<br>1100.1 | 12950<br>:<br>11001 | 3296$_H$<br>:<br>2AF9$_H$ | 2363.0<br>:<br>2012.1 | 23630<br>:<br>20121 | 5CE4$_H$<br>:<br>4E99$_H$ | Overshoot range |
| 1100.0<br>:<br>-260.0 | 11000<br>:<br>-2600 | 2AF8$_H$<br>:<br>F5D8$_H$ | 2012.0<br>:<br>-436.0 | 20120<br>:<br>-4360 | 4E98$_H$<br>:<br>EEF8$_H$ | Rated range |
| -260.1<br>:<br>-273.2 | -2601<br>:<br>-2732 | F5D7$_H$<br>:<br>F554$_H$ | -436.1<br>:<br>-459.7 | -4361<br>:<br>-4597 | EEF7$_H$<br>:<br>EE0B$_H$ | Undershoot range |
| < - 273.2 | -32768 | 8000$_H$ | < - 459.7 | -32768 | 8000$_H$ | Underflow |

## Representation of analog values for Pt x00 and Pt x0 GOST (0.003850 and 0.003910) climatic resistance thermometers

Table 5- 13 Representation of analog values for Pt 100, 200, 500,1000 and Pt 10, 50, 100, 500 GOST (0.003850 and 0.003910) climatic resistance thermometers

| Pt x00 climatic/GOST in °C (1 digit = 0.01 °C) | Units | | Pt x00 climatic/GOST in °F (1 digit = 0.01 °F) | Units | | Range |
|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | |
| > 155.00 | 32767 | 7FFF$_H$ | > 311.00 | 32767 | 7FFF$_H$ | Overflow |
| 155.00<br>:<br>130.01 | 15500<br>:<br>13001 | 3C8C$_H$<br>:<br>32C9$_H$ | 311.00<br>:<br>266.01 | 31100<br>:<br>26601 | 797C$_H$<br>:<br>67E9$_H$ | Overshoot range |
| 130.00<br>:<br>-120.00 | 13000<br>:<br>-12000 | 32C8$_H$<br>:<br>D120$_H$ | 266.00<br>:<br>-184.00 | 26600<br>:<br>-18400 | 67E8$_H$<br>:<br>B820$_H$ | Rated range |
| -120.01<br>:<br>-145.00 | -12001<br>:<br>-14500 | D11F$_H$<br>:<br>C75C$_H$ | -184.01<br>:<br>-229.00 | -18401<br>:<br>-22900 | B81F$_H$<br>:<br>A68C$_H$ | Undershoot range |
| < - 145.00 | -32768 | 8000$_H$ | < - 229.00 | -32768 | 8000$_H$ | Underflow |



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## Representation of the analog values of Ni x00 Standard resistance thermometers

Table 5- 14 Representation of the analog values of Ni100, 120, 200, 500, 1000 and LG-Ni 1000 resistance thermometers

| Ni x00 Standard in °C (1 digit = 0.1°C) | Units | | Ni x00 Standard in °F (1 digit = 0.1 °F) | Units | | Ni x00 standard in K (1 digit = 0.1 K) | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 295.0 | 32767 | $7FFF_H$ | > 563.0 | 32767 | $7FFF_H$ | > 568.2 | 32767 | $7FFF_H$ | Overflow |
| 295.0<br>:<br>250.1 | 2950<br>:<br>2501 | $B86_H$<br>:<br>$9C5_H$ | 563.0<br>:<br>482.1 | 5630<br>:<br>4821 | $15FE_H$<br>:<br>$12D5_H$ | 568.2<br>:<br>523.3 | 5682<br>:<br>5233 | $1632_H$<br>:<br>$1471_H$ | Overshoot range |
| 250.0<br>:<br>-60.0 | 2500<br>:<br>-600 | $9C4_H$<br>:<br>$FDA8_H$ | 482.0<br>:<br>-76.0 | 4820<br>:<br>-760 | $12D4_H$<br>:<br>$FD08_H$ | 523.2<br>:<br>213.2 | 5232<br>:<br>2132 | $1470_H$<br>:<br>$854_H$ | Rated range |
| -60.1<br>:<br>-105.0 | -601<br>:<br>-1050 | $FDA7_H$<br>:<br>$FBE6_H$ | -76.1<br>:<br>-157.0 | -761<br>:<br>-1570 | $FD07_H$<br>:<br>$F9DE_H$ | 213.1<br>:<br>168.2 | 2131<br>:<br>1682 | $853_H$<br>:<br>$692_H$ | Undershoot range |
| < -105.0 | -32768 | $8000_H$ | < -157.0 | -32768 | $8000_H$ | < 168.2 | 32768 | $8000_H$ | Underflow |

## Representation of the analog values of Ni x00 climate resistance thermometers

The following table shows the analog values for the resistance thermometer Nix00 Climatic for all analog input modules.

Exceptions:

- Analog input module AI 8x12-bit; 6ES7331-7KF02-0AB0
- Analog input module AI 2x12-bit; 6ES7331-7KB02-0AB0

There is no overrange for these analog input modules. Overflow begins at 240 °C and is encoded with $7FFF_H$.



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Table 5- 15 Representation of the analog values of Ni 100, 120, 200, 500, 1000 and LG-Ni 1000 resistance thermometers

| Ni x00 climatic in °C (1 digit = 0.01 °C) | Units | | Ni x00 climatic in °F (1 digit = 0.01 °F) | Units | | Range |
|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | |
| > 295.00 | 32767 | $7FFF_H$ | > 327.66 | 32767 | $7FFF_H$ | Overflow |
| 295.00<br>:<br>250.01 | 29500<br>:<br>25001 | $733C_H$<br>:<br>$61A9_H$ | 327.66<br>:<br>280.01 | 32766<br>:<br>28001 | $7FFE_H$<br>:<br>$6D61_H$ | Overshoot range |
| 250.00<br>:<br>-60.00 | 25000<br>:<br>-6000 | $61A8_H$<br>:<br>$E890_H$ | 280.00<br>:<br>-76.00 | 28000<br>:<br>-7600 | $6D60_H$<br>:<br>$E250_H$ | Rated range |
| -60.01<br>:<br>-105.00 | -6001<br>:<br>-10500 | $E88F_H$<br>:<br>$D6FC_H$ | -76.01<br>:<br>-157.00 | -7601<br>:<br>-15700 | $E24F_H$<br>:<br>$C2AC_H$ | Undershoot range |
| < - 105.00 | -32768 | $8000_H$ | < - 157.00 | -32768 | $8000_H$ | Underflow |

## Representation of the analog values of Ni 100 GOST Standard resistance thermometers

Table 5- 16 Representation of the analog values of Ni 100 GOST Standard resistance thermometers

| Ni 100 GOST Standard in °C (1 digit = 0.1°C) | Units | | Ni 100 GOST Standard in °F (1 digit = 0.1 °F) | Units | | Range |
|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | |
| > 212.4 | 32767 | $7FFF_H$ | > 414.3 | 32767 | $7FFF_H$ | Overflow |
| 212.4<br>:<br>180.1 | 2124<br>:<br>1801 | $084C_H$<br>:<br>$0709_H$ | 414.3<br>:<br>356.1 | 4143<br>:<br>3561 | $102F_H$<br>:<br>$0DE9_H$ | Overshoot range |
| 180.0<br>:<br>-60.0 | 1800<br>:<br>-600 | $0708_H$<br>:<br>$FDA8_H$ | 356.0<br>:<br>-76.0 | 3560<br>:<br>-760 | $0DE8_H$<br>:<br>$FD08_H$ | Rated range |
| -60.1<br>:<br>-105.0 | -601<br>:<br>-1050 | $FDA7_H$<br>:<br>$FBE6_H$ | -76.1<br>:<br>-157.0 | -761<br>:<br>-1570 | $FD07_H$<br>:<br>$F9DE_H$ | Undershoot range |
| < - 105.0 | -32768 | $8000_H$ | < - 157.0 | -32768 | $8000_H$ | Underflow |



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## Representation of the analog values of Ni 100 GOST Klima resistance thermometers

Table 5- 17 Representation of the analog values of Ni 100 GOST Klima resistance thermometers

| Ni 100 GOST Klima in °C (1 digit = 0.1°C) | Units | | Ni 100 GOST Klima in °F (1 digit = 0.1 °F) | Units | | Range |
|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | |
| > 212.40 | 32767 | $7FFF_H$ | > 327.66 | 32767 | $7FFF_H$ | Overflow |
| 212.40<br>:<br>180.01 | 21240<br>:<br>18001 | $52F8_H$<br>:<br>$4651_H$ | 327.66<br>:<br>280.01 | 32766<br>:<br>28001 | $7FFE_H$<br>:<br>$6D61_H$ | Overshoot range |
| 180.00<br>:<br>-60.00 | 18000<br>:<br>-6000 | $4650_H$<br>:<br>$E890_H$ | 280.00<br>:<br>-76.00 | 28000<br>:<br>-7600 | $6D60_H$<br>:<br>$E250_H$ | Rated range |
| -60.01<br>:<br>-105.00 | -6001<br>:<br>-10500 | $E88F_H$<br>:<br>$D6FC_H$ | -76.01<br>:<br>-157.00 | -7601<br>:<br>-15700 | $E24F_H$<br>:<br>$C2AC_H$ | Undershoot range |
| < - 105.00 | -32768 | $8000_H$ | < - 157.00 | -32768 | $8000_H$ | Underflow |

## Representation of the analog values for Cu 10 standard resistance thermometers

Table 5- 18 Representation of the analog values for Cu 10 standard resistance thermometers

| Cu 10 standard in °C (1 digit = 0.01 °C) | Units | | Cu 10 standard in °F (1 digit = 0.01 °F) | Units | | Cu 10 standard in K (1 digit = 0.01 K) | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 312.0 | 32767 | $7FFF_H$ | > 593.6 | 32767 | $7FFF_H$ | > 585.2 | 32767 | $7FFF_H$ | Overflow |
| 312.0<br>:<br>260.1 | 3120<br>:<br>2601 | $C30_H$<br>:<br>$A29_H$ | 593.6<br>:<br>500.1 | 5936<br>:<br>5001 | $1730_H$<br>:<br>$12D5_H$ | 585.2<br>:<br>533.3 | 5852<br>:<br>5333 | $16DC_H$<br>:<br>$14D5_H$ | Overshoot range |
| 260.0<br>:<br>-200.0 | 2600<br>:<br>-2000 | $A28_H$<br>:<br>$F830_H$ | 500.0<br>:<br>-328.0 | 5000<br>:<br>-3280 | $1389_H$<br>:<br>$F330_H$ | 533.2<br>:<br>73.2 | 5332<br>:<br>732 | $14D4_H$<br>:<br>$2DC_H$ | Rated range |
| -200.1<br>:<br>-240.0 | -2001<br>:<br>-2400 | $F82F_H$<br>:<br>$F6A0_H$ | -328.1<br>:<br>-400.0 | -3281<br>:<br>-4000 | $F32F_H$<br>:<br>$F060_H$ | 73.1<br>:<br>33.2 | 731<br>:<br>332 | $2DB_H$<br>:<br>$14C_H$ | Undershoot range |
| < - 240.0 | -32768 | $8000_H$ | < - 400.0 | -32768 | $8000_H$ | < 33.2 | 32768 | $8000_H$ | Underflow |



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## Representation of analog values for Cu 10 climatic and Cu 10, 50, 100 GOST climatic resistance thermometers

Table 5- 19 Representation of analog values for Cu 10 climatic and Cu 10, 50, 100 GOST climatic resistance thermometers

| Cu x0 climatic/in °C (1 digit = 0.01 °C) | Units | | Cu x0 climatic in °F (1 digit = 0.01 °F) | Units | | Range |
|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | |
| > 180.00 | 32767 | 7FFF$_H$ | > 327.66 | 32767 | 7FFF$_H$ | Overflow |
| 180.00<br>:<br>150.01 | 18000<br>:<br>15001 | 4650$_H$<br>:<br>3A99$_H$ | 327.66<br>:<br>280.01 | 32766<br>:<br>28001 | 7FFE$_H$<br>:<br>6D61A$_H$ | Overshoot range |
| 150.00<br>:<br>-50.00 | 15000<br>:<br>-5000 | 3A98$_H$<br>:<br>EC78$_H$ | 280.00<br>:<br>- 58.00 | 28000<br>:<br>-5800 | 6D60$_H$<br>:<br>E958$_H$ | Rated range |
| -50.01<br>:<br>-60.00 | -5001<br>:<br>-6000 | EC77$_H$<br>:<br>E890$_H$ | -58.01<br>:<br>-76.00 | -5801<br>:<br>-7600 | E957$_H$<br>:<br>E250$_H$ | Undershoot range |
| < - 60.00 | -32768 | 8000$_H$ | < - 76.00 | -32768 | 8000$_H$ | Underflow |

## Representation of analog values for Cu 10, 50, 100, 500 GOST standard (0.00426) resistance thermometers

Table 5- 20 Representation of analog values for Cu 10, 50, 100, 500 GOST standard (0.00426) resistance thermometers

| Cu x0 Standard in °C (1 digit = 0.1°C) | Units | | Cu x0 standard in °F (1 digit = 0.01 °F) | Units | | Range |
|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | |
| > 240.0 | 32767 | 7FFF$_H$ | > 464.0 | 32767 | 7FFF$_H$ | Overflow |
| 240.0<br>:<br>200.1 | 2400<br>:<br>2001 | 0960$_H$<br>:<br>07D1$_H$ | 464.0<br>:<br>392.1 | 4640<br>:<br>3921 | 1220$_H$<br>:<br>0F51$_H$ | Overshoot range |
| 200.0<br>:<br>-50.0 | 2000<br>:<br>-500 | 07D0$_H$<br>:<br>FE0C$_H$ | 392.0<br>:<br>-58.0 | 3920<br>:<br>-580 | 0F50$_H$<br>:<br>FDBC$_H$ | Rated range |
| -50.1<br>:<br>-60.0 | -501<br>:<br>-600 | FE0B$_H$<br>:<br>FDA8$_H$ | -58.1<br>:<br>-76.0 | -581<br>:<br>-760 | FDBB$_H$<br>:<br>FD08$_H$ | Undershoot range |
| < - 60.00 | -32768 | 8000$_H$ | < - 76.0 | -32768 | 8000$_H$ | Underflow |



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## Representation of the analog values for Cu 10, 50, 100, 500 GOST standard (0.00428) resistance thermometers

Table 5- 21 Representation of the analog values for Cu 10, 50, 100, 500 GOST standard (0.00428) resistance thermometers

| Cu x0 standard in °C (1 digit = 0.01 °C) | Units | | Cu x0 standard in °F (1 digit = 0.01 °F) | Units | | Range |
|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | |
| > 240.0 | 32767 | 7FFF$_H$ | > 464.0 | 32767 | 7FFF$_H$ | Overflow |
| 240.0<br>:<br>200.1 | 2400<br>:<br>2001 | 0960$_H$<br>:<br>07D1$_H$ | 464.0<br>:<br>392.1 | 4640<br>:<br>3921 | 1220$_H$<br>:<br>0F51$_H$ | Overshoot range |
| 200.0<br>:<br>-200.0 | 2000<br>:<br>-2000 | 07D0$_H$<br>:<br>F830$_H$ | 392.0<br>:<br>-328.0 | 3920<br>:<br>-3280 | 0F50$_H$<br>:<br>F330$_H$ | Rated range |
| -200.1<br>:<br>-240.0 | -2001<br>:<br>-2400 | F82F$_H$<br>:<br>F6A0$_H$ | -328.1<br>:<br>-405.4 | -3281<br>:<br>-4054 | F32F$_H$<br>:<br>F02A$_H$ | Undershoot range |
| < - 240.0 | -32768 | 8000$_H$ | < - 405.4 | -32768 | 8000$_H$ | Underflow |

## Representation of analog values for KTY83/110 silicon temperature sensors

Table 5- 22 Representation of analog values for KTY83/110 silicon temperature sensors

| KTY83/110 in °C (1 digit = 0.1 °C) | Units | | KTY83/110 in °F (1 digit = 0.1 °F) | Units | | KTY83/110 in °K (1 digit = 0.1 °K) | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 206.3 | 32767 | 7FFF$_H$ | > 403.3 | 32767 | 7FFF$_H$ | > 479.5 | 32767 | 7FFF$_H$ | Overflow |
| 206.3<br>:<br>175.1 | 2063<br>:<br>1751 | 080F$_H$<br>:<br>06D7$_H$ | 403.3<br>:<br>347.1 | 4033<br>:<br>3471 | 0FC1$_H$<br>:<br>0D8F$_H$ | 479.5<br>:<br>448.3 | 4795<br>:<br>4483 | 12BB$_H$<br>:<br>1183$_H$ | Overshoot range |
| 175<br>:<br>-55 | 1750<br>:<br>-550 | 06D6$_H$<br>:<br>FDDA$_H$ | 347<br>:<br>-67 | 3470<br>:<br>-670 | 0D8E$_H$<br>:<br>FD62$_H$ | 448.2<br>:<br>218.2 | 4482<br>:<br>2182 | 1182$_H$<br>:<br>0886$_H$ | Rated range |
| -55.1<br>:<br>-64.7 | -551<br>:<br>-647 | FDD9$_H$<br>:<br>FD79$_H$ | -67.1<br>:<br>-84.5 | -671<br>:<br>-845 | FD61$_H$<br>:<br>FCB3$_H$ | 218.1<br>:<br>208.5 | 2181<br>:<br>2085 | 0885$_H$<br>:<br>08205$_H$ | Undershoot range |
| < -64.7 | -32768 | 8000$_H$ | < -84.5 | -32768 | 8000$_H$ | < 208.5 | -32768 | 8000$_H$ | Underflow |



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## Representation of analog values for KTY84/130 silicon temperature sensors

Table 5- 23 Representation of analog values for KTY84/130 silicon temperature sensors

| KTY84/130 in °C (1 digit = 0.1 °C) | Units | | KTY84/130 in °F (1 digit = 0.1 °F) | Units | | KTY84/130 in °K (1 digit = 0.1 °K) | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 352.8 | 32767 | $7FFF_H$ | > 667.0 | 32767 | $7FFF_H$ | > 626.0 | 32767 | $7FFF_H$ | Overflow |
| 352.8<br>:<br>300.1 | 3528<br>:<br>3001 | $0DC8_H$<br>:<br>$0BB9_H$ | 667.0<br>:<br>572.1 | 6670<br>:<br>5721 | $1A0E_H$<br>:<br>$1659_H$ | 626.0<br>:<br>573.3 | 6260<br>:<br>5733 | $1874_H$<br>:<br>$1665_H$ | Overshoot range |
| 300<br>:<br>-40 | 3000<br>:<br>-400 | $0BB8_H$<br>:<br>$FE70_H$ | 572<br>:<br>-40 | 5720<br>:<br>-400 | $1658_H$<br>:<br>$FE70_H$ | 573.2<br>:<br>233.2 | 5732<br>:<br>2332 | $1664_H$<br>:<br>$091C_H$ | Rated range |
| -40.1<br>:<br>-47.0 | -401<br>:<br>-470 | $FE6F_H$<br>:<br>$FE2A_H$ | -40.1<br>:<br>-52.6 | -401<br>:<br>-526 | $FE6F_H$<br>:<br>$FDF2_H$ | 233.1<br>:<br>226.2 | 2331<br>:<br>2262 | $091B_H$<br>:<br>$08D6_H$ | Undershoot range |
| < -47.0 | -32768 | $8000_H$ | < -52.6 | -32768 | $8000_H$ | < 226.2 | -32768 | $8000_H$ | Underflow |

## Representation of the analog values of thermocouples type B

Table 5- 24 Representation of the analog values of thermocouples type B

| Type B in °C | Units | | Type B in °F | Units | | Type B in K | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 2070.0 | 32767 | $7FFF_H$ | > 3276.6 | 32767 | $7FFF_H$ | > 2343.2 | 32767 | $7FFF_H$ | Overflow |
| 2070.0<br>:<br>1820.1 | 20700<br>:<br>18201 | $50DC_H$<br>:<br>$4719_H$ | 3276.6<br>:<br>2786.6 | 32766<br>:<br>27866 | $7FFE_H$<br>:<br>$6CDA_H$ | 2343.2<br>:<br>2093.3 | 23432<br>:<br>20933 | $5B88_H$<br>:<br>$51C5_H$ | Overshoot range |
| 1820.0<br>:<br>0.0 | 18200<br>:<br>0 | $4718_H$<br>:<br>$0000_H$ | 2786.5<br>:<br>32.0 | 27865<br>:<br>320 | $6CD9_H$<br>:<br>$0140_H$ | 2093.2<br>:<br>273.2 | 20932<br>:<br>2732 | $51C4_H$<br>:<br>$0AAC_H$ | Rated range |
| :<br>-120.0 | :<br>-1200 | :<br>$FB50_H$ | :<br>-184.0 | :<br>-1840 | :<br>$F8D0_H$ | :<br>153.2 | :<br>1532 | :<br>$05FC_H$ | Undershoot range |
| < -120.0 | -32768 | $8000_H$ | < -184.0 | -32768 | $8000_H$ | < 153.2 | 32768 | $8000_H$ | Underflow |



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## Representation of the analog values of thermocouples type C

Table 5- 25 Representation of the analog values of thermocouples type C

| Type C in °C | Units | | Type C in °F | Units | | Range |
|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | |
| > 2500.0 | 32767 | $7FFF_H$ | > 3276.6 | 32767 | $7FFF_H$ | Overflow |
| 2500.0<br>:<br>2315.1 | 25000<br>:<br>23151 | $61A8_H$<br>:<br>$5A6F_H$ | 3276.6<br>:<br>2786.6 | 32766<br>:<br>27866 | $7FFE_H$<br>:<br>$6CDA_H$ | Overshoot range |
| 2315.0<br>:<br>0.0 | 23150<br>:<br>0 | $5A6E_H$<br>:<br>$0000_H$ | 2786.5<br>:<br>32.0 | 27865<br>:<br>320 | $6CD9_H$<br>:<br>$0140_H$ | Rated range |
| -0.1<br>:<br>-120.0 | -1<br>:<br>-1200 | $FFFF_H$<br>:<br>$FB50_H$ | 31.9<br>:<br>-184.0 | 319<br>:<br>-1840 | $013F_H$<br>:<br>$F8D0_H$ | Undershoot range |
| < -120.0 | -32768 | $8000_H$ | < -184.0 | -32768 | $8000_H$ | Underflow |

## Representation of the analog values of thermocouples type E

Table 5- 26 Representation of the analog values of thermocouples type E

| Type E in °C | Units | | Type E in °F | Units | | Type E in K | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 1200.0 | 32767 | $7FFF_H$ | > 2192.0 | 32767 | $7FFF_H$ | > 1473.2 | 32767 | $7FFF_H$ | Overflow |
| 1200.0<br>:<br>1000.1 | 12000<br>:<br>10001 | $2EE0_H$<br>:<br>$2711_H$ | 2192.0<br>:<br>1832.2 | 21920<br>:<br>18322 | $55A0_H$<br>:<br>$4792_H$ | 1473.2<br>:<br>1273.3 | 14732<br>:<br>12733 | $398C_H$<br>:<br>$31BD_H$ | Overshoot range |
| 1000.0<br>:<br>-270.0 | 10000<br>:<br>-2700 | $2710_H$<br>:<br>$F574_H$ | 1832.0<br>:<br>-454.0 | 18320<br>:<br>-4540 | $4790_H$<br>:<br>$EE44_H$ | 1273.2<br>:<br>0 | 12732<br>:<br>0 | $31BC_H$<br>:<br>$0000_H$ | Rated range |
| < -270.0 | < -2700 | < $F574_H$ | < -454.0 | < -4540 | <$EE44_H$ | <0 | <0 | <$0000_H$ | Underflow |
| Faulty wiring (polarity reversal, or open inputs, for example), or sensor error in the negative range (wrong type of thermocouple, for example) will cause the analog input module to signal underflow, starting at... | | | | | | | | | |
| ... from $F0C4_H$ underflow and outputs $8000_H$. | | | ... from $FB70_H$ underflow and outputs $8000_H$. | | | ... from $E5D4_H$ underflow and outputs $8000_H$. | | | |



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## Representation of the analog values of thermocouples type J

Table 5- 27 Representation of the analog values of thermocouples type J

| Type J in °C | Units | | Type J in °F | Units | | Type J in K | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 1450.0 | 32767 | $7FFF_H$ | > 2642.0 | 32767 | $7FFF_H$ | > 1723.2 | 32767 | $7FFF_H$ | Overflow |
| 1450.0<br>:<br>1200.1 | 14500<br>:<br>12001 | $38A4_H$<br>:<br>$2EE1_H$ | 2642.0<br>:<br>2192.2 | 26420<br>:<br>21922 | $6734_H$<br>:<br>$55A2_H$ | 1723.2<br>:<br>1473.3 | 17232<br>:<br>14733 | $4350_H$<br>:<br>$398D_H$ | Overshoot range |
| 1200.0<br>:<br>-210.0 | 12000<br>:<br>-2100 | $2EE0_H$<br>:<br>$F7CC_H$ | 2192.0<br>:<br>-346.0 | 21920<br>:<br>-3460 | $55A0_H$<br>:<br>$F27C_H$ | 1473.2<br>:<br>63.2 | 14732<br>:<br>632 | $398C_H$<br>:<br>$0278_H$ | Rated range |
| < -210.0 | < -2100 | $<F7CC_H$ | < -346.0 | < -3460 | $<F27C_H$ | < 63.2 | < 632 | $< 0278_H$ | Underflow |
| Faulty wiring (polarity reversal, or open inputs, for example), or sensor error in the negative range (wrong type of thermocouple, for example) will cause the analog input module to signal underflow, starting at ... | | | | | | | | | |
| ... from $F31C_H$ underflow and outputs $8000_H$. | | | ... from $EA0C_H$ underflow and outputs $8000_H$. | | | ... from $FDC8_H$ underflow and outputs $8000_H$. | | | |

## Representation of the analog values of thermocouples type K

Table 5- 28 Representation of the analog values of thermocouples type K

| Type K in °C | Units | | Type K in °F | Units | | Type K in K | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 1622.0 | 32767 | $7FFF_H$ | > 2951.6 | 32767 | $7FFF_H$ | > 1895.2 | 32767 | $7FFF_H$ | Overflow |
| 1622.0<br>:<br>1372.1 | 16220<br>:<br>13721 | $3F5C_H$<br>:<br>$3599_H$ | 2951.6<br>:<br>2501.8 | 29516<br>:<br>25018 | $734C_H$<br>:<br>$61BA_H$ | 1895.2<br>:<br>1645.3 | 18952<br>:<br>16453 | $4A08_H$<br>:<br>$4045_H$ | Overshoot range |
| 1372.0<br>:<br>-270.0 | 13720<br>:<br>-2700 | $3598_H$<br>:<br>$F574_H$ | 2501.6<br>:<br>-454.0 | 25061<br>:<br>-4540 | $61B8_H$<br>:<br>$EE44_H$ | 1645.2<br>:<br>0 | 16452<br>:<br>0 | $4044_H$<br>:<br>$0000_H$ | Rated range |
| < -270.0 | < -2700 | $< F574_H$ | < -454.0 | < -4540 | $<EE44_H$ | < 0 | < 0 | $< 0000_H$ | Underflow |
| Faulty wiring (polarity reversal, or open inputs, for example), or sensor error in the negative range (wrong type of thermocouple, for example) will cause the analog input module to signal underflow, starting at ... | | | | | | | | | |
| ... from $F0C4_H$ underflow and outputs $8000_H$. | | | ... from $E5D4_H$ underflow and outputs $8000_H$. | | | ... from $FB70_H$ underflow and outputs $8000_H$. | | | |



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## Representation of the analog values of thermocouples type L

Table 5- 29 Representation of the analog values of thermocouples type L

| Type L in °C | Units | | Type L in °F | Units | | Type L in K | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 1150.0 | 32767 | $7FFF_H$ | > 2102.0 | 32767 | $7FFF_H$ | > 1423.2 | 32767 | $7FFF_H$ | Overflow |
| 1150.0<br>:<br>900.1 | 11500<br>:<br>9001 | $2CEC_H$<br>:<br>$2329_H$ | 2102.0<br>:<br>1652.2 | 21020<br>:<br>16522 | $521C_H$<br>:<br>$408A_H$ | 1423.2<br>:<br>1173.3 | 14232<br>:<br>11733 | $3798_H$<br>:<br>$2DD5_H$ | Overshoot range |
| 900.0<br>:<br>-200.0 | 9000<br>:<br>-2000 | $2328_H$<br>:<br>$F830_H$ | 1652.0<br>:<br>-328.0 | 16520<br>:<br>-3280 | $4088_H$<br>:<br>$F330_H$ | 1173.2<br>:<br>73.2 | 11732<br>:<br>732 | $2DD4_H$<br>:<br>$02DC_H$ | Rated range |
| < -200.0 | < -2000 | < $F830_H$ | < -328.0 | < -3280 | < $F330_H$ | < 73.2 | < 732 | <$02DC_H$ | Underflow |
| Faulty wiring (polarity reversal, or open inputs, for example), or sensor error in the negative range (wrong type of thermocouple, for example) will cause the analog input module to signal underflow, starting at ... | | | | | | | | | |
| ... from $F380_H$ underflow and outputs $8000_H$. | | | ... from $EAC0_H$ underflow and outputs $8000_H$. | | | ... from $FE2C_H$ underflow and outputs $8000_H$. | | | |

## Representation of the analog values of thermocouples type N

Table 5- 30 Representation of the analog values of thermocouples type N

| Type N in °C | Units | | Type N in °F | Units | | Type N in K | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 1550.0 | 32767 | $7FFF_H$ | > 2822.0 | 32767 | $7FFF_H$ | > 1823.2 | 32767 | $7FFF_H$ | Overflow |
| 1550.0<br>:<br>1300.1 | 15500<br>:<br>13001 | $3C8C_H$<br>:<br>$32C9_H$ | 2822.0<br>:<br>2372.2 | 28220<br>:<br>23722 | $6E3C_H$<br>:<br>$5CAA_H$ | 1823.2<br>:<br>1573.3 | 18232<br>:<br>15733 | $4738_H$<br>:<br>$3D75_H$ | Overshoot range |
| 1300.0<br>:<br>-270.0 | 13000<br>:<br>-2700 | $32C8_H$<br>:<br>$F574_H$ | 2372.0<br>:<br>-454.0 | 23720<br>:<br>-4540 | $5CA8_H$<br>:<br>$EE44_H$ | 1573.2<br>:<br>0 | 15732<br>:<br>0 | $3D74_H$<br>:<br>$0000_H$ | Rated range |
| < -270.0 | < -2700 | < $F574_H$ | < -454.0 | < -4540 | <$EE44_H$ | < 0 | < 0 | < $0000_H$ | Underflow |
| Faulty wiring (polarity reversal, or open inputs, for example), or sensor error in the negative range (wrong type of thermocouple, for example) will cause the analog input module to signal underflow, starting at ... | | | | | | | | | |
| ... from $F0C4_H$ underflow and outputs $8000_H$. | | | ... from $E5D4_H$ underflow and outputs $8000_H$. | | | ... from $FB70_H$ underflow and outputs $8000_H$. | | | |



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## Representation of the analog values of thermocouples type R, S

Table 5- 31 Representation of the analog values of thermocouples type R, S

| Type R, S in °C | Units | | Type R, S in °F | Units | | Types R, S in K | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 2019.0 | 32767 | 7FFF$_H$ | > 3276.6 | 32767 | 7FFF$_H$ | > 2292.2 | 32767 | 7FFF$_H$ | Overflow |
| 2019.0<br>:<br>1769.1 | 20190<br>:<br>17691 | 4EDE$_H$<br>:<br>451B$_H$ | 3276.6<br>:<br>3216.4 | 32766<br>:<br>32164 | 7FFE$_H$<br>:<br>7DA4$_H$ | 2292.2<br>:<br>2042.3 | 22922<br>:<br>20423 | 598A$_H$<br>:<br>4FC7$_H$ | Overshoot range |
| 1769.0<br>:<br>-50.0 | 17690<br>:<br>-500 | 451A$_H$<br>:<br>FE0C$_H$ | 3216.2<br>:<br>-58.0 | 32162<br>:<br>-580 | 7DA2$_H$<br>:<br>FDBC$_H$ | 2042.2<br>:<br>223.2 | 20422<br>:<br>2232 | 4FC6$_H$<br>:<br>08B8$_H$ | Rated range |
| -50.1<br>:<br>-170.0 | -501<br>:<br>-1700 | FE0B$_H$<br>:<br>F95C$_H$ | -58.2<br>:<br>-274.0 | -582<br>:<br>-2740 | FDBA$_H$<br>:<br>F54C$_H$ | 223.1<br>:<br>103.2 | 2231<br>:<br>1032 | 08B7$_H$<br>:<br>0408$_H$ | Undershoot range |
| < -170.0 | -32768 | 8000$_H$ | < -274.0 | -32768 | 8000$_H$ | < 103.2 | < 1032 | 8000$_H$ | Underflow |

## Representation of the analog values of thermocouples type T

Table 5- 32 Representation of the analog values of thermocouples type T

| Type T in °C | Units | | Type T in °F | Units | | Type T in K | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 540.0 | 32767 | 7FFF$_H$ | > 1004.0 | 32767 | 7FFF$_H$ | > 813.2 | 32767 | 7FFF$_H$ | Overflow |
| 540.0<br>:<br>400.1 | 5400<br>:<br>4001 | 1518$_H$<br>:<br>0FA1$_H$ | 1004.0<br>:<br>752.2 | 10040<br>:<br>7522 | 2738$_H$<br>:<br>1D62$_H$ | 813.2<br>:<br>673.3 | 8132<br>:<br>6733 | 1FC4$_H$<br>:<br>1AAD$_H$ | Overshoot range |
| 400.0<br>:<br>-270.0 | 4000<br>:<br>-2700 | 0FA0$_H$<br>:<br>F574$_H$ | 752.0<br>:<br>-454.0 | 7520<br>:<br>-4540 | 1D60$_H$<br>:<br>EE44$_H$ | 673.2<br>:<br>3.2 | 6732<br>:<br>32 | 1AAC$_H$<br>:<br>0020$_H$ | Rated range |
| < -270.0 | < -2700 | < F574$_H$ | < -454.0 | < -4540 | <EE44$_H$ | < 3.2 | < 32 | < 0020$_H$ | Underflow |
| Faulty wiring (polarity reversal, or open inputs, for example), or sensor error in the negative range (wrong type of thermocouple, for example) will cause the analog input module to signal underflow, starting at ... | | | | | | | | | |
| ... from F0C4$_H$ underflow and outputs 8000$_H$. | | | ... from E5D4$_H$ underflow and outputs 8000$_H$. | | | ... from FB70$_H$ underflow and outputs 8000$_H$. | | | |



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## Representation of the analog values of thermocouples type U

Table 5- 33 Representation of the analog values of thermocouples type U

| Type U in °C | Units | | Type U in °F | Units | | Type U in K | Units | | Range |
|---|---|---|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | | dec | hex | |
| > 850.0 | 32767 | $7FFF_H$ | > 1562.0 | 32767 | $7FFF_H$ | > 1123.2 | 32767 | $7FFF_H$ | Overflow |
| 850.0<br>:<br>600.1 | 8500<br>:<br>6001 | $2134_H$<br>:<br>$1771_H$ | 1562.0<br>:<br>1112.2 | 15620<br>:<br>11122 | $2738.0_H$<br>:<br>$2B72_H$ | 1123.2<br>:<br>873.2 | 11232<br>:<br>8732 | $2BE0_H$<br>:<br>$221C_H$ | Overshoot range |
| 600.0<br>:<br>-200.0 | 6000<br>:<br>-2000 | $1770_H$<br>:<br>$F830_H$ | 1112.0<br>:<br>-328.0 | 11120<br>:<br>-3280 | $2B70_H$<br>:<br>$F330_H$ | 873.2<br>:<br>73.2 | 8732<br>:<br>732 | $221C_H$<br>:<br>$02DC_H$ | Rated range |
| < -200.0 | < -2000 | < $F830_H$ | < -328.0 | < -3280 | < $F330_H$ | < 73.2 | < 732 | <$02DC_H$ | Underflow |
| Faulty wiring (polarity reversal, or open inputs, for example), or sensor error in the negative range (wrong type of thermocouple, for example) will cause the analog input module to signal underflow, starting at ... | | | | | | | | | |
| ... from $F380_H$ underflow and outputs $8000_H$. | | | ... from $EAC0_H$ underflow and outputs $8000_H$. | | | ... from $FE2C_H$ underflow and outputs $8000_H$. | | | |

## Representation of analog values for type TXK/XKL GOST thermocouple

Table 5- 34 Representation of analog values for type TXK/XKL GOST thermocouple

| Type TXK/XKL in °C | Units | | Type TXK/XKL in °F | Units | | Range |
|---|---|---|---|---|---|---|
| | dec | hex | | dec | hex | |
| > 1050.0 | 32767 | $7FFF_H$ | > 1922.0 | 32767 | $7FFF_H$ | Overflow |
| 1050.0<br>:<br>800.1 | 8500<br>:<br>8001 | $2904_H$<br>:<br>$1F41_H$ | 1922.0<br>:<br>1472.1 | 19220<br>:<br>14721 | $4B14_H$<br>:<br>$3981_H$ | Overshoot range |
| 800.0<br>:<br>0.0<br>:<br>-200.0 | 8000<br>:<br>0<br>:<br>-2000 | $1F40_H$<br>:<br>$0000_H$<br>:<br>$F830_H$ | 1472.0<br>:<br>32.0<br>:<br>-328.0 | 14720<br>:<br>320<br>:<br>-3280 | $3980_H$<br>:<br>$0140_H$<br>:<br>$F330_H$ | Rated range |
| < -200.0 | <-32768 | < $F8000_H$ | < -328.0 | <-32768 | $8000_H$ | Underflow |



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# 5.2 Representation of analog values for analog output channels

## Binary representation of output ranges

Table 5- 35 Bipolar output ranges

| | | $2^{15}$ | $2^{14}$ | $2^{13}$ | $2^{12}$ | $2^{11}$ | $2^{10}$ | $2^{9}$ | $2^{8}$ | $2^{7}$ | $2^{6}$ | $2^{5}$ | $2^{4}$ | $2^{3}$ | $2^{2}$ | $2^{1}$ | $2^{0}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ≥32512 | 0 % | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | x | x | x | x | x | x | x | x | Overflow |
| 32511 | 117,589 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Overshoot range |
| 27649 | ≥100,004 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 27648 | 100,000 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Rated range |
| 1 | 0,003617 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 0 | 0,000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| -1 | -0,003617 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| -27648 | -100,000 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| -27649 | ≤100,004 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Undershoot range |
| -32512 | -117,593 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ≤-32513 | 0 % | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | x | x | x | x | x | x | x | x | Underflow |

Table 5- 36 Unipolar output ranges

| Units | Output value in % | Data word | | | | | | | | | | | | | | | | Range |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $2^{15}$ | $2^{14}$ | $2^{13}$ | $2^{12}$ | $2^{11}$ | $2^{10}$ | $2^{9}$ | $2^{8}$ | $2^{7}$ | $2^{6}$ | $2^{5}$ | $2^{4}$ | $2^{3}$ | $2^{2}$ | $2^{1}$ | $2^{0}$ | |
| ≥32512 | 0 % | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | x | x | x | x | x | x | x | x | Overflow |
| 32511 | 117,589 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Overshoot range |
| 27649 | ≥100,004 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 27648 | 100,000 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Rated range |
| 1 | 0,003617 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 0 | 0,000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| -1 | 0,000 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | limited to the low limit of the rated range, 0 V or 0 mA |
| -32512 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ≤-32513 | 0 % | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | x | x | x | x | x | x | x | x | Underflow |



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## Representation of analog values in the voltage output ranges

Table 5- 37 Representation of analog values in the ±10 V output range

| System | | | Voltage output range | |
|---|---|---|---|---|
| | dec | hex | ±10 V | |
| 118,5149 % | 32767 | 7FFF | 0.00 V | Overflow, off power |
| | 32512 | 7F00 | | |
| 117,589 % | 32511 | 7EFF | 11.76 V | Overshoot range |
| | 27649 | 6C01 | | |
| 100 % | 27648 | 6C00 | 10 V | Rated range |
| 75 % | 20736 | 5100 | 7.5 V | |
| 0,003617 % | 1 | 1 | 361.7 µV | |
| 0 % | 0 | 0 | 0 V | |
| | -1 | FFFF | -361.7 µV | |
| -75 % | -20736 | AF00 | -7.5 V | |
| -100 % | -27648 | 9400 | -10 V | |
| | -27649 | 93FF | | Undershoot range |
| -117,593 % | -32512 | 8100 | -11.76 V | |
| | -32513 | 80FF | | Underflow, at zero voltage and current |
| -118,519 % | -32768 | 8000 | 0.00 V | |

Table 5- 38 Representation of analog values in the 0 V to 10 V and 1 V to 5 V output ranges

| System | | | Voltage output range | | |
|---|---|---|---|---|---|
| | dec | hex | 0 V to 10 V | 1 V to 5 V | |
| 118,5149 % | 32767 | 7FFF | 0.00 V | 0.00 V | Overflow, off power |
| | 32512 | 7F00 | | | |
| 117,589 % | 32511 | 7EFF | 11.76 V | 5.70 V | Overshoot range |
| | 27649 | 6C01 | | | |
| 100 % | 27648 | 6C00 | 10 V | 5 V | Rated range |
| 75 % | 20736 | 5100 | 7.5 V | 3.75 V | |
| 0,003617 % | 1 | 1 | 361.7 µV | 1 V +144.7 µV | |
| 0 % | 0 | 0 | 0 V | 1 V | |
| | -1 | FFFF | | | Undershoot range |
| -25 % | -6912 | E500 | | 0 V | |
| | -6913 | E4FF | | | Not supported. Output value limited to 0 V. |
| -117,593 % | -32512 | 8100 | | | |
| | -32513 | 80FF | | | Underflow, at zero voltage and current |
| -118,519 % | -32768 | 8000 | 0.00 V | 0.00 V | |



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## Representation of analog values in the current output ranges

Table 5- 39 Representation of analog values in the ±20 mA output range

| System | | | Current output range | |
|---|---|---|---|---|
| | dec | hex | ±20 mA | |
| 118,5149 % | 32767 | 7FFF | 0.00 mA | Overflow, off power |
| | 32512 | 7F00 | | |
| 117,589 % | 32511 | 7EFF | 23.52 mA | Overshoot range |
| | 27649 | 6C01 | | |
| 100 % | 27648 | 6C00 | 20 mA | |
| 75 % | 20736 | 5100 | 15 mA | Rated range |
| 0,003617 % | 1 | 1 | 723.4 nA | |
| 0 % | 0 | 0 | 0 mA | |
| | -1 | FFFF | -723.4 nA | |
| -75 % | -20736 | AF00 | -15 mA | |
| -100 % | -27648 | 9400 | -20 mA | |
| | -27649 | 93FF | | Undershoot range |
| -117,593 % | -32512 | 8100 | -23.52 mA | |
| | -32513 | 80FF | | Underflow, at zero voltage and current |
| -118,519 % | -32768 | 8000 | 0.00 mA | |

Table 5- 40 Representation of analog values in the 0 mA to 20 mA and 4 mA to 20 mA output ranges

| System | | | Current output range | | |
|---|---|---|---|---|---|
| | dec | hex | 0 mA to 20 mA | 4 mA to 20 mA | |
| 118,5149 % | 32767 | 7FFF | 0.00 mA | 0.00 mA | Overflow, off power |
| | 32512 | 7F00 | | | |
| 117,589 % | 32511 | 7EFF | 23.52 mA | 22.81 mA | Overshoot range |
| | 27649 | 6C01 | | | |
| 100 % | 27648 | 6C00 | 20 mA | 20 mA | Rated range |
| 75 % | 20736 | 5100 | 15 mA | 16 mA | |
| 0,003617 % | 1 | 1 | 723.4 nA | 4 mA + 578.7 nA | |
| 0 % | 0 | 0 | 0 mA | 4 mA | |
| | -1 | FFFF | | | Undershoot range |
| -25 % | -6912 | E500 | | 0 mA | |
| | -6913 | E4FF | | | Not supported. Output value limited to 0 mA. |
| -117,593 % | -32512 | 8100 | | | |
| | -32513 | 80FF | | | Underflow, at zero voltage and current |
| -118,519 % | -32768 | 8000 | 0.00 mA | 0.00 mA | |



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# 5.3 Setting the measuring method and ranges of analog input channels

## Two procedures

There are two methods of setting the measuring method and ranges of analog input channels at analog modules:

- using a measuring range module and *STEP 7*
- hardwiring of the analog input channel and STEP 7

The method to use for the various analog modules is module-specific and is described in detail in the special module chapters.

This section describes how to set up the type and range of measurement using measuring range modules.

## Setting the measurement type and ranges using measuring range modules

The analog modules are supplied with corresponding measuring range modules as required.

You may have to change the position of the measuring range module to suit the measurement type and range.

**Note**

Note that the measuring range modules are installed on the side of the analog input module.

Always check whether the measuring range modules needs to be set up for a different measurement type and range **before** you install the analog input module.

## Optional settings of the measuring range modules

Optional settings of the measuring range modules: "A", "B", "C" and "D".

For detailed information on settings to be made for a specific measurement type and range, refer to the special module chapter.

The settings for the different measurement types and ranges are also printed onto the analog module.



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## Changing the positioning of measuring range modules

To insert the measuring range module into a different slot:

1. Remove the measuring range module from the slot of the analog input module by lifting it out with a screwdriver.

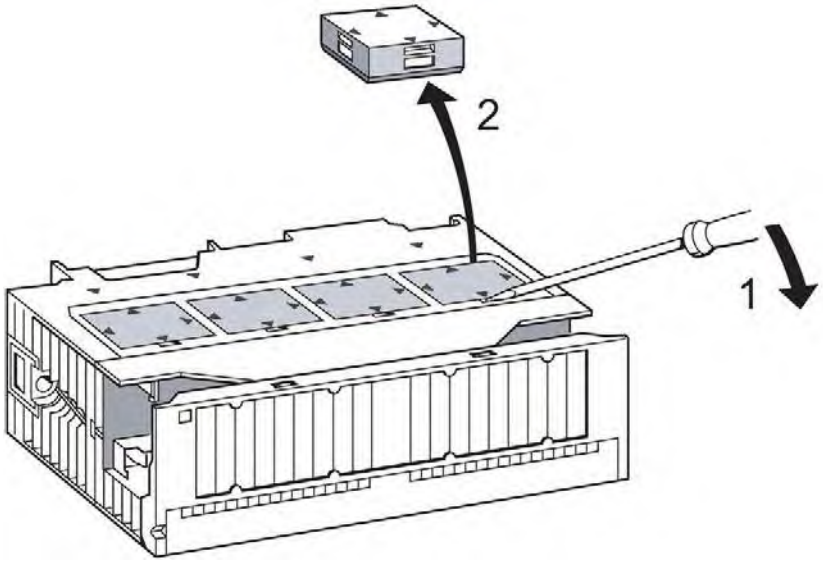



Figure 5-1 Removing the measuring range module from a slot of the analog input module

2. Insert the measuring range module into the required slot (1) of the analog input module.

   The indicator of the selected measuring range must be in line with the marker on the module (2).

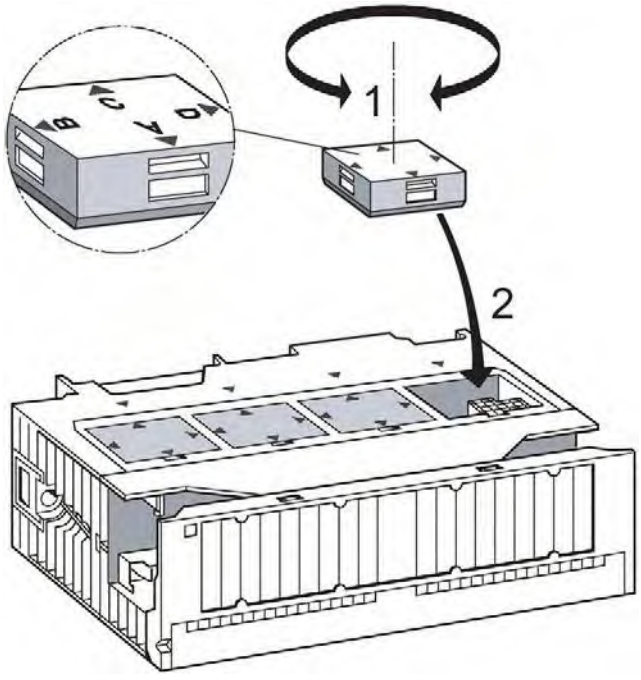



Figure 5-2 Inserting the measuring range module into the analog input module



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Proceed likewise with any other measuring range modules.

You can now install the module.

**CAUTION**

Incorrect settings of the measuring range modules may lead to the destruction of the module.

Always make sure that the measuring range module is in the correct position before you connect a sensor to the module.



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# 5.4 Response of the analog modules

## This chapter

This chapter describes:

- the dependency of analog input and output values on CPU operating states and on the supply voltage of the analog module
- the reaction of analog modules, based on the actual analog value within the relevant range of values
- the influence of the operational limits of analog modules on analog IO values, as illustrated by an example

## 5.4.1 Influence of the power supply and operating state

## Introduction

This chapter describes:

- the dependency of analog IO values on CPU operating states, and on the supply voltage of the analog module
- the reaction of analog modules, based on the actual analog value within the relevant range of values
- the influence of the operational limits of analog modules on analog IO values, as illustrated by an example



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## Influence of the supply voltage and operating state on the modules

The IO values of analog modules are determined by the CPU operating state and the module's supply voltage.

Table 5- 41 Dependencies of the analog IO values on the CPU's operating State and on the L+ supply voltage

| CPU operating state | | Supply voltage L+ at the analog module | Input value of the analog input module | Output value of the analog output module |
|---|---|---|---|---|
| POWER ON | RUN | L+ present | Measured value | CPU values |
| | | | $7FFF_H$, until the first conversion after POWER ON is completed, or when the module has been programmed. | Until the first conversion...<br>• after POWER ON, the module outputs a 0 mA or 0 V signal.<br>• after programming is successfully completed, it outputs the previous value. |
| | | L+ missing | Overflow value | 0 mA / 0 V |
| POWER ON | STOP | L+ present | Measured value | Substitution value / last value (default: 0 mA / 0 V) |
| | | | $7FFF_H$, until the first conversion after POWER ON is completed, or when the module has been programmed. | |
| | | L+ missing | Overflow value | 0 mA / 0 V |
| POWER OFF | - | L+ present | - | 0 mA / 0 V |
| | | L+ missing | - | 0 mA / 0 V |

## Reaction to power failure

Power failure at analog modules is always indicated by their relevant SF LED. This information is also available on the module (in diagnostics buffer data.)

Diagnostics interrupt triggering is based on parameter settings.

## See also

Programming analog modules (Page 294)



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## 5.4.2 Influence of the range of analog values

### influence of errors on analog modules with diagnostics functions

Errors may lead to an entry in the diagnostics buffer and trigger a diagnostics interrupt at analog modules with diagnostics function and corresponding parameter settings.

### Influence of the range of values on the analog input module

The reaction of analog modules is determined by the actual input values within the range of values.

Table 5- 42 Reaction of analog input modules as a function of the actual analog value within the range of values

| Measured value within | Input value | SF LED | Diagnostics | Interrupt |
|---|---|---|---|---|
| Rated range | Measured value | - | - | - |
| Over-shoot/undershoot range | Measured value | - | - | - |
| Overflow | $7FFF_H$ | lit[1] | Entry is made[1] | Diagnostics interrupt[1)] |
| Underflow | $8000_H$ | lit[1] | Entry is made[1] | Diagnostics interrupt[1)] |
| beyond programmed limit | Measured value | - | - | Process interrupt[1)] |
| [1)], only supported by modules with diagnostics function, and depending on parameter settings | | | | |

### Influence of the range of values on the analog output module

The reaction of analog modules is determined by the actual output values within the value range.

Table 5- 43 Reaction of analog output modules as a function of the actual analog value within the range of values

| Output value within | Output value | SF LED | Diagnostics | Interrupt |
|---|---|---|---|---|
| Rated range | CPU value | - | - | - |
| Over-shoot/undershoot range | CPU value | - | - | - |
| Overflow | 0 signal | - | - | - |
| Underflow | 0 signal | - | - | - |



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## 5.4.3 Influence of operational limits and basic error limits

### Operational limit

The operational limit represents the total measuring/output error of an analog module within the permissible temperature range, based on the module's rating.

### Basic error limit

The basic error limit represents the total measuring/output error at 25 °C, based on the module's rating.

**Note**

The percentile values of operational and basic error limits in the module's technical data always refer to the **highest possible** input and output value within the nominal range of the module.

### Example of the determination of the output error of a module

An analog output module SM 332; AO 4 x 12 Bit is being used for voltage output. An output range of "0 to 10 V" is set. The module is operating at an ambient temperature of 30 °C, i.e. the operational limit applies. The technical data of the module state:

- Operational limit for voltage output: ±0,5 %

Hence, an output error of ±0.05 V (±0.5 % of 10 V) across the nominal range of the module must be expected.

At an actual voltage of 1 V, for example, the module will then output a value in the range from 0.95 V to 1.05 V. The relative error is ±5 % in this case.

For the example, the figure below shows how the relative error decreases as the output value approaches the end of the 10-V range.

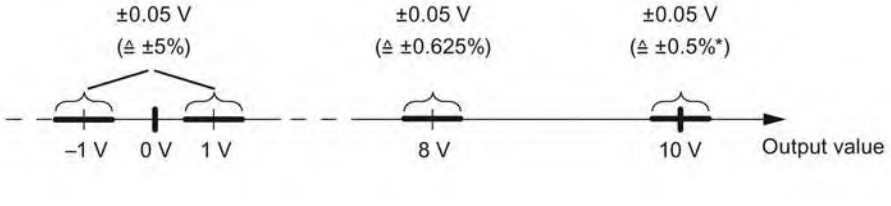



Figure 5-3 Example of the relative error of an analog output module



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# 5.5 Conversion and cycle times of analog modules

## Conversion time of analog input channels

The conversion time is the total of the basic conversion time plus additional processing times of the module for:

- Resistance measurement
- Wirebreak monitoring

The basic conversion time depends directly on the conversion method of the analog input channel (integrating method, actual value conversion.)

The integration time of integrating conversions has a direct influence on conversion times. The integration time depends on the interference frequency suppression you set in *STEP 7*.

For information on basic conversion times and additional processing times of the various analog modules, refer to the technical data of the relevant module.

## Cycle time of analog input channels

Analog-to-digital conversion, and the transfer of digitized measured values to memory and/or to the backplane bus, are carried out sequentially, i.e. the analog input channels are converted in successive order. The cycle time, i.e. the time expiring until an analog input value is converted again, represents the accumulated conversion time of all activated analog input channels of the analog input module.

The figure below provides an overview of the cycle time elements for an n-channel analog module.

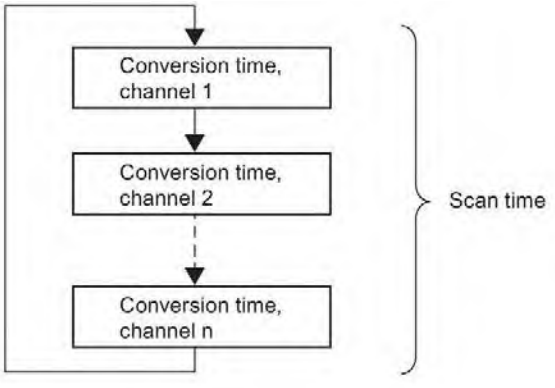



Figure 5-4 Cycle time of an analog input or output module

## Conversion and cycle times for analog input channels in channel groups

Make allowances for the accumulated channel conversion time when the analog input channels are joined to form channel groups.



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### Example

Two analog input channels of the SM 331; AI 2 x 12 Bit analog input module form a channel group. You must therefore grade the cycle time in steps of 2.

### Setting smoothing of analog values

Certain analog input modules allow you to set smoothing of analog values in *STEP 7*.

### Using smoothing

Smoothed analog values provide a reliable analog signal for further processing.

It is useful to smooth the analog values with slow variations of measured values, for example, when measuring temperature.

### Smoothing principle

The measured values are smoothed by digital filtering. Smoothing is accomplished by the module calculating mean values, derived from a defined number of converted (digitized) analog values.

The user configures up to four grades of smoothing (none, low, average, high). The grade determines the number of analog signals used for averaging.

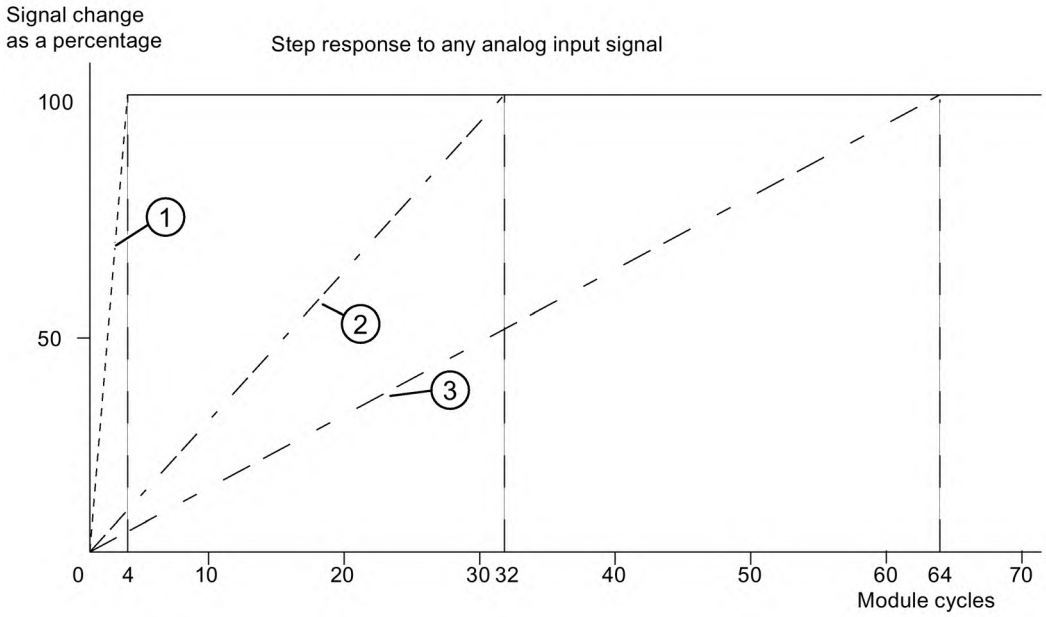
A higher smoothing provides a more reliable analog value, and prolongs the time it takes to apply a smoothed analog signal following a step response (see the example below.)



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## Examples

The figures below show the number of cycles a module requires to apply a close to 100% smoothed analog value after a step response, based on the smoothing function settings. The figure applies to all signal changes at the analog input.

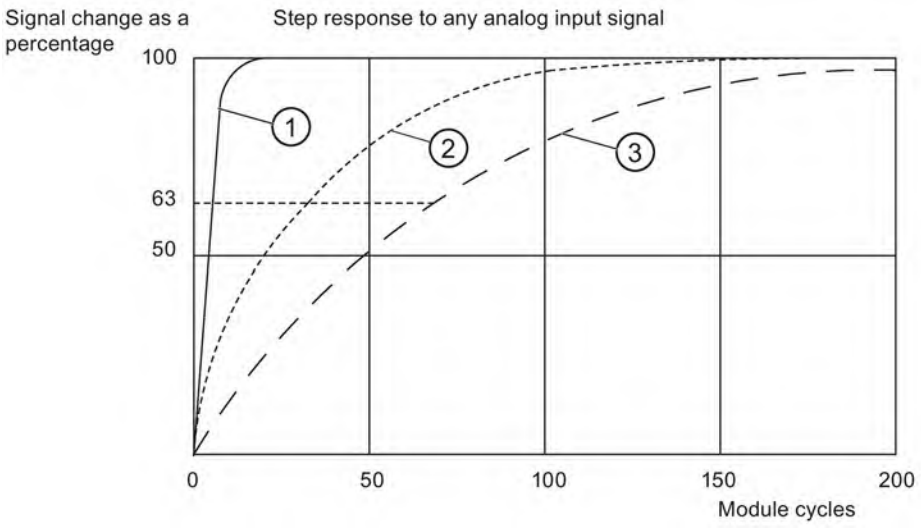



① Low smoothing grade
② Medium smoothing grade
③ High smoothing grade

Figure 5-5 Example of impact of smoothing on the jump response with the AI 8 x 14 bit



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① Low smoothing grade
② Medium smoothing grade
③ High smoothing grade

Figure 5-6 Example of impact of smoothing on the step response with the AI 6 x TC

### Further information on smoothing

For information showing whether a specific module supports smoothing functions, and special features to observe, refer to the chapter dealing with the analog input module.

### Conversion time of the analog output channels

The conversion time of the analog output channels includes the transfer of digitized output values from internal memory, and their digital-to-analog conversion.

### Cycle time of analog output channels

Analog output channels are converted sequentially, i.e. successively.

The cycle time, i.e. the time expiring until an analog output value is converted again, is equivalent to the accumulated conversion times of all activated analog output channels. Refer to the figure *Cycle time of an analog IO channel*.

### Tip

You should disable all unused analog channels in **STEP 7** in order to reduce cycle times.



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# 5.6 Settling and response times of analog output channels

## Settling time

The settling time ($t_2$ to $t_3$), i.e. the time expiring until a converted value has gained a specified level at an analog output, is load-dependent. We therefore distinguish between resistive, capacitive and inductive load.

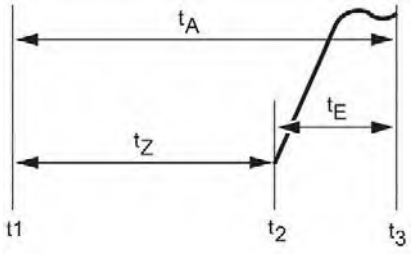
For information on settling times as a function of load at the various analog output modules, refer to the technical data of the relevant module.

## Response time

The worst case response time ($t_1$ to $t_3$), i.e. the time expiring between the input of digital output values to internal memory, and the signal settling time at the analog output, may be equivalent to the total of cycle time plus settling time.

The worst case scenario is given, when the analog channel has been converted immediately before a new output value is transferred, and is not converted again until all other channels have been converted (cycle time.)

## Overview of the settling time and response time of analog output modules




$t_A$ Response time
$t_C$ tC = Cycle time, equivalent to n x conversion time (n = active channels)
$t_S$ Settling time
$t_1$ new digital output value is set
$t_2$ Output value is applied and converted
$t_3$ specified output value is reached



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# 5.7 Programming analog modules

## Introduction

The properties of analog modules may differ. The module properties can be programmed.

## Programming tools

You program analog modules in *STEP 7*. Always program the module while the CPU is in STOP mode.

After you defined all parameters, download these from your PG to the CPU. The CPU transfers the parameters to the relevant analog modules at the STOP → RUN transition.

Also, position the measuring range modules of the module as required.

## Static and dynamic parameters

Parameters are organized by static and dynamic properties.

Set the static parameters while the CPU is in STOP, as described earlier.

You can also modify dynamic parameters in the active user program using SFCs. However, the parameters set in *STEP 7* will be applied again after a RUN → STOP, STOP → RUN transition of the CPU.

| Parameters | configurable using | CPU operating state |
|---|---|---|
| static | PG (STEP 7 HW CONFIG) | STOP |
| dynamic | PG (STEP 7 HW CONFIG) | STOP |
| | SFC 55 in the user program | RUN |

## See also

Programmable parameters (Page 348)

## 5.7.1 Parameters of analog input modules

## Parameters of analog input modules

For information on parameters supported by specific analog modules, refer to the chapter dealing with the relevant module.

The defaults apply if you have not set any parameters in **STEP 7**.



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# 5.8 Diagnostics of analog modules

## Programmable and non-programmable diagnostic messages

We distinguish between programmable and non-programmable diagnostic messages.

You only obtain programmable diagnostic messages if you have enabled diagnostics at the relevant parameters. Program these functions in the "Diagnostics" parameter block in *STEP 7*.

The the analog module always provides non-programmable diagnostic messages, irrespective of the enable state of diagnostic functions.

## Reactions to a diagnostic message in *STEP 7*

Actions initiated by diagnostic messages:

- The diagnostic message is written to the diagnostics buffer of the analog module, and is then passed to the CPU.
- The error LED on the analog module is lit.
- When "Enable Diagnostics Interrupt" is set in STEP 7, the system triggers a diagnostic interrupt and calls OB82.

## Reading diagnostic messages

You can read detailed diagnostic messages in the user program using SFCs.

## Viewing the cause of error

You can view the cause of the error in the module diagnostics data in *STEP 7* (refer to the *STEP 7* Online Help.)

## Diagnostic message included in the measured value of analog input modules

All analog input modules return the measured value $7FFF_H$ as a reaction to errors, irrespective of parameter settings. This measured value indicates either overflow, error, or a disabled channel.

## Diagnostic message using the SF LED

Diagnostics-capable analog modules indicate errors by means of their SF LED (group error LED). The SF LED lights up when the analog module has generated a diagnostic message. It goes dark after all error states are cleared.

## See also

Programming analog modules (Page 294)



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## 5.8.1 Diagnostics messages of analog input modules

### Overview of the diagnostics messages of analog input modules

The table below provides an overview of the diagnostics messages of analog input modules.

Table 5- 44 Diagnostics messages of analog input modules

| Diagnostics message | LED | Scope of diagnostics | programmable |
|---|---|---|---|
| External load voltage missing | SF | Module | no |
| Configuration / programming error | SF | Channel | yes |
| Common-mode error | SF | Channel | yes |
| Wirebreak | SF | Channel | yes |
| Underflow | SF | Channel | yes |
| Overflow | SF | Channel | yes |

## 5.8.2 Diagnostic messages of analog output modules

### Overview of the diagnostic messages of analog output modules

The table below provides an overview of the diagnostic messages of analog output modules.

Table 5- 45 Diagnostic messages of analog output modules

| Diagnostic message | LED | Scope of diagnostics | programmable |
|---|---|---|---|
| External load voltage missing | SF | Module | no |
| Configuration / programming error | SF | Channel | yes |
| Short-circuit to M* | SF | Channel | yes |
| Wire-break* | SF | Channel | yes |

* Not with the SM 332, AO 4 x 16 bit, isochrone

**Note**

The detection of errors which are indicated in programmable diagnostic messages requires appropriate configuration of the analog module in *STEP 7*.



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## 5.8.3 Causes of error and troubleshooting at analog input modules

### Overview of the causes of error and troubleshooting at analog input modules

Table 5- 46 Diagnostics messages of analog input modules, causes of error and troubleshooting

| Diagnostics message | Possible cause of error | To correct or avoid errors |
|---|---|---|
| External load voltage missing | Load voltage L+ of module missing | Connect supply L+ |
| Configuration / programming error | Faulty parameters transferred to module | Check the measuring range module |
| | | Program the module |
| Common-mode error | Potential difference $C_{MV}$ between inputs M- and the reference potential of measuring circuit ($M_{ANA}$ out of limits) | Connect M- with $M_{ANA}$ |
| Wirebreak | Resistance of transducer circuit too high | Use a different type of sensor, or modify the wiring, for example, using a larger conductor cross-section. |
| | Open circuit between module and sensor | Connect the cable |
| | Channel not connected (open) | Disable the channel group ("measuring method" parameter) |
| | | Wire the channel |
| Underflow | Input value below undershoot range; possible cause of error:<br>wrong measuring range setting | program a different measuring range |
| | polarity reversal of the sensor wiring in the measuring ranges 4 to 20 mA and 1 to 5 V | Check the connections |
| Overflow | Input value exceeds overshoot range | program a different measuring range |

## 5.8.4 Causes of error and troubleshooting at analog output modules

### Overview of the causes of error and troubleshooting routines at analog output modules

Table 5- 47 Diagnostics messages of analog output modules, causes of error and troubleshooting

| Diagnostics message | Possible cause of error | To correct or avoid errors |
|---|---|---|
| External load voltage missing | Load voltage L+ of module missing | Connect supply L+ |
| Configuration / programming error | Faulty parameters transferred to module | Assign new module parameters |
| Short-circuit to M | Overload at output | Eliminate overload |
| | Short-circuit at output $Q_V$ to $M_{ANA}$ | Eliminate the short-circuit |
| Wirebreak | Actuator impedance too high | Use a different type of actuator, or modify the wiring using cables with a larger conductor cross-section |
| | Wire-break between the module and actuator | Connect the cable |
| | Channel not used (open) | Disable the channel group ("output type" parameter) |



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# 5.9 Interrupts of analog modules

## Introduction

This section describes the interrupt response of analog modules. Always distinguish between the following interrupts:

- Diagnostic interrupt
- Hardware interrupt

Note that certain analog modules do not support interrupts, or are only partially capable of "handling" the interrupts described below. For information on modules which support interrupt functionality, refer to their technical data.

## Description of the *STEP 7* blocks

For detailed information on the OBs and SFCs mentioned below, refer to the *STEP 7* Online Help.

## Enabling interrupts

There are no default interrupt settings, that is, interrupts are disabled if not set accordingly. Program the interrupt enable parameter in *STEP 7*.

## Diagnostic interrupt

Incoming error events (initial occurrence) and outgoing error events (error is cleared) are reported by means of diagnostic interrupt, if this interrupt is enabled.

The CPU interrupts user program execution in order to process diagnostic interrupt OB82.

You can call SFC51 or 59 in OB82 in the user program to view details of diagnostics data output by the module.

Diagnostics data remain consistent until the program exits OB82. The program acknowledges the diagnostic interrupt at the module when it exits OB82.

## Hardware interrupt with "high or low limit exceeded" trigger

Define a working range by setting a high and low limit. If the process signal (for example, the temperature) overshoots this working range, the module triggers a hardware interrupt, provided the interrupt is enabled.

The CPU interrupts user program execution in order to execute hardware interrupt OB40.

In the user program of OB 40, you can define the reaction of the automation system to the violation of limits.



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The program acknowledges the diagnostic interrupt at the module when it exits OB40.

**Note**

Note: the system does not generate a hardware interrupt if your limit setting exceeds the overshoot or undershoot range.

## Structure of the start information variable OB40_POINT_ADDR of OB 40

The channel at which a specific limit is exceeded is logged to the OB40_POINT_ADDR variable in the start information of OB40. The diagram below shows the bit assignment of DWORD 8 in local data.

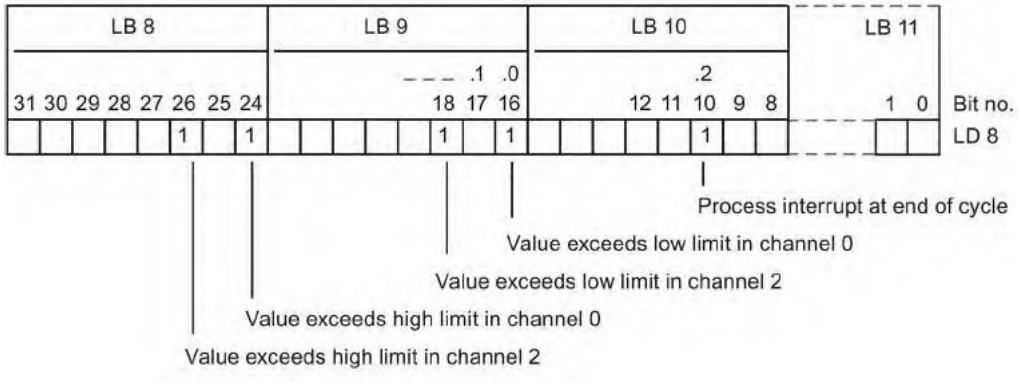



Figure 5-7 Start information of OB40: which limits event has triggered a hardware interrupt

## Hardware interrupt triggered by "End of cycle reached"

You can synchronize a process with the cycle of the analog input module by programming a hardware interrupt trigger at the end of the cycle.

One cycle comprises the conversion of the measured values of all active channels of the analog input module. The module processes the channels in successive order. After all measured values were successfully converted, the module outputs an interrupt to the CPU in order to report new measured values at its channels.

You can always use this interrupt to download the actual converted analog values.



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# Analog modules

# 6

## Introduction

This chapter describes:

1. Analog module selection and commissioning sequence
2. Overview of essential module properties
3. Modules which are available (properties, connection and block diagrams, technical data and additional information on the module):

   a) for analog input modules

   b) for analog output modules

   c) for analog IO modules

## *STEP 7* blocks for analog functions

You can use FC105 "SCALE" (scale values) and FC106 "UNSCALE" (unscale values) blocks to read and output analog values in *STEP 7*. Those FCs are available in the *STEP 7* standard library, in the "TI-S7-Converting Blocks" subfolder.

## Description of *STEP 7* blocks for analog functions

For information on FCs 105 and 106, refer to the *STEP 7* Online Help.

## Further information

You should be familiar with the structure of the parameter sets (data records 0, 1 and 128) in system data before you edit module parameters in the *STEP 7* user program.

You should be familiar with the structure of diagnostics data (data records 0, 1) in system data before you edit any diagnostics data of the module in the *STEP 7* user program.

## See also

Principles of programming signal modules in the user program (Page 522)

Evaluating diagnostic data of signal modules in the user program (Page 583)



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# 6.1 Analog module selection and commissioning sequence

## Introduction

The table below contains the steps required to successfully complete commissioning of analog modules.

You do not strictly have to adhere to this suggested sequence, that is, you can complete other tasks such as installing or commissioning other modules, or program the module at an earlier or later time.

## Analog module selection and commissioning sequence

1. Selecting the module
2. For certain analog input modules: Set the measuring type and range using the measuring range module
3. Installing the module in the SIMATIC S7 system
4. Assigning module parameters
5. Connect the measuring transducers or loads to the module
6. Commission the configuration
7. Analyze the configuration if commissioning failed

## More information on installation and commissioning

See the "Installation" and "Commissioning" chapter in the Installation Manual for your automation system:

- S7-300 Automation System, Installation or
- S7-400 Automation System, Installation or
- Distributed I/O Device ET 200M

The documentation is available on the Internet (http://support.automation.siemens.com/WW/view/en).



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# 6.2 Module overview

## Introduction

The tables below summarize the essential properties of the analog modules. This overview supports you in selecting a module to suit your requirements.

## 6.2.1 Analog input modules

### Overview of properties

The table below shows essential properties of the analog input modules

Table 6- 1 Analog input modules

| Properties | Module | | | | |
|---|---|---|---|---|---|
| | SM 331; AI 8 x 16 Bit | SM 331; AI 8 x 16 Bit | SM 331; AI 8 x 14 Bit High Speed | SM 331; AI 8 x 13 Bit | SM 331; AI 8 x 12 Bit |
| | (-7NF00-) | (-7NF10-) | (-7HF0x-) | (-1KF02-) | (-7KF02-) |
| Number of inputs | 8 inputs in 4 channel groups | 8 inputs in 4 channel groups | 8 inputs in 4 channel groups | 8 inputs in 8 channel groups | 8 inputs in 4 channel groups |
| Resolution | programmable for each channel group:<br>• 15 bits+sign | programmable for each channel group:<br>• 15 bits+sign | programmable for each channel group:<br>• 13 bits+sign | programmable for each channel group:<br>• 12 bits+sign | programmable for each channel group:<br>• 9 bits+sign<br>• 12 bits+sign<br>• 14 bits+sign |
| Measurement type | programmable for each channel group:<br>• Voltage<br>• Current | programmable for each channel group:<br>• Voltage<br>• Current | programmable for each channel group:<br>• Voltage<br>• Current | programmable per channel:<br>• Voltage<br>• Current<br>• Resistance<br>• Temperature | programmable for each channel group:<br>• Voltage<br>• Current<br>• Resistance<br>• Temperature |
| Measuring range selection | any, per channel group | any, per channel group | any, per channel group | any, per channel | any, per channel group |
| Supports isochronous mode | no | no | yes | no | yes |
| Programmable diagnostics | yes | yes | yes | no | no |
| Diagnostic interrupt | programmable | programmable | programmable | no | programmable |



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| Properties | Module | | | | |
|---|---|---|---|---|---|
| Limit value monitoring | programmable for 2 channels | programmable for 8 channels | programmable for 2 channels | no | programmable for 2 channels |
| Hardware interrupt when limit exceeded | programmable | programmable | programmable | no | Programmable |
| Hardware interrupt at end of cycle | no | yes | no | No | no |
| Potential ratios | electrically isolated from:<br>• The backplane bus interface | electrically isolated from:<br>• The backplane bus interface | electrically isolated from:<br>• The backplane bus interface<br>• The load voltage (not for 2-DMU) | electrically isolated from:<br>• The backplane bus interface | electrically isolated from:<br>• the CPU<br>• The load voltage (not for 2-DMU) |
| maximum potential difference between inputs (ICM) | 50 V DC | 60 V DC | 11 V DC | 2.0 V DC | ≤ DC 2.3 V |
| Special features | - | - | - | Motor protection with PTC and<br>silicone temperature sensors | - |
| Z sign<br>2-DMU = 2-wire transducer | | | | | |

Table 6- 2 Analog input modules (continued)

| Properties | Module | | | | |
|---|---|---|---|---|---|
| | **SM 331; AI 2 x 12 Bit** | **SM 331; AI 6 x TC** | **SM 331; AI 8 x TC** | **SM 331; AI 8 x RTD** | **SM 331; AI 8 x 0/4...20 mA HART** |
| | **(-7KB02-)** | **(-7PE10-)** | **(-7PF11-)** | **(-7PF01-)** | **(-7TF00-)*** |
| Number of inputs | 2 inputs in 1 channel group | 6 inputs in 1 channel group | 8 inputs in 4 channel groups | 8 inputs in 4 channel groups | 8 inputs in 1 channel group |
| Resolution | programmable for each channel group:<br>• 9 bits+sign<br>• 12 bits+sign<br>• 14 bits+sign | Programmable for each channel group:<br>• 15 bits+sign | Programmable for each channel group:<br>• 15 bits+sign | Programmable for each channel group:<br>• 15 bits+sign | programmable for each channel group:<br>15 bits+sign |
| Measurement type | programmable for each channel group:<br>• Voltage<br>• Current<br>• Resistance<br>• Temperature | Programmable for each channel group:<br>• Voltage<br>• Temperature | programmable for each channel group:<br>• Temperature | programmable for each channel group:<br>• Resistance<br>• Temperature | Programmable for each channel group:<br>• Current |



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| Properties | Module | | | | |
|---|---|---|---|---|---|
| Measuring range selection | any, per channel group | any, per channel group | any, per channel group | any, per channel group | any, per channel group |
| Supports isochronous mode | Yes | No | Yes | Yes | Yes |
| Programmable diagnostics | No | Yes | No | No | no |
| Diagnostic interrupt | programmable | Programmable | Programmable | Programmable | Programmable |
| Limit value monitoring | programmable for 1 channel | Programmable for 6 channels | programmable for 8 channels | programmable for 8 channels | programmable for 8 channels |
| Hardware interrupt when limit exceeded | Programmable | Programmable | Programmable | Programmable | programmable |
| Hardware interrupt at end of cycle | no | No | Programmable | Programmable | No |
| Potential ratios | electrically isolated from:<br>• the CPU<br>• The load voltage (not for 2-DMU) | electrically isolated from:<br>• the CPU | electrically isolated from:<br>• of the CPU | electrically isolated from:<br>• the CPU | electrically isolated from:<br>• the CPU<br>• The load voltage (not for 2-DMU) |
| maximum potential difference between inputs (ICM) | ≤ DC 2.3 V | 250 V AC | - | - | - |
| Special features | - | Calibration | - | - | - |
| Z sign<br>2-DMU = 2-wire transducer | | | | | |

* This module is described in the Distributed I/O Device ET 200M HART Analog Modules manual. You can find the manual on the Internet (http://support.automation.siemens.com/WW/view/en/22063748).



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## 6.2.2 Analog output modules

### Overview of properties

The table below shows the analog output modules based on their essential properties

Table 6- 3 Analog output modules: Overview of properties

| Properties | Modules | | | | |
|---|---|---|---|---|---|
| | **SM 332; AO 8 x 12 Bit** | **SM 332; AO 4 x 16 Bit** | **SM 332; AO 4 x 12 Bit** | **SM 332; AO 2 x 12 Bit** | **SM 332; AO 8 x 0/4...20mA HART** |
| | **(-5HF00-)** | **(-7ND02-)** | **(-5HD01-)** | **(-5HB01-)** | **(-8TF00-) *** |
| Number of outputs | 8 output channels | 4 outputs in 4 channel groups | 4 output channels | 2 output channels | 8 output channels |
| Resolution | 12 bits | 16 bits | 12 bits | 12 bits | 15 bits (0 mA to 20mA)<br>15 bits +sign (4 mA to 20mA) |
| Output type | per channel:<br>• Voltage<br>• Current | per channel:<br>• Voltage<br>• Current | per channel:<br>• Voltage<br>• Current | per channel:<br>• Voltage<br>• Current | per channel:<br>• Voltage<br>• Current |
| Supports isochronous mode | no | yes | no | no | no |
| Programmable diagnostics | yes | yes | yes | yes | yes |
| Diagnostic interrupt | programmable | programmable | programmable | programmable | programmable |
| Substitute value output | no | programmable | programmable | programmable | programmable |
| Potential ratios | electrical isolation between:<br>• the backplane bus connection<br>• load voltage | electrical isolation between:<br>• backplane bus interface and channel<br>• channels<br>• output and L+, M<br>• CPU and L+, M | electrically isolated from:<br>• the backplane bus interface<br>• load voltage | electrically isolated from:<br>• the backplane bus interface<br>• load voltage | electrically isolated from:<br>• the backplane bus interface<br>• load voltage |
| Special features | - | - | - | - | - |
| +sign = plus sign | | | | | |

* This module is described in the Distributed I/O Device ET 200M HART Analog Modules manual. You can find the manual on the Internet (http://support.automation.siemens.com/WW/view/en/22063748).



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## 6.2.3 Analog I/O modules

### Overview of properties

The table below shows the analog IO modules based on their essential properties

Table 6- 4 Analog IO modules: Overview of properties

| Properties | Modules | |
|---|---|---|
| | SM 334; AI 4/AO 2 x 8/8 Bit (-0CE01-) | SM 334; AI 4/AO 2 x 12 Bit (-0KE00-) |
| Number of inputs | 4 inputs in 1 channel group | 4 inputs in 2 channel groups |
| Number of outputs | 2 outputs in 1 channel group | 2 outputs in 1 channel group |
| Resolution | 8 bits | 12 bits + sign |
| Measurement type | programmable for each channel group:<br>• Voltage<br>• Current | programmable for each channel group:<br>• Voltage<br>• Resistance<br>• Temperature |
| Output type | per channel:<br>• Voltage<br>• Current | per channel:<br>• Voltage |
| Supports isochronous mode | no | no |
| Programmable diagnostics | no | no |
| Diagnostic interrupt | no | no |
| Limit value monitoring | no | no |
| Hardware interrupt when limit is exceeded | no | no |
| Hardware interrupt at end of cycle | no | no |
| Substitute value output | no | no |
| Potential ratios | • connected to potential of the backplane bus interface<br>• electrically isolated to load voltage | electrically isolated to:<br>• backplane bus interface<br>• load voltage |
| Special features | Not programmable, measurement and output type defined by hardwiring | - |



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# 6.3 Analog input module SM 331; AI 8 x 16 bit; (6ES7331-7NF00-0AB0)

## Order number

6ES7331-7NF00-0AB0

## Properties

- 8 inputs in 4 channel groups
- Programmable measurement type at each channel group
  - Voltage
  - Current
- Programmable resolution for each channel group (15 bits + sign)
- Any measuring range per channel group
- Programmable diagnostics and diagnostic interrupt
- Programmable limit value monitoring for 2 channels
- Programmable hardware interrupt when limit is exceeded
- High-speed update of measured values
- Electrically isolated to the CPU
- Supports parameter reassignment in RUN

## Resolution

The resolution of measured values is independent of the selected integration time.

## Diagnostics

For information on diagnostic messages at the "group diagnostics" parameter, refer to the table *Diagnostic messages of analog input modules*.

## Hardware interrupts

Hardware interrupts for channel groups 0 and 1 can be programmed in *STEP 7*. However, set a hardware interrupt only for the first channel of a channel group, that is, either at channel 0, or at channel 2



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## High-speed update of measured values

A high-speed update of measured values at two channels of a channel group is three times compared to the activation of several channel groups.

Example: When channels 0 and 1 are active with 2.5 ms filtering, both channels return new measured values to the PLC at intervals of 10 ms. (with other settings, the refresh rate is equivalent to the filter setting.)

High-speed update of measured values is only possible if both channels of channel group 0 and 1 are active, that is, the "measuring type" parameter is set. However, only one of the two channel groups 0 or 1 may be active (not concurrently active.)

## Terminal assignment

The diagrams below show various wiring options



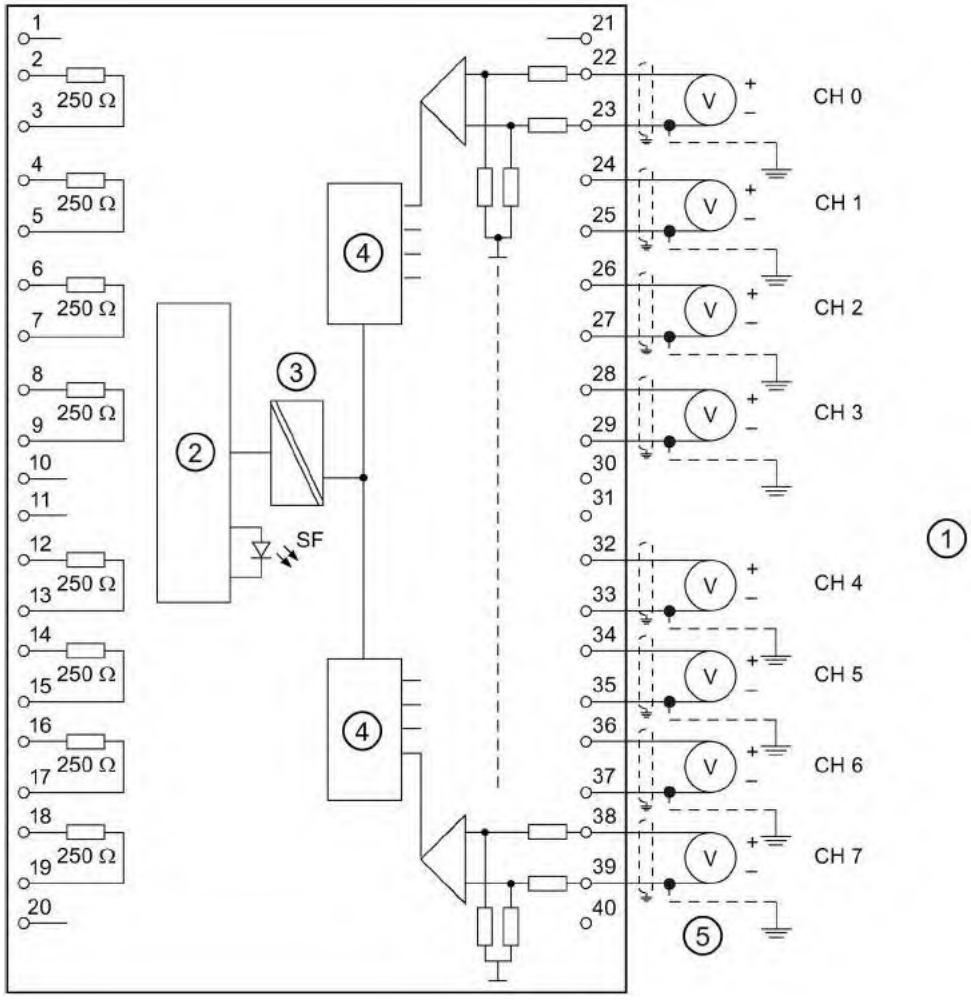
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## Wiring: Voltage and current measurement

Wire the voltage inputs of the channel voltage in parallel using the corresponding shunt resistor when measuring current. Bridge the channel input terminals with the adjacent connector terminals.

Example: You configure channel 0 for current measurement by bridging terminals 22 and 2, and terminals 23 to 3.

At the channel configured for current measurements, connect the shunt resistor to the adjacent channel terminals in order to achieve the specified precision.



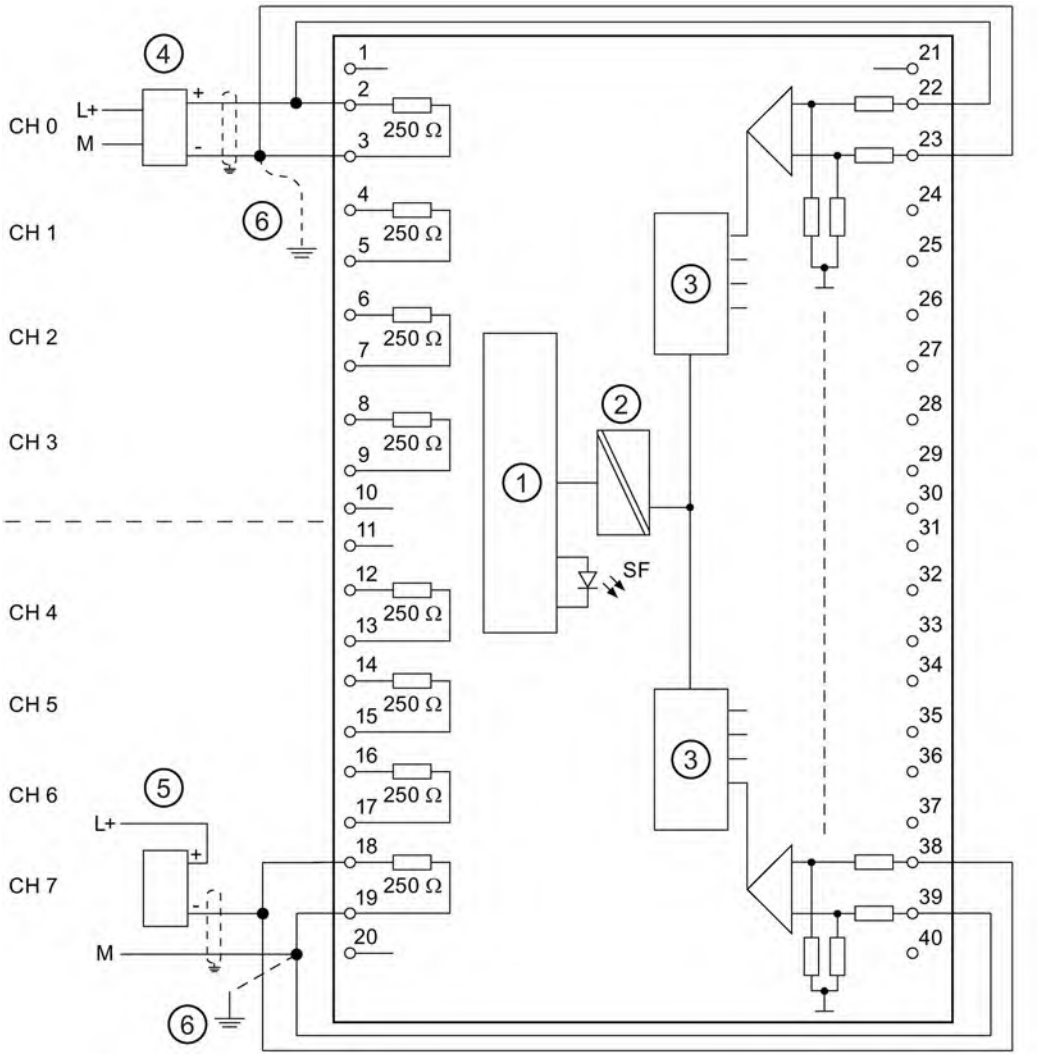

① Voltage measurement
② Backplane bus interface
③ Electrical isolation
④ Analog-to-Digital Converter (ADC)
⑤ Equipotential bonding

Figure 6-1 Wiring and block diagram



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## Wiring: 2-wire and 4-wire transducers




① Backplane bus interface
② Electrical isolation
③ Analog-to-Digital Converter (ADC)
④ Channel 0 for 4-wire transducer
⑤ Channel 7 for 2-wire transducer (with external supply)
⑥ Equipotential bonding

Figure 6-2 Wiring and block diagram



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## Technical specifications

| **Technical specifications** | | | | |
|---|---|---|---|---|
| **Dimensions and weight** | | | | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 | | | |
| Weight | ca. 272 g | | | |
| **Module-specific data** | | | | |
| Supports parameter reassignment in RUN | Yes | | | |
| Response of non-configured inputs | Return the process value which was valid before configuration | | | |
| Supports isochronous mode | no | | | |
| Number of inputs | 8 | | | |
| Cable length<br>• shielded | max. 200 m | | | |
| **Voltages, currents, electrical potentials** | | | | |
| Electrical isolation<br>• between channels and the backplane bus | yes | | | |
| Maximum potential difference<br>• between inputs (CMV) | 35 V AC / 50 V DC, | | | |
| Isolation test voltage | 500 V DC | | | |
| Current consumption<br>• from the backplane bus | max. 130 mA | | | |
| Power loss of the module | typ. 0.6 W | | | |
| **Generation of analog values** | | | | |
| Measuring principle | Integrating | | | |
| Integration/conversion time/resolution (per channel) | | | | |
| • programmable | yes | | | |
| • Integration time in ms | 10 | 16.7 | 20 | 100 |
| • Basic conversion time for each group with more than one active channel | 35 | 55 | 65 | 305 |
| • Channel conversion time for each group, only with active channel group 0 or 1 | 10 | 16.7 | 20 | 100 |
| Channel integration time (1/f1) in ms | 10 | 16.7 | 20 | 100 |
| • Resolution (including overshoot range) | 15 bits + sign | | | |
| • Interference frequency suppression at interference frequency f1 in Hz | 100 | 60 | 50 | 10 |
| Basic execution time of the module in ms (all channels enabled) | 140 | 220 | 260 | 1220 |



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| | | |
|---|---|---|
| **Technical specifications** | | |
| **Interference frequency suppression and error limits** | | |
| Interference frequency suppression at f = n (f1 1%), (f1 = interference frequency); n= 1, 2, ... | | |
| • Common mode interference (CMV < 50 V)<br>• Series mode interference (peak value of interference < rated input range) | > 100 dB<br>> 90 dB | |
| Crosstalk between inputs | > 100 dB | |
| Operational limit (across entire temperature range, relative to measurement range end value in the selected input range) | $C_{MV}$ = 0 / CMV = ±50 V | |
| • Voltage input<br>• Current input | ±0.1% / ± 0.7%<br>±0.3% / ± 0.9% | |
| Basic error limit (operational limit at 25 °C, relative to measurement range end value in the selected input range) | | |
| • Voltage input<br>• Current input | ±0.05%<br>±0.05% | |
| Temperature error (relative to input range) | ± 0.005%/K | |
| Linearity error (relative to input range) | ±0.03% | |
| Repeat accuracy (in transient state at 25 °C, relative to input range) | ±0.025% | |
| **Status, interrupts, diagnostics** | | |
| Interrupts<br>• Limit interrupt<br>• Diagnostic interrupt | <br>programmable<br>Channels 0 and 2<br>programmable | |
| Diagnostic functions<br>• Group error display<br>• Reading diagnostic information | programmable<br>red LED (SF)<br>supported | |
| **Encoder selection data** | | |
| Input ranges (rated values) / input impedance | | |
| • Voltage | ± 5 V<br>1 V to 5 V<br>± 10 V | / 2 MΩ<br>/ 2 MΩ<br>/ 2 MΩ |
| • Current | 0 mA to 20 mA<br>± 20 mA<br>4 mA to 20 mA | / 250 Ω<br>/ 250 Ω<br>/ 250 Ω |
| Maximum voltage at voltage input (destruction limit) | max. 50 V, continuous | |
| Maximum current at current input (destruction limit) | max. 32 mA | |
| Wiring of the signal transmitters | using a 40pin front connector | |
| • for voltage measurement<br>• for current measurement<br>– as 2-wire transducer<br>– as 4-wire transducer | supported<br><br>possible, with separate transducer supply<br>supported | |



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### Parameter reassignment in RUN

If you reassign parameters in RUN, the following special characteristic applies.

SF LED is lit:

If a diagnostics was pending prior to reconfiguration, the SF LEDs (on CPU, IM or module) may be lit even though diagnostics are no longer pending and the module is operating correctly.

Solution:

- Only assign new parameters if no diagnostics is pending, or
- unplug module and plug it in again.

## 6.3.1 Measurement types and ranges

### Introduction

The measurement type and range is configured at the "measuring range" parameter in *STEP 7*.

The default setting of the module is "voltage" measurement with "± 10V" range. You can use these default settings without having to program the SM 331; AI 8 x 16 Bit in *STEP 7*.

### Measurement types and ranges

Table 6- 5 Measurement types and ranges

| Selected type of measurement | Measuring range |
|---|---|
| Voltage V: | ± 5 V<br>1 V to 5 V<br>± 10 V |
| Current | 0 mA to 20 mA<br>± 20 mA<br>4 mA to 20 mA |



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## 6.3.2 Programmable parameters

### Introduction

For information on programming analog modules, refer to the chapter Programming analog modules (Page 294).

### Parameters

Table 6- 6 Overview of the parameters of SM 331; AI 8 x 16 Bit

| Parameters | Range of values | Default | Parameter type | Scope |
|---|---|---|---|---|
| Enable<br>• Diagnostic interrupt<br>• Hardware interrupt when limit exceeded | <br>yes/no<br>yes/no | <br>no<br>no | dynamic | Module |
| Hardware interrupt trigger<br>• High limit<br>• Low limit | May be restricted by the measuring range.<br>from 32511 to - 32512<br>from - 32512 to 32511 | - | dynamic | Channel |
| Diagnostics<br>• Group diagnostics<br>• with line continuity check | <br>yes/no<br>yes/no | <br>no<br>no | static | Channel group |
| Measurement<br>• Measurement type | <br>disabled<br>Voltage V:<br>4DMU current (4-wire transducer) | V | dynamic | Channel group |
| • Measuring range | See the table *Measurement types and ranges* | ± 10 V | | |
| • Noise suppression | 100 Hz; 60 Hz; 50 Hz; 10 Hz | 50 Hz | | |

### Channel groups

The channels of SM 331; AI 8 x 16 Bit are arranged in four groups of two channels. You can assign parameters only to one channel group.



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The table below shows the relevant configuration of channel groups. The channel group number is required to program SFC parameters in the user program.

Table 6- 7 Assignment of SM 331; AI 8 x 16 Bit channels to channel groups

| Channels ... | ... form one channel group each |
|---|---|
| Channel 0 | Channel group 0 |
| Channel 1 | |
| Channel 2 | Channel group 1 |
| Channel 3 | |
| Channel 4 | Channel group 2 |
| Channel 5 | |
| Channel 6 | Channel group 3 |
| Channel 7 | |

### See also

Diagnostics messages of analog input modules (Page 296)

## 6.3.3 Additional information on SM 331; AI 8 x 16 Bit

### Unused channels

Set the "disabled" value at the "measuring type" parameter for unused channels. This setting reduces module cycle times.

As certain programmed inputs may remain unused due to the channel group configuration, make allowances for the special features of those inputs outlined below in order to be able to use the diagnostic functions at these used channels:

- **Measuring range 1 V to 5 V:** wire the used input and unused input of the same channel group in parallel.
- **Current measurement, 4 mA to 20 mA:** wire the used input and unused input of the same channel group in series. Connect a shunt resistor to each programmed and unused channel.
- **Other measuring ranges:**Short-circuit the plus and minus inputs of the channel.



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## Line continuity check

The line continuity check is available for the 1 V to 5 V and 4 mA to 20 mA ranges.

Rule for both measuring ranges:

When the line continuity check is **enabled**, the module logs the wire-break to diagnostics data when the current drops below 3.6 mA (0.9 V.)

The module also triggers a diagnostic interrupt if this function is enabled in the program.

A wire break can only be signaled by means of the lit SF LED and the diagnostic bytes must be evaluated in the user program if diagnostic interrupts are disabled.

When line continuity check is **disabled** and diagnostic interrupts are enabled, the module triggers a diagnostic interrupt when underflow is detected.

## Special features in programming high and low limits

The programmable limits (hardware interrupt triggers) of SM 331; AI 8 x 16 Bit differ from the range of value shown in the *Overview of parameters of SM 331; AI 8 x 16 Bit.* table.

Reason: The calculation methods deployed in the module software to evaluate the process variables do not allow the reporting of values up to 32511 in certain situations. The process value triggering a hardware interrupt at underflow or overflow limits is based on the calibration factors of the relevant channel, and may vary between the low limits shown in the table below and the value 32511 ($7EFF_H$).

You may not define any limits which exceed the minimum limits specified in the table below.

Table 6- 8 Minimum high and low limits of SM 331; AI 8 x 16 Bit

| Measuring range | Minimum high limit | Minimum low limit |
|---|---|---|
| ± 10 V | 11.368 V<br>31430<br>$7AC6_H$ | -11.369 V<br>-31433<br>$8537_H$ |
| ± 5 V | 5.684 V<br>31430<br>$7AC6_H$ | -5.684 V<br>-31430<br>$853A_H$ |
| 1 V to 5 V | 5.684 V<br>32376<br>$7E78_H$ | 0.296 V<br>-4864<br>$ED00_H$ |
| 0 mA to 20 mA | 22.737 mA<br>31432<br>$7AC8_H$ | -3.519 mA<br>-4864<br>$ED00_H$ |
| 4 mA to 20 mA | 22.737 mA<br>32378<br>$7E7A_H$ | 1.185 mA<br>-4864<br>$ED00_H$ |
| ± 20 mA | 22.737 mA<br>31432<br>$7AC8_H$ | -22.737 mA<br>-31432<br>$8538_H$ |



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## Measuring errors as a result of CMV

SM 331; AI 8 x 16 Bit is capable of taking measurements, irrespective of the presence of any CMV in the AC or DC range.

With **AC CMV** values of a multiple of filter frequency settings, noise is suppressed as a result of ADC integration time and common mode suppression at the input amplifiers. With AC CMV < 35 $V_{RMS}$, the noise suppression of > 100 dB results in negligible measurement errors.

The influence of **DC CMV** can only be reduced to minimum using the noise suppression function of the input amplifier unit. A certain degradation of measuring accuracy in proportion to CMV must be expected. The worst case error is generated at 50 VDC between one channel and the remaining seven channels. The calculated worst case error is 0.7% at 0 °C to 60 °C, while the measured error usually lies at ≤ 0.1% at 25 °C.



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# 6.4 Analog input module SM 331; AI 8 x 16 Bit; (6ES7331-7NF10-0AB0)

## Order number

6ES7331-7NF10-0AB0

## Properties

- 8 inputs in 4 channel groups
- Programmable measurement type at each channel group
  - Voltage
  - Current
- Programmable resolution for each channel group (15 bits + sign)
- Any measuring range selection per channel group
- Programmable diagnostics and diagnostic interrupt
- Programmable limit value monitoring for 8 channels
- Programmable hardware interrupt when limit is exceeded
- Programmable hardware interrupt at end of cycle
- High-speed update of measured values at up to 4 channels
- Electrical isolation to the CPU
- Supports parameter reassignment in RUN

## Diagnostics

For information on diagnostic messages at the "group diagnostics" parameter, refer to the table *Diagnostic messages of analog input modules*.

## Terminal assignment

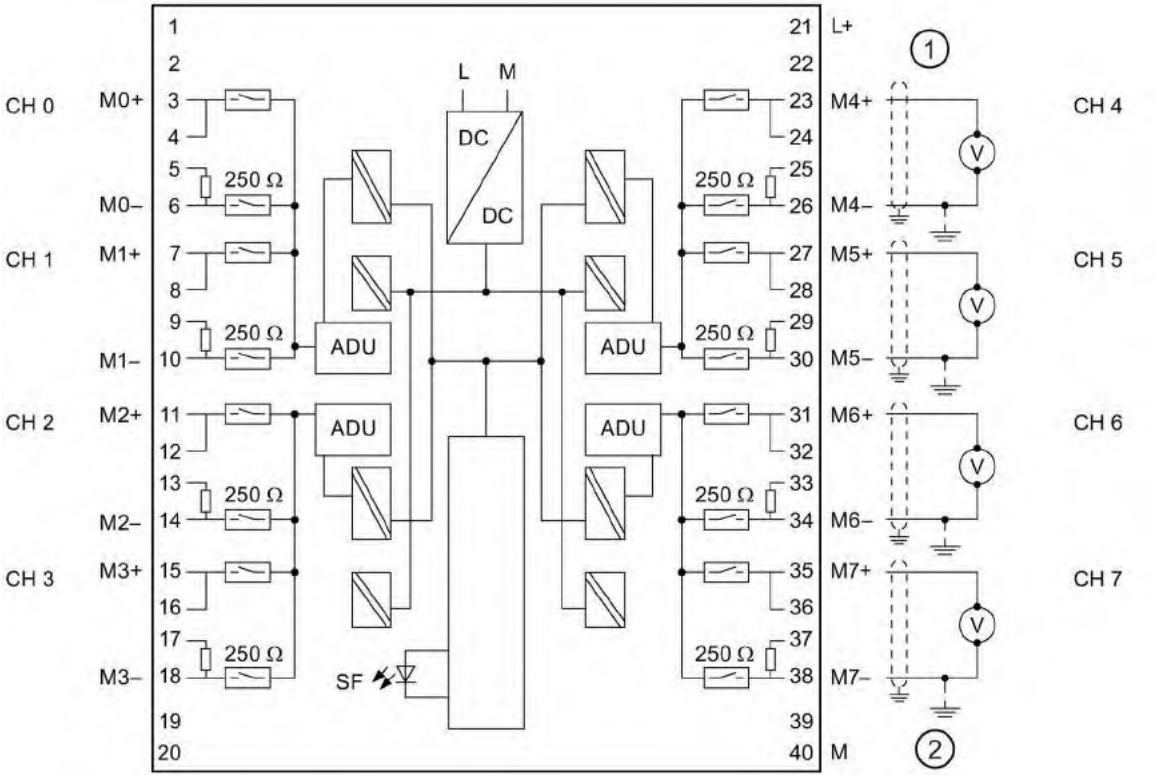
The diagrams below show various wiring options



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## Wiring: Voltage and current measurement

Connection possible at both sides to channels 0 to 7




① Connection for voltage measurement
② Equipotential bonding

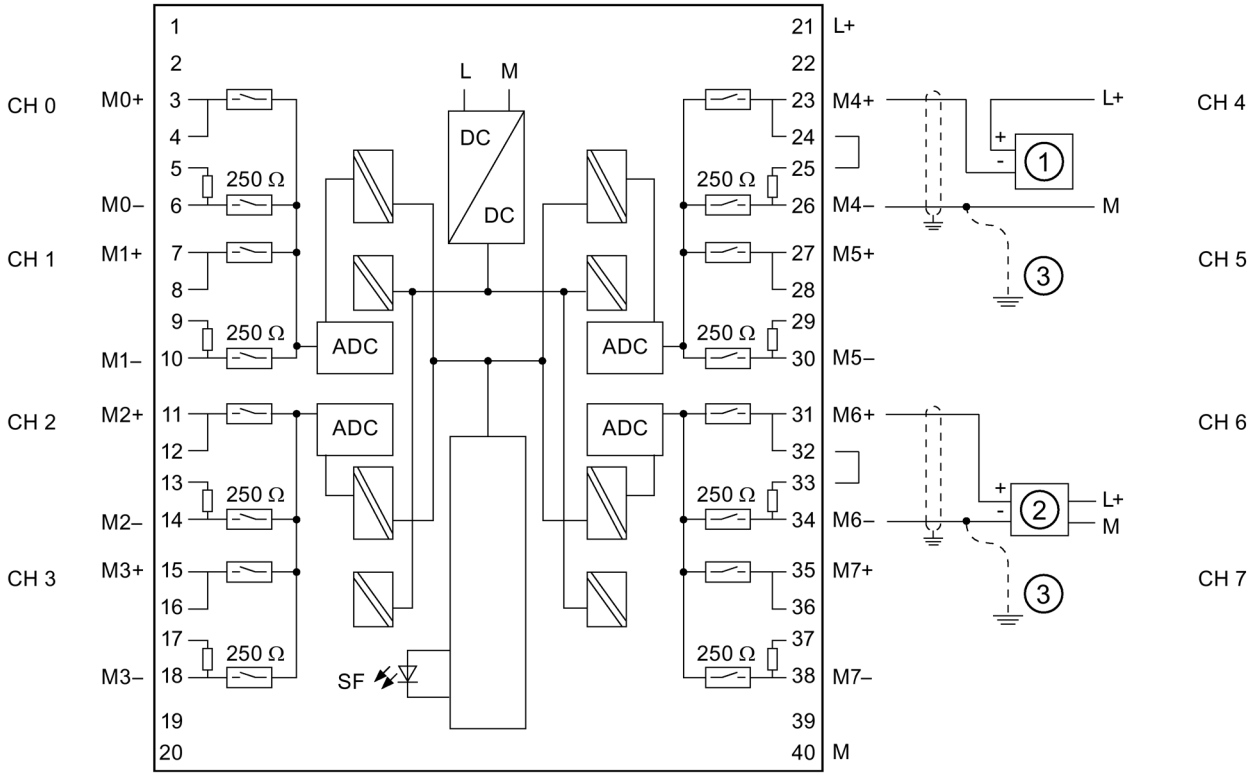
Figure 6-3 Wiring and block diagram



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## Wiring: 2-wire and 4-wire transducer

Connection possible at both sides to channels 0 to 7




① 2-wire transducer
② 4-wire transducer
③ Equipotential bonding

Figure 6-4 Wiring and block diagram

## Technical specifications

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 272 g |
| **Module-specific data** | |
| Supports parameter reassignment in RUN | Yes |
| Response of non-programmed inputs | Return the process value which was valid before configuration |
| Supports isochronous mode | no |
| Number of inputs | 8 |
| Cable length<br>• shielded | <br>max. 200 m |



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| **Technical specifications** | |
|---|---|
| **Voltages, currents, electrical potentials** | |
| Rated electronics supply voltage L + | 24 V DC |
| • Reverse polarity protection | yes |
| Electrical isolation | |
| • between channels and the backplane bus<br>• between channels and electronics power supply<br>• between channels<br>in groups of | yes<br>yes<br>yes<br>2 |
| Isolation test voltage | 500 V AC |
| Current consumption | |
| • from the backplane bus<br>• from supply voltage L+ | max. 100 mA<br>max. 200 mA |
| Power loss of the module | typ. 3.0 W |
| **Generation of analog values** | |
| Measuring principle | Integrating |
| Integration/conversion time/resolution (per channel) | |
| • programmable<br>• Basic conversion time in ms (8-channel mode)<br>• Basic conversion time in ms (4-channel mode)<br>• Resolution, including sign<br>• Interference frequency suppression at frequency f1 in Hz | yes<br>95/83/72/23<br>10[1) 4)]<br>16 bits<br>All[2)]/50/60/400 |
| Measured value smoothing | None / low/ average/ high |
| Basic execution time of the module, in ms (8-channel-mode) | 190/166/144//46 |
| Basic execution time of the module, in ms (4-channel-mode) | 10[1)] |
| **Interference frequency suppression, error limits** | |
| Interference frequency suppression at F = n x (f1 1%)(f1 = interference frequency, n = 1, 2, ...) | |
| • Common mode interference (VCM < AC 60 V)<br>• Series mode interference (peak value of disturbance < rated input range) | > 100 dB<br>> 90 dB [3)] |
| Crosstalk between inputs | > 100 dB |
| Operational limit (across entire temperature range, relative to the measurement range end value in the selected input range) | |
| • Input voltage<br>• Input current | ±0.1%<br>±0.1% |
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected input range) | |
| • Voltage input<br>• Current input | ±0.05%<br>±0.05% |
| Temperature error (relative to input range) | ± 0.005%/K |
| Linearity error (relative to input range) | ±0.01% |
| Repeat accuracy (in settled state at 25 °C, relative to measurement range end value in the input range) | ±0.01% |



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| **Technical specifications** | |
|---|---|
| **Status, interrupts, diagnostics** | |
| Interrupts | |
| • Hardware interrupt when limit value is exceeded<br>• Hardware interrupt at end of cycle<br>• Diagnostic interrupt | Programmable channels 0 to 7<br>programmable<br>programmable |
| Diagnostic functions | programmable |
| • Group error display<br>• Reading diagnostic information | red LED (SF)<br>supported |
| **Encoder selection data** | |
| Input range (rated values) / input impedance | |
| • Voltage | ± 5 V / 2 MΩ<br>1 V to 5 V / 2 MΩ<br>± 10 V / 2 MΩ |
| • Current | 0 mA to 20 mA / 250 Ω<br>4 mA to 20 mA / 250 Ω<br>± 20 mA / 250 Ω |
| Maximum voltage at voltage input (destruction limit) | 35 V continuous; 75 V for max. duration of 1 s (duty factor 1:20) |
| Maximum current at current input (destruction limit) | 40 mA |
| Wiring of the signal transmitters | using a 40pin front connector |
| • for voltage measurement<br>• for current measurement<br>as 2-wire transducer<br><br>as 4-wire transducer | supported<br><br>possible, with separate transducer supply<br>supported |
| [1] Interference frequency for 4-channel mode is "All"<br>[2] Interference frequencies 50/60/400 Hz are designated as "All"<br>[3] The series mode rejection in 8-channel mode is reduced as follows:<br>50 Hz > 70 db<br>60 Hz > 70 db<br>400 Hz > 80 dB<br>50/60/400 Hz > 90 dB<br>[4] In 4-channel mode, the converted value settles to 100% within 80 ms. The value determined in this process is returned at intervals of max. 10 ms. | |



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### Reassigning parameters in RUN

If you reassign parameters in RUN, the following special characteristic applies.

SF LED is lit:

If a diagnostics was pending prior to reconfiguration, the SF LEDs (on CPU, IM or module) may be lit even though diagnostics is no longer pending and the module is operating correctly.

Solution:

- Only assign new parameters if no diagnostics is pending, or
- unplug module and plug it in again.

## 6.4.1 Measurement types and measuring ranges

### Introduction

The measurement type and range is configured at the "measuring type" parameter in *STEP 7*.

Table 6- 9 Measurement types and ranges

| Selected type of measurement | Output range |
|---|---|
| Voltage V: | ± 5 V, from 1 V to 5 V, ± 10 V |
| Current (4-wire transducer)<br>4DMU | 0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA |

### Channel groups

The channels of SM 331; AI 8 x 16 bits are arranged in four groups of two channels. You always assign parameters to a group. The interrupt limits form the exception.

The table below shows the relevant configuration of channel groups. The channel group number is required to program SFC parameters in the user program.

Table 6- 10 Assignment of SM 331; AI 8 x 16 Bit channels to channel groups

| Channels ... | ...form one channel group each |
|---|---|
| Channel 0 | Channel group 0 |
| Channel 1 | |
| Channel 2 | Channel group 1 |
| Channel 3 | |
| Channel 4 | Channel group 2 |
| Channel 5 | |
| Channel 6 | Channel group 3 |
| Channel 7 | |



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## 6.4.2 Programmable parameters

### Introduction

For information on programming analog modules, refer to the chapter Programming analog modules (Page 294).

### Parameter

Table 6- 11 Overview of parameters of SM 331; AI 8 x 16 Bit

| Parameters | Range of values | Defaults | Parameter type | Scope |
|---|---|---|---|---|
| Enable | | | | |
| • Process interrupt when limit value is exceeded | yes/no | no | dynamic | Module |
| • Process interrupt at end of cycle | yes/no | no | dynamic | |
| • Diagnostics interrupt | yes/no | no | dynamic | |
| Process interrupt trigger | | | | |
| • High limit | 32511 to -32512 | - | dynamic | Channel |
| • Low limit | -32512 to 32511 | - | dynamic | Channel |
| Diagnostics | | | | |
| • Group diagnostics | yes/no | no | static | Channel |
| • Line continuity check | yes/no | no | | Channel |
| Measurement | | | | |
| • Module operating mode | • 8 channels<br>• 4 channels | yes<br>no | dynamic | Module<br>Channel group |
| • Noise suppression | 50 Hz<br>60 Hz<br>400 Hz<br>50/60/400 Hz | 50/60/400 Hz | | |
| • Smoothing | • none<br>• weak<br>• medium<br>• strong | none | dynamic | Channel group |
| • Measurement type | • Measuring range: | | dynamic | Channel group |
| disabled | | | | |
| Voltage | • ± 5 V<br>• 1 V to 5 V<br>• ± 10 V | ± 10 V | | |
| Current (4-wire transducer) | • 0 mA to 20 mA<br>• 4 mA to 20 mA<br>• ± 20 mA | 4 mA to 20 mA | | |

### See also

Diagnostics messages of analog input modules (Page 296)
Programming analog modules (Page 294)



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## 6.4.3 Additional information for SM 331; AI 8 x 16 Bit

### Modes of operation

Operating modes of SM 331; AI 8 x 16 Bit:

- 8-channel mode
- 4-channel mode

### 8-channel operating mode

In this mode, the module changes between the two channels of each group. Since the module contains four analog/digital converters (ADC), all four ADCs convert simultaneously for channels 0, 2, 4 and 6. After converting the channels with the even numbers, all ADCs simultaneously convert for the channels with the odd numbers 1, 3, 5 and 7 (see the figure below).

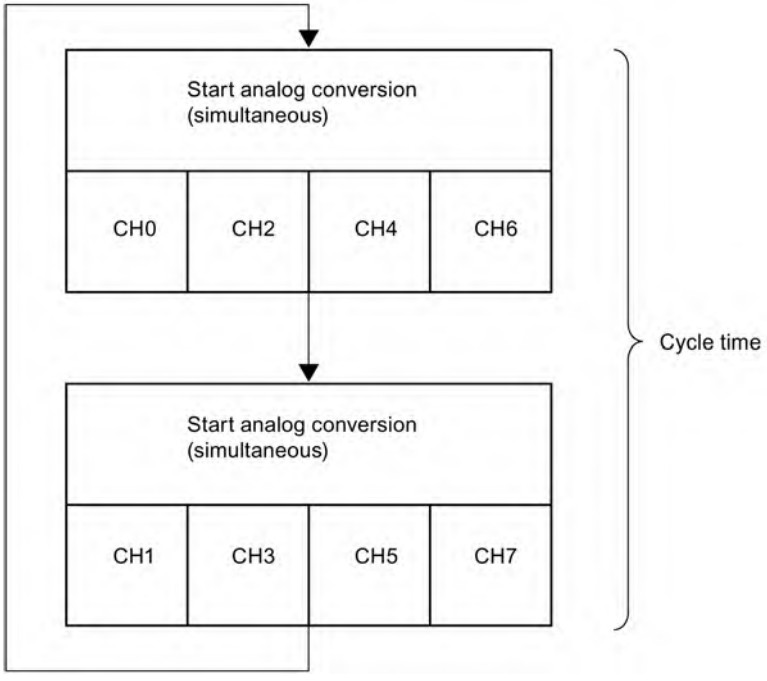



Figure 6-5 8-channel mode cycle time



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## Cycle time of module in 8-channel mode

The channel conversion time is based on the programmed noise suppression. The channel conversion time is 76 ms, including communication time, at a set interference frequency of 50 Hz. The channel conversion time is 65 ms when you set an interference frequency of 60 Hz. You can reduce channel conversion times to 16 ms by setting an interference frequency of 400 Hz. When you set 50, 60 and 400 Hz , the channel conversion time amounts to 88 ms. The module then has to switch to a different channel of the group by means of the OptoMOS relay. Opto-MOS relays require 7 ms for switching and settling. The following table shows this relationship.

Table 6- 12 Cycle times in 8-channel mode

| Interference frequency (Hz) | Channel cycle time (ms) | Module cycle time (all channels) |
|---|---|---|
| 50 | 83 | 166 |
| 60 | 72 | 144 |
| 400 | 23 | 46 |
| 50/60/400 | 95 | 190 |

## 4-channel operating mode

In this mode, the module does not change between the channels of the groups. The four ADCs of the module simultaneously convert the channels 0, 2, 4 and 6.

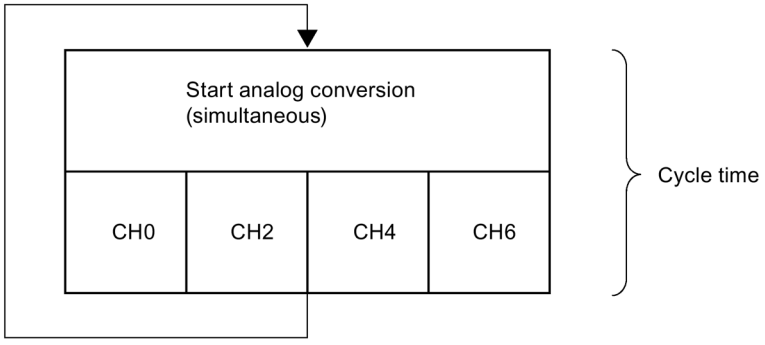



Figure 6-6 4-channel mode cycle time

## Module cycle time

The converted value settles to 100% within 80 ms and is updated every 10 ms when 4-channel mode is set. The channel and module cycle times are always identical, because the module does not change between the channels of a group: 10 ms.

Channel conversion time = channel cycle time = module cycle time = 10 ms



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## Unused channels

Set the "disabled" value at the "measuring method" parameter for unused channels. This setting reduces module cycle times.

As certain programmed inputs may remain unused due to the channel group configuration in 8-channel mode, make allowances for the special features of these inputs outlined below to activate the diagnostics functions at the channels being used:

- **Measuring range 1 V to 5 V:** wire the used input and unused input of the same channel group in parallel.
- **Current measurement, 4 to 20 mA:** Connect unused input in series to the input of the same channel group. A shunt resistor must be connected for each programmed and unused channel.
- **Other measuring ranges:** Short-circuit the plus and minus inputs of the channel.

## Line continuity check

The wire break test is available for the voltage measuring range 1 to 5 V and the current measuring range 4 to 20 mA.

When there is a configured measuring range of 1 to 5 V or 4 to 20 mA and the wire break test is **activated**, the analog input module reports a wire break in the diagnostics when underflow (-32768) is reached.

- The module also triggers a diagnostic interrupt if this function is enabled in the program.
- A wire break can only be signaled by means of the lit SF LED and the diagnostic bytes must be evaluated in the user program if diagnostic interrupts are disabled.

Under the following circumstances, wire-break detection can take up to 2 s:

- If a wire break occurs during voltage measurement.
- If a wire break occurs on the front-connector jumpers from shunt (250 Ω) to the inputs during current measurement.

The measured value can go through the entire valid value range during the wire break detection.

When there are configured measuring ranges ± 10 V, ± 5 V, 1 to 5 V or 4 to 20 mA, the wire break test is **not activated** and a diagnostic interrupt is enabled, the module triggers a diagnostic interrupt when the underflow is reached. The module detect the underflow when the input signal is below 0.296 V or 1.185 mA.

## Overflow, underflow and hardware interrupt limits

The limits in diagnostics response to overflow and underflow in certain measuring ranges differ compared to the listed ranges starting at the chapter*Analog value representation for analog input channels* of the manual. In certain situations the numerical methods of the module software used to evaluate the process variables do not return values up to 32511.

Do not set any hardware interrupt limits higher than the lowest possible overflow or underflow response limits. End of cycle interrupt starting at the chapter *Analog value representation for analog input channels*.



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## End of cycle interrupt

You can synchronize a process with the conversion cycle of the module by enabling the end of cycle interrupt. The interrupt is set when enabled channels have been converted.

The table below shows the contents of the 4 bytes of additional OB40 information during process or end of cycle interrupts.

| Content of the 4 bytes of additional information | | 27 | 26 | 25 | 24 | 23 | $2^2$ | $2^1$ | $2^0$ | Byte |
|---|---|---|---|---|---|---|---|---|---|---|
| Special analog flags | 2 bits per channel to identify the range | | | | | | | | | |
| | High limit exceeded at channel | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 0 |
| | Low limit exceeded at channel | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 |
| | End of cycle event | | | | | | X | | | 2 |
| | Free bit | | | | | | | | | 3 |

## Operation of the module on the ET 200M Distributed IO devices

Operation of SM 331; AI 8 x 16 Bit on ET 200M requires one of the following IM 153 x:

- IM 153-1; as of 6ES7153-1AA03-0XB0, E 01
- IM 153-2; as of 6ES7153-2AA02-0XB0; E 05
- IM 153-2; as of 6ES7153-2AB01-0XB0; E 04

## Programming restrictions when operating SM 331; AI 8 x 16 Bit on PROFIBUS masters which only support DPV0

Certain parameters are not supported when operating an electrically isolated SM 331; AI 8 16 Bit analog input module on an ET200M PROFIBUS slave system in combination with a PROFIBUS master which is not an S7 master. Non-S7 masters do not support hardware interrupts. All parameters associated with these functions are disabled for this reason. This includes hardware interrupt enable, hardware restrictions and end the enabling of cycle interrupts. All other parameters are allowed.



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# 6.5 Analog input module SM 331; AI 8 x 14 Bit High Speed; isochrone; (6ES7331-7HF0x-0AB0)

## Order number

6ES7331-7HF00-0AB0 or 6ES7331-7HF01-0AB0

## Properties

- 8 inputs in 4 channel groups
- Measurement type programmable for each channel group:
  - Voltage
  - Current
- Programmable resolution for each group (13 bits + sign)
- Any measuring range per channel group
- Programmable diagnostics and diagnostic interrupt
- Programmable limit value monitoring for 2 channels
- Programmable hardware interrupt when limit is exceeded
- High-speed update of measured values
- Supports isochronous mode
- Electrical isolation from the CPU
- Electrically isolated from load voltage (not for 2-wire transducers)

## Diagnostics

For information on diagnostics messages at the "group diagnostics" parameter, refer to chapter Diagnostic messages of analog input modules (Page 296).

## Hardware interrupts

Hardware interrupts for channel groups 0 and 1 can be programmed in STEP 7. However, set a hardware interrupt only for the first channel of a channel group, that is, either at channel 0, or at channel 2



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## Terminal assignment

The diagrams below show the various wiring options.

## Wiring: Voltage measurement

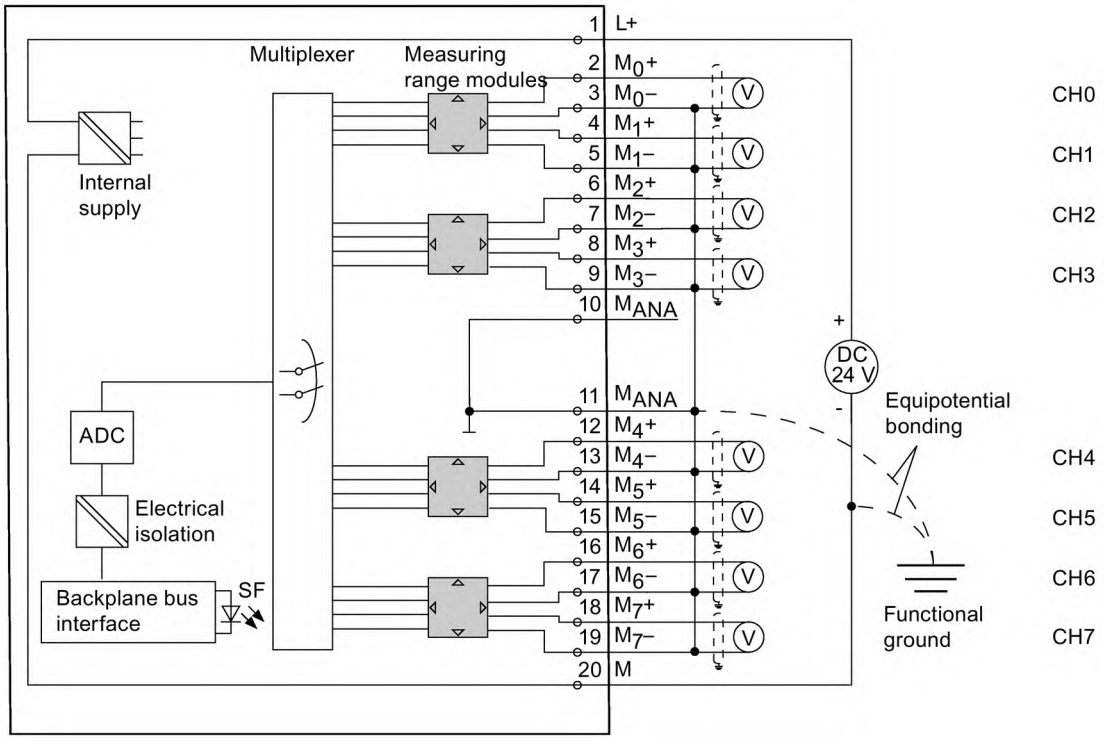



Figure 6-7 Block diagram and wiring diagram

## Measuring range module settings

| Measuring range | Measuring range module setting |
|---|---|
| ± 1V | A |
| ± 5V | B |
| ± 10V | B (Default) |
| 1 V to 5V | B |



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## Wiring: 2-wire and 4-wire transducers for current measurement

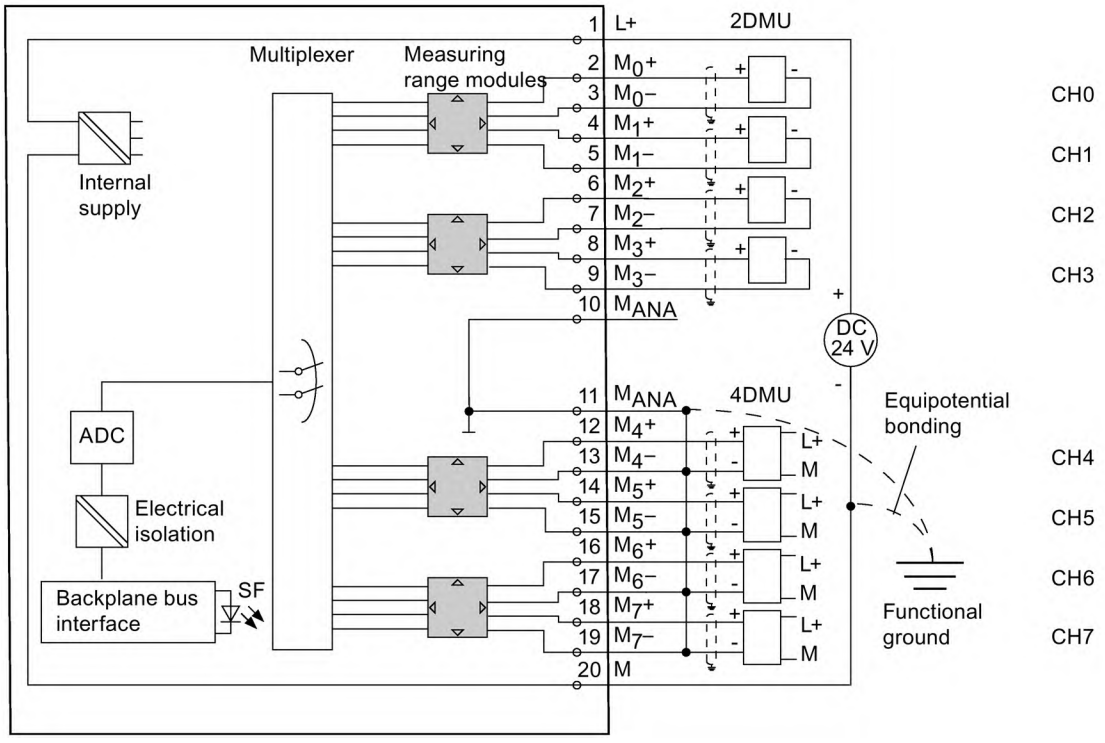



Figure 6-8 Block diagram and wiring diagram

## Measuring range module settings

| Measuring range | | Measuring range module setting |
|---|---|---|
| 2-wire transducer | 4 mA to 20mA | D |
| 4-wire transducer | ± 20mA<br>0 mA to 20mA<br>4 mA to 20mA | C |



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## Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 230 g |
| **Module-specific data** | |
| Supports isochronous mode | yes |
| Number of inputs | 8 |
| Cable length<br>• shielded | <br>max. 200 m |
| **Voltages, currents, electrical potentials** | |
| Rated electronics supply voltage L +<br>• Reverse polarity protection | 24 V DC<br>yes |
| Transducer power supply | |
| • Supply current<br>• short circuit-proof | max. 30 mA (per channel)<br>yes |
| Electrical isolation | |
| • between channels and the backplane bus<br>• between channels<br>• between channels and electronics power supply | yes<br>no<br>yes |
| Maximum potential difference<br>• between inputs and $M_{ANA}$ (CMV)<br>– at signal = 0 V<br>– not for 2-wire transducers<br>• between inputs (CMV) | <br>11 V DC / 8 V AC<br><br><br>11 V DC / 8 V AC |
| Isolation test voltage<br>• Channels to backplane bus and load voltage L + | <br>500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L + (without 2-wire transducer) | <br>max. 100 mA<br>max. 50 mA |
| Power loss of the module | typ. 1.5 W |



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| **Technical specifications** | | | | |
|---|---|---|---|---|
| **Generation of analog values** | | | | |
| Measuring principle | Actual value conversion | | | |
| Integration/conversion time/resolution (per channel) | | | | |
| • programmable | yes | | | |
| • Basic conversion time per channel | 52 µs | | | |
| • Resolution (including overshoot range) | 14 bits | | | |
| • Interference frequency suppression at interference frequency f1 in Hz | none | 400 | 60 | 50 |
| • Basic execution time of the module (independent of the number of enabled channels) | 0.42 ms | 2.5 ms | 16.7 ms | 20 ms |
| **Interference frequency suppression, error limits** | | | | |
| Interference frequency suppression at f = n (f1 ± 1 %), (f1 = interference frequency) n=1.2... | | | | |
| • Common mode interference (CMV < 11 Vpp)<br>• Series-mode interference (peak value < rated input range) | > 80 dB<br>> 40 dB | | | |
| Crosstalk between inputs | > 65 dB | | | |
| Operational limit (across entire temperature range, relative to measurement range end value in the selected input range) | | | | |
| • Voltage input | ± 1 V<br>± 5 V<br>± 10 V<br>1 V to 5 V | ± 0.3 %<br>± 0.4 %<br>± 0.3 %<br>± 0.4 % | | |
| • Current input | ± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA | ± 0.3 %<br>± 0.3 %<br>± 0.3 % | | |
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected input range) | | | | |
| • Voltage input | ± 1 V<br>± 5 V<br>± 10 V<br>1 V to 5 V | ± 0.2 %<br>± 0.25 %<br>± 0.2 %<br>± 0.25 % | | |
| • Current input | ± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA | ± 0.2 %<br>± 0.2 %<br>± 0.2 % | | |
| Temperature error (relative to input range) | ± 0.004 %/K | | | |
| Linearity error (relative to input range) | ± 0.03 % | | | |
| Repeat accuracy (in settled state at 25 °C, relative to input range) | ± 0.1 % | | | |



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| **Technical specifications** | | |
|---|---|---|
| **Status, interrupts, diagnostics** | | |
| Interrupts<br>• Hardware interrupt<br>• Diagnostic interrupt | <br>programmable<br>programmable | |
| Diagnostic functions<br>• Group error display<br>• Reading diagnostics information | <br>red LED (SF)<br>supported | |
| **Encoder selection data** | | |
| Input ranges (rated values) / input impedance | | |
| • Voltage | ± 1 V<br>± 5 V<br>± 10 V<br>1 V to 5 V | 10 MΩ<br>100 kΩ<br>100 kΩ<br>100 kΩ |
| • Current | ± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA | 50 Ω<br>50 Ω<br>50 Ω |
| Maximum voltage at voltage input (destruction limit) | max. 20 V continuous; 75 V for the duration of max. 1 s (duty factor 1:20) | |
| Maximum current at current input (destruction limit) | 40 mA | |
| Wiring of the signal transmitters<br>• for voltage measurement<br>• for current measurement<br>as 2-wire transducer<br>as 4-wire transducer<br>• Load of the 2-wire transducer at L+ = DC 24 V | using a 20-pin front connector<br>supported<br><br>supported<br>supported<br>max. 820 Ω | |
| Characteristics linearization | none | |

## 6.5.1 Measurement types and measuring ranges

### Introduction

The analog input module has measuring range modules. The measurement type and range is configured at the "measuring range" parameter in *STEP 7*.

The default setting of the module *STEP 7* is "voltage" measurement with "± 10V" range. You can use those default settings without having to program the SM 331;
AI 8 x 14 Bit High Speed in *STEP 7*.



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## Measuring range modules

You may have to change the position of the measuring range module to suit the measurement type and range. See table *Setting measuring methods and ranges of analog input channels*. The settings are also printed on the module. Mark the position of the measuring range module on the front door (see figure).




## Measurement types and measuring ranges

Table 6- 13 Measurement types and ranges

| Selected type of measurement | Measuring range (type of sensor) | Measuring range module settings |
|---|---|---|
| V: Voltage | ± 1 V | A |
| | ± 5 V<br>1 V to 5 V<br>± 10 V | B |
| 4DMU: Current (4-wire transducer) | 0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA | C |
| 2DMU: Current (2-wire transducer) | 4 mA to 20 mA | D |

## Channel groups

The channels of SM 331; AI 8 x 14 Bit High Speed are arranged in four groups of two channels. You can assign parameters only to one channel group.

SM 331; AI 8 x 14 bits High Speed is equipped with one measuring range module per channel group.

The table below shows the relevant configuration of channel groups. The channel group number is required to program SFC parameters in the user program.

Table 6- 14 Assignment of SM 331; AI 8 x 14 bits High Speed channels to channel groups

| Channels ... | ... form one channel group each |
|---|---|
| Channel 0 | Channel group 0 |
| Channel 1 | |
| Channel 2 | Channel group 1 |
| Channel 3 | |
| Channel 4 | Channel group 2 |
| Channel 5 | |
| Channel 6 | Channel group 3 |
| Channel 7 | |



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## 6.5.2 Programmable parameters

### Introduction

For information on programming analog modules, refer to the chapter Programming analog modules (Page 294).

### Parameter

Table 6- 15 Overview of parameters for SM 331; AI 8 x 14 Bit High Speed

| Parameters | Range of values | Default | Parameter type | Scope |
|---|---|---|---|---|
| Enable<br>• Diagnostics interrupt<br>• Process interrupt when limit exceeded | <br>yes/no<br>yes/no | <br>no<br>no | dynamic | Module |
| Fast Mode (can only be set if the 331-7HF01 is included for isochronous operation in the DP slave properties) | yes/no | no | static | Module |
| Process interrupt trigger<br>• High limit<br>• Low limit | May be restricted by the measuring range.<br>from 32511 to - 32512<br>from - 32512 to 32511 | - | dynamic | Channel |
| Diagnostics<br>• Group diagnostics | yes/no | no | static | Channel group |
| Measurement<br>• Measurement type | <br>disabled<br>Voltage V<br>4DMU current (4-wire transducer)<br>2DMU current (2-wire transducer) | <br>V | dynamic | Channel or channel group |
| • Measuring range | See the table *Measurement types and ranges* | ± 10 V | | |
| • Noise suppression | none; 400 Hz; 60 Hz; 50 Hz | 50 Hz | | |



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## 6.5.3 Isochronous mode

### Properties

Reproducible reaction times (i.e. of the same length) are achieved in a SIMATIC system by means of a constant DP bus cycle, and synchronization of the single cyclic processes outlined below:

- Independent user program cycle. The length of the cycle time may vary due to non-cyclic program branching.
- Independent and variable DP cycle on the PROFIBUS subnet
- Cyclic operation of the backplane bus of the DP slave.
- Cyclic signal preparation and conversion at the electronic modules of the DP slave.

The constant DP cycle runs in synchronism and at the same length. The CPU run levels (OB61 to OB64) and isochronous IO are synchronized with this cycle. I/O data are therefore transferred at defined and constant intervals (isochronous mode.)

### Requirements

- The DP master and slave must support isochronous mode. You require *STEP 7* V5.2 or higher.

### Mode of operation: Isochronous mode

Table 6- 16 Conditions of isochronous mode:

| | |
|---|---|
| **Standard Mode** | |
| Filtering and processing time $T_{WE}$ between reading actual values and writing these to the transfer buffer(the value defined for $T_{WE}$ applies, irrespective of the enable status of diagnostics) | max. 625 µs |
| including an input delay time of | 10 µs |
| $T_{DPmin}$ | 3.5 ms |
| Diagnostics interrupt | max. 4 x $T_{DP}$ |
| **Fast Mode** (only possible with 6ES7331-7HF01-0AB0) | |
| Filter and processing time $T_{WE}$ between reading actual value and writing the results to the transfer buffer (diagnosis not selectable) | max. 625 µs |
| including an input delay time of | 10 µs |
| $T_{DPmin}$ | 1 ms |

**Note**

You can accelerate the cycle of your DP system by setting "Fast Mode." However, this is at the expense of diagnostics: Diagnostics functions will be disabled in this operating mode.



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The minimum $T_i$ value of 875 µs which you can set in *HW Config* is derived from the defined $T_{WE}$ value plus calculation and transfer times required by the IM 153.

The specified $T_{DPmin}$ value is determined by the size of the DP slave/IM 153 configuration: Of the diverse installed modules, the slowest always determines the time $T_{DPmin}$.

**Note**

When operated in "isochronous" mode, the modules automatically sets "Integration time: none/interference frequency", irrespective of parameter settings in *STEP 7*. none / interference frequency". "Process interrupt" functionality is not available in "isochronous" mode.

## Calculation of filter and processing times

The same time conditions always apply, regardless of the number of configured channels. The time relative to the clock signal for reading a specific channel is calculated according to the formula:

$T_{WE}$_CH = (channel number +1) x 52 µs + tv; tv = 119 to 209 µs

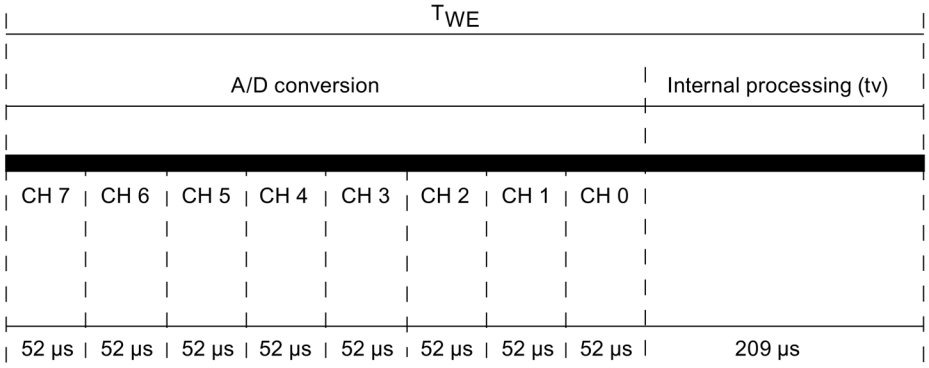



Figure 6-9 Calculation of filter and processing times

## Definition of isochronous mode

The module starts with the analog-to-digital conversion of channel 7, and saves the result internally. Next, it converts channels 6...0 sequentially at intervals of 52 ms and in the same way. After an additional internal processing time, it outputs the result of all converted channels to the backplane bus interface where it can be fetched by the CPU.

## Further information

You can find additional information on isochronous mode in the online help for *STEP 7,* and in the operating instructions Distributed I/O System ET 200M (http://support.automation.siemens.com/WW/view/en/1142798).



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## 6.5.4 Additional information on SM 331; AI 8 x 14 Bit High Speed, isochrone

### Unused channels

You should wire unused channels as shown in the following table. This optimizes interference immunity of the analog input module.

| Measuring range | M+/ M- | M_ana |
|---|---|---|
| Voltage | short-circuit | connect with M- |
| Current / 4-wire transducer | leave open | connect with M- |
| Current / 2-wire transducer | leave open | connect with M |

As certain programmed inputs may remain unused due to the channel group configuration, make allowances for the special features of these inputs outlined below in order to be able to use the diagnostics functions at these used channels:

- **Measuring range 1 V to 5 V:** wire the used input and unused input of the same channel group in parallel.
- **Current measurement, 2-wire transducer:** There are two options of wiring the channel circuit.

  a) Open unused inputs; channel group diagnostics disabled. If you were to enable diagnostics, the analog module would trigger a single diagnostic interrupt, and light up its SF LED.

  b) Loading the unused input using a 1.5 kΩ to 3.3 kΩ resistor. This allows you to enable diagnostics for this channel group.
- **Current measurement 4 mA to 20 mA, 4-wire transducer:** wire the used input and unused input of the same channel group in series.

### Line continuity check for the 4 mA to 20 mA measuring range

If you configured a measuring range of 4 mA to 20 mA, and **enabled the line continuity check**, the analog input module logs a wire-break event to diagnostics data when the current drops below 1.185 mA.

The module also triggers a diagnostics interrupt if this function is enabled in the program.

A wire break can only be signaled by means of the lit SF LED and the diagnostic bytes must be evaluated in the user program if diagnostics interrupts are disabled.

If you configured a measuring range of 4 mA to 20 mA, **disabled** the line continuity check, and enabled diagnostic interrupts, the module triggers a diagnostic interrupt when the underflow value is reached.



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# 6.6 Analog input module SM 331; AI 8 x 13 Bit; (6ES7331-1KF02-0AB0)

## Order number

6ES7331-1KF02-0AB0

## Properties

- 8 inputs in 8 channel groups
- Programmable resolution for each group (12 bits + sign)
- Measurement type programmable for each channel group:
  - Voltage
  - Current
  - Resistance
  - Temperature
- Any measuring range per channel
- Motor protection / temperature monitoring with PTC in accordance with IEC 60034-11-2 type A
- Temperatures recorded via KTY83/110, KTY84/130 silicon temperature sensors

## Terminal assignment

The diagrams below show various wiring options. These examples apply to all channels (channel 0 to 7).

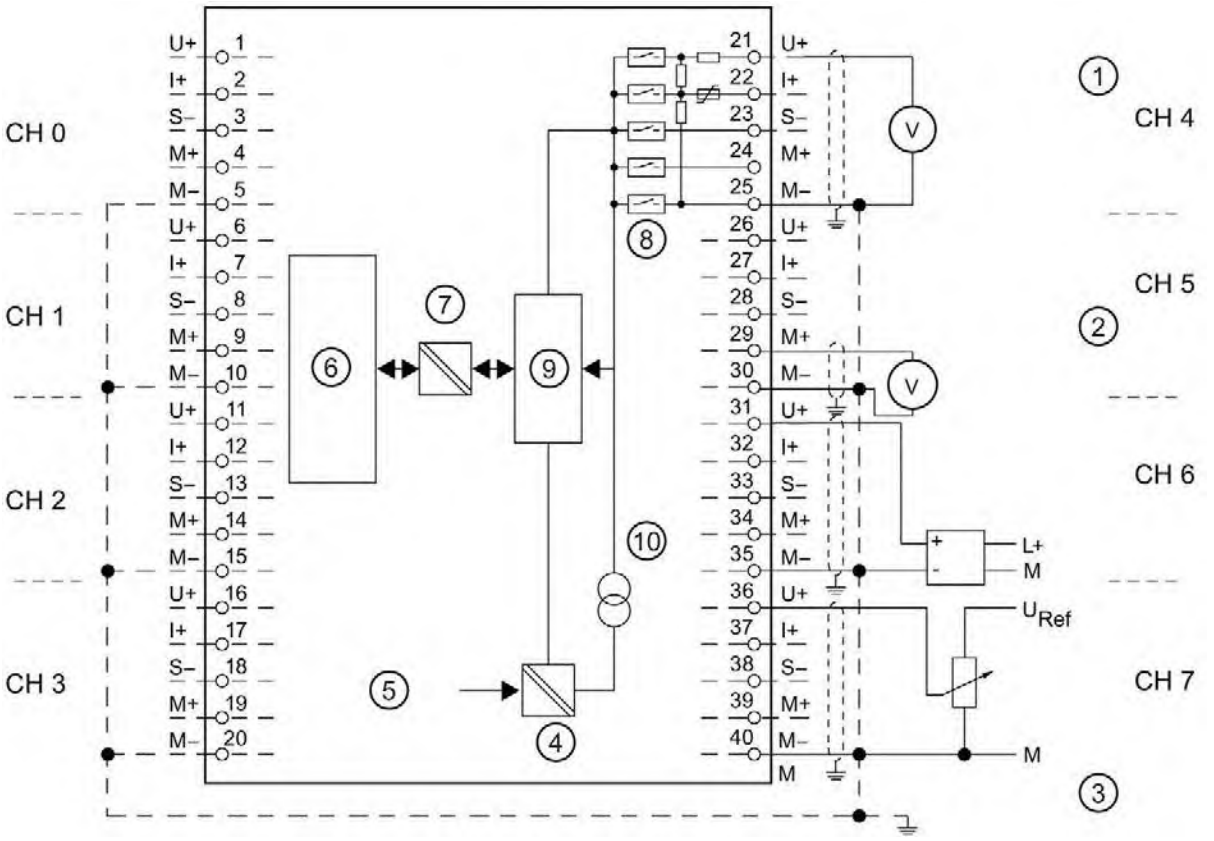
**Note**

When connecting voltage and current transducers, make sure that the maximum permitted common-mode voltage $C_{MV}$ of 2 V is not exceeded between the inputs. Prevent measuring errors by interconnecting the corresponding M- terminals.



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## Wiring: Voltage measurement



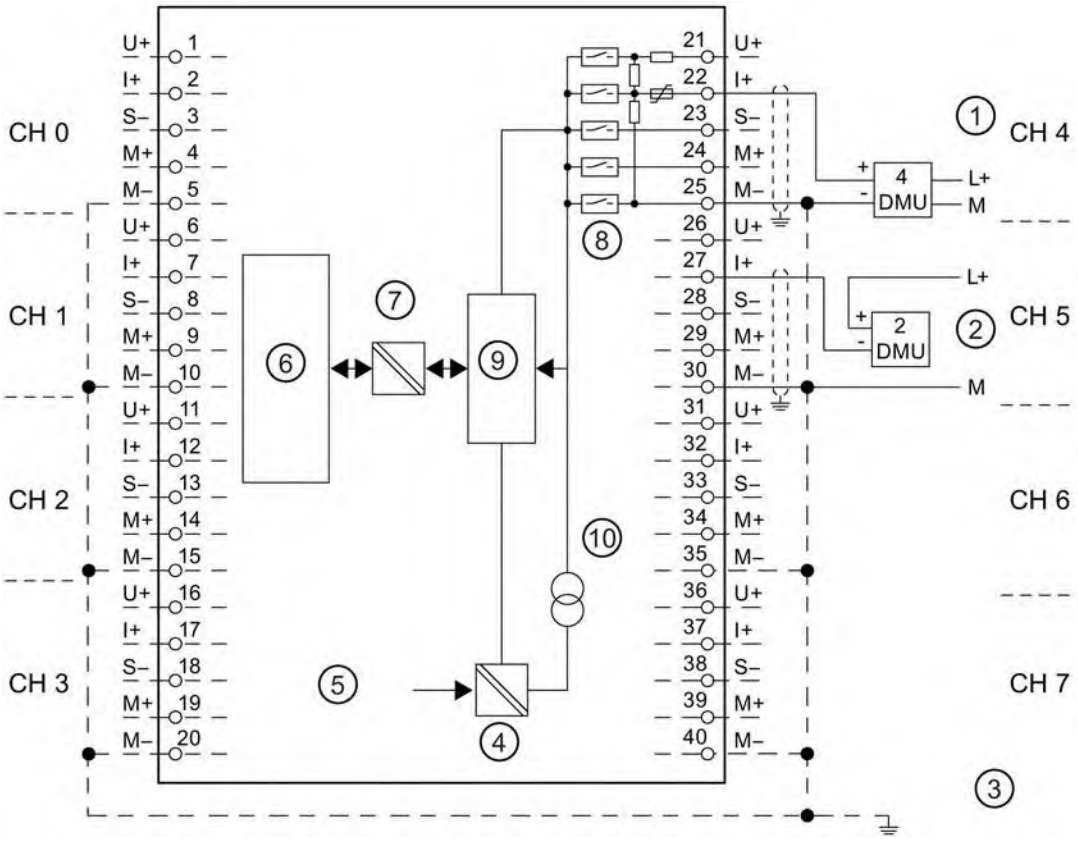

① Voltage measurement: (± 5V, ± 10V, 1 ... 5V, 0...10V)
② Voltage measurement (± 50 mV, ± 500 mV, ± 1 V) (note the input resistance defined in the technical data)
③ Equipotential bonding
④ Internal supply
⑤ + 5 V from backplane bus
⑥ Logic and backplane bus interface
⑦ Electrical isolation
⑧ Multiplexer
⑨ Analog to Digital Converter (ADC)
⑩ Current source

Figure 6-10 Block diagram and terminal diagram



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## Wiring: 2-wire and 4-wire transducers for current measurement




① 4-wire transducer (0/4 mA to 20 mA or ± 20 mA)
② 2-wire transducer (4 mA to 20 mA)
③ Equipotential bonding
④ Internal supply
⑤ + 5 V from backplane bus
⑥ Logic and backplane bus interface
⑦ Electrical isolation
⑧ Multiplexer
⑨ Analog to Digital Converter (ADC)
⑩ Current source

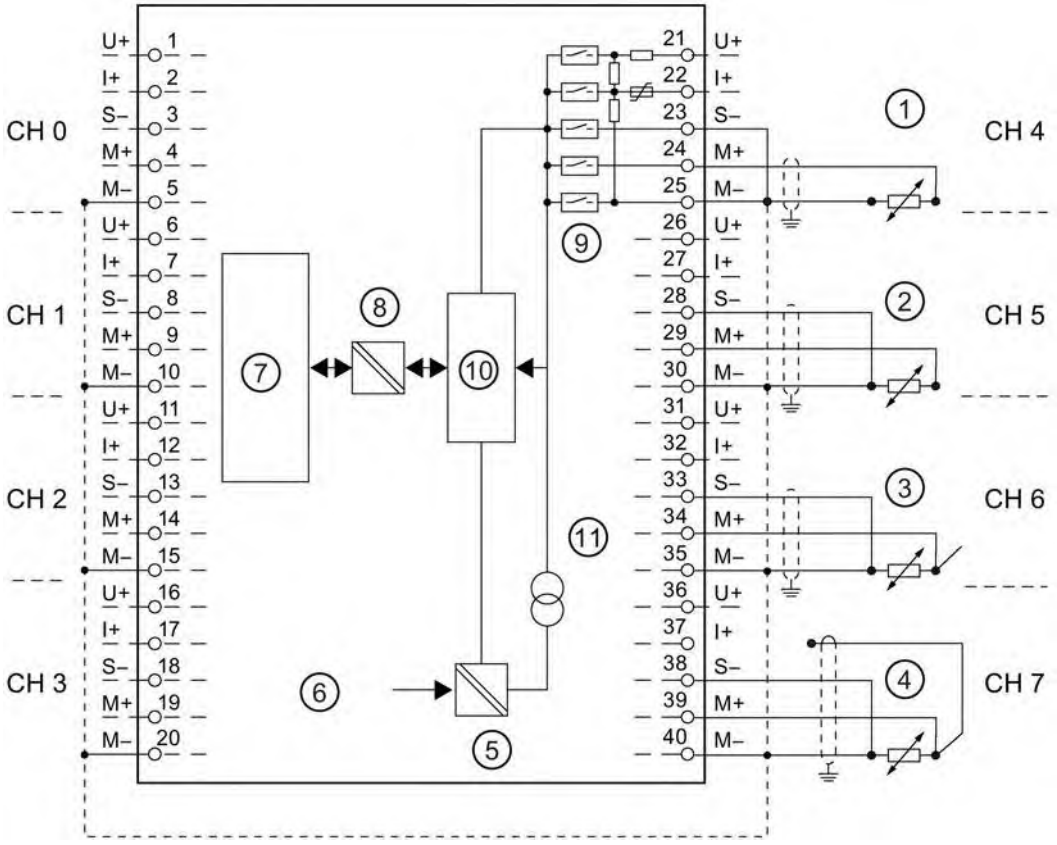
Figure 6-11 Block diagram and wiring diagram



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## Wiring: Resistance measurement with 2-, 3- and 4-wire connection

The following connection possibilities also apply to silicon temperature sensors and PTCs.




① 2-wire connection. Insert a bridge between M and S (no line resistance compensation).
② 3-wire connection
③ 4-wire connection. The fourth line may not be wired (remains unused)
④ 4-wire connection. The fourth line is routed to the terminal strip in the cabinet but is not wired.
⑤ Internal supply
⑥ + 5 V from backplane bus
⑦ Logic and backplane bus interface
⑧ Electrical isolation
⑨ Multiplexer
⑩ Analog to Digital Converter (ADC)
⑪ Current source

Figure 6-12 Block diagram and terminal diagram

**Note**

It is not necessary to interconnect the M- terminals when measuring using resistors, resistance thermometers, PTCs, or silicon temperature sensors. However, interconnection of the M- terminals may enhance interference immunity.



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## Technical specifications

| Technical specifications | | |
|---|---|---|
| **Dimensions and weight** | | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 | |
| Weight | ca. 250 g | |
| **Module-specific data** | | |
| Supports isochronous mode | no | |
| Number of inputs<br>• with resistive transducers | 8<br>8 | |
| Cable length<br>• shielded | <br>max. 200 m<br>max. 50 m at 50 mV | |
| **Voltages, currents, electrical potentials** | | |
| Constant current for resistive transducers<br>• Resistance thermometer and resistance measurements 0 Ω to 600 Ω<br>• Resistance measurement 0 to 6 kΩ, PTC, silicon temperature sensors | <br>0.83 mA (pulsed)<br>0.25 mA (pulsed) | |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels | <br>yes<br>no | |
| Maximum potential difference<br>• between inputs (CMV) | <br>2.0 V DC | |
| Isolation test voltage | 500 V DC | |
| Current consumption<br>• from the backplane bus | <br>max. 90 mA | |
| Power loss of the module | typ. 0.4 W | |
| **Generation of analog values** | | |
| Measuring principle | Integrating | |
| Integration/conversion time/resolution (per channel) | | |
| • programmable | yes | |
| • Interference frequency suppression at interference frequency f1 in Hz | 50 | 60 |
| • Integration time in ms | 60 | 50 |
| • Basic conversion time, including the integration time in ms | 66 | 55 |
| Additional conversion time for resistance measurements in ms | 66 | 55 |
| • Resolution in bits (including overshoot range) | 13 bits | 13 bits |



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| **Technical specifications** | | |
|---|---|---|
| **Interference frequency suppression, error limits** | | |
| Interference frequency suppression at f = n (f1 ± 1 %), (f1 = interference frequency) n=1.2 | | |
| • Common mode interference ($V_{CM}$ < 2 V)<br>• Seriesmode interference (peak value < rated input range) | > 86 dB<br>> 40 dB | |
| Crosstalk between inputs | > 50 dB | |
| Operational limit (across entire temperature range, relative to the measurement range end value in the selected input range) | | |
| • Voltage input | ± 5 V | ± 0.6 % |
| | ± 10 V<br>1 V to 5 V<br>0 V to 10 V<br>± 50 mV<br>± 500 mV<br>±1 V | ± 0.5 % |
| • Current input | ± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA | ± 0.5 % |
| • Resistor/PTC | 0 kΩ to 6 kΩ<br>0 Ω to 600 Ω<br>PTC | ± 0.5 %<br>± 0.5 %<br>± 0.5 % |
| • Resistance thermometer/silicon temperature sensors | Pt 100<br>Ni 100<br>Standard | ± 1.2 K |
| | Pt 100<br>Ni 100<br>Klima | ± 1 K |
| | Ni 1000,<br>LG-Ni 1000<br>Standard | ± 1 K |
| | Ni 1000<br>LG-Ni 1000<br>Klima | ± 1 K |
| | KTY83/110<br>KTY84/130 | ± 3.5 K<br>± 4.5 K |



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| **Technical specifications** | | |
|---|---|---|
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected input range) | | |
| • Voltage input | ± 5 V | ± 0.4 % |
| | ± 10 V<br>1 V to 5 V<br>0 V to 10 V<br>± 50 mV<br>± 500 mV<br>± 1 V | ± 0.3 % |
| • Current input | ± 20 mA<br>0 to 20 mA<br>4 mA to 20 mA | ± 0.3 % |
| • Resistor/PTC | 0 kΩ to 6 kΩ<br>0 Ω to 600 Ω<br>PTC | ± 0.3 %<br>± 0.3 %<br>± 0.3 % |
| • Resistance thermometer/silicon temperature sensors | Pt 100<br>Ni 100<br>Standard | ± 1 K |
| | Pt 100<br>Ni 100<br>Klima | ± 0.8 K |
| | Ni 1000<br>LG-Ni 1000<br>Standard | ± 0.8 K |
| | Ni 1000<br>LG-Ni<br>1000 Klima | ± 0.8 K |
| | KTY83/110<br>KTY84/130 | ± 2 K<br>± 2.7 K |
| Temperature error (relative to input range) | ± 0.006 %/K / 0.006 K/K | |
| Linearity error (relative to input range) | ± 0.1 % / 0.1 K | |
| Repeat accuracy (in transient state at 25 °C, relative to input range) | ± 0.1 % / ± 0.1 K | |
| **Status, interrupts, diagnostics** | | |
| Interrupts | none | |
| Diagnostic functions | none | |



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| **Technical specifications** | | |
|---|---|---|
| **Encoder selection data** | | |
| Input ranges (rated values) / input impedance | | |
| • Voltage | ± 50 mV<br>± 500 mV<br>± 1 V<br>± 5 V<br>± 10 V<br>1 V to 5 V<br>0 V to 10 V | 100 kΩ |
| • Current | ± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA | 100 Ω |
| • Resistor/PTC | 0 kΩ to 6 kΩ<br>0 Ω to 600 Ω<br>PTC | 100 MΩ |
| • Resistance thermometer/silicon temperature sensors | Pt 100<br>Ni 100<br>Ni 1000<br>LG-Ni<br>1000<br>Standard / Klima<br>KTY83/110<br>KTY84/130 | 100 MΩ |
| Maximum voltage at voltage input U+ (destruction limit) | max. 30 V, continuous | |
| Maximum voltage at voltage inputs M+, M-, S- (destruction limit) | max. 12 V continuous; 30 V for a duration of max. 1 s | |
| Maximum current at current input I+ (destruction limit) | 40 mA | |
| Wiring of the signal transmitters | using a 40pin front connector | |
| • for voltage measurement<br>• for current measurement<br>– as 2-wire transducer<br>– as 4-wire transducer | supported<br><br>supported, with external supply<br>supported | |
| • for resistance measurement<br>with 2-wire connection<br>with 3-wire connection<br>with 4-wire connection | <br>supported<br>supported<br>supported | |
| Characteristics linearization | programmable | |
| • for resistance thermometers | Pt 100 Standard / Klima<br>Ni 100 Standard / Klima<br>Ni 1000 Standard / Klima<br>LG-Ni 1000 Standard / Klima | |
| • Technical unit of temperature measurement | Degrees Centigrade, degrees Fahrenheit, Kelvin | |



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## 6.6.1 Measurement types and measuring ranges

### Introduction

The measurement type and range is configured at the "measuring type" parameter in *STEP 7*.

| Selected type of measurement | Measuring range |
|---|---|
| Voltage<br>V: | ± 50 mV<br>± 500 mV<br>± 1 V<br>± 5 V<br>1 V to 5 V<br>0 V to 10 V<br>± 10 V |
| Current I | 0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA |
| resistance (4-wire connection)<br>R-4L | 6 kΩ<br>600 Ω<br>PTC |
| Thermal resistance<br>RTD-4L (linear, 4-wire connection)<br>(temperature measurement)<br>Silicon temperature sensors | Pt 100 Klima / Standard<br>Ni 100 Klima / Standard<br>Ni 1000 Klima / Standard<br>LG-Ni 1000 Klima / Standard<br>KTY83/110<br>KTY84/130 |

## 6.6.2 Programmable parameters

### Introduction

You will find a description of the general procedure for assigning parameters to analog modules in section Programming analog modules (Page 294).



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## Parameter

Table 6- 17 Overview of the parameters of SM 331; AI 8 x 13 Bit

| Parameters | Range of values | Default | Parameter type | Scope |
|---|---|---|---|---|
| Measurement<br>• Measurement type | disabled<br>Voltage V<br>Current I<br>Resistance R, PTC<br>Thermal resistance RTD,<br>silicon temperature sensors | V | dynamic | Channel |
| • Measuring range | Voltage<br>± 50 mV; ± 500 mV; ±1 V;<br>1 V to 5 V<br>± 5 V; 0 V to 10 V; ± 10 V | ± 10 V | | |
| | Current<br>0 mA to 20 mA; 4 mA to 20 mA; ± 20 mA | ± 20 mA | | |
| | Resistance<br>0 Ω to 600 Ω; 0 kΩ to 6 kΩ; PTC | 600 Ω | | |
| | Thermoelectric resistance (linear)<br>Pt 100 Klima / Standard<br>Ni 100 Klima / Standard<br>Ni 1000 Klima / Standard<br>LG-Ni 1000 Klima / Standard<br>KTY83/110<br>KTY84/130 | Pt 100<br>Standard | | |
| • Temperature coefficient | Pt 100<br>0.003850 Ω/Ω/ °C (IST-90)<br>Ni 100 / Ni 1000<br>0.006180 Ω/Ω/ °C<br>LG-Ni 1000<br>0.005000 Ω/Ω/ °C | 0,003850 | | |
| • Interference frequency suppression | 50 Hz; 60 Hz | 50 Hz | | Module |
| • Temperature unit | Degrees Centigrade, degrees Fahrenheit, Kelvin* | degrees Centigrade | | |
| ***** only Pt 100 Standard, Ni 100 Standard, Ni 1000 Standard, LG-Ni 1000 Standard | | | | |



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## 6.6.3 Additional information on SM 331; AI 8 x 13 Bit

### Using the module

The spare parts of the SM 331-1KF02 are compatible with the SM 331-1KF01 and are configured with HSP 2067. HSP 2067 can be installed for STEP7 V5.4, SP5 and higher and is included for STEP7 V5.4, SP6 and higher.

### Unused channels

Set the "disabled" value at the "measurement type" parameter for unused channels. This setting reduces module cycle times.

Interconnect the M- terminals of unused channels.

### Using PTC resistors

PTCs are suitable for monitoring the temperature of or providing thermal protection for complex drives and transformer windings. The module has no analog values when PTC resistances are used. Status information on fixed temperature ranges are displyed instead of analog values.

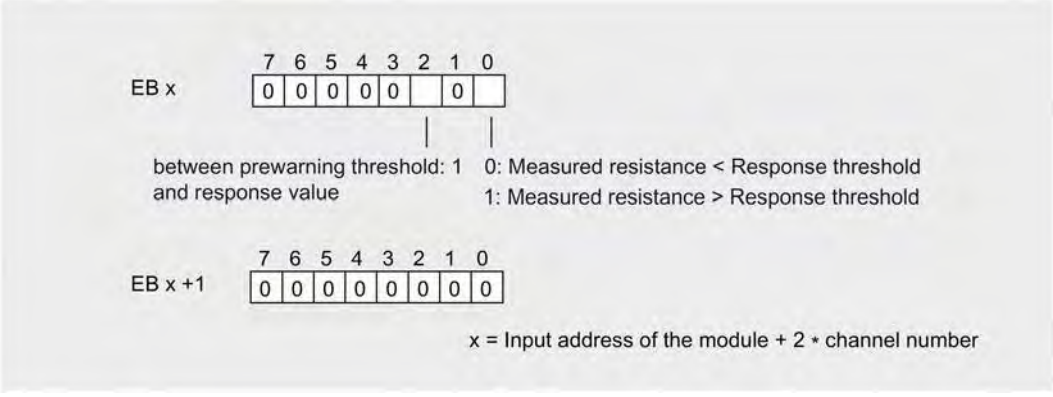
- When setting the parameters, select measurement type R "Resistance" and measuring range "PTC".
- Connect the PTC (see "Terminal diagram for resistance measurement").
- Use PTC resistors that comply with IEC 60034-11-2 (previously, PTC thermistors that complied with DIN/VDE 0660, Part 302).
- Sensor data for the PTC resistor:



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| Property | Technical specifications | Comment |
|---|---|---|
| Switching points | **Response to rising temperature** | |
| | < 550 Ω | **Normal range:**<br>Bit 0 = "0", bit 2 = "0" (in the PII) |
| | 550 Ω to 1650 Ω | **Advance warning range:**<br>Bit 0 = "0", bit 2 = "1" (in the PII) |
| | > 1650 Ω | **Actuating range:**<br>Bit 0 = "1", bit 2 = "0" (in the PII) |
| | **Response to falling temperature** | |
| | > 750 Ω | **Actuating range:**<br>Bit 0 = "1", bit 2 = "0" (in the PII) |
| | 750 Ω to 540 Ω | **Advance warning range:**<br>Bit 0 = "0", bit 2 = "1" (in the PII) |
| | < 540 Ω | **Normal range:**<br>Bit 0 = "0", bit 2 = "0" (in the PII) |
| (RRT-5) °C<br>(RRT+5) °C<br>(RRT+15) °C<br>Measurement voltage<br>Voltage at PTC | Max. 550 Ω<br>Min. 1,330 Ω<br>Min. 4,000 Ω<br>Max. 7.5 V | RRT = Rated response temperature |

- Assignment in the process image input (PII)






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- Notes on programming

**Note**

Only bits 0 and 2 in the process image input are relevant for evaluation. You can use bits 0 and 2 to monitor the temperature of a motor, for example.

Bits 0 and 2 in the process image input cannot be saved. When assigning parameters, make sure that the motor, for example, starts up in a controlled manner (by means of an acknowledgment).

Bits 0 and 2 can never be set at the same time; they are set one after the other.

## Using silicon temperature sensors

Silicon temperature sensors are commonly used to detect temperatures in motors.

- When assigning the parameters, select measurement type "thermoresistor" and measuring range "KTY83/110" or "KTY84/130".
- Connect the temperature sensor (see "Terminal diagram for resistance measurement").

Use temperature sensors which comply with the Product Specifications published by Philips Semiconductors.

- KTY83 series (KTY83/110)
- KTY84 series (KTY84/130)

Also take note of the accuracy of the temperature sensors.

The temperature is specified in 0.1 degrees C, 0.1 degrees K, and/or 0.1 degrees F, see section Representation of the values for analog input channels (Page 262).



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# 6.7 Analog input module SM 331; AI 8 x 12 bit;(6ES7331-7KF02-0AB0)

## 6.7.1 Analog input module SM 331; AI 8 x 12 bit;(6ES7331-7KF02-0AB0)

### Order number

6ES7331-7KF02-0AB0

### Properties

- 8 inputs in 4 channel groups
- Programmable measurement type at each channel group
  - Voltage
  - Current
  - Resistance
  - Temperature
- Programmable resolution at each channel group (9/12/14 bits + sign)
- Any measuring range selection per channel group
- Programmable diagnostics and diagnostic interrupt
- Programmable limit value monitoring for 2 channels
- Programmable hardware interrupt when limit is exceeded
- Electrically isolated to CPU and load voltage (not for 2-wire transducers)

### Resolution

The resolution of measured values is directly dependent of the selected integration time. In other words, the longer the integration time for an analog input channel, the higher the resolution of a measured value.

### Diagnostics

For information on diagnostics messages at the "group diagnostics" parameter, refer to chapter Diagnostic messages of analog input modules.

### Hardware interrupts

Hardware interrupts for channel groups 0 and 1 can be programmed in *STEP 7*. However, set a hardware interrupt only for the first channel of a channel group, that is, either at channel 0, or at channel 2



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## Terminal assignment

The diagrams below show various wiring options The input impedance depends on the setting of the measuring range module, see table *Measurement types and ranges*.

## Wiring: Voltage measurement

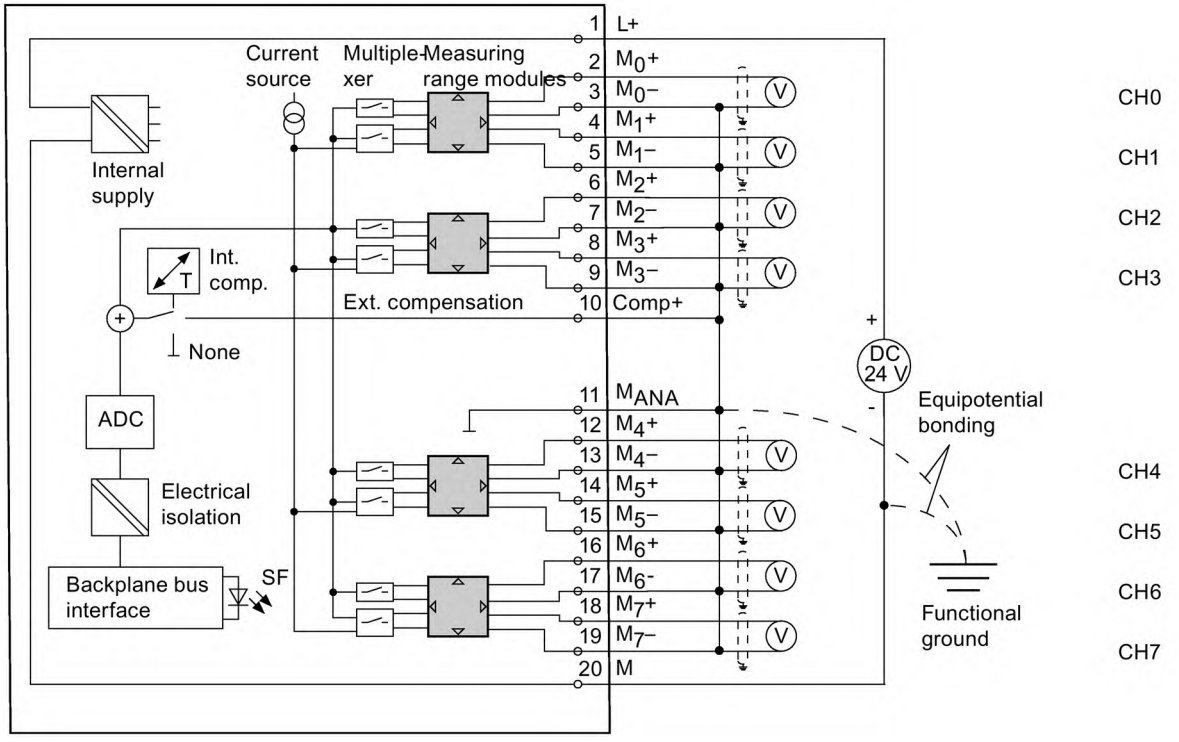



Figure 6-13 Block diagram and wiring diagram

## Measuring range module settings

| Measuring range | Measuring range module setting |
|---|---|
| ± 80 mV<br>± 250 mV<br>± 500 mV<br>± 1,000 mV | A |
| ± 2.5 V<br>± 5 V<br>1 V to 5 V<br>± 10 V | B |



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## Wiring: 2-wire and 4-wire transducers for current measurement

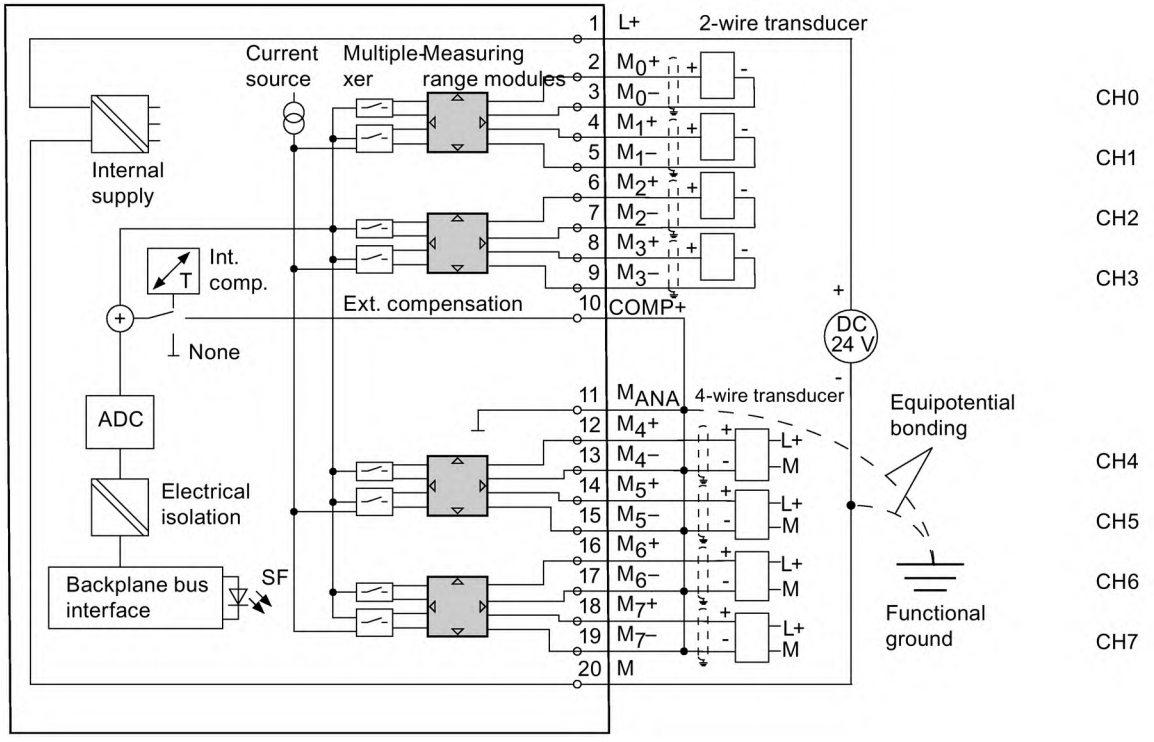



Figure 6-14 Block diagram and wiring diagram

**Note**

The interconnection between $M_{ANA}$ and M- (terminals 11, 13, 15, 17, 19) is not required when using grounded 4-wire transducers with non-isolated supply.

## Measuring range module settings

| Measuring range | | Measuring range module setting |
|---|---|---|
| 2-wire transducer | 4 mA to 20 mA | D |
| 4-wire transducer | ± 3.2 mA<br>± 10 mA<br>0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA | C |

**CAUTION**

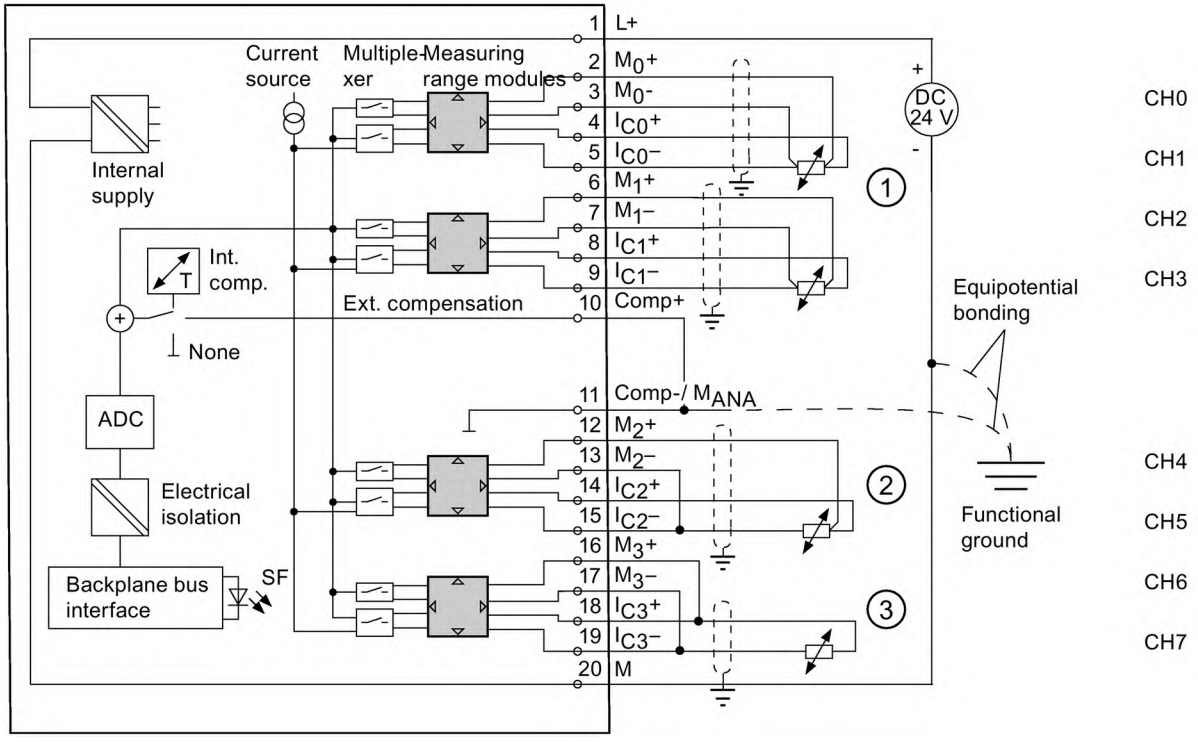
**Measuring range module in "Current" position**

Any voltage measurement will destroy the measuring range module if "current" measuring mode is set.



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## Wiring: 2-, 3- and 4-wire connection of resistance transducers or thermoresistors




① 4-wire connection
② 3-wire connection, no compensation for line resistors
③ 2-wire connection, no compensation for line resistors

Figure 6-15 Block diagram and wiring diagram

## Measuring range module settings

| Measuring range | | Measuring range module setting |
|---|---|---|
| 150 Ω<br>300 Ω<br>600 Ω | | A |
| Thermoresistor<br>(linear, 4-wire connection) (temperature measurement)<br>RTD-4L | Pt 100 Klima<br>Ni 100 Klima<br>Pt 100 Standard<br>Ni 100 Standard | A |

**Note**

- "Resistance measurement" is only available at one channel per group. The "2nd" channel of the group is used accordingly for current measuring mode ($I_C$). The "1st" channel of the group returns the measured value. The "2nd" channel of the group is assigned the default overflow value "$7FFF_H$."
- There is no compensation of the line resistance with a 2 and 3-wire connection.



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## Wiring: Thermocouples with external compensation

Insert a bridge between Comp+ and $M_{ANA}$ when using the internal compensation.

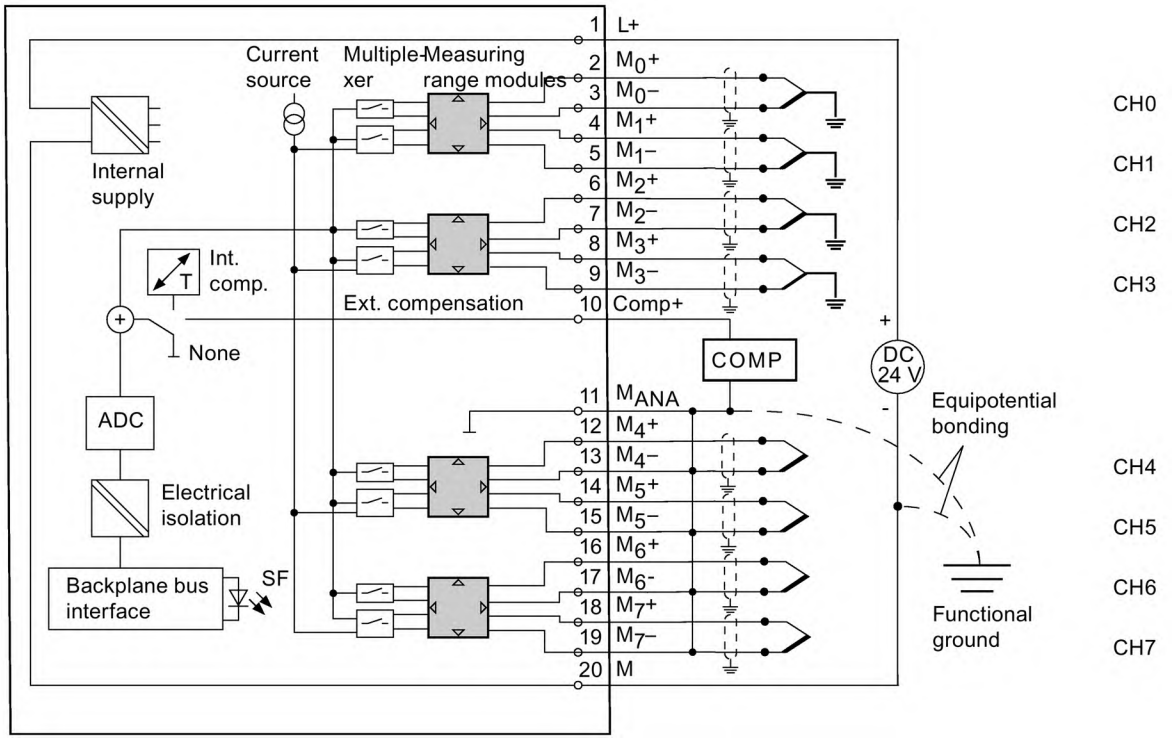



Figure 6-16 Block diagram and wiring diagram



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## Measuring range module settings

| Measuring range | | Measuring range module setting |
|---|---|---|
| Thermocouple TC-I<br>(internal comparison) (thermal voltage measurement)<br>Linearization is ignored | Type N [NiCrSi-NiSi]<br>Type E [NiCr-CuNi]<br>Type J [Fe-CuNi]<br>Type K [NiCr-Ni]<br>Type L [Fe-CuNi] | A |
| Thermocouple TC-E<br>(external comparison) (thermovoltage measurement)<br>Linearization is ignored | | |
| Thermocouple<br>(linear, internal comparison)<br>(temperature measurement) TC-IL | Type N [NiCrSi-NiSi]<br>Type E [NiCr-CuNi]<br>Type J [Fe-CuNi]<br>Type K [NiCr-Ni]<br>Type L [Fe-CuNi] | A |
| Thermocouple<br>(linear, external comparison)<br>(temperature measurement) TC-EL | | |

**Note**

- An interconnection of M- and $M_{ANA}$ is prohibited when using grounded thermocouples. In this case, you must ensure that low-resistance equipotential bonding is in place so that the permitted common-mode voltage is not exceeded.
- Interconnect M- and $M_{ANA}$ when using non-grounded thermocouples



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## Technical specifications

| **Technical specifications** | | | | |
|---|---|---|---|---|
| **Dimensions and weight** | | | | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 | | | |
| Weight | approx. 250 g | | | |
| **Module-specific data** | | | | |
| Supports isochronous mode | No | | | |
| Number of inputs<br>• with resistive transducers | 8<br>4 | | | |
| Cable length<br>• shielded | max. 200 m<br>max. 50 m at 80 mV and with thermocouples | | | |
| **Voltages, currents, electrical potentials** | | | | |
| Rated electronics supply voltage L +<br>• Reverse polarity protection | 24 V DC<br>Yes | | | |
| Transducer power supply<br>• Supply current<br>• short circuit-proof | <br>max. 60 mA (per channel)<br>Yes | | | |
| Constant current for resistive transducers | typ. 1.67 mA (pulsed) | | | |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels and electronics power supply<br>– Not for 2-wire transducers | <br>Yes<br>Yes | | | |
| Maximum potential difference<br>• between inputs and $M_{ANA}$ ($V_{CM}$)<br>– at signal = 0 V<br>• between inputs ($V_{CM}$) | <br>typ. 2.5 V DC (> 2.3 V DC)<br><br>typ. 2.5 V DC (> 2.3 V DC) | | | |
| Isolation test voltage | 500 V DC | | | |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ | <br>max. 50 mA<br>max. 30 mA (without 2-wire transducer) | | | |
| Power loss of the module | typ. 1 W | | | |
| **Generation of analog values** | | | | |
| Measuring principle | Integrating | | | |
| Integration/conversion time/resolution (per channel) | | | | |
| • programmable | Yes | | | |
| • Integration time in ms | 2.5 | $16^2/_3$ | 20 | 100 |
| • Basic conversion time, including the integration time in ms | 3 | 17 | 22 | 102 |
| Additional conversion time for resistance measurement, in ms or | 1 | 1 | 1 | 1 |



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| **Technical specifications** | | | | |
|---|---|---|---|---|
| additional conversion time for wire-break monitoring in ms<br>or | 10 | 10 | 10 | 10 |
| additional conversion time for resistance measurements **and** wire-break monitoring in ms | 16 | 16 | 16 | 16 |
| • Resolution in bits (including overrange) | 9 bits | 12 bits | 12 bits | 14 bits |
| • Interference frequency suppression at interference frequency f1 in Hz | 400 | 60 | 50 | 10 |
| • Basic execution time of the module in ms (all channels enabled) | 24 | 136 | 176 | 816 |
| Measured value smoothing | none | | | |
| **Interference frequency suppression, error limits** | | | | |
| Interference frequency suppression at F = n (f1 ± 1 %), (f1 = interference frequency) | | | | |
| • Common mode interference ($V_{CM}$ < 2.5 V)<br>• Seriesmode interference (peak interference value < rated input range) | > 70 dB<br>> 40 dB | | | |
| Crosstalk between inputs | > 50 dB | | | |
| Operational limit (across entire temperature range, relative to the measurement range end value in the selected input range) | | | | |
| • Voltage input | 80 mV<br>250 mV to 1,000 mV<br>2.5 V to 10 V | | ± 1 %<br>± 0.6 %<br>± 0.8 % | |
| • Current input | 3.2 mA to 20 mA | | ± 0.7 % | |
| • Resistance | 150 Ω; 300Ω; 600 Ω | | ± 0. 7 % | |
| • Thermocouple | Types E, N, J, K, L | | ± 1. 1 % | |
| • Resistance thermometer | Pt 100/Ni 100 | | ± 0. 7 % | |
| | Pt 100 Klima | | ± 0. 8 % | |
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected input range) | | | | |
| • Voltage input | 80 mV<br>250 mV to 1,000 mV<br>2.5 V to 10 V | | ± 0.7 %<br>± 0.4 %<br>± 0.6 % | |
| • Current input | 3.2 mA to 20 mA | | ± 0.5 % | |
| • Resistance | 150 Ω; 300 Ω; 600 Ω | | ± 0.5 % | |
| • Thermocouple | Types E, N, J, K, L | | ± 0.7 % | |
| • Resistance thermometer | Pt 100/Ni 100 | | ± 0.5 % | |
| | Pt 100 Klima | | ± 0.6 % | |
| Temperature error (relative to input range) | ± 0.005%/K | | | |
| Linearity error (relative to input range) | ± 0.05 % | | | |
| Repeat accuracy (in settled state at 25 °C, relative to input range) | ± 0.05 % | | | |
| Temperature error of internal compensation | ± 1 % | | | |



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| **Technical specifications** | | |
|---|---|---|
| **Status, interrupts, diagnostics** | | |
| Interrupts<br>• Limit interrupt<br>• Diagnostic interrupt | programmable<br>Channels 0 and 2<br>programmable | |
| Diagnostic functions<br>• Group error display<br>• Reading diagnostics information | programmable<br>red LED (SF)<br>supported | |
| **Encoder selection data** | | |
| Input ranges (rated values) / input impedance | | |
| • Voltage | ± 80 mV<br>± 250 mV<br>± 500 mV<br>± 1,000 mV<br>± 2.5 V<br>± 5 V<br>1 V to 5 V<br>± 10 V | 10 MΩ<br>10 MΩ<br>10 MΩ<br>10 MΩ<br>100 kΩ<br>100 kΩ<br>100 kΩ<br>100 kΩ |
| • Current | ± 3.2 mA<br>± 10 mA<br>± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA | 25 Ω<br>25 Ω<br>25 Ω<br>25 Ω<br>25 Ω |
| • Resistance | 150 Ω<br>300 Ω<br>600 Ω | 10 MΩ<br>10 MΩ<br>10 MΩ |
| • Thermocouples | Types E, N, J, K, L | 10 MΩ |
| • Resistance thermometer | Pt 100, Ni 100 | 10 MΩ |
| Maximum voltage at voltage input (destruction limit) | max. 20 V, continuous<br>75 V for the duration of max. 1 s (duty factor 1:20) | |
| Maximum current at current input (destruction limit) | 40 mA | |
| Wiring of the signal transmitters | using a 20-pin front connector | |
| • for voltage measurement | supported | |
| • for current measurement<br>as 2-wire transducer<br>as 4-wire transducer | <br>supported<br>supported | |
| • For thermoresistor/resistance measurement<br>with 2-wire connection | <br>Supported, cable resistances are not compensated | |
| with 3-wire connection | Supported, cable resistances are not compensated | |
| with 4-wire connection | Supported, cable resistances are compensated | |
| • Load of the 2-wire transducer | max. 820 Ω | |
| Characteristics linearization<br>• for thermocouples | programmable<br>Types E, N, J, K, L | |
| • for resistance thermometers | Pt 100 (Standard and Klima range)<br>Ni 100 (Standard and Klima range) | |



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| Technical specifications | |
|---|---|
| Temperature compensation<br>• Internal temperature compensation | programmable<br>supported |
| • External temperature compensation with compensating box | supported |
| • Compensation for 0 °C reference junction temperature | supported |
| • Technical unit of temperature measurement | degrees Centigrade |

### See also

Diagnostics messages of analog input modules (Page 296)

## 6.7.2 Measurement types and ranges

### Introduction

Module SM 331; AI 8 x 12 Bit has measuring range modules

The measurement type and range is configured at the "measuring range" parameter in *STEP 7*.

The default setting of the module is "voltage" measurement with "± 10V" range. You can use these default settings without having to program the SM 331; AI 8 x 12 Bit in *STEP 7*.

### Measuring range modules

You may have to change the position of the measuring range modules to suit the measurement type and range (see the chapter *Setting the measuring types and ranges of analog input channels*). The necessary settings are also available on the module's imprint. Mark the position of the measuring range module on the front door (see figure).






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## Measurement types and ranges

Table 6- 18 Measurement types and ranges

| Selected type of measurement | Measuring range (type of sensor) | Measuring range module settings |
|---|---|---|
| Voltage<br>V | ± 80 mV<br>± 250 mV<br>± 500 mV<br>± 1000 mV | A |
| | ± 2.5 V<br>± 5 V<br>1 V to 5 V<br>± 10 V | B |
| Thermocouple<br>TC-I<br>(internal comparison) (thermal voltage measurement)<br>Linearization is ignored | Type N [NiCrSi-NiSi]<br>Type E [NiCr-CuNi]<br>Type J [Fe-CuNi]<br>Type K [NiCr-Ni]<br>Type L [Fe-CuNi] | A |
| Thermocouple<br>TC-E<br>(external comparison) (thermovoltage measurement)<br>Linearization is ignored | | |
| Thermocouple<br>(linear, internal comparison)<br>(temperature measurement) TC-IL | Type N [NiCrSi-NiSi]<br>Type E [NiCr-CuNi]<br>Type J [Fe-CuNi]<br>Type K [NiCr-Ni]<br>Type L [Fe-CuNi] | A |
| Thermocouple<br>(linear, external comparison)<br>(temperature measurement) TC-EL | | |
| Current (2-wire transducer)<br>2DMU | 4 mA to 20 mA | D |
| Current (4-wire transducer)<br>4DMU | ± 3.2 mA<br>± 10 mA<br>0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA | C |
| Resistance (4-wire connection)<br>R-4L | 150 Ω<br>300 Ω<br>600 Ω | A |
| Thermoresistor<br>(linear, 4-wire connection) (temperature measurement)<br>RTD-4L | Pt 100 Klima<br>Ni 100 Klima<br>Pt 100 Standard<br>Ni 100 Standard | A |



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### Channel groups

The channels of SM 331; AI 8 x 12 Bit are arranged in four groups of two channels. You can assign parameters only to one channel group.

SM 331; AI 8 x 12 Bit is equipped with one measuring range module per channel group.

The table below shows the relevant configuration of channel groups. The channel group number is required to program SFC parameters in the user program.

Table 6- 19 Assignment of SM 331; AI 8x12 bit channels to channel groups

| Channels ... | ...form one channel group each |
|---|---|
| Channel 0 | Channel group 0 |
| Channel 1 | |
| Channel 2 | Channel group 1 |
| Channel 3 | |
| Channel 4 | Channel group 2 |
| Channel 5 | |
| Channel 6 | Channel group 3 |
| Channel 7 | |

### See also

Programming analog modules (Page 294)

Diagnostics messages of analog input modules (Page 296)

## 6.7.3 Programmable parameters

### Introduction

For information on programming analog modules, refer to the chapter Programming analog modules (Page 294).



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## Parameters

Table 6- 20 Overview of the parameters for SM 331; AI 8 x 12 Bit

| Parameters | Range of values | Default | Parameter type | Scope |
|---|---|---|---|---|
| Enable<br>• Diagnostics interrupt<br>• Process interrupt when limit exceeded | <br>yes/no<br>yes/no | <br>no<br>no | dynamic | Module |
| Process interrupt trigger<br>• High limit<br>• Low limit | May be restricted by the measuring range<br>from 32511 to - 32512<br>from - 32512 to 32511 | - | dynamic | Channel |
| Diagnostics<br>• Group diagnostics<br>• with line continuity check | <br>yes/no<br>yes/no | <br>no<br>no | static | Channel group |
| Measurement<br>• Measurement type | <br>disabled<br>Voltage V<br>4DMU current (4-wire transducer)<br>2DMU current (2-wire transducer)<br>R-4L resistance (4-wire connection)<br>RTD-4L thermoresistor (linear, 4-wire connection)<br>TC-I thermocouple (internal comparison)<br>TC-E thermocouple (external comparison)<br>TC-IL thermocouple (internal comparison)<br>TC-EL thermocouple (linear, external comparison) | V | dynamic | Channel or channel group |
| • Measuring range | See the table *Measurement types and ranges* | ± 10 V | | |
| • Noise suppression | 400 Hz; 60 Hz; 50 Hz; 10 Hz | 50 Hz | | |



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## 6.7.4 Additional information on SM 331; AI 8 x 12 Bit

### Unused channels

As certain programmed inputs may remain unused due to the channel group configuration, make allowances for the special features of these inputs outlined below in order to be able to use the diagnostics functions at these used channels:

- **Voltage measurement (except 1 V to 5V)** and for thermocouples: Short-circuit unused channels and connect these with $M_{ANA}$. This optimizes interference immunity of the analog input module. Set the "disabled" value at the "measurement type" parameter for unused channels. This setting reduces module cycle times. Also short-circuit the COMP input if this is not used.
- **Measuring range 1 V to 5 V:** wire the used and unused inputs of the same channel group in parallel.
- **Current measurement, 2-wire transducer:** There are two options of wiring the channel circuit.

  a) Open unused input; channel group diagnostics disabled. If you were to enable diagnostics, the analog module would trigger a single diagnostic interrupt, and light up its SF LED.

  b) Loading the unused input using a 1.5 kΩ to 3.3 kΩ resistor. This allows you to enable diagnostics for this channel group.
- **Current measurement 4 mA to 20 mA, 4-wire transducer:** wire the unused inputs of the same channel group in series.

### All channels deactivated

If you disable **all** input channels of the module and enable diagnostics at the parameters of SM 331; AI 8 x 12 Bit, the module does **not** report "external auxiliary voltage missing."

### Line continuity check for the 4 mA to 20 mA measuring range

If you configured a measuring range of 4 mA to 20 mA, and **enabled the line continuity check**, the analog input module logs a wire-break event to diagnostics data when the current drops below 3.6 mA.

The module also triggers a diagnostics interrupt if this function is enabled in the program.

A wire break can only be signaled by means of the lit SF LED and the diagnostic bytes must be evaluated in the user program if diagnostics interrupts are disabled.

If you configured a measuring range of 4 mA to 20 mA, **disabled** the line continuity check, and enabled diagnostic interrupts, the module triggers a diagnostic interrupt when the underflow value is reached.

### Line continuity check

The line continuity check is designed only for temperature measurements (thermocouples and thermoresistors.)

### See also

Representation of the values for analog input channels (Page 262)



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# 6.8 Analog input module SM 331; AI 2 x 12 Bit; (6ES7331-7KB02-0AB0)

## 6.8.1 Analog input module SM 331; AI 2 x 12-bit; (6ES7331-7KB02-0AB0)

### Order number: "Standard module"

6ES7331-7KB02-0AB0

### Order number: "SIPLUS S7-300 module"

6AG1331-7KB02-2AB0

### Properties

- Two inputs in one channel group
- Programmable measurement type for each channel group
  - Voltage
  - Current
  - Resistance
  - Temperature
- Programmable resolution at each channel group (9/12/14 bits + sign)
- Any measuring range selection per channel group
- Programmable diagnostics and diagnostic interrupt
- Programmable limit value monitoring for one channel
- Programmable hardware interrupt when limit is exceeded
- Electrically isolated from the CPU and load voltage (not for 2DMU)

### Resolution

The measured value resolution is directly proportional to the selected integration time, that is, the measured value resolution increases in proportion to length of the integration time at the analog input channel.

### Diagnostics

For information on diagnostics messages at the "group diagnostics" parameter, refer to chapter Diagnostic messages of analog input modules.



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## Hardware interrupts

Hardware interrupts for channel groups can be programmed in *STEP 7*. However, set a hardware interrupt only for the first channel of a channel group, that is channel 0.

## Terminal assignment

The diagrams below show various wiring options The input impedance depends on programmed measuring range.

## Wiring: Voltage measurement

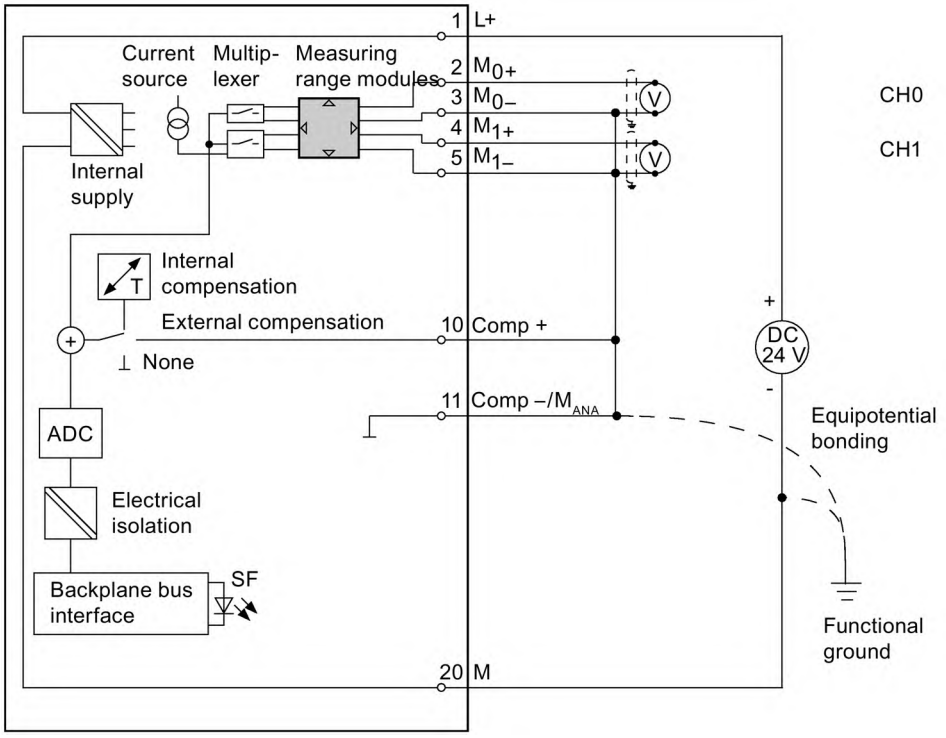



Figure 6-17 Wiring and block diagram

## Measuring range module settings

| Measuring range | Measuring range module setting |
|---|---|
| ± 80 mV<br>± 250 mV<br>± 500 mV<br>± 1,000 mV | A |
| ± 2.5 V<br>± 5 V<br>1 V to 5 V<br>± 10 V | B |



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## Wiring: Thermocouple with external compensation

Insert a bridge between Comp+ and $M_{ANA}$ when using the internal compensation.

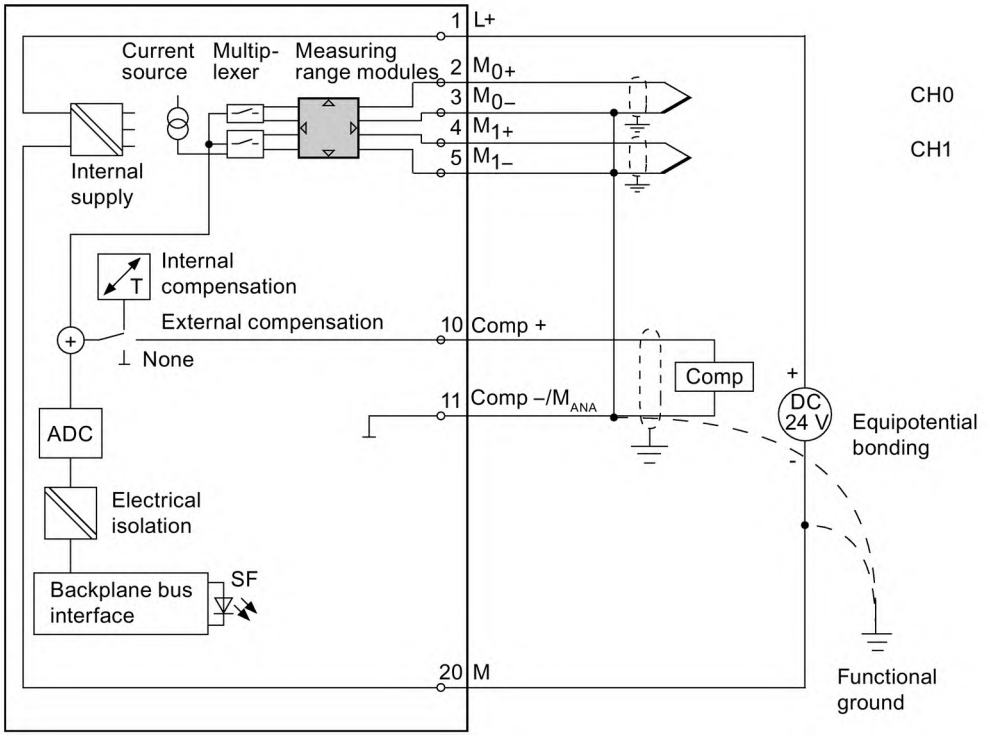



Figure 6-18 Wiring and block diagram

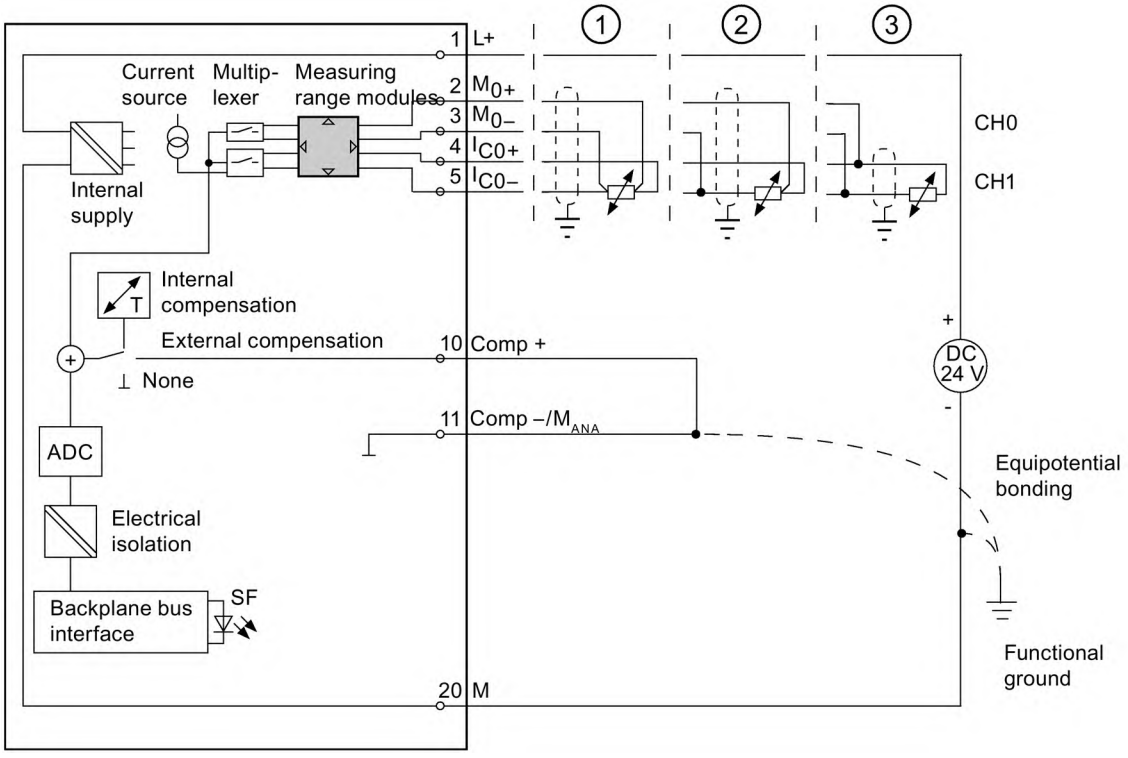
## Measuring range module settings

| Measuring range | | Measuring range module setting |
|---|---|---|
| TC-I: Thermocouple (internal comparison) (thermal voltage measurement) | Type N [NiCrSi-NiSi]<br>Type E [NiCr-CuNi]<br>Type J [Fe-CuNi]<br>Type K [NiCr-Ni]<br>Type L [Fe-CuNi] | A |
| TC-E: Thermocouples (external comparison) (thermovoltage measurement) | | |
| TC-IL: Thermocouples (linear, internal comparison) (temperature measurement) | Type N [NiCrSi-NiSi]<br>Type E [NiCr-CuNi]<br>Type J [Fe-CuNi]<br>Type K [NiCr-Ni]<br>Type L [Fe-CuNi] | A |
| TC-EL: Thermocouples (linear, external comparison) (temperature measurement) | Type N [NiCrSi-NiSi]<br>Type E [NiCr-CuNi]<br>Type J [Fe-CuNi]<br>Type K [NiCr-Ni]<br>Type L [Fe-CuNi] | A |



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## Wiring: 2-, 3- and 4-wire connection of resistance transducers or thermoresistors




① 4-wire connection
② 3-wire connection, no compensation for line resistors
③ 2-wire connection, no compensation for line resistors

Figure 6-19 Wiring and block diagram

## Measuring range module settings

| Measuring range | | Measuring range module setting |
|---|---|---|
| 150 Ω<br>300 Ω<br>600 Ω | | A |
| RTD-4L: Thermal resistance<br>(linear, 4-wire connection) (temperature measurement) | Pt 100 Klima<br>Ni 100 Klima<br>Pt 100 Standard<br>Ni 100 Standard | A |

**Note**

"Resistance measurement" is only available at one channel per group. The "2nd" channel of the group is used accordingly for current measuring mode ($I_C$).

The "1st" returns the measured value. The "2nd" channel of the group is assigned the default overflow value "$7FFF_H$."



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## Wiring: 2-wire and 4-wire transducers for current measurement

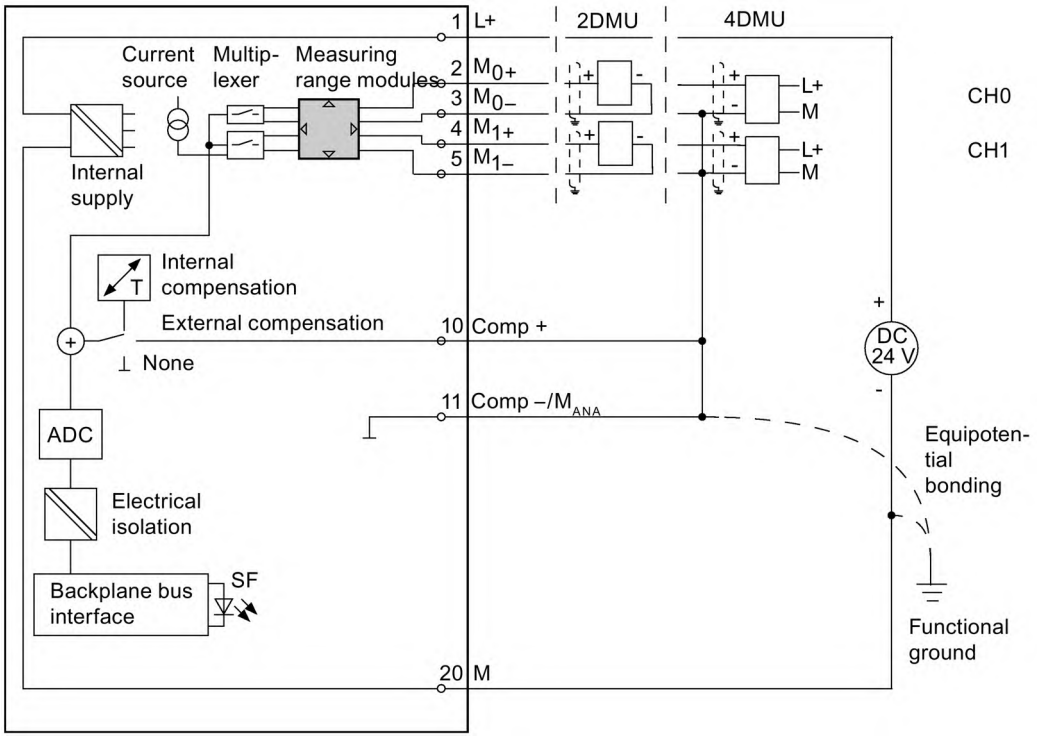



Figure 6-20 Wiring and block diagram

## Measuring range module settings

| Measuring range | | Measuring range module setting |
|---|---|---|
| 2-wire transducer | 4 mA to 20 mA | D |
| 4-wire transducer | ± 3.2 mA<br>± 10 mA<br>0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA | C |

**CAUTION**

**Measuring range module in "Current" position**

If "current" measuring mode is set, any voltage measurement will destroy the measuring range module.



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## Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | approx. 250 g |
| **Module-specific data** | |
| Supports isochronous mode | No |
| Number of inputs<br>• with resistive transducers | 2<br>1 |
| Cable length<br>• shielded | max. 200 m<br>max. 50 m at 80 mV and with thermocouples |
| **Voltages, currents, electrical potentials** | |
| Rated electronics supply voltage L +<br>• Reverse polarity protection | 24 V DC<br>Yes |
| Transducer power supply<br>• Supply current<br>• short circuit-proof | <br>max. 60 mA (per channel)<br>Yes |
| Constant current for resistive transducers | typ. 1.67 mA (pulsed) |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels and electronics power supply<br>– Not for 2-wire transducers | <br>Yes<br>Yes |
| Maximum potential difference<br>• between inputs and $M_{ANA}$ ($V_{CM}$)<br>– at signal = 0 V<br>• between inputs ($V_{CM}$) | <br>typ. 2.5 V DC (> 2.3 V DC)<br><br>typ. 2.5 V DC (> 2.3 V DC) |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ | <br>max. 50 mA<br>max. 30 mA (without 2-wire transducer) |
| Power loss of the module | typ. 1 W |



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| **Technical specifications** | | | | |
|---|---|---|---|---|
| **Generation of analog values** | | | | |
| Measuring principle | Integrating | | | |
| Integration/conversion time/resolution (per channel) | | | | |
| • programmable | Yes | | | |
| • Integration time in ms | 2.5 | $16^2/_3$ | 20 | 100 |
| • Basic conversion time, including the integration time in ms | 3 | 17 | 22 | 102 |
| Additional conversion time for resistance measurement, in ms or | 1 | 1 | 1 | 1 |
| additional conversion time for wire-break monitoring in ms or | 10 | 10 | 10 | 10 |
| additional conversion time for resistance measurements **and** wire-break monitoring in ms | 16 | 16 | 16 | 16 |
| • Resolution in bits (including overshoot range) | 9 bits | 12 bits | 12 bits | 14 bits |
| • Interference frequency suppression at interference frequency f1 in Hz | 400 | 60 | 50 | 10 |
| • Basic execution time of the module in ms (all channels enabled) | 6 | 34 | 44 | 204 |
| Measured value smoothing | none | | | |
| Interference frequency suppression, error limits | | | | |
| Interference frequency suppression at f = n (f1 ± 1%), (f1 = interference frequency) n=1.2... | | | | |
| • Common mode interference ($V_{CM}$ < 2.5 V)<br>• Seriesmode interference (peak interference value < rated input range) | > 70 dB<br>> 40 dB | | | |
| Crosstalk between inputs | > 50 dB | | | |
| Operational limit (across entire temperature range, relative to the measurement range end value of the selected input range) | | | | |
| • Voltage input | 80 mV<br>250 mV to 1,000 mV<br>2.5 V to 10 V | | ± 1 %<br>± 0.6 %<br>± 0.8 % | |
| • Current input | 3.2 mA to 20 mA | | ± 0.7 % | |
| • Resistance | 150 Ω; 300 Ω; 600 Ω | | ± 0. 7 % | |
| • Thermocouple | Types E, N, J, K, L | | ± 1. 1 % | |
| • Resistance thermometer | Pt 100/Ni 100 | | ± 0. 7 % | |
| | Pt 100 Klima | | ± 0. 8 % | |



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| **Technical specifications** | | |
|---|---|---|
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected input range) | | |
| • Voltage input | 80 mV<br>250 mV to 1,000 mV<br>2.5 V to 10 V | ± 0.6 %<br>± 0.4 %<br>± 0.6 % |
| • Current input | 3.2 mA to 20 mA | ± 0.5 % |
| • Resistance | 150 Ω; 300 Ω; 600 Ω | ± 0.5 % |
| • Thermocouple | Types E, N, J, K, L | ± 0.7 % |
| • Resistance thermometer | Pt 100/Ni 100 | ± 0.5 % |
| | Pt 100 Klima | ± 0.6 % |
| Temperature error (relative to input range) | ± 0.005%/K | |
| Linearity error (relative to input range) | ± 0.05 % | |
| Repeat accuracy (in settled state at 25°C, relative to input range) | ± 0.05 % | |
| Temperature error of internal compensation | ± 1 % | |
| **Status, interrupts, diagnostics** | | |
| Interrupts<br>• Limit interrupt<br>• Diagnostic interrupt | programmable<br>Channels 0<br>programmable | |
| Diagnostic functions<br>• Group error display<br>• Reading diagnostics information | programmable<br>red LED (SF)<br>supported | |
| **Encoder selection data** | | |
| Input ranges (rated values) / input impedance | | |
| • Voltage | ± 80 mV<br>± 250 mV<br>± 500 mV<br>± 1,000 mV<br>± 2.5 V<br>± 5 V<br>1 V to 5 V<br>± 10 V | 10 MΩ<br>10 MΩ<br>10 MΩ<br>10 MΩ<br>100 kΩ<br>100 kΩ<br>100 kΩ<br>100 kΩ |
| • Current | ± 3.2 mA<br>± 10 mA<br>± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA | 25 Ω<br>25 Ω<br>25 Ω<br>25 Ω<br>25 Ω |
| • Resistance | 150 Ω<br>300 Ω<br>600 Ω | 10 MΩ<br>10 MΩ<br>10 MΩ |
| • Thermocouples | Types E, N, J, K, L | 10 MΩ |
| • Resistance thermometer | Pt 100, Ni 100 | 10 MΩ |



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| **Technical specifications** | |
|---|---|
| Maximum voltage at voltage input (destruction limit) | max. 20 V continuous; 75 V for the duration of max. 1 s (duty factor 1:20) |
| Maximum current at current input (destruction limit) | 40 mA |
| Wiring of the signal transmitters | using a 20-pin front connector |
| • for voltage measurement | supported |
| • for current measurement<br>as 2-ire transducer<br>as 4-wire transducer | <br>supported<br>supported |
| • For thermoresistor/resistance measurement<br>With 2-wire connection<br>With 3-wire connection<br>With 4-wire connection | <br>Supported, cable resistances are not compensated<br>Supported, cable resistances are not compensated<br>Supported, cable resistances are compensated |
| • Load of the 2-wire transducer | max. 820 Ω |
| Characteristics linearization<br>• for thermocouples<br>• for resistance thermometers | programmable<br>Types E, N, J, K, L<br>Pt 100 (Standard and Klima range)<br>Ni 100 (Standard and Klima range) |
| Temperature compensation<br>• Internal temperature compensation<br>• External temperature compensation with compensating box<br>• Compensation for 0 °C reference junction temperature<br>• Technical unit of temperature measurement | programmable<br>supported<br>supported<br>supported<br>degrees Centigrade |

## See also

Causes of error and troubleshooting at analog input modules (Page 297)



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## 6.8.2 Measurement types and measuring ranges

### Introduction

SM 331; AI 2 x 12 Bit is equipped with a measuring range module. The measurement type and range is configured at the "measuring range" parameter in *STEP 7*. You can use the default "voltage" measurement type and "± 10 V range without having to program the SM 331; AI 2 x 12 Bit in *STEP 7*.

### Measuring range module

Change the position of the measuring range module to set the measurement type and range (see the chapter *Setting the measurement types and ranges of analog input channels* ). The necessary settings are also available on the module's imprint. Mark the position of the measuring range module on the front door (see figure).




Table 6- 21 Measurement types and ranges

| Selected type of measurement | Measuring range (type of sensor) | Measuring range module settings |
|---|---|---|
| V: Voltage | ± 80 mV<br>± 250 mV<br>± 500 mV<br>± 1000 mV | A |
| | ± 2.5 V<br>± 5 V<br>1 V to 5 V<br>± 10 V | B |
| TC-I: Thermocouple<br>(internal comparison) (thermal voltage measurement) | Type N [NiCrSi-NiSi]<br>Type E [NiCr-CuNi]<br>Type J [Fe-CuNi]<br>Type K [NiCr-Ni]<br>Type L [Fe-CuNi] | A |
| TC-E: Thermocouples<br>(external comparison)<br>(thermal voltage measurement) | | |
| 2DMU: Current (2-wire transducer) | 4 mA to 20 mA | D |
| 4DMU: Current (4-wire transducer) | ± 3.2 mA<br>± 10 mA<br>0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA | C |
| R-4L: Resistance<br>(4-wire connection) | 150 Ω<br>300 Ω<br>600 Ω | A |



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| Selected type of measurement | Measuring range (type of sensor) | Measuring range module settings |
|---|---|---|
| TC-IL: Thermocouples (linear, internal comparison)<br>(temperature measurement) | Type N [NiCrSi-NiSi]<br>Type E [NiCr-CuNi]<br>Type J [Fe-CuNi]<br>Type K [NiCr-Ni]<br>Type L [Fe-CuNi] | A |
| TC-EL: Thermocouples<br>(linear, external comparison)<br>(temperature measurement) | Type N [NiCrSi-NiSi]<br>Type E [NiCr-CuNi]<br>Type J [Fe-CuNi]<br>Type K [NiCr-Ni]<br>Type L [Fe-CuNi] | A |
| RTD-4L: Thermal resistance<br>(linear, 4-wire connection) (temperature measurement) | Pt 100 Klima<br>Ni 100 Klima<br>Pt 100 Standard<br>Ni 100 Standard | A |

## Channel groups

The two channels of SM 331; AI 2 x 12 Bit form a channel group. You can assign parameters only to one channel group.

SM 331; AI 2 x 12 Bit is equipped with a measuring range module for channel group 0.

## Line continuity check

The line continuity check is designed only for temperature measurements (thermocouples and thermoresistors.)

## Special features of the line continuity check for the 4 mA to 20 mA measuring range

If you configured a measuring range of 4 mA to 20 mA, and **enabled the line continuity check**, the analog input module logs a wire-break event to diagnostics data when the current drops below 3.6 mA.

The module also triggers a diagnostics interrupt if this function is enabled in the program.

A wire break can only be signaled by means of the lit SF LED and the diagnostic bytes must be evaluated in the user program if diagnostics interrupts are disabled.

If you configured a measuring range of 4 mA to 20 mA, **disabled** the line continuity check, and enabled diagnostic interrupts, the module triggers a diagnostic interrupt when the underflow value is reached.



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## 6.8.3 Programmable parameters

### Introduction

For general information on programming analog modules, refer to the chapter Programming analog modules (Page 294).

### Parameters

Table 6- 22 Overview of the parameters of SM 331; AI 2 x 12 Bit

| Parameters | Range of values | Default | Parameter type | Scope |
|---|---|---|---|---|
| Enable<br>• Diagnostics interrupt<br>• Process interrupt when limit exceeded | <br>yes/no<br>yes/no | <br>no<br>no | dynamic | Module |
| Process interrupt trigger<br>• High limit<br>• Low limit | <br>32511 to -32512<br>from - 32512 to 32511 | - | dynamic | Channel |
| Diagnostics<br>• Group diagnostics<br>• with line continuity check | <br>yes/no<br>yes/no | <br>no<br>no | static | Channel group |
| Measurement<br>• Measurement type | <br>disabled<br>Voltage V<br>4DMU current (4-wire transducer)<br>2DMU current (2-wire transducer)<br>R-4L resistance (4-wire connection)<br>RTD-4L thermoresistor (linear, 4-wire connection)<br>TC-I thermocouple (internal comparison)<br>TC-E thermocouple (external comparison)<br>TC-IL thermocouple (internal comparison)<br>TC-EL thermocouple (linear, external comparison) | V | dynamic | Channel or channel group |
| • Measuring range | Refer to the chapter Measuring methods and ranges (Page 376) for the adjustable measuring ranges of the input channels | ± 10 V | | |
| • Noise suppression | 400 Hz; 60 Hz; 50 Hz; 10 Hz | 50 Hz | | |

### See also

Diagnostics messages of analog input modules (Page 296)



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## 6.8.4 Additional information on SM 331; AI 2 x 12 Bit

### Unused channels

Short-circuit unused channels and connect these with $M_{ANA}$. This optimizes interference immunity of the analog input module. Set the "disabled" value at the "measurement type" parameter for unused channels. This setting reduces module cycle times.

Also short-circuit the COMP input if this is not used.

As certain programmed inputs may remain unused due to the channel group configuration, make allowances for the special features of these inputs outlined below in order to be able to use the diagnostics functions at these used channels:

- **Measuring range 1 V to 5 V:** wire the used input and unused input of the same channel group in parallel.
- **Current measurement, 2-wire transducer:** There are two options of setting up the channel circuit:

  a) Open unused input; channel group diagnostics disabled. The analog module would trigger a single diagnostics interrupt and set its SF LED if diagnostics is enabled.

  b) Terminating the unused input using a 1.5 kΩ to 3.3 kΩ resistor. This allows you to enable diagnostics for this channel group.
- **Current measurement 4 mA to 20 mA, 4-wire transducer:** wire the used input and unused input of the same channel group in series.

### Line continuity check

The line continuity check is designed only for temperature measurements (thermocouples and thermoresistors.)

### Special features of the line continuity check for the 4 mA to 20 mA measuring range

If you configured a measuring range of 4 mA to 20 mA, and **enabled the line continuity check**, the analog input module logs a wire-break event to diagnostics data when the current drops below 3.6 mA.

The module also triggers a diagnostics interrupt if this function is enabled in the program.

A wire break can only be signaled by means of the lit SF LED and the diagnostic bytes must be evaluated in the user program if diagnostics interrupts are disabled.

If you configured a measuring range of 4 mA to 20 mA, **disabled the line continuity check** and enabled diagnostic interrupts, the module triggers a diagnostic interrupt when the underflow value is reached.



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# 6.9 Analog input module SM 331; AI 8 x RTD; (6ES7331-7PF01-0AB0)

## 6.9.1 Analog input module SM 331; AI 8 x RTD (6ES7331-7PF01-0AB0)

### Order number

6ES7331-7PF01-0AB0

### Properties

- 8 inputs in 4 channel groups
- Measurement type programmable for each channel group
  - Resistor
  - Temperature
- Programmable resolution for each channel group (15 bits + sign)
- Measuring range selection for each channel group
- Configurable diagnostics and diagnostic interrupt
- Limit monitoring adjustable for 8 channels
- Hardware interrupt can be set for violation of the limit
- Fast measurement update for 4 channels
- Hardware interrupt can be set for end of scan cycle
- Potential-free from the CPU
- Supports the Configuration in RUN function

### Resolution

The resolution of measured values is independent of the selected integration time.

### Diagnostics

You can find the diagnostic messages grouped under the "Group diagnostics" parameter in the section Diagnostic messages of the analog input modules.

### Hardware interrupts

You can set hardware interrupts in STEP 7 for channel groups 0 and 1. However, set a hardware interrupt only for the first channel of a channel group, that is, either at channel 0, or at channel 2.



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## Pin assignment

The figures below show the various connection options. These connection examples apply to all channels (channels 0 to 7).

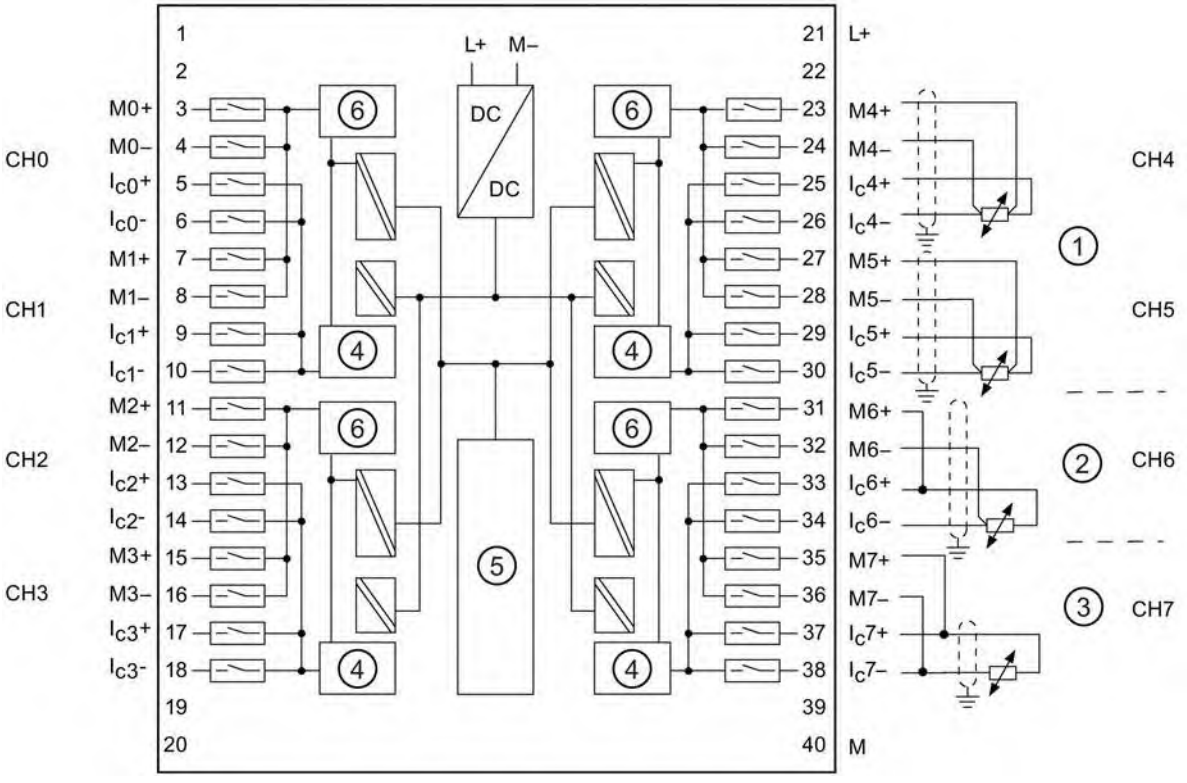
**CAUTION**

**Wiring**

Incorrect wiring of the 3-wire connection can result in unpredictable operation of the module and dangerous conditions in the plant.

## Wiring: 2, 3 and 4-wire connection for resistance and thermal resistance measurement

Connection possible at both sides to channels 0 to 7




① 4-wire connection
② 3-wire connection
③ 2-wire connection
④ Digital-analog converter
⑤ Backplane bus interface
⑥ Analog-to-digital converter (ADC)

Figure 6-21 Wiring and block diagram



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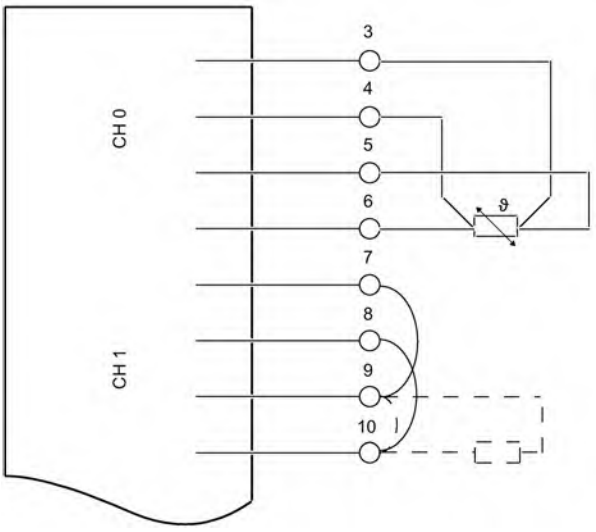



Figure 6-22 Unused channel

**Note**

- Always use channel n (in this case channel 0) for measurement

- Short-circuit unused channels (in this case channel 1) **or** connect them in order to avoid diagnostic results with a resistance of the rated range (eg.100 ohms at Pt 100)

**CAUTION**

**Wiring**

Incorrect wiring of the 3-wire connection can result in unpredictable operation of the module and dangerous conditions in the plant.

## Wiring: 3-wire connection

With a 3-wire connection to the SM 331; AI 8 x RTD, you need to set a **jumper between $M_{+}$ and $I_{C+}$**.

Always ensure that the connected **$I_C$ and M** cables are directly to the resistance thermometer.

## Wiring: 2-wire connection

With a 2-wire connection to the SM 331; AI 8 x RTD, you need to set a **jumper between $M_{+}$ and $I_{C+}$** as well as $M_{-}$ and $I_{C-}$ .

There is no compensation of the line resistance with a 2-wire connection. The line resistances are also measured!



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## Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | approx. 272 g |
| **Module-specific data** | |
| Configuration in RUN possible | Yes |
| Behavior of the non-configured inputs | Provides the last valid process value before the parameter assignment |
| Supports isochronous operation | No |
| Number of inputs | 8 |
| Cable length<br>• Shielded | <br>max. 200 m |
| **Voltages, currents, potentials** | |
| Supply voltage of the electronics L+<br>• Reverse polarity protection | 24 V DC<br>Yes |
| Constant measurement current for resistance-type transmitter | max. 5 mA (pulsed) |
| Electrical isolation<br>• Between channels and backplane bus<br>• between channels and electronics power supply<br>• Between the channels<br>In groups of | <br>Yes<br>Yes<br>Yes<br>2 |
| Insulation tested with | 500 V DC |
| Current consumption<br>• From backplane bus<br>• from supply voltage L+ | <br>max. 100 mA<br>max. 240 mA |
| Power loss of the module | typ. 4.6 W |
| **Analog value formation** | |
| Measuring principle | Integrating |
| Mode | **8-channel mode (hardware filter)** |
| Integration/conversion time/resolution (per channel)<br>• Configurable<br>• Basic conversion time in ms<br>• Additional conversion time for resistance measurement in ms<br>• Additional conversion time for wire break monitoring in ms<br>• Resolution (including overrange)<br>• Interference voltage suppression at interference frequency f1 in Hz | <br>Yes<br>80<br>100*<br>0<br>16-bit (including sign)<br>400 / 60 / 50 |
| Smoothing of the measured values | None/Weak/Medium/Strong |
| Conversion time (per channel) | 100 ms |
| Basic execution time of the module (all channels enabled) | 200 ms |



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| **Technical specifications** | |
|---|---|
| Mode | **8-channel mode (software filter)** |
| Integration/conversion time/resolution (per channel)<br>• Configurable<br>• Basic conversion time in ms<br>• Additional conversion time for resistance measurement in ms<br>• Additional conversion time for wire break monitoring in ms<br>• Resolution (including overrange)<br>• Interference voltage suppression at interference frequency f1 in Hz | <br>Yes<br>8 / 25 / 30<br>25/ 43/ 48*<br>0<br>16-bit (including sign)<br>400 / 60 / 50 |
| Smoothing of the measured values | None/Weak/Medium/Strong |
| Conversion time (per channel) | 25/ 43/ 48 ms |
| Basic execution time of the module (all channels enabled) | 50/ 86/ 96 ms |
| Mode | **4-channel mode (hardware filter)** |
| Integration/conversion time/resolution (per channel)<br>• Configurable<br>• Basic conversion time in ms<br>• Additional conversion time for resistance measurement in ms<br>• Additional conversion time for wire break monitoring in ms<br>• Resolution (including overrange)<br>• Interference voltage suppression at interference frequency f1 in Hz | <br>Yes<br>3.3****<br>100*<br>100**<br>16-bit (including sign)<br>400 / 60 / 50 |
| Smoothing of the measured values | None/Weak/Medium/Strong |
| Basic execution time of the module (all channels enabled) | 10 ms |
| **Interference suppression, error limits** | |
| Interference voltage suppression for f = n x (f1 ± 1 %), (f1 = interference frequency), n = 1, 2, etc. | |
| • Common mode interference ($U_{CM}$ < 60 V AC)<br>• Series-mode interference (peak value of the interference < rated value of the input range) | > 100 dB<br>> 90 dB |
| Crosstalk between inputs | > 100 dB |
| Operational limit (within the entire temperature range, relative to the measuring range end value of the selected input range) | |
| • Resistance thermometer<br>– Pt 50, Pt 100, Pt 200, Pt 500, Pt 1000, Ni 100, Ni 120, Ni 200, Ni 500, Ni 1000, LG-Ni 1000, Cu 50, Cu 100,<br>– Pt 10, Cu 10<br>• Resistor | <br>± 1.0 °C<br>± 2.0 °C<br>± 0.1 % |
| Basic error limit (operational limit at 25 °C, in relation to measuring range full-scale value of the input range) | |
| • Resistance thermometer<br>– Pt 50, Pt 100, Pt 200, Pt 500, Pt 1000, Ni 100, Ni 120, Ni 200, Ni 500, Ni 1000, LG-Ni 1000, Cu 50, Cu 100,<br>– Pt 10, Cu 10<br>• Resistor | <br>± 0.5 °C<br>± 1.0 °C<br>±0.05 % |



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| **Technical specifications** | |
|---|---|
| Temperature error (in relation to input range)<br>• Resistance thermometer<br>• Resistor | <br>± 0.015 °C/K<br>± 0.005 %/K |
| Linearity error (referenced to input range)<br>• Resistance thermometer<br>• Resistor | <br>± 0.2 °C<br>± 0.02 % |
| Repeat accuracy (in steady state at 25 °C, referenced to input range)<br>• Resistance thermometer<br>• Resistor | <br>± 0.2 °C<br>± 0.01 % |
| **Status, interrupts, diagnostics** | |
| Interrupts<br>• Hardware interrupt<br>• Diagnostics interrupt | <br>Configurable (channels 0-7)<br>Configurable |
| Diagnostics function<br>• Group error display<br>• Diagnostic information can be read | Configurable<br>Red LED (group error)<br>possible |
| **Encoder selection data** | |
| Input range (rated values) input resistance<br>• Resistance thermometer<br>• Resistor | <br>Pt 10, Pt 50, Pt 100, Pt 200, Pt 500, Pt 1000, Ni 100, Ni 120, Ni 200, Ni 500, Ni 1000, LG-Ni 1000, Cu 10, Cu 50, Cu 100 (standard and climatic)<br>150, 300, 600 Ω |
| Permissible input voltage at voltage input (destruction limit) | 35 V DC continuous 75 V DC for max. 1 s (duty cycle 1 : 20) |
| Wiring of the signal transmitters<br>• for resistance measurement<br>with 2-wire connection<br>with 3-wire connection<br>with 4-wire connection | with 40-pin front connector<br><br>possible<br>possible***<br>possible |
| Characteristic linearization<br>• Resistance thermometer<br>• Technical unit for temperature measurement | <br>Pt 10, Pt 50, Pt 100, Pt 200, Pt 500, Pt 1000, Ni 100, Ni 120, Ni 200, Ni 500, Ni 1000, LG-Ni 1000, Cu 10, Cu 50, Cu 100 (standard and climatic)<br>Degrees Celsius / degrees Fahrenheit |

* The resistance test for compensation of the line resistances with a 3-wire connection is performed every 5 minutes.

** Wire break monitoring in 4-channel mode (hardware filter) is performed every 3 seconds.

*** The maximum line resistance with 3-wire encoder measurements for the RTD elements PT 10 and Cu 10 is 10 Ω. For all other RTD elements, the maximum power resistance for 3-wire encoder measurements is 20 Ω.

**** In 4-channel mode, the converted value settles to 100% within 80 ms. The value determined in this process is switched typically every 3.3 ms (max. 10 ms).



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## Configuration in RUN

Special considerations must be given if you use the Configuration in RUN function.

SF LED is lit:

Status before re-configuration diagnostics on, SF LEDs lit among others (on CPU, IM or module), although diagnostics are no longer pending and the module is operating correctly.

Solution:

- Only change the configuration when no diagnostics are pending for the module or
- Pulling and plugging the module.



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## 6.9.2 Measurement types and measuring ranges

### Introduction

The measurement type and range is configured at the "measurement type" parameter in *STEP 7*.

Table 6- 23 Measurement types and ranges

| Selected type of measurement | Measuring range |
|---|---|
| Resistance:<br>(3-/4-wire connection) | 150 Ω<br>300 Ω<br>600 Ω |



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| Selected type of measurement | Measuring range |
|---|---|
| RTD resistance and linearization:<br>(3-/4-wire connection) | Pt 100 Klima<br>Pt 200 Klima<br>Pt 500 Klima<br>Pt 1000 Klima<br>Ni 100 Klima<br>Ni 120 Klima<br>Ni 200 Klima<br>Ni 500 Klima<br>Ni 1000 Klima*<br>LG-Ni 1000 Klima<br>Cu 10 Klima<br>Pt 100 Standard<br>Pt 200 Standard<br>Pt 500 Standard<br>Pt 1000 Standard<br>Ni 100 Standard<br>Ni 120 Standard<br>Ni 200 Standard<br>Ni 500 Standard<br>Ni 1000 Standard*<br>LG-Ni 1000 Standard<br>Cu 10 Standard<br>Pt 10 GOST Klima<br>Pt 10 GOST Standard<br>Pt 50 GOST Klima<br>Pt 50 GOST Standard<br>Pt 100 GOST Klima<br>Pt 100 GOST Standard<br>Pt 500 GOST Klima<br>Pt 500 GOST Standard<br>Cu 10 GOST Klima<br>Cu 10 GOST Standard<br>Cu 50 GOST Klima<br>Cu 50 GOST Standard<br>Cu 100 GOST Klima<br>Cu 100 GOST Standard<br>Ni 100 GOST Klima<br>Ni 100 GOST Standard |

* ≙ LG-Ni 1000 with temperature coefficient 0.00618 or 0.00672



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### Channel groups

The channels of SM 331; AI 8 x RTD are arranged in four groups of two channels. You can assign parameters only to one channel group.

The table below shows the relevant configuration of channel groups. The channel group number is required to program SFC parameters in the user program.

Table 6- 24 Assignment of SM 331; AI 8 x RTD channels to channel groups

| Channels ... | ... form one channel group each |
|---|---|
| Channel 0 | Channel group 0 |
| Channel 1 | |
| Channel 2 | Channel group 1 |
| Channel 3 | |
| Channel 4 | Channel group 2 |
| Channel 5 | |
| Channel 6 | Channel group 3 |
| Channel 7 | |

## 6.9.3 Programmable parameters

### Introduction

For general information on programming analog modules, refer to the chapter Programming analog modules (Page 294).

The table below provides an overview of programmable parameters and of their defaults:

### Parameters

Table 6- 25 Overview of SM 331; AI 8 x RTD parameters

| Parameters | Range of values | Default | Parameter type | Scope |
|---|---|---|---|---|
| Enable<br>• Diagnostics interrupt<br>• Process interrupt when limit exceeded<br>• Process interrupt at end of cycle | <br>yes/no<br>yes/no<br>yes/no | <br>no<br>no<br>no | dynamic | Module |
| Process interrupt trigger<br>• High limit<br>• Low limit | 32511 to -32512<br>from - 32512 to 32511 | 32767<br>-32768 | dynamic | Channel |
| Diagnostics<br>• Group diagnostics<br>• with line continuity check | <br>yes/no<br>yes/no | <br>no<br>no | static | Channel group |



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| Parameters | Range of values | Default | Parameter type | Scope |
|---|---|---|---|---|
| Measurement<br>• Measurement type | disabled<br>R-4L resistance (4-wire connection)<br>R-3L resistance (3-wire connection)<br>RTD-4L thermoresistor (linear, 4-wire connection)<br>RTD-3L thermoresistor (linear, 3-wire connection) | RTD-4L | dynamic | Channel group |
| • Measuring range | See chapter Measurement types and measuring ranges (Page 387) | Pt 100 Klima<br>0.003850 (IPTS-68) | | |
| • Temperature unit | Degrees Centigrade; degrees Fahrenheit | degrees Centigrade | dynamic | Module |
| • Mode of operation | 8-channel mode (hardware filter)<br>8-channel mode (software filter)<br>4-channel mode (hardware filter) | 8-channel mode, hardware filter | dynamic | Module |
| • Temperature coefficient for temperature measurement with thermoresistor (RTD) | Platinum (Pt)<br>0.003850 Ω/Ω/ °C (IPTS-68)<br>0.003916 Ω/Ω/ °C<br>0.003902 Ω/Ω/ °C<br>0.003920 Ω/Ω/ °C<br>0.003850 Ω/Ω/ °C (ITS-90)<br>0.003910 Ω/Ω/ °C<br>Nickel (Ni)<br>0.006170 Ω/Ω/ °C<br>0.006180 Ω/Ω/ °C<br>0.006720 Ω/Ω/ °C<br>0.005000 Ω/Ω/ °C (LG Ni 1000)<br>Copper (Cu)<br>0.004260 Ω/Ω/ °C<br>0.004270 Ω/Ω/ °C<br>0.004280 Ω/Ω/ °C | 0,003850 | dynamic | Channel group |
| • Noise suppression* | 50/60/400 Hz; 400 Hz; 60 Hz; 50 Hz | 50/60/400 Hz | dynamic | Channel group |
| • Smoothing | none<br>weak<br>medium<br>strong | none | dynamic | Channel group |
| ***** 50/60/400 Hz only programmable for 8-channel mode (hardware filter) and 4-channel mode (hardware filter); 50 Hz, 60 Hz or 400 Hz only programmable for 8-channel mode (software filter) | | | | |

## See also

Diagnostics messages of analog input modules (Page 296)



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## 6.9.4 Additional information on SM 331; AI 8 x RTD

### Modes of operation

Operating modes of SM 331; AI 8 x RTD:

- 8-channel mode (hardware filter)
- 8-channel mode (software filter)
- 4-channel mode (hardware filter)

The operating mode influences the module cycle time.

### 8-channel mode (hardware filter)

In this mode, the module changes between the two channels of each group. The four ADCs of the module simultaneously convert channels 0, 2, 4 and 6. The ADCs first convert the channels with even numbers, and then the channels with the odd numbers 1, 3, 5 and 7 (see the figure below.)

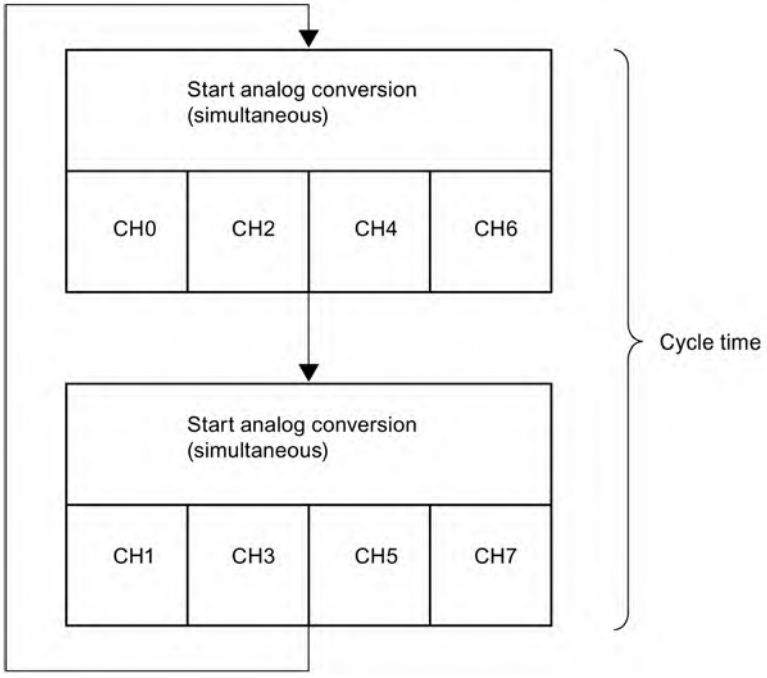



Figure 6-23 8-channel mode cycle time (hardware filter)



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## Cycle time of module in 8-channel mode

The channel conversion time, including module communication time, is 84 ms. The module must change to the second channel of the group using OptoMOS relays when conversion is completed. Opto-MOS relays require 12 ms for switching and settling. Each channel requires a time of 97 ms, i.e. the total cycle time equals 194 ms.

Cycle time = ($t_K$ + $t_U$) x 2

Cycle time = (84 ms + 16 ms) x 2

Cycle time = 200 ms

$t_C$: Conversion time for one channel
$t_C$: Channel changeover time within the channel group

## 8-channel mode (software filter)

Analog-to-digital conversion in this mode is identical to the conversion in 8-channel mode (hardware filter). The four ADCs of the module simultaneously convert channels 0, 2, 4 and 6. The ADCs first convert the channels with even numbers, and then the channels with the odd numbers 1, 3, 5 and 7 (see the figure below.)

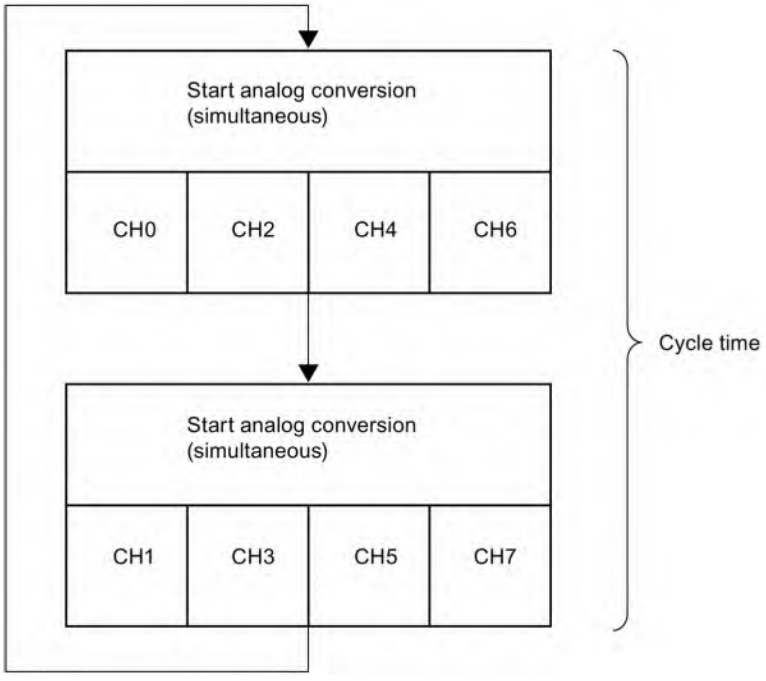



Figure 6-24 8-channel mode cycle time (software filter)



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## Cycle time of module in 8-channel mode (software filter)

The channel conversion time is based on the programmed interference frequency. The channel conversion time is 32 ms, including communication time, when you set an interference frequency of 50 Hz. The channel conversion time is 27 ms when you set an interference frequency of 60 Hz. You can reduce channel conversion times to 9 ms by setting an interference frequency of 400 Hz. As in "hardware filter, 8channel" mode, the module has to toggle to the second channel of the group within a changeover time of 16 ms using the Opto-MOS relays. The table below shows this correlation.

Table 6- 26 Cycle times in "8-channel mode (software filter)"

| Interference frequency | Channel cycle time* | Module cycle time (all channels) |
|---|---|---|
| 50 Hz | 48 ms | **96 ms** |
| 60 Hz | 43 ms | **86 ms** |
| 400 Hz | 25 ms | **50 ms** |
| * Channel cycle time = channel conversion time + 12 ms channel changeover time within the group | | |

## 4-channel mode (hardware filter)

In this mode, the module does not change between the channels of the groups. The four ADCs of the module simultaneously convert the channels 0, 2, 4 and 6.

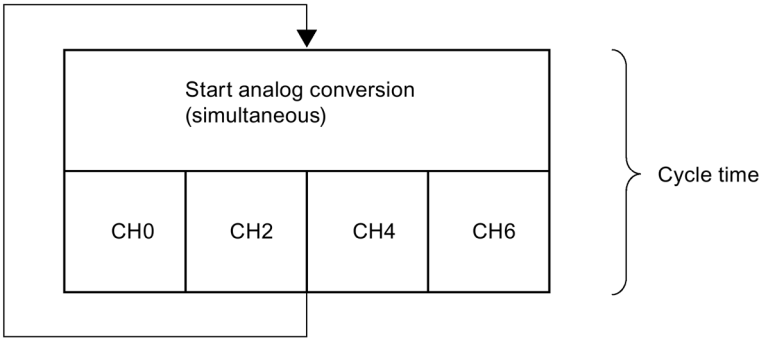



Figure 6-25 4-channel mode cycle time (hardware filter)

## Cycle time of the module in 4-channel mode (hardware filter)

The converted value settles to 100% within 80 ms and is updated at intervals of 10 ms when 4-channel mode is set. The channel and module cycle times are always identical, as the module does not change between the channels of a group: 10 ms.

Channel conversion time = channel cycle time = module cycle time = **10 ms**



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## Cycle time extension due to wire-break monitoring

The wire-break monitoring software function of the module is available in all operating modes.

The cycle time of the module is doubled **in 8-channel mode (hardware or software filter)**, irrespective of the number of channels at which wire-break monitoring is enabled.

**In 4-channel mode (hardware filter)**, the module interrupts processing of input data for the duration of 100 ms and performs a line continuity check. That is, each line continuity check extends the module cycle time by 100 ms.

## Unused channels

In order to avoid incorrect measurements, an unused channel from an active group of channels must be configured. Connect a resistor of the nominal range to the unused channel in order to suppress diagnostics errors.

Set the "disabled" value at the "measurement type" parameter for unused channels. This setting reduces module cycle times.

## Short-circuit to M or L

The module does not suffer any damage if you short-circuit an input channel to M or L.. The channel continues to output valid data and does not report a diagnostics event.

## End of cycle interrupt

You can synchronize a process with the conversion cycle of the module by enabling the end of cycle interrupt. The interrupt is set when all active channels have been converted.

The table below shows the contents of the 4 bytes of additional OB40 information during process or end of cycle interrupts.

| Content of the 4 bytes with additional information | | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | Byte |
|---|---|---|---|---|---|---|---|---|---|---|
| Special analog flags | 2 bits per channel to identify the range | | | | | | | | | |
| | High limit exceeded at channel | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 0 |
| | Low limit exceeded at channel | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 |
| | End of cycle event | | | | | | X | | | 2 |
| | Free bit | | | | | | | | | 3 |

## Programming restrictions when operating SM 331; AI 8 x RTD with PROFIBUS masters which only support DPV0.

Certain parameters are not allowed when operating the SM 331; AI 8 x RTD analog input module on an ET 200M PROFIBUS slave system and the PROFIBUS master is not an S7 master.. Non-S7 masters do not support process interrupts. All parameters associated with these functions are disabled for this reason. This includes process interrupt enable, hardware restrictions and end the enabling of cycle interrupts. All other parameters are allowed.



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### Operating the module on the ET 200M Distributed IO device

Operation of SM 331; AI 8 x RTD on ET 200M requires one of the following IM 153 x:

- IM 153-1; as of 6ES7153-1AA03-0XB0, V 01
- IM 153-2; as of 6ES7153-2AA02-0XB0, V 05
- IM 153-2; as of 6ES7153-2BA00-0XA0; V 01
- IM 153-2; as of 6ES7153-2AA01-0XB0, V 04



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# 6.10 Analog input module SM 331; AI 8 x TC; (6ES7331-7PF11-0AB0)

## Order number

6ES7331-7PF11-0AB0

## Properties

- 8 inputs in 4 channel groups
- Programmable measurement type at each channel group
  - Temperature
- Programmable resolution at each channel group (15 bits + sign)
- Any measuring range selection per channel group
- Programmable diagnostics and diagnostic interrupt
- Programmable limit value monitoring for 8 channels
- Programmable hardware interrupt when limit is exceeded
- High-speed update of measured values at up to 4 channels
- Programmable hardware interrupt at end of cycle
- Electrically isolated from the CPU
- Supports parameter reassignment in RUN

## Resolution

The resolution of measured values is independent of the selected integration time.

## Diagnostics

For information on diagnostics messages at the "group diagnostics" parameter, refer to chapter Diagnostic messages of analog input modules (Page 296).

## Hardware interrupts

Hardware interrupts for channel groups 0 and 1 can be programmed in *STEP 7*. However, set a hardware interrupt only for the first channel of a channel group, that is, either at channel 0, or at channel 2

## Terminal assignment

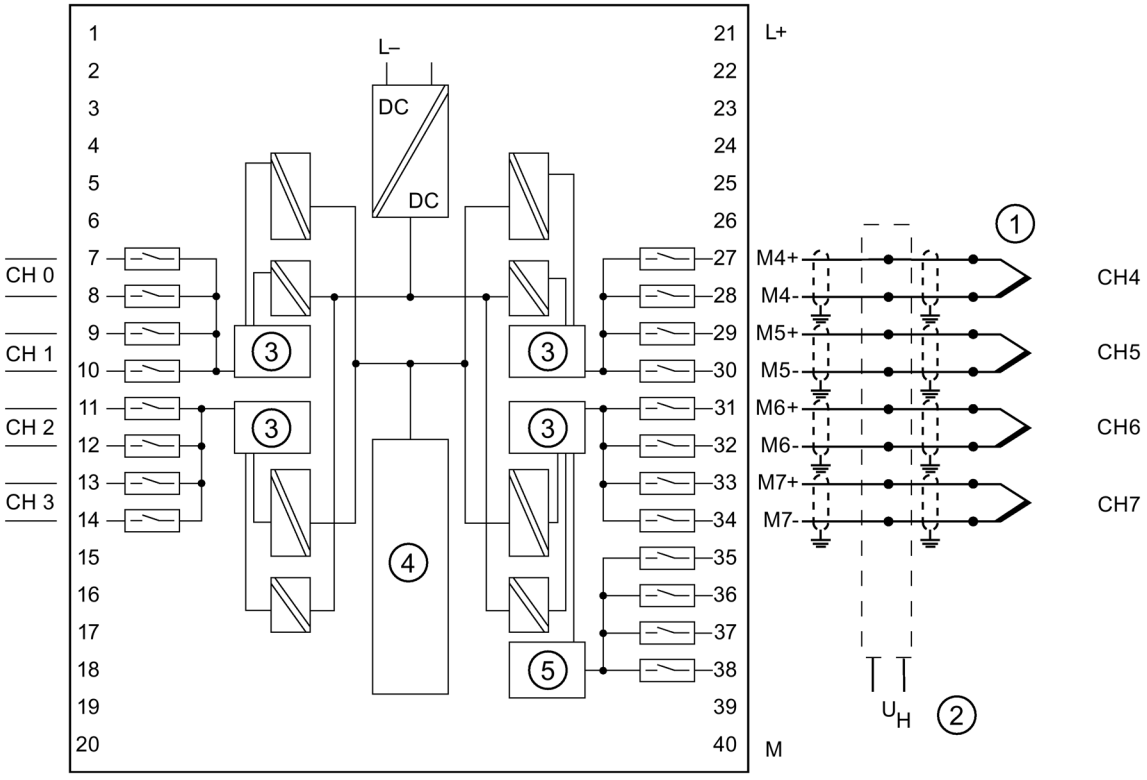
The diagrams below show various wiring options. These examples apply to all channels (channel 0 to 7).



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## Wiring: Thermocouple via reference junction

All 8 inputs are available as measurement channels if thermocouples are wired via reference junctions which are regulated to 0 °C or 50 °C.




① Thermocouple via reference junction
② Reference junction regulated to 0 °C or 50 °C
for example, compensation box (per channel) or thermostat
③ Analog-to-Digital Converter (ADC)
④ Backplane bus interface
⑤ External cold spot comparison

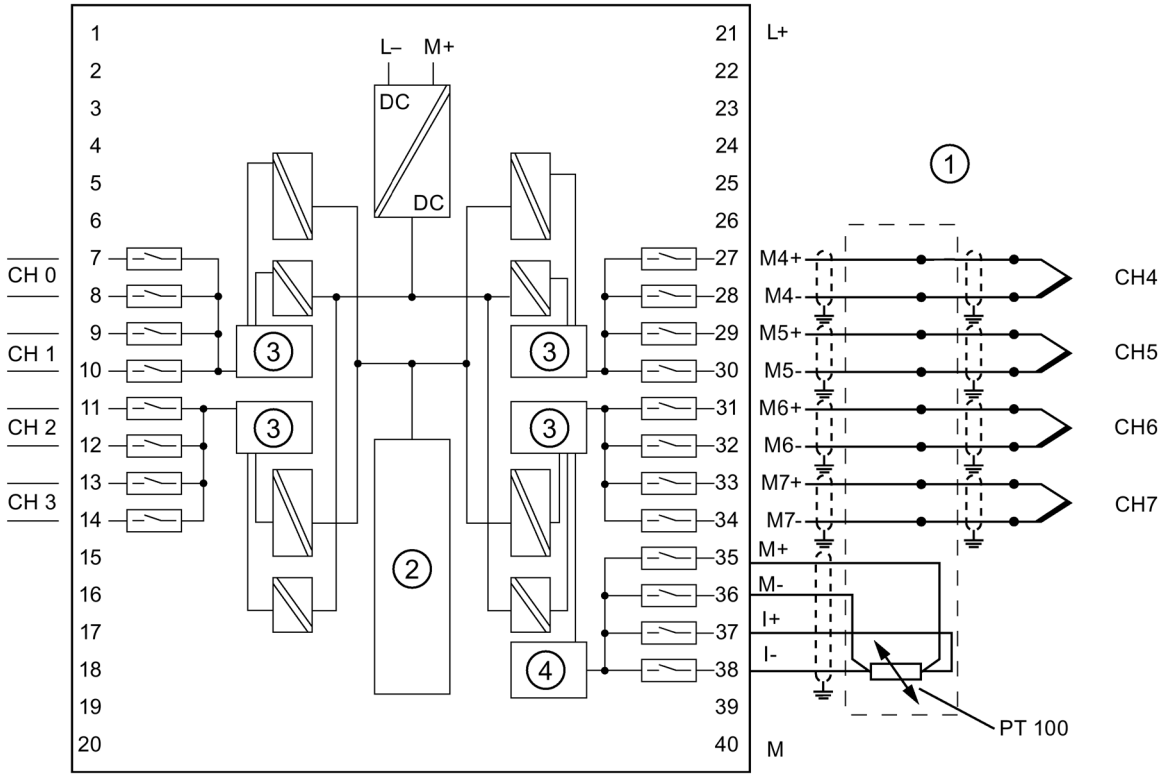
Figure 6-26 Wiring and block diagram



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## Wiring: Thermocouple with external compensation

With this type of compensation, the temperature of the terminals at the reference junction is established using a resistance thermometer Pt100 with a temperature range of -25 °C to 85 °C (see terminals 35 to 38).




① Thermocouple with external temperature compensation
② Backplane bus interface
③ Analog-to-Digital Converter (ADC)
④ External cold spot comparison

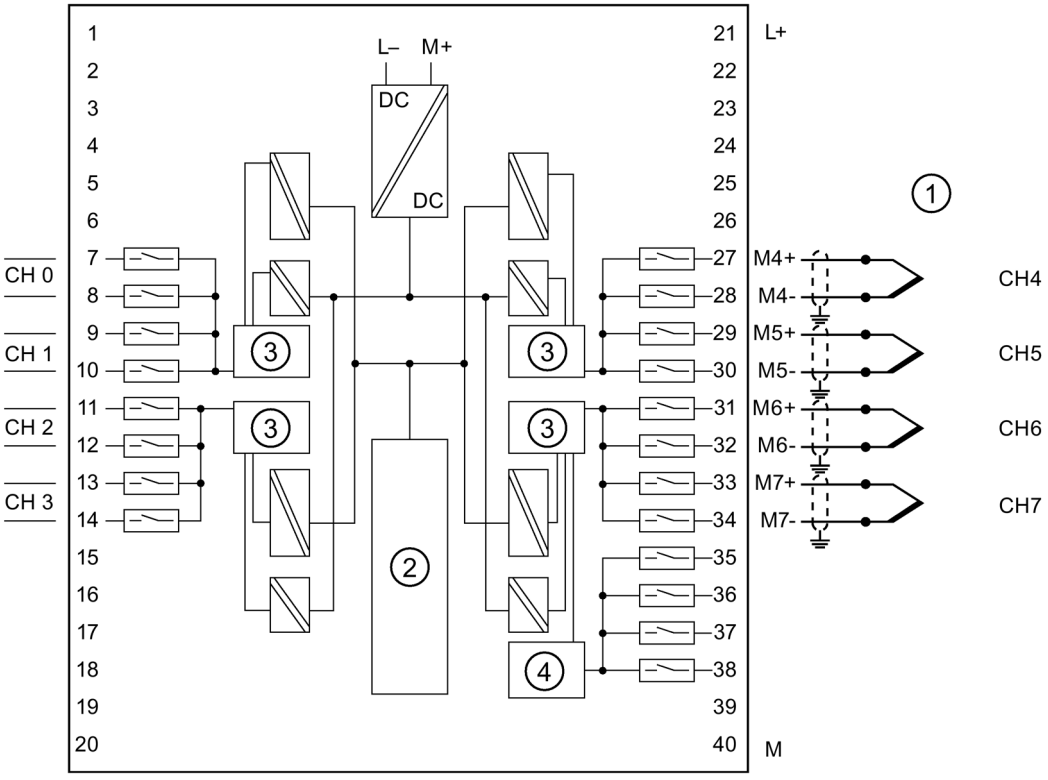
Figure 6-27 Wiring and block diagram



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## Wiring: Thermocouple with internal compensation

With this kind of compensation, the module registers the temperature at the reference junction in the connector.




① Thermocouple with equalizing conductor up to front connector
② Backplane bus interface
③ Analog-to-Digital Converter (ADC)
④ External cold spot comparison

Figure 6-28 Wiring and block diagram

## Technical specifications

| **Technical specifications** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x117 |
| Weight | approx. 272 g |
| **Module-specific data** | |
| Supports parameter reassignment in RUN | Yes |
| Response of non-programmed inputs | Return the process value which was valid before configu-ration |
| Supports isochronous mode | No |
| Cable length<br>• shielded | max. 100 m |



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| | |
|---|---|
| **Technical specifications** | |
| **Voltages, currents, electrical potentials** | |
| Rated electronics supply voltage L +<br>• Reverse polarity protection | 24 V DC<br>Yes |
| Constant measuring current for resistance-type transmitters | typ. 0.7 mA |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels and electronics power supply<br>• between channels<br>in groups of | <br>Yes<br>Yes<br><br>Yes<br>2 |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from supply voltage L+ | <br>max. 100 mA<br>max. 240 mA |
| Power loss of the module | typ. 3.0 W |
| **Generation of analog values** | |
| Measuring principle | Integrating |
| Operating mode | **8-channel mode (hardware filter)** |
| Integration/conversion time/resolution (per channel)<br>• programmable<br>• Basic conversion time in ms<br>• additional conversion time for wire-break monitoring in ms<br>• Resolution (including overshoot range)<br>• Interference frequency suppression at<br>interference frequency f1 in Hz | <br>Yes<br>95<br>4<br><br>16 bits (including sign)<br>400/60/50 |
| Measured value smoothing | none/weak/medium/strong |
| Basic execution time of the module (all channels enabled) | 196 ms ****** |
| Operating mode | **8-channel mode (software filter)** |
| Integration/conversion time/resolution (per channel)<br>• programmable<br>• Basic conversion time in ms<br>• additional conversion time for wire-break monitoring in ms<br>• Resolution (including overshoot range)<br>• Interference frequency suppression at<br>interference frequency f1 in Hz | <br>Yes<br>23/72/83<br>4<br><br>16 bits (including sign)<br>400/60/50 |
| Measured value smoothing | none/weak/medium/strong |
| Basic execution time of the module (all channels enabled) | 46/144/166 ms ****** |
| Measuring principle | Integrating |



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| **Technical specifications** | | | |
|---|---|---|---|
| Operating mode | | **4-channel mode (hardware filter)** | |
| Integration/conversion time/resolution (per channel) | | | |
| • programmable<br>• Basic conversion time in ms | | Yes<br>3.3 ms ***** | |
| • additional conversion time for wire-break monitoring in ms | | 93 * | |
| • Resolution (including overshoot range)<br>• Interference frequency suppression at interference frequency f1 in Hz | | 16 bits (including sign)<br>400/60/50 | |
| Measured value smoothing | | none/weak/medium/strong | |
| Basic execution time of the module (all channels enabled) | | 10 ms ****** | |
| **Interference frequency suppression, error limits** | | | |
| Interference frequency suppression at f = n (f1 1%), (f1 = interference frequency) n = 1.2, etc. | | | |
| • Common mode interference ($V_{CM}$ < 60 V AC)<br>• Series-mode interference (peak interference value < rated input range) | | > 100 dB<br>> 90 dB ** | |
| Crosstalk between inputs | | > 100 dB | |
| Operational limit (across temperature range, relative to the measurement range end value of the input range) (0 to 60 °C)<br>Note: This limit does not cover the temperature-error comparison points. | | | |
| • Thermocouple | | | |
| Type T | -200 °C to | +400 °C | ± 0.7 °C |
| | -230 °C to | -200 °C | ± 1.5 °C |
| Type U | -150 °C to | +600 °C | ± 0.9 °C |
| | -200 °C to | -150 °C | ± 1.2 °C |
| Type E | -200 °C to | +1000 °C | ± 1.2 °C |
| | -230 °C to | -200 °C | ± 1.5 °C |
| Type J | -150 °C to | +1200 °C | ± 1.4 °C |
| | -210 °C to | -150 °C | ± 1.7 °C |
| Type L | -150 °C to | +900 °C | ± 1.5 °C |
| | -200 °C to | -150 °C | ± 1.8 °C |
| Type K | -150 °C to | +1372 °C | ± 2.1 °C |
| | -220 °C to | -150 °C | ± 2.9 °C |
| Type N | -150 °C to | +1300 °C | ± 2.2 °C |
| | -220 °C to | -150 °C | ± 3.0 °C |
| Type R | +100 °C to | +1769 °C | ± 1.5 °C |
| | -50 °C to | +100 °C | ± 1.8 °C |
| Type S | +100 °C to | +1769 °C | ± 1.7 °C |
| | -50 °C to | +100 °C | ± 2.0 °C |
| Type B **** | +800 °C to | +1820 °C | ± 2.3 °C |
| | +200 °C | +800 °C | ± 2.5 °C |
| Type C | +100 °C to | +2315 °C | ± 2.3 °C |
| | 0 °C | +100 °C | ± 2.5 °C |



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| | | | |
|---|---|---|---|
| **Technical specifications** | | | |
| Txk/xk(L) | -150 °C to | +800 °C | ± 1.0 °C |
| | -200 ° C | -150 ° C | ± 1.5 °C |
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected input range) | | | |
| • Thermocouple | | | |
| Type T | -200 °C to | +400 °C | ± 0.5 °C |
| | -230 °C to | -200 °C | ± 1.0 °C |
| Type U | -150 °C to | +600 °C | ± 0.5 °C |
| | -200 °C to | -150 °C | ± 1.0 °C |
| Type E | -200 °C to | +1000 °C | ± 0.5 °C |
| | -230 °C to | -200 °C | ± 1.0 °C |
| Type J | -150 °C to | +1200 °C | ± 0.5 °C |
| | -210 °C to | -150 °C | ± 1.0 °C |
| Type L | -150 °C to | +900 °C | ± 0.5 °C |
| | -200 °C to | -150 °C | ± 1.0 °C |
| Type K | -150 °C to | +1372 °C | ± 0.5 °C |
| | -220 °C to | -150 °C | ± 1.0 °C |
| Type N | -150 °C to | +1300 °C | ± 0.5 °C |
| | -200 °C to | -150 °C | ± 1.0 °C |
| Type R | +100 °C to | +1769 °C | ± 0.5 °C |
| | -50 °C to | +100 °C | ± 0.5 °C |
| Type S | +100 °C to | +1769 °C | ± 0.5 °C |
| | -50 °C to | +100 °C | ± 1.0 °C |
| Type B **** | +800 °C to | +1820 °C | ± 1.0 °C |
| | +200 °C to | +800 °C | ± 2.0 °C |
| Type C | +100 °C to | +2315 °C | ± 0.5 °C |
| | 0 °C | +100 °C | ± 1.0 °C |
| Txk/xk(L) | -150 °C to | +800 °C | ± 0.5 °C |
| | -200 ° C | -150 ° C | ± 1.0 °C |
| Temperature error (relative to input range) | | ± 0.005%/K | |
| Linearity error (relative to input range) | | ±0.02% | |
| Repeat accuracy (in settled state at 25 °C, relative to input range)*** | | ±0.01% | |
| **Status, interrupts, diagnostics** | | | |
| Interrupts<br>• Hardware interrupt<br>• Diagnostic interrupt | | <br>programmable<br>(channels 0 to 7)<br>programmable | |
| Diagnostic functions<br>• Group error display<br>• Reading diagnostics information | | programmable<br>red LED (SF)<br>supported | |



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| **Technical specifications** | |
|---|---|
| **Encoder selection data** | |
| Input ranges (rated values) / input impedance<br>• Thermocouples | <br>Types B, C, N, E, R, S, J, L, T, K, U, TxK/xK (L)/ > 10 megaohms |
| Maximum voltage at voltage input (destruction limit) | 20 V DC continuous; 75 V DC for the duration of max. 1 s (duty factor 1:20) |
| Characteristics linearization | programmable |
| Temperature compensation<br>• Internal temperature compensation<br>• External temperature compensation with Pt 100 (0.003850)<br>• Compensation for 0 °C reference junction temperature<br>• Compensation for 50 °C reference junction temperature<br>• Technical unit of temperature measurement | programmable<br>supported<br>supported<br>supported<br>supported<br>Degrees Centigrade / degrees Fahrenheit |
| Wiring of the signal transmitters | using a 40-pin front connector |

** Wire-break monitoring in 4-channel mode (hardware filter) at intervals of three seconds.

** In 8-channel software mode (software filter), series-mode rejection is reduced as follows:

- 50 Hz > 70 dB
- 60 Hz > 70 dB
- 400 Hz > 80 dB

*** The operational limit comprises only the basic error of the analog input at Ta = 25 °C and the total temperature error. The total error must include the compensation error of the cold reference junction. Internal compensation of the reference junction = max. 1.5 °C
External compensation of the reference junction = accuracy of the used external RTD ± 0.1 °C.
External compensation of the reference junction at which the reference junction is maintained at 0 °C or 50 °C = accuracy of the temperature control of the reference junction.

**** Due to its small slope of approx. 0 °C to 40 °C, a lack of compensation for the reference junction temperature only has a slight effect with thermocouple type B. With missing compensation and set measuring type "Compensation to 0 °C", the deviation with thermocouple type B at measuring temperatures between:

- 700 °C and 1820 °C is < 0.5 °C
- 500 °C and 700 °C is < 0.7 °C.

If the reference junction temperature is approximately that of the module temperature, "internal compensation" should be set. As a result, the error for the temperature range from 500 °C to 1820 °C is reduced to < 0.5 °C.

***** In 4-channel mode, the converted value settles to 100 % within 80 ms. The value determined in this process is set at intervals of 3.3 ms (max. 10 ms).

****** If internal or external reference junction compensation is configured, the measured values of all channels are not updated for about 1 s in each minute. ###



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### Parameter reassignment in RUN

If you reassign parameters in RUN, the following special characteristic applies.

SF LED is lit:

If a diagnostics was pending prior to reconfiguration, the SF LEDs (on CPU, IM or module) may be lit even though diagnostics is no longer pending and the module is operating correctly.

Solution:

- Only assign new parameters if no diagnostics is pending, or
- unplug module and plug it in again.

## 6.10.1 Measurement types and measuring ranges

### Introduction

The measurement type and range are configured at the "measuring range" parameter in *STEP 7*.

Table 6- 27 Measurement types and ranges

| Selected type of measurement | Measuring range |
|---|---|
| TC-L00C:<br>(thermocouple, linear, 0 °C reference temperature)<br>TC-L50C:<br>(thermocouple, linear, 50 °C reference temperature)<br>TC-IL:<br>(thermocouple, linear, internal comparator)<br>TC-EL:<br>(thermocouple, linear, external comparison) | Type B<br>Type C<br>Type E<br>Type J<br>Type K<br>Type L<br>Type N<br>Type R<br>Type S<br>Type T<br>Type U<br>Type Txk / xk (L) |



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### Channel groups

The channels of SM 331; AI 8 x TC are arranged in four groups of two channels. You can assign parameters only to one channel group.

The table below shows the relevant configuration of channel groups. The channel group number is required to program SFC parameters in the user program.

Table 6- 28 Assignment of SM 331; AI 8 x TC channels to channel groups

| Channels ... | ... form one channel group each |
|---|---|
| Channel 0 | Channel group 0 |
| Channel 1 | |
| Channel 2 | Channel group 1 |
| Channel 3 | |
| Channel 4 | Channel group 2 |
| Channel 5 | |
| Channel 6 | Channel group 3 |
| Channel 7 | |

## 6.10.2 Adjustable parameters

### Introduction

For general information on programming analog modules, refer to the chapter Programming analog modules (Page 294).

### Parameters

Table 6- 29 Parameters of SM 331; AI 8 x TC

| Parameters | Range of values | Default | Parameter type | Scope |
|---|---|---|---|---|
| Enable<br>• Diagnostics interrupt<br>• Process interrupt when limit exceeded<br>• Process interrupt at end of cycle | <br>yes/no<br>yes/no<br>yes/no | <br>no<br>no<br>no | dynamic | Module |
| Process interrupt trigger<br>• High limit<br>• Low limit | 32511 to -32512<br>from - 32512 to 32511 | 32767<br>-32768 | dynamic | Channel |



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| Parameters | Range of values | Default | Parameter type | Scope |
|---|---|---|---|---|
| Diagnostics<br>• Group diagnostics<br>• with line continuity check | <br>yes/no<br>yes/no | <br>no<br>no | static | Channel group |
| Measurement<br>• Measurement type | <br>disabled<br>TC-IL thermocouple (linear, internal comparison)<br>TC-EL thermocouple (linear, external comparison)<br>TC-L00C thermocouple (linear, ref. temp. 0 °C)<br>TC-L50C thermocouple (linear, ref. temp. 50 °C) | TC-IL | dynamic | Channel group |
| • Measuring range | See table Measurement types and measuring ranges (Page 404) | Type K | | |
| • Reaction to open thermocouple | Overflow; underflow | Overflow | | |
| • Temperature unit | Degrees Centigrade; degrees Fahrenheit | degrees Centigrade | dynamic | Module |
| • Mode of operation | 8-channel mode (hardware filter)<br>8-channel mode (software filter)<br>4-channel mode (hardware filter) | 8 channels, hardware filter | dynamic | Module |
| • Noise suppression* | 50/60/400 Hz; 400 Hz; 60 Hz; 50 Hz; | 50/60/400 Hz | dynamic | Channel group |
| • Smoothing | none<br>weak<br>medium<br>strong | none | dynamic | Channel group |
| ***** 50/60/400 Hz only programmable for 8-channel mode (hardware filter) and 4-channel mode (hardware filter);<br>50 Hz, 60 Hz or 400 Hz only programmable for 8-channel mode (software filter) | | | | |

## See also

Diagnostics messages of analog input modules (Page 296)



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## 6.10.3 Additional information on SM 331; AI 8 x TC

### Modes of operation

Operating modes of SM 331; AI 8 x TC:

- 8-channel mode (hardware filter)
- 8-channel mode (software filter)
- 4-channel mode (hardware filter)

The operating mode influences the module cycle time.

### 8-channel mode (hardware filter)

In this mode, the module changes between the two channels of each group. The four ADCs of the module simultaneously convert channels 0, 2, 4 and 6. The ADCs first convert the channels with even numbers, and then the channels with the odd numbers 1, 3, 5 and 7 (see the figure below.)

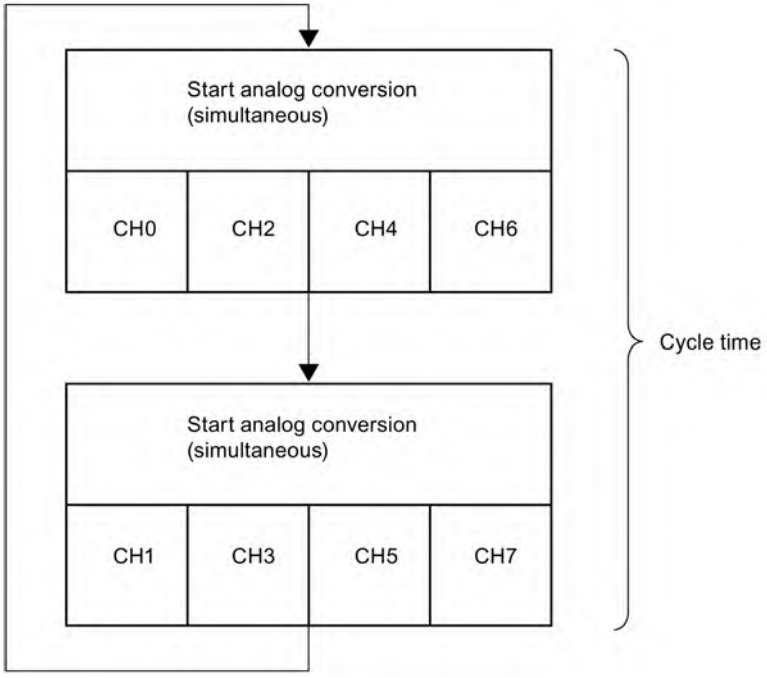



Figure 6-29 8-channel mode cycle time (hardware filter)



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## Cycle time of the module in 8-channel mode (hardware filter)

The channel conversion time, including module communication time, is 91 ms. The module must change to the second channel of the group using OptoMOS relays when conversion is completed. Opto-MOS relays require 7 ms for switching and settling. Each channel requires a time of 98 ms, i.e. the total cycle time equals 196 ms.

Cycle time = ($t_K$ + $t_U$) x 2

Cycle time = (91 ms + 7 ms) x 2

Cycle time = **196 ms**

$t_C$: Conversion time for one channel
$t_C$: Time for changing over to the other channel in a channel group

## 8-channel mode (software filter)

Analog-to-digital conversion in this mode is similar to conversion in 8-channel mode (hardware filter). The four ADCs of the module simultaneously convert channels 0, 2, 4 and 6. The ADCs first convert the channels with even numbers, and then the channels with the odd numbers 1, 3, 5 and 7 (see the figure below.)

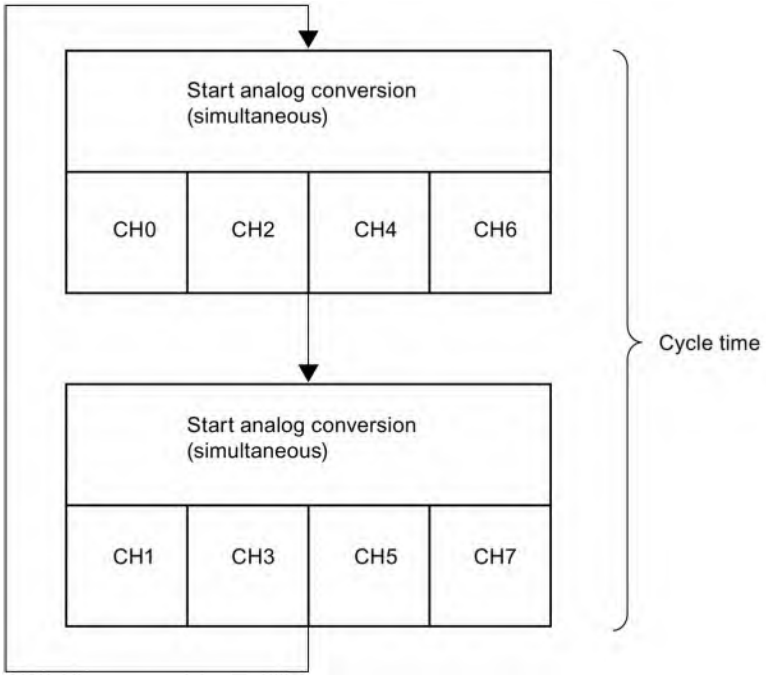



Figure 6-30 8-channel mode cycle time (software filter)



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## Cycle time of module in 8-channel mode (software filter)

However, the channel conversion time is oriented on the programmed noise suppression. The channel conversion time is 76 ms, including communication time, when you set an interference frequency of 50 Hz. The channel conversion time is 65 ms when you set an interference frequency of 60 Hz. You can reduce channel conversion times to 16 ms by setting an interference frequency of 400 Hz. As in "hardware filter, 8channel" mode, the module has to change to the second channel of the group within a changeover time of 7 ms using the Opto-MOS relays. The table below shows this correlation.

Table 6- 30 Cycle times in 8-channel mode (software filter)

| Programmed noise suppression | Channel cycle time* | Module cycle time (all channels) |
|---|---|---|
| 50 Hz | 83 ms | **166 ms** |
| 60 Hz | 72 ms | **144 ms** |
| 400 Hz | 23 ms | **46 ms** |
| ***** Channel cycle time = channel conversion time +7 ms channel changeover time within the group | | |

## 4-channel mode (hardware filter)

In this mode, the module does not change between the channels of the groups. The four ADCs of the module simultaneously convert the channels 0, 2, 4 and 6.

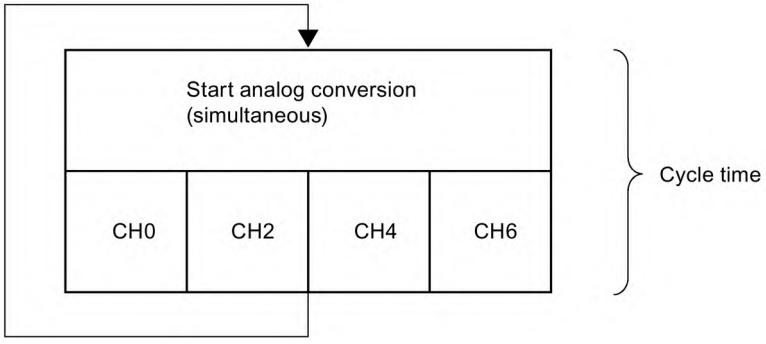



Figure 6-31 4-channel mode cycle time (hardware filter)

## Cycle time of the module in 4-channel mode (hardware filter)

The converted value settles to 100 % within 80 ms and is updated every 10 ms when 4-channel mode is set. The channel and module cycle times are always identical, as the module does not change between the channels of a group: 10 ms.

Channel conversion time = channel cycle time = module cycle time = **10 ms**



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## Cycle time extension due to wire-break monitoring

The wire-break monitoring software function of the module is available in all operating modes.

**The 8-channel mode (hardware or software filter modes)** extends module cycle times by 4 ms, irrespective of the number of channels at which wire-break monitoring is enabled.

**In 4-channel mode (hardware filter)**, the module interrupts processing of input data for the duration of 170 ms and performs a line continuity check. That is, each line continuity check extends the module cycle time by 93 ms.

## Unused channels

Set the "disabled" value at the "measurement type" parameter for unused channels. This setting reduces module cycle times.

You must short-circuit all unused channels of an active group, that is, you short-circuit the positive and negative inputs of these channels.

Effect of this measure:

- Measurement errors at the channels used of a group are avoided
- Diagnostic messages from the unused channel in a group are suppressed

## Short-circuit to M or L

The module does not suffer any damage if you short-circuit an input channel to M or L.. The channel continues to output valid data and does not report a diagnostics event.

## Special features of channel groups with respect to hardware interrupts upon limit violation

You can set the high and low limits triggering hardware interrupts separately for each channel in *STEP 7*.

## End of cycle interrupt

You can synchronize a process with the conversion cycle of the module by enabling the end of cycle interrupt. The interrupt is set when all active channels have been converted.

Table 6- 31 The table below shows the contents of the 4 bytes of additional OB40 information during process or end of cycle interrupts.

| Content of the 4 bytes with additional information | | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | Byte |
|---|---|---|---|---|---|---|---|---|---|---|
| Special analog flags | 2 bits per channel to identify the range | | | | | | | | | |
| | High limit exceeded at channel | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 0 |
| | Low limit exceeded at channel | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 1 |
| | End of cycle event | | | | | | X | | | 2 |
| | Free byte | | | | | | | | | 3 |



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### Programming restrictions when operating SM 331; AI 8 x TC with PROFIBUS masters which only support DPV0.

When operating the SM 331; AI 8 xTC analog input module on an ET 200M PROFIBUS slave system and the PROFIBUS master is not an S7 master, certain parameters are not permitted. Non-S7 masters do not support hardware interrupts. All parameters associated with these functions are disabled for this reason. This includes hardware interrupt enable, hardware restrictions and end of cycle interrupt enable. All other parameters are allowed.

### Operating the module on the ET 200M Distributed IO device

Operation of SM 331; AI 8 x TC on ET 200M requires one of the following IM 153 x:

- IM 153-1; as of 6ES7153-1AA03-0XB0, E 01
- IM 153-2; as of 6ES7153-2AA02-0XB0, E 05
- IM 153-2; as of 6ES7153-2AB01-0XB0, E 04



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# 6.11 Analog input module SM 331, AI 6 x TC isolated (6ES7331-7PE10-0AB0)

## Order number

6ES7331-7PE10-0AB0

## Properties

The SM 331; AI 6 x TC isolated analog input module has the following properties:

- 6 inputs in one group
- Electrical isolation 250 VAC between channels
- Support for user calibration via SIMATIC PDM
- Compensation via internal or external cold spot comparison, or via remote access by means of a separate thermoresistor module.
- Measurement type can be set for each channel
  - Voltage
  - Temperature
- Resolution of 15 bits + sign
- Any measuring range for each channel
- Programmable diagnostics and diagnostic interrupt
- Limit value monitoring can be set for 6 channels
- Programmable hardware interrupt when limit is exceeded
- Electrically isolated from the CPU

## Resolution

The maximum resolution of the measured value (15 bits + sign or 0.1 K) is independent of the programmed integration time.

## Diagnostics

For information on diagnostics messages at the "group diagnostics" parameter, refer to chapter Diagnostic messages of analog input modules (Page 296).

## Hardware interrupts

Hardware interrupts can be set in *STEP 7* for all channels.



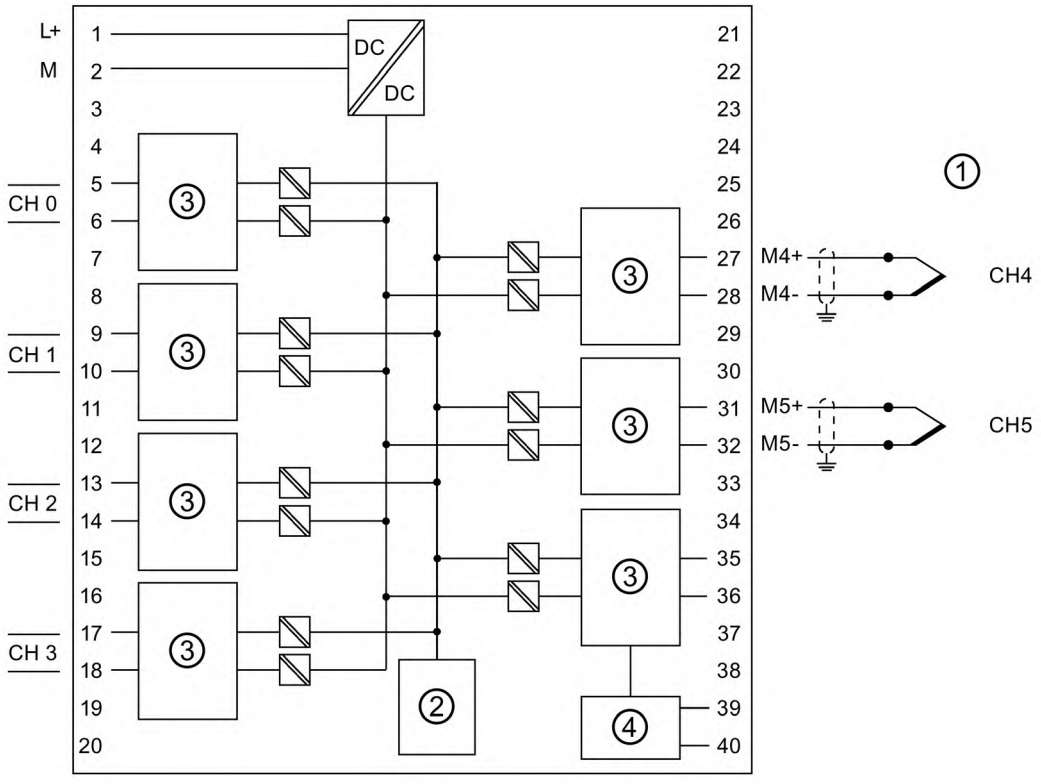
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## Terminal assignment

The figures below show various connection possibilities. These examples apply to all channels (channels 0 to 5).

## Wiring: Thermocouple with internal compensation

With this kind of compensation, the module detects the temperature at the reference junction of the connector.




① Thermocouple with compensating line (extension) to front connector
② Backplane bus interface
③ Analog digital converter (ADC)
④ External cold spot comparison (ADC and current source)

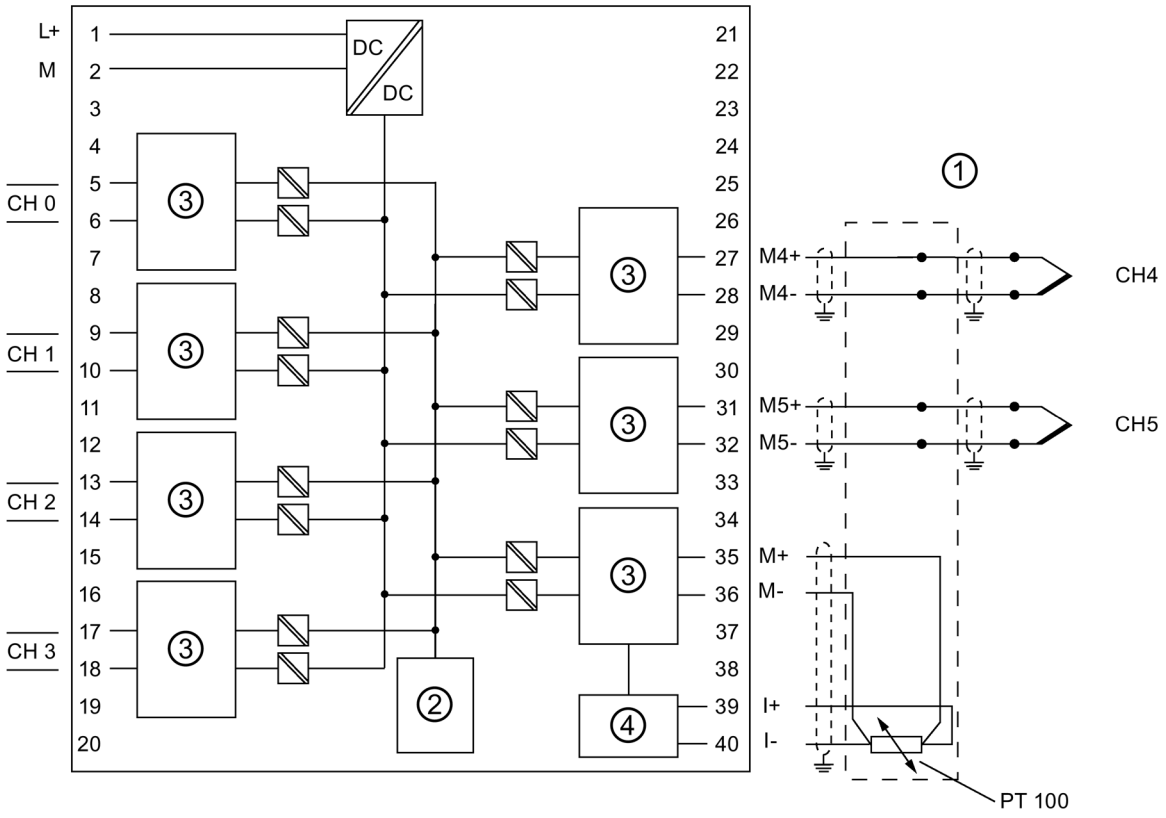
Figure 6-32 Internal compensation



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## Wiring: Thermocouple with external compensation

With this type of compensation, the temperature of the terminals at the reference junction is established using a Pt 100 Klima resistance thermometer with a temperature range of -145 °C to +155 °C (see terminals 35, 36, 39, and 40).




① Thermocouple with terminal for external temperature compensation via copper wire at front connector
② Backplane bus interface
③ Analog digital converter (ADC)
④ External cold spot comparison (ADC and current source)

Figure 6-33 External compensation

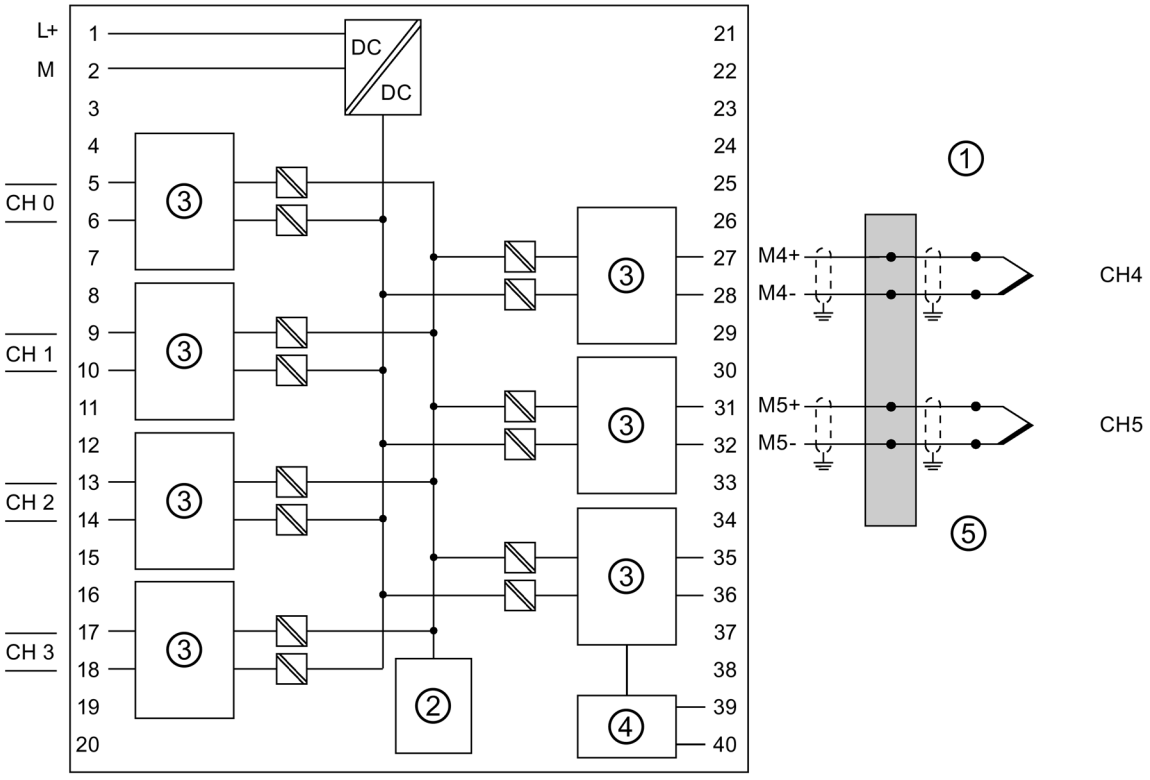
If no Pt 100 resistance thermometer is available, the reference junction can be read using a thermoresistor module. The measured temperature values are then transferred to module AI 6 x TC via data record 2 (for details on the structure of data record 2, see the figure "Structure of data record 2 for TC").



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## Wiring: Thermocouple via reference junction

With this kind of compensation, the temperature of the terminals at the reference junction is regulated at 0 °C or 50 °C.



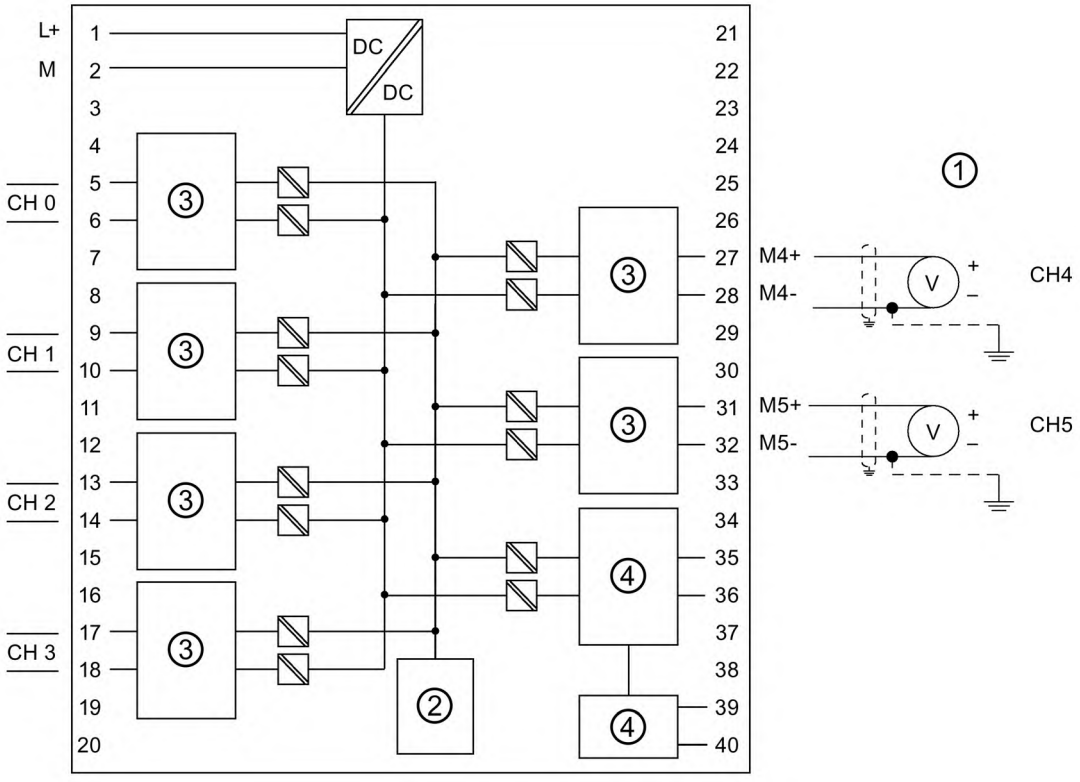

① Thermocouple via reference-junction terminal with copper wire at front connector
② Backplane bus interface
③ Analog digital converter (ADC)
④ External cold spot comparison (ADC and current source)
⑤ Reference junction regulated at 0 °C or 50 °C, for example, via compensation box (for each channel) or a thermostat

Figure 6-34 Reference junction



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## Wiring: Voltage input




① Applied input voltage
② Backplane bus interface
③ Analog digital converter (ADC)
④ External cold spot comparison (ADC and current source)

Figure 6-35 Voltage input

## Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions (W x H x D) (mm) | 40 x 125 x 120 |
| Weight | approx. 272 g |
| **Module-specific data** | |
| Supports isochronous mode | No |
| Cable length<br>• shielded | <br>Max. 200 m<br>Max. 80 m in voltage ranges ≤ 80 mV and where thermo-couples are used. |



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| **Technical specifications** | |
|---|---|
| **Voltages, currents, electrical potentials** | |
| Rated electronics supply voltage L +<br>• Reverse polarity protection | 24 VDC<br>Yes |
| Constant measuring current for resistance-type transmitters | Typ. 0.9 mA |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels and electronics power supply<br>• between channels<br>In groups of | <br>Yes<br>Yes<br>Yes<br>1 |
| Maximum potential difference<br>• between channels ($U_{CM}$)<br>• Between the channels and $M_{internal}$ ($V_{iso}$) | <br>250 VAC<br>250 VAC |
| Isolation test voltage | 2,500 VDC |
| Current consumption<br>• from the backplane bus<br>• from supply voltage L+ | <br>max. 100 mA<br>max. 150 mA |
| Power loss of the module | Typ. 2.2 W |
| **Generation of analog values** | |
| Measuring principle | Integrating |
| • Integration/conversion time/resolution (per channel)<br>programmable | Yes |
| • Integration time in ms(1) | 10/16.67/20/100 |
| • Basic conversion time in ms(2) | 30/50/60/300 |
| • Additional conversion time for wire-break monitoring | 65 ms |
| • Resolution (including overshoot range) | 15 bits + sign |
| • Interference frequency suppression at interference frequency f1 in Hz | 400/60/50/10 |
| Measured value smoothing | none/weak/medium/strong |



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| **Technical specifications** | | | |
|---|---|---|---|
| **Interference frequency suppression, error limits** | | | |
| Interference frequency suppression at f = n x (f1 ± 1%), (f1 = interference frequency) n = 1.2, etc. | | | |
| • Common mode interference (CMV < 250 VAC)<br>• Series-mode interference (peak interference value < rated input range) | > 130 dB(3)<br>> 90 dB | | |
| Crosstalk between inputs | > 130 dB(3) | | |
| Operational limit (across entire temperature range, relative to measurement range end value in the selected input range, 0-60 °C).<br>Note: This limit does not cover the temperature-error comparison points. | | | |
| Voltage input<br>• ± 25 mV<br>• ± 50 mV<br>• ± 80 mV<br>• ± 250 mV<br>• ± 500 mV<br>• ± 1 V | <br>± 0.12%<br>± 0.08%<br>± 0.06%<br>± 0.05%<br>± 0.05%<br>± 0.05% | | |
| Thermocouple(4) (5) | | | |
| Type T | -200 °C to | +400 °C | ± 0.6 °C |
| | -230 °C to | -200 °C | ± 1.6 °C |
| Type U | -150 °C to | +600 °C | ± 0.9 °C |
| | -200 °C to | -150 °C | ± 1.2 °C |
| Type E | -200 °C to | +1000 °C | ± 0.5 °C |
| | -230 °C to | -200 °C | ± 1.3 °C |
| Type J | -150 °C to | +1200 °C | ± 0.5 °C |
| | -210 °C to | -150 °C | ± 1.2 °C |
| Type L | -150 °C to | +900 °C | ± 0.9 °C |
| | -200 °C to | -150 °C | ± 1.7 °C |
| Type K | -150 °C to | +1372 °C | ± 0.8 °C |
| | -220 °C to | -150 °C | ± 1.6 °C |
| Type N | -150 °C to | +1300 °C | ± 1.1 °C |
| | -220 °C to | -150 °C | ± 1.9 °C |
| Type R | +100 °C to | +1769 °C | ± 1.2 °C |
| | -50 °C to | +100 °C | ± 2.2 °C |
| Type S | +100 °C to | +1769 °C | ± 1.2 °C |
| | -50 °C to | +100 °C | ± 1.9 °C |
| Type B(5) | +700 °C to | +1820 °C | ± 1.7 °C |
| | +500 °C to | +700 °C | ± 1.9 °C |
| | +200 °C to | +500 °C | ± 4.4 °C |
| Type C | +100 °C to | +2315 °C | ± 2.3 °C |
| | 0 °C | +100 °C | ± 2.5 °C |
| Type TxK/XK(L) | -150 °C | +800 °C | ± 1.0 °C |
| | -200 °C | -150 °C | ± 1.5 °C |



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| **Technical specifications** | | | |
|---|---|---|---|
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected input range) | | | |
| Voltage input<br>• ± 25 mV<br>• ± 50 mV<br>• ± 80 mV<br>• ± 250 mV<br>• ± 500 mV<br>• ± 1 V | | ± 0.04%<br>± 0.03%<br>± 0.03%<br>± 0.02%<br>± 0.02%<br>± 0.02% | |
| Thermocouple(5) | | | |
| Type T | -150 °C to | +400 °C | ± 0.4 °C |
| | -230 °C to | -150 °C | ± 1.0 °C |
| Type U | -150 °C to | +600 °C | ± 0.4 °C |
| | -200 °C to | -150 °C | ± 1.0 °C |
| Type E | -100 °C to | +1000 °C | ± 0.2 °C |
| | -230 °C to | -100 °C | ± 1.0 °C |
| Type J | -150 °C to | +1200 °C | ± 0.2 °C |
| | -210 °C to | -150 °C | ± 0.5 °C |
| Type L | -50 °C to | +900 °C | ± 0.4 °C |
| | -200 °C to | -50 °C | ± 1.0 °C |
| Type K | -100 °C to | +1372 °C | ± 0.3 °C |
| | -220 °C to | -100 °C | ± 1.0 °C |
| Type N | -150 °C to | +1300 °C | ± 0.5 °C |
| | -220 °C to | -150 °C | ± 1.2 °C |
| Type R | +200 °C to | +1769 °C | ± 0.8 °C |
| | -50 °C to | +200 °C | ± 1.5 °C |
| Type S | +100 °C to | +1769 °C | ± 0.8 °C |
| | -50 °C to | +100 °C | ± 1.5 °C |
| Type B(5) | +700 °C to | +1820 °C | ± 1.0 °C |
| | +500 °C to | +700 °C | ± 1.3 °C |
| | +200 °C to | +500 °C | ± 3.0 °C |
| Type C | +100 °C to | +2315 °C | ± 0.5 °C |
| | 0 °C to | +100 °C | ± 1.0 °C |
| Type TxK/XK(L) | -150 °C to | +800 °C | ± 0.5 °C |
| | -200 °C to | -150 °C | ± 1.0 °C |
| The accuracy of the temperature measurement with *internal compensation (terminal temperature)* is derived from: (4) (6) | | • Error for the analog input of the type of thermocouple used<br>• Measuring accuracy for the temperature of the internal reference junction ± 1.5 K | |



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| **Technical specifications** | |
|---|---|
| The accuracy of the temperature measurement *with external compensation by means of thermoresistors connected locally or via remote access by means of an external thermoresistor module* is derived from: (4) | • Error for the analog input of the type of thermocouple used<br>• Measuring accuracy for the type of thermoresistor used for compensation purposes<br>• Error for the compensation input (local connection) ± 0.5 K<br>• Error for the thermoresistor module (remote connection) |
| The accuracy of the temperature measurement with *compensation of the external reference junction, which is maintained at 0 °C/50 °C,* is derived from: (4) | • Error for the analog input of the type of thermocouple used<br>• Measuring accuracy for the temperature of the reference junction |
| Temperature error (relative to input range) | |
| Voltage input<br>• ± 25 mV<br>• ± 50 mV<br>• ± 80 mV<br>• ± 250 mV<br>• ± 500 mV<br>• ± 1 V | <br>± 0.0023%/K<br>± 0.0015%/K<br>± 0.0010%/K<br>± 0.0010 %/K<br>± 0.0010 %/K<br>± 0.0010%/K |
| Thermocouple (at integration time of 100 ms)<br>Type T<br>Type U<br>Type E<br>Type J<br>Type L<br>Type K<br>Type N<br>Type R<br>Type S<br>Type B<br>Type C<br>Type TxK/XK(L) | <br>± 0.0060 K/K<br>± 0.0175 K/K<br>± 0.0086 K/K<br>± 0.0086 K/K<br>± 0.0175 K/K<br>± 0.0143 K/K<br>± 0.0175 K/K<br>± 0.0115 K/K<br>± 0.0115 K/K<br>± 0.0200 K/K<br>± 0.0515 K/K<br>± 0.0143 K/K |
| Linearity error (relative to input range) | ± 0.05% |
| Repeat accuracy (in settled state at 25 °C, relative to input range) | ± 0.05% |



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| **Technical specifications** | | |
|---|---|---|
| **Status, interrupts, diagnostics** | | |
| Interrupts<br>• Hardware interrupt<br>• Diagnostic interrupt | <br>Programmable (channels 0 to 5)<br>programmable | |
| Diagnostic functions<br>• Group error display<br>• Reading diagnostics information | programmable<br>red LED (SF)<br>Supported | |
| **Sensor selection data** | | |
| Input ranges (rated values) / input impedance<br>• Thermocouple<br>• Voltage | <br>Type B, C, N, E, R, S, J, L, T, K, U, TxK/XK (L)<br>± 25 mV<br>± 50 mV<br>± 80 mV<br>± 250 mV<br>± 500 mV<br>± 1 V | <br>10 MΩ<br><br>10 MΩ<br>10 MΩ<br>10 MΩ<br>10 MΩ<br>10 MΩ<br>10 MΩ |
| Maximum input voltage for voltage input (destruction limit) | 35 VDC continuous; 75 VDC for the duration of max. 1 s (duty factor 1:20) | |
| Characteristics linearization | programmable | |
| Temperature compensation<br>• Internal temperature compensation<br>• External temperature compensation with Pt 100<br>• Compensation for 0 °C reference junction temperature<br>• Compensation for 50 °C reference junction temperature<br>• Technical unit of temperature measurement | programmable<br>Supported<br>Supported<br>Supported<br>Supported<br>Degrees Centigrade/Degrees Fahrenheit/Kelvin | |



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| **Technical specifications** | |
|---|---|
| Wiring of the signal sensors | using a 40-pin front connector |

1. The integration time of the module at 400 Hz suppression is displayed in HW Config as 2.5 ms. To achieve the required resolution of 15 bits (plus sign), an integration time of 10 ms is needed.
2. If wire-break monitoring is active, the module cycle is performed within the basic conversion time + 65 ms. and the reaction time to a change in the step input is no longer than twice the module-cycle time. If wire-break monitoring is inactive, in the best-case scenario the module-cycle time is exactly the same as the integration time. However, this time interval cannot be guaranteed due to the time needed to process the input channels. If wire-break monitoring is inactive, the reaction time to a change in the step input is no longer than four times the integration time.
3. Common mode interference suppression and crosstalk between inputs are executed at > 130 dB, if 10 Hz, 50 Hz, or 60 Hz has been selected as the interference frequency. If 400 Hz has been selected as the interference frequency, common mode interference suppression and crosstalk between inputs are implemented at > 110 dB
4. The operational limit comprises only the basic error of the analog input at Ta = 25 °C and the total temperature error. The total error must include the compensation error of the cold reference junction. Internal compensation of the reference junction = max. 1.5 °C External compensation of the reference junction = accuracy of the external thermoresistor used ± 0.1 °C. External compensation of the reference junction, which maintains the reference junction at 0 °C or 50 °C = accuracy of temperature control for the reference junction.
5. An integration time of 100 ms is recommended for thermocouple measurements. Integration times set lower than this will result in a higher repeat-accuracy error for the temperature measurements.
6. With thermocouple type B, a missing compensation of the reference junction temperature has no significant effect owing to its slight increase from approx. 0 °C to 40 °C. With missing compensation and set measuring type "Compensation to 0 °C", the deviation with thermocouple type B at measuring temperatures between:
   - 700 °C and 1820 °C is < 0.5 °C
   - 500 °C and 700 °C is < 0.7 °C.

   If the reference junction temperature is approximately that of the module temperature, "internal compensation" should be set. As a result, the error for the temperature range from 500 °C to 1820 °C is reduced to < 0.5 °C.



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## 6.11.1 Measurement types and measuring ranges

### Measurement types and measuring ranges

The measurement type and measuring range is configured at the "measuring range" parameter in *STEP 7*.

| Selected measurement type | Measuring range |
|---|---|
| Voltage | ± 25 mV<br>± 50 mV<br>± 80 mV<br>± 250 mV<br>± 500 mV<br>± 1 V |
| TC-L00C:<br>(thermocouple, linear, 0 °C reference temperature)<br>TC-L50C:<br>(thermocouple, linear, 50 °C reference temperature)<br>TC-IL:<br>(thermocouple, linear, internal comparison)<br>TC-EL:<br>(thermocouple, linear, external comparison) | Type B<br>Type C<br>Type E<br>Type J<br>Type K<br>Type L<br>Type N<br>Type R<br>Type S<br>Type T<br>Type U<br>Type TxK/XK(L) |



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## 6.11.2 Programmable parameters

### Adjustable parameters

For general information on programming analog modules, refer to the section titled Programming analog modules (Page 294).

| Parameters | Range of values | Default | Type of parameter | Scope |
|---|---|---|---|---|
| Diagnostics<br>• Group diagnostics<br>• With wirebreak monitoring | <br>Yes/no<br>Yes/no | <br>No<br>No | Static | Channel |
| Enable<br>• Diagnostic interrupt<br>• Hardware interrupt when limit exceeded<br>• Auto-calibration | <br>Yes/no<br>Yes/no<br>Yes/no | <br>No<br>No<br>Yes | Dynamic | Module |
| • Temperature unit | Degrees Celsius; degrees Fahrenheit; Kelvin | degrees Celsius | Dynamic | Module |
| • Interference frequency suppression | 400 Hz; 60 Hz; 50 Hz; 10 Hz | 50 Hz | Dynamic | Module |
| Measurement<br>• Measurement type | <br>disabled<br>TC-IL thermocouple (linear, internal comparison)<br>TC-EL thermocouple (linear, external comparison)<br>TC-L00C thermocouple (linear, 0 °C reference temperature)<br>TC-L50C thermocouple (linear, 50 °C reference temperature) | <br>TC-IL: | Dynamic | Channel |
| • Measuring range | See chapter Measurement types and measuring ranges (Page 423) | Type K | | |
| • Response to open thermocouple | Overflow; underflow | Overflow | Dynamic | Channel |
| • Smoothing | None<br>Low<br>Average<br>High | None | Dynamic | Channel |
| • External reference junction | Local thermoresistor | Local thermoresistor | Dynamic | Channel |



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| Parameters | Range of values | Default | Type of parameter | Scope |
|---|---|---|---|---|
| • Temperature coefficient | 0.003850 (IPTS-68)<br>0.003850 (ITS-90)<br>0.003916<br>0.003902<br>0.003920<br>0.003910 (GOST) | 0.003850 (IPTS-68) | Dynamic | Module |
| Hardware-interrupt trigger<br>• High limit<br>• Low limit | <br>32511 to -32512<br>From - 32512 to 32511 | <br>32767<br>-32768 | Dynamic | Channel |

## 6.11.3 Additional information relating to SM 331; AI 6 x TC

### Using the module

The following hardware and software requirements must be met to use the SM 331; AI 6 x TC isolated S7-300 analog input module:

- If the module is to be used centrally in S7-300, all CPUs must have firmware version 2.6 or higher (with the exception of 6ES7318-2AJ00-0AB0).
- If the module is to be used on a distributed basis in ET 200M, the following IM 153 modules are suitable:
  6ES7153-1AA03-0XB0, product version 12 or higher
  6ES7153-2BA02-0XB0
  6ES7153-2BA82-0XB0
  6ES7153-4BA00-0XB0
  6ES7153-4AA01-0XB0
- A GSD file must be used if the module is part of a distributed installation and controlled by a master produced by a third-party manufacturer with DPV1 support (operation with DPV0 is not supported). The GSD file for the selected IM 153 is available for download from the Internet (http://www.siemens.com/automation/service&support).
- STEP 7 V5.4 SP4 (HSP0158) or higher
- For user calibration:
  SIMATIC PDM V6.0 + SP3 + HF2 (HSP0158) or PDM V6.0 + SP4 or higher
  and EDD for ET 200M "DP_IOSystem_Siemens_ET200M_Module.Device" V1.1.10 or higher.

### Unused channels

Set the "disabled" value at the "measurement type" parameter for unused channels. Unused channels should also be short-circuited at the connection plug.

Effect of this measure:

- You prevent measurement errors at the unused channels.
- You suppress diagnostic messages from the unused channels.



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### Short-circuit to M or L

The module does not suffer any damage if you short-circuit an input channel to M or L. The channel continues to output valid data and does not report a diagnostics event.

### Special features of channel groups with respect to hardware interrupts when limit is exceeded

You can set the high and low limits triggering hardware interrupts separately for each channel in STEP 7.

### Hardware interrupt

The table below shows the contents of the 4 bytes of additional OB40 information during a hardware interrupt.

| Content of the 4 bytes with additional information | | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | Byte |
|---|---|---|---|---|---|---|---|---|---|---|
| Special analog flags | 2 bits per channel to identify the range | | | | | | | | | |
| | High limit exceeded at channel | | | 5 | 4 | 3 | 2 | 1 | 0 | 0 |
| | Low limit undershot at channel | | | 5 | 4 | 3 | 2 | 1 | 0 | 1 |
| | Free byte | | | | | | | | | 2 |
| | Free byte | | | | | | | | | 3 |

### Startup characteristics and compensation time monitoring (watchdog) for external cold spot compensation via remote thermoresistor

When the module starts up, all inputs report an overflow (32767). Once a compensation value has been received via data record 2, the module starts to read the TC inputs and to output correct data. If the module does not receive any data from data record 2 within 5 minutes of startup, a reference channel fault is reported in the standard channel diagnostics data. If enabled, a diagnostic interrupt is sent.

The module features time monitoring (watchdog) set to 5 minutes, which is reset when a new compensation value is received via data record 2. If the module does not receive any data from data record 2 within the 5 minute interval set for the time-monitoring function in normal operation, a reference channel fault is reported in the standard channel diagnostics data. If enabled, a diagnostic interrupt is sent.

### Internal calibration while the process is running

The module can compensate most of the internal temperature-drift errors. Internal calibration while the process is running is always executed after startup, when parameters are reassigned, and when the power is switched on/off. Once the relevant parameters have been activated, internal calibration while the process is running is also performed if the ambient temperature at the module changes by 5 degrees Celsius. Enabling calibration while the process is running interrupts the module I/O cycle until calibration is complete. The duration of the interruption depends on the programmed interference frequency; see the table below for information about this relationship.



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### Duration of interruption caused by calibration while the process is running

| Interference frequency | Duration of interruption |
|---|---|
| 10 Hz | 600 ms |
| 50 Hz | 120 ms |
| 60 Hz | 100 ms |
| 400 Hz (100 Hz) | 60 ms |

Calibration while the process is running should be activated to ensure measuring accuracy over a long period of time. Some applications do not permit an interruption of the I/O cycle. In such cases, you can disable the parameter for calibration while the process is running, although this will result in less accurate measurements over time. The parameter for calibration is activated as standard while the process is running.

### Compensation of the reference junction

If the measuring point is exposed to a different temperature than the free ends of the thermocouple (connection point), a voltage known as the thermoelectric voltage arises between the free ends.
The level of the thermoelectric voltage depends on the difference between the temperature at the measuring point and that at the free ends, as well as on the type of materials combined in the thermocouple. Because a thermocouple always detects any temperature difference, the free ends at the reference junction must be maintained at a certain temperature to determine the temperature at the measuring point.

### External compensation of the reference junction via remote thermoresistor

The reference-junction temperature can also be measured via an external module and transferred to the AI 6 x TC isolated module by means of SFC 58 in data record 2 (DR2).

The permitted reference temperature corresponds to the Pt100 climatic temperature range for platinum thermoresistors.

$$-145.0\ °C \leq t_{ref} \leq +155.0\ °C$$
$$-229.0\ °F < t_{ref} < +311.0\ °F$$
$$+128.2\ K < t_{ref} < +327.6\ K$$

The Kelvin measurement is only limited to 327.6 if the reference temperature is output in technical units. If the reference temperature is reported in standard units, the Kelvin measurement limit is 428.2 K.



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If a reference value above the permitted temperature limit is received in DR2, it will cause a reference channel fault, which is displayed in the standard channel diagnostic data. If enabled, a diagnostic interrupt is sent.

**Note**

If an analog input module such as AI 8 x thermoresistor is used to measure the reference-junction temperature, the thermoresistor module parameters for the output structure and the measuring accuracy must be represented by bytes 0 and 1 in data record 2. This is shown in the figure "Structure of data record 2 for SM 331; AI 6 x TC". If the external thermoresistor module does not provide correct information about data structure and scaling, it will lead to inaccurate measurements being output by the isolated SM 331; AI 6 x TC module.



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## Structure of data record 2 for SM 331; AI 6 x TC

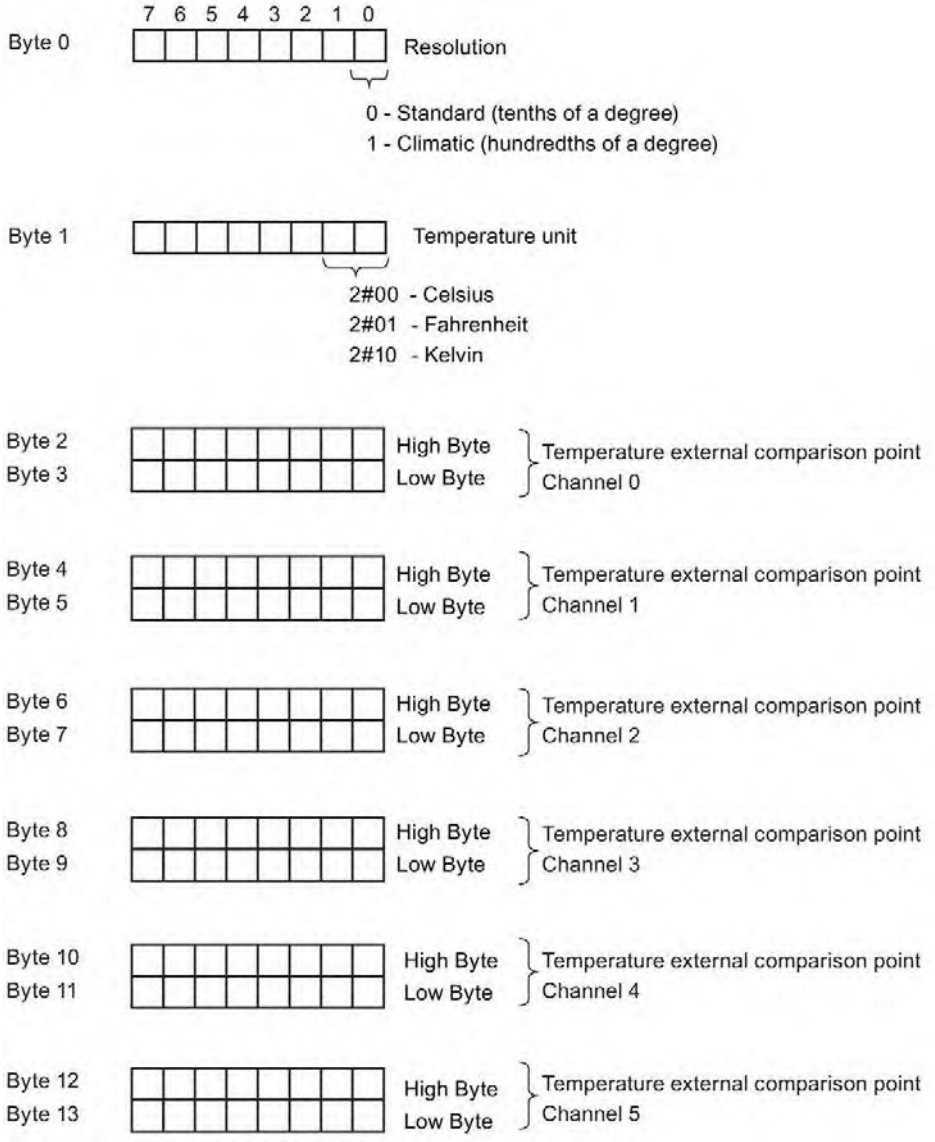



Figure 6-36 Structure of data record 2 for SM 331; AI 6 x TC



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### Compensation of the thermocouple via an external Pt100 element with external thermoresistor module

Because of the flexible structure of data record 2, you can use a separate external Pt100 element for each channel. In addition, the channels can also be grouped together by means of the user application in such a way that they all use the same external Pt100. This simply requires the same temperature value to be specified in DR2 for all the channels which use the same reference temperature.

**Note**

Reference-junction compensation also results in an error in the temperature measured by the isolated AI 6 x TC module. For this reason, great care must be taken when detecting the reference junction. To keep this error to an absolute minimum, the reference-junction temperature must remain as constant as possible.

### Example: Transfer of a temperature value as a cold-spot temperature for channels 0 to 5, from a thermoresistor module to AI 6 x TC:

Input address of AI 6 x TC: 238 (module address)
Input address of the thermoresistor: 128 (channel address)

Occupied memory:
M 20.0: Request bit for SFC "WR_REC"
M 20.1: Busy bit for SFC "WR_REC"
MW 22: Return value for SFC "WR_REC"
MW 0 to MW 12: Memory for data transfer (see table below).

```
UN      M    20.0        // Check the request: new cold spot temperature
UN      M    20.1        // Check whether WR_REC is busy
SPB     END              // Skip, if no transfer is required
                                ist

U       M    20.1        //Check whether WR_REC is busy
 SPB     WRT

        //Create the memory for data transfer
        L      B#16#01          // Transfer the temperature in hundredthsl
                                // of a degree (Pt100 climatic))
        T      MB    0
        L      B#16#02          // Transer the temperature in Kelvin
        T      MB    1
        L      PEW    128       // Read out the input address of the used channel
                                   of
                                // the thermoresistor module
        T      MW    2          // for channel 0 of AI 6 x TC
        T      MW    4          // for channel 1 of AI 6 x TC
        T      MW    6          // for channel 2 of AI 6 x TC
        T      MW    8          // for channel 3 of AI 6 x TC
        T      MW    10         // for channel 4 of AI 6 x TC
```



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```
        T      MW    12         // for channel 5 ofAI 6 x TC

        // Transfer the cold-spot temperature to AI 6 x TC
WRT:    CALL "WR_REC"
               REQ        :=M20.0             // Request bit for data transfer
IOID       :=B#16#54
LADDR      :=W#16#EE           // Input address of AI 6 x TC
RECNUM     :=B#16#2            // Data record number must be set to 2

RECORD     :=P#M 0.0 Byte 14   // Indicator for the memory for data
                                              // transfer, 14 bytes long
RET_VAL    :=MW22              // Return value for SFC "WR_REC"
BUSY       :=M20.1             // Busy bit of SFC "WR_REC"

U      M    20.1                      // check whether WR_REC is busy
 SPB    END
        CLR
        =      M    20.0                      // Reset request for cold-spot
                                              // temperature

END:     NOP 0
```

This is just an example. The logic and memory allocation must be adapted to the structure of the particular PLC program used.

The return value of SFC "WR_REC" (MW 22) can be evaluated in accordance with the structure of the PLC program used. Additional information is available in the manual titled System Software for S7-300/400 System and Standard Functions (http://support.automation.siemens.com/WW/view/en/1214574).

## 6.11.4 Firmware update via HW Config for analog input module SM 331; AI 6 x TC

### Introduction

Depending on the available comaptible function updates, the module AL 6 x TC can be updated to the newest firmware version.

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

### Requirements

- STEP 7 V 5.4 SP4 (HSP0158) or higher
- For central use of the module Al 6 x TC in a S7-300, the firmware update must occur in the CPU-operating mode STOP. If the CPU is in the RUN operating mode, it may result in unexpected behavior and the module will first be available again after a network off/network on.
- If the module Al 6 x TC is set in a distributed IO device ET 200M, a firmware update is also possible in the CPU-operating mode RUN.



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## Firmware update

This is how you update the firmware of a central or distributed module with the IM 153:

1. Select the module AI 6 x TC in HW Config.
2. Select the "SPS" > "Update Firmware" menu command.
3. Use the "Browse" button to select the path to the firmware files (*.upd).
4. Click the "Execute" button.
   – The module performs the firmware update.

For additional information, refer to the STEP 7 online help.

**Note**

- During the firmware update, the OB 83 (alarm due to removing and inserting modules), the OB 85 (program execution error) and the OB 86 (error due to module rack failure) are opened. If the diagnostics alarm of the module is approved, the OB 82 will also be opened during the firmware update. Make sure that the OB is set correspondingly.
- If the red LED (SF) on the module blinks, an error occurred during the firmware update and the update must be repeated. In this case, the bootloader version Ex.x.x is displayed in the online diagnostics.
- A firmware update through HW-config is not permitted if the AI 6 x TC module is in redundant mode.

## Identification of the firmware

After the firmware update, you must label the firmware version on the module.



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## 6.11.5 I&M data for identifying the analog input module SM 331; AI 6 x TC

### Properties

I data: Information about the module, which is normally found on the module casing. I-data is write-protected. They include:

- Hardware release status
- Firmware release status
- Serial number

M data: System-dependent information (e.g. plant designation).

M data is created during configuration.

All identification data (I&M-data) is retentively saved in a module and supports you with the following tasks:

- Error search and repair in the system
- Testing the system configuration
- Finding changes to the system hardware

### Reading and writing the identification data with STEP 7

System-dependent information is configured in the properties dialog field of the module.

You obtain information on the module (I data) from the module status dialog. The system-dependent information on the module is displayed here too.

**Note**

I&M data can only be written if the CPU is in the STOP operating mode.

The AI 6 x TC supports only I&M0 and I&M1 data.



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## 6.11.6 Calibration of analog input module SM 331; AI 6 x TC

### Introduction

The SM 331 is calibrated at the factory and complies with the specified accuracy values. As a rule, there is no need to recalibrate the module.

With certain systems, it may be advisable or even a requirement laid down in standards (as required by particular institutions in the food and beverage or pharmaceutical industries) to recalibrate the module once it has been integrated into the system, for example, at specific time intervals.

Particularly in systems where sensors detect and/or process relatively low voltages and/or currents, it may be advisable to perform recalibration when the module is in the system including all connected cables. This approach compensates any influence by cables and/or temperature.

If you carry out a calibration procedure, new calibration values are detected and saved retentively on the module. This means that the calibration values determined for the module at the factory prior to delivery are not lost when users perform their own calibration work. You can revert to these original calibration values at any time.

**Note**

The calibration values from each channel are saved retentively on the module for a specific measuring range, which means they only apply to the measuring range in which the user calibration work was performed.

If the parameters of a channel which has active user-calibration values are reassigned to change the measuring range, the calibration values saved at the factory for this channel and this measuring range are used from this point on.

However, the user-calibration values still remain in the memory; they are not overwritten until the user calibrates the channel again. But if the original measuring range is reset for this channel without the user performing the calibration procedure again, the user-calibration values which have already been established become effective once more.

### Requirements

The calibration function can only be used in a distributed installation and in conjunction with the SIMATIC PDM ("**P**rocess **D**evice **M**anager").

The following requirements must be met to use the module calibration functions: SIMATIC PDM V6.0 + SP3 or higher + HF2 in conjunction with HSP158, or SIMATIC PDM V6.0 + SP4 or higher, and the EDD for the ET 200M, "DP_IOSystem_Siemens_ET200M_Module.Device", Version V1.1.10 or higher

User calibration is not permitted if the AI 6 x TC module is running in redundant mode.



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## Launching the calibration function

The following diagrams show the sequence of a user calibration in SIMATIC PDM V6.0 + SP5. More recent versions of SIMATIC PDM can deviate from the content of these diagrams.

The module calibration function is launched in the SIMATIC PDM via <Device ⇒ Calibration> for the selected module.

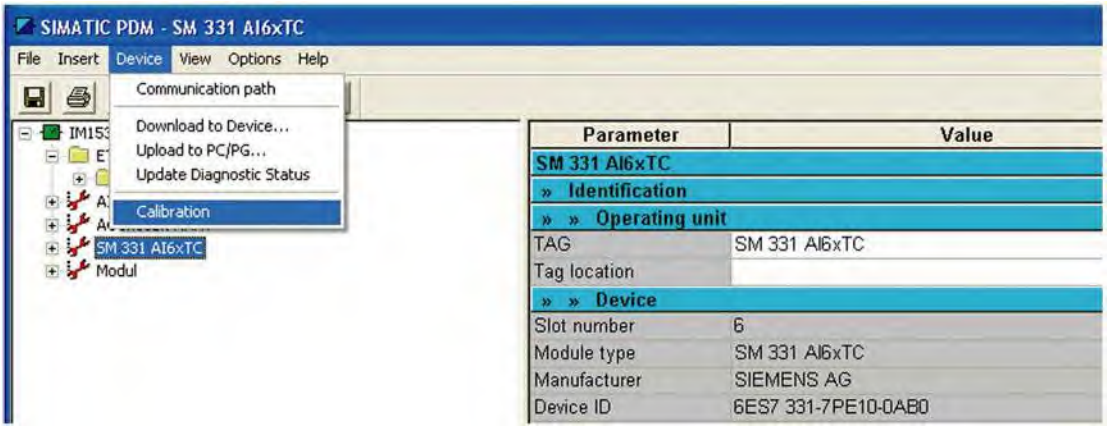



Figure 6-37 Calibration function

Once the calibration function has been launched, the calibration start screen appears. Each time a new channel is selected, the module reads the following general data and calibration values:

General data:

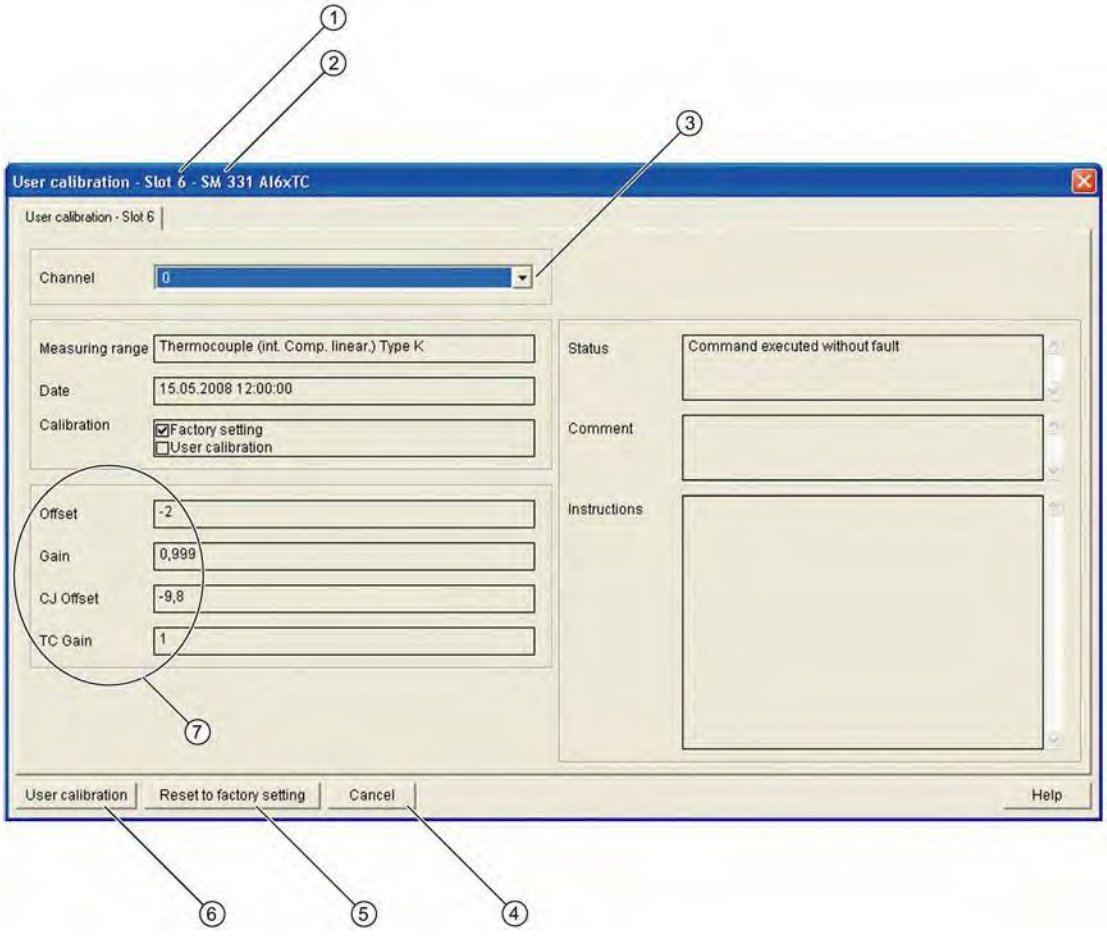
- Measuring range: Currently programmed measuring range for the selected channel
- Date: Date and time when the displayed calibration values were determined
- Calibration: Indicates whether the currently active calibration values are factory-set or user values



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**Calibration values:**

- Offset: Currently active offset for the analog digital converter
- Gain: Currently active gain for the analog digital converter
- CJ Offset: Currently active temperature offset for the internal reference-temperature sensor (only relevant for TC-IL thermocouples)
- TC Gain: Currently active gain for recording the temperature (only relevant for TC-IL, TC-EL, TC-L00C, and TC-L50C thermocouples)




① Slot address of the module
② Current system ID (HID)
③ Selection of the channel to be calibrated
④ Cancels the calibration function
⑤ Resets the calibration values of the selected channel to the factory settings
⑥ Starts user calibration for the selected channel
⑦ Current calibration values

Figure 6-38 User-calibration values



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## Options

Now you can:

- Start user calibration for the selected channel
  -> "User calibration" button
- Reset the calibration values set at the factory for the selected channel
  -> "Reset to factory setting" button
- Cancel the calibration function
  -> "Cancel" button

**Note**

If you reset the currently active channel to its factory settings, the original calibration values saved on the module when it was delivered become valid again. Any user-calibration values which may exist for this channel are then lost. You cannot restore these user-calibration values.

## User calibration

User calibration is started for the selected channel by pressing the "User calibration" button.

A 24 V load voltage must be applied at the module for calibration.
The user calibration function re-establishes the calibration values required by the selected channel in accordance with the measuring range which has been programmed for that channel.

Calibration can be executed in the CPU's RUN or STOP operating modes. Please note that in the CPU's RUN operating mode, the module does not return any correct analog values to the process for the duration of the calibration.

**Note**

While user calibration is ongoing, none of the module channels can handle new process values.

- All analog input values of the module are set to 0x7FFF ("invalid analog value") until calibration is complete.
- All channels indicate this status by means of a corresponding channel-diagnostic function using the second type of diagnosis (see Section 1.7, "Diagnostics of the analog input module SM 331; AI 6 x TC isolated").

The previously selected channel is calibrated using the calibration display which is output.



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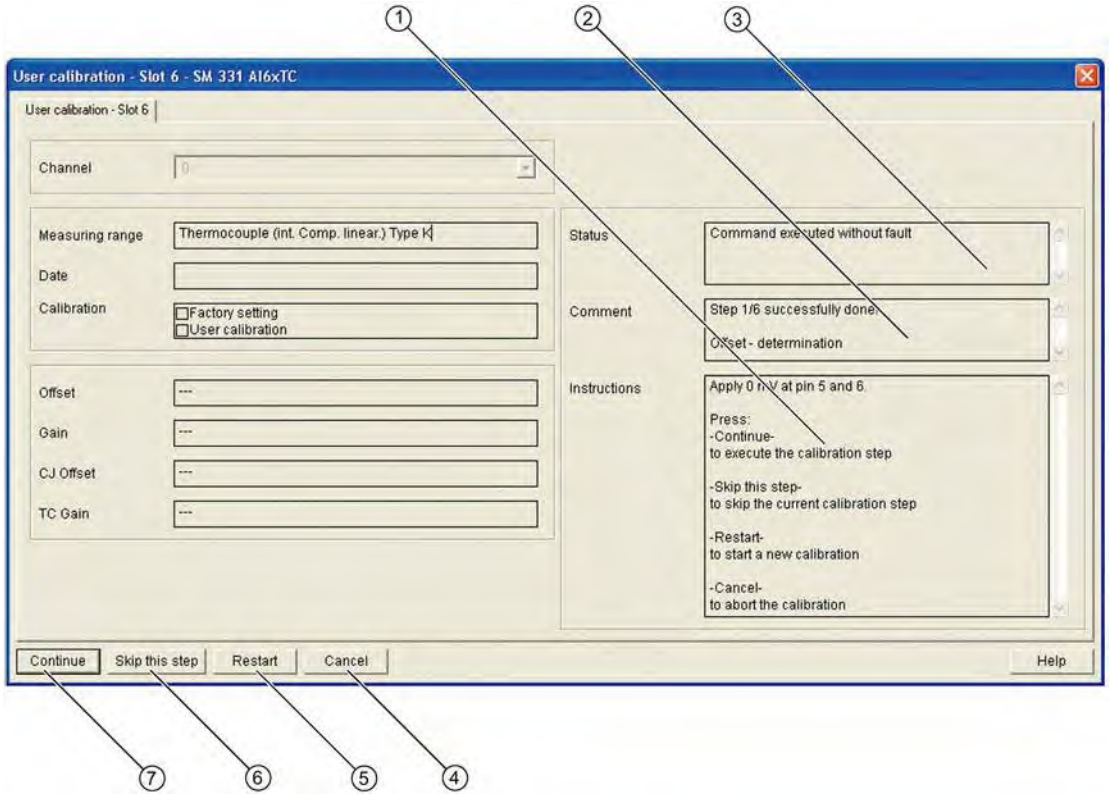
Calibration consists of several different steps, during which the individual calibration values are determined.

- If a fault occurs during calibration or if new parameters are assigned to the module, the calibration of the relevant channel is canceled and the most recently active calibration values for the channel become effective once more. All of the calibration values recorded up to this point are lost. The module can now handle the current process values once again.
- Calibration can be canceled at any time once it has been started. Following cancelation, the previously active calibration values take effect again and the calibration values recorded up to this point are lost. The module can now handle the current process values once again.



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You must provide a voltage and/or temperature during user calibration. You do this by using the appropriate external wiring and an external voltage/temperature transmitter. As shown in the figure "User-calibration status", the "Instructions" field indicates the numbers of the pins where the calibration stimulus can be applied. The first pin number corresponds to the positive terminal, the second to the negative terminal. The accuracy of the calibration depends on the accuracy of the voltage/temperature supplied. To ensure that the module maintains the specified measuring accuracy following user calibration, the voltage/temperature provided must demonstrate an accuracy at least twice that defined for the module. Inaccurate voltages or temperatures will result in an incorrect calibration.




① Here you will find instructions on how to carry out the currently active calibration step
② Here you will find information relating to the currently active calibration step
③ Here you will find information relating to the current status of the calibration procedure
④ Cancels the calibration function completely
⑤ Cancels the currently active calibration and returns to the calibration start screen
⑥ Skips the currently active calibration step
⑦ Confirms the currently active calibration step and proceeds to the next step

Figure 6-39 User-calibration status



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### Status

Several different calibration steps are required to calibrate a channel, depending on the measurement type which has been set. The "Status" field indicates whether the last calibration step was completed with or without a fault. If a fault occurs while a calibration step is being executed, the fault is indicated here and the calibration for that channel is canceled. All calibration values recorded up to that point are deleted. The calibration values which were active before the user-calibration function was launched take effect once more.

### Comment

The following entries are displayed in the "Comment" field:

- The number of calibration steps completed thus far
- The number of calibration steps which still need to be carried out for the channel to be fully calibrated
- The calibration value currently being determined by the module

### Instructions

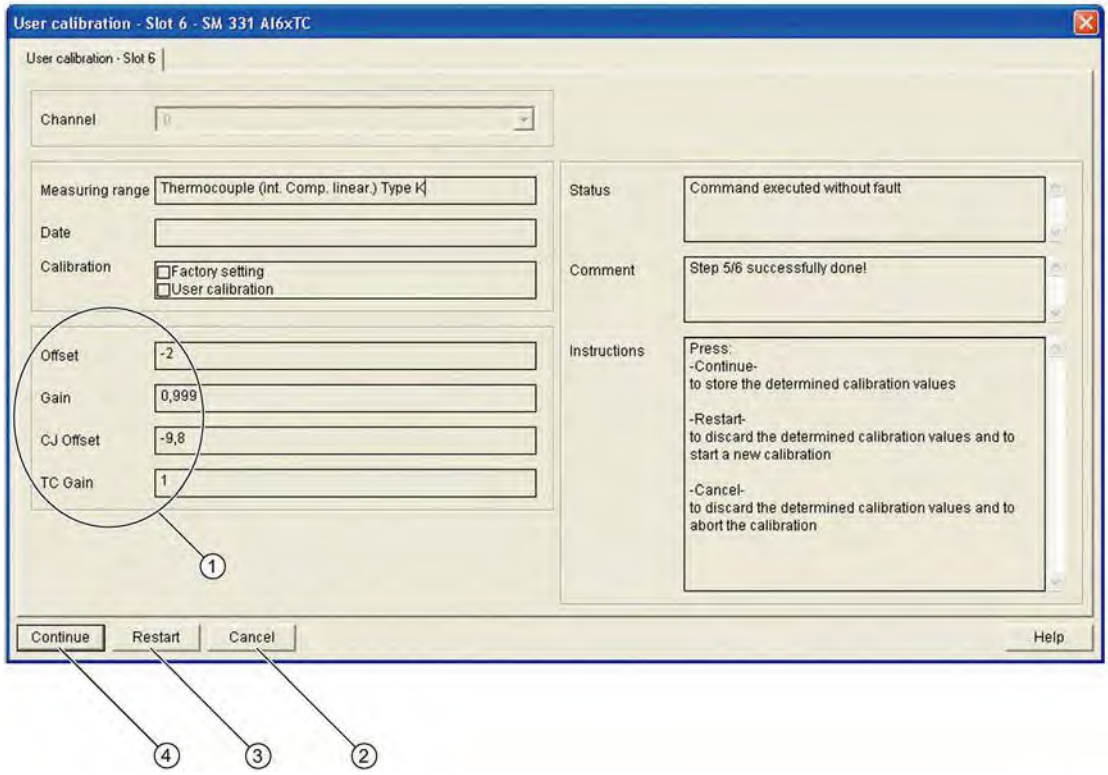
The "Instructions" field indicates which actions the user has to personally carry out for the currently active calibration step. Perform the actions indicated here and confirm by pressing the "Continue" button. The module now executes the actions required for the currently active calibration step. If this step is processed without a fault, the function proceeds to the next calibration step.

If you want to avoid recording existing calibration values again during user calibration, confirm the currently active calibration step by pressing the "Skip this step" button (rather than "Continue"). In this case, the factory-set calibration value is used for the calibration step which has been skipped (see "Comment" field).



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In the last calibration step, the values determined during the course of calibration are displayed.




① New calibration values
② Cancels the calibration function completely
③ Cancels the currently active calibration and returns to the calibration start screen
④ Confirms the determined calibration values, saves the values, and returns to the calibration start screen

Figure 6-40 User-calibration values

You can now adopt these calibration values as the new values for this channel by pressing the "Continue" button. The calibration values are saved retentively and the channel calibration is complete.

If you do not want to use the displayed calibration values, you can either return to the start screen and start a new calibration procedure by pressing the "Restart" button, or exit calibration altogether by pressing the "Cancel" button.



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# 6.12 Analog output module SM 332; AO 8 x 12 bit; (6ES7332-5HF00-0AB0)

## Order number

6ES7332-5HF00-0AB0

## Order number: "SIPLUS S7-300 module"

6AG1332-5HF00-2AB0

## Properties

- 8 outputs in one group
- The output can be selected by individual channel
  - Voltage output
  - Current output
- Resolution 12 bits
- Programmable diagnostics and diagnostic interrupt
- Programmable diagnostic interrupt
- Electrically isolated from the backplane bus interface and load voltage
- Supports parameter reassignment in RUN

## Diagnostics

For information on diagnostics messages at the "group diagnostics" parameter, refer to chapter Diagnostic messages of analog output modules (Page 296).

## Terminal assignment

The diagrams below show various wiring options. These examples apply to all channels (channel 0 to 7).

**Note**

When you switch the rated load voltage (L+) off and on, the outputs can return incorrect voltage/current values for the duration of about 500 ms.

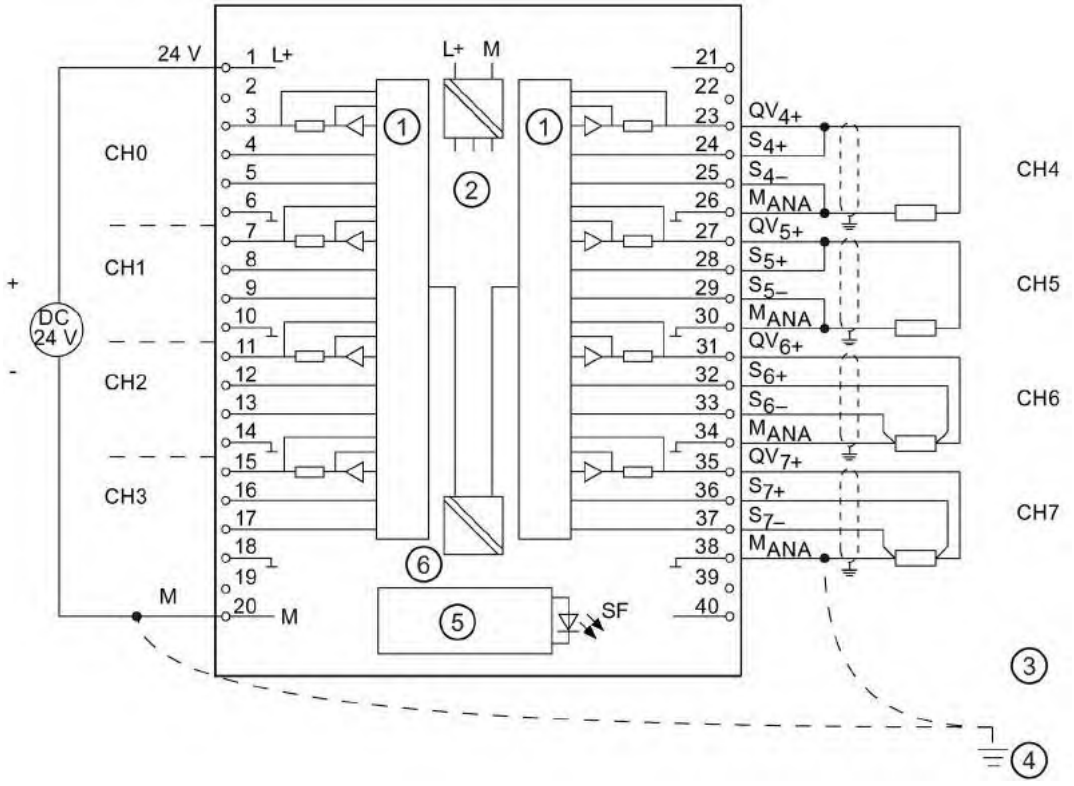


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## Wiring: 2 and 4-wire connection for voltage output

The following image depicts:

- 2-wire connection, no compensation for line impedance and
- 4-wire connection with compensation for line impedance



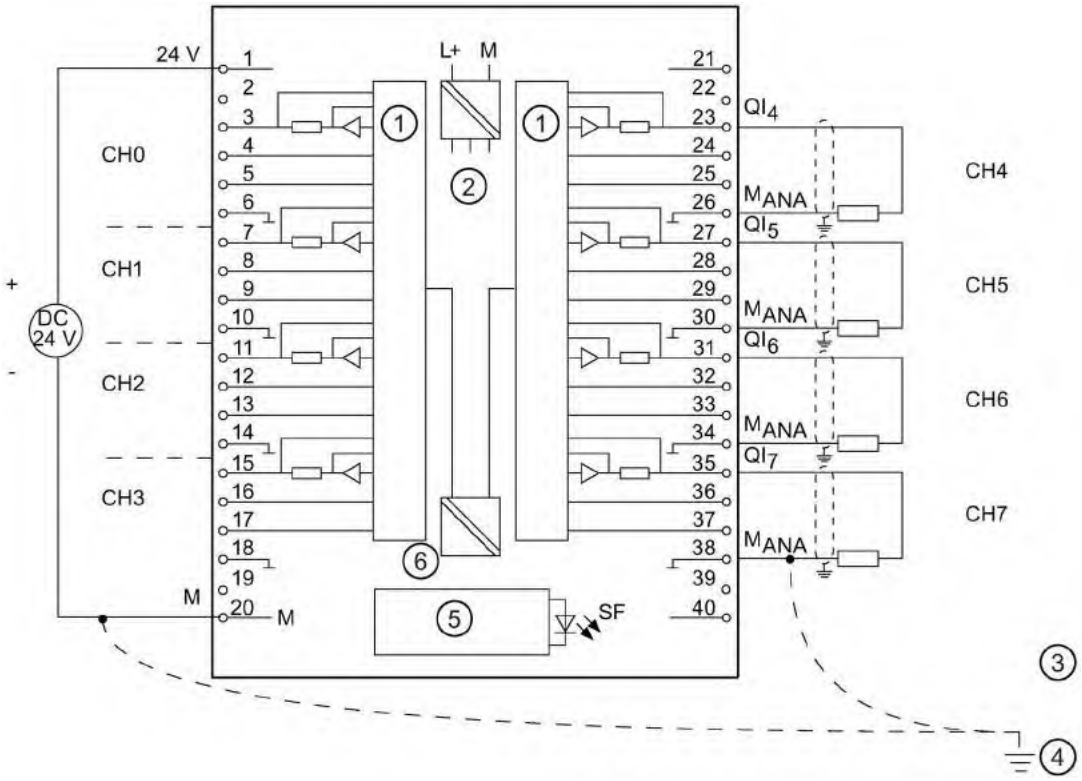

① DAC
② Internal supply
③ Equipotential bonding
④ Functional ground
⑤ Backplane bus interface
⑥ Electrical isolation

Figure 6-41 Wiring and block diagram



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## Wiring: Current output




① DAC
② Internal supply
③ Equipotential bonding
④ Functional ground
⑤ Backplane bus interface
⑥ Electrical isolation

Figure 6-42 Wiring and block diagram



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## Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 272 g |
| **Module-specific data** | |
| Supports parameter reassignment in RUN | Yes |
| Reaction of non-programmed outputs | Return the output value which was valid before the parameterization |
| Supports isochronous mode | no |
| Number of inputs | 8 |
| Cable length<br>• shielded | <br>max. 200 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+<br>• Reverse polarity protection | 24 V DC<br>yes |
| • Electrical isolation<br>• between channels and the backplane bus<br>• between channels and electronics power supply<br>• between channels<br>• between channels and load voltage L+ | <br>yes<br>yes<br>no<br>yes |
| Maximum potential difference<br>• between S- and $M_{ANA}$ (CMV) | <br>3 V DC |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• From supply voltage L+ | <br>max. 100 mA<br>max. 340 mA |
| Power loss of the module | typ. 6.0 W |
| **Generation of analog values** | |
| Resolution, including sign<br>• ± 10 V; ± 20 mA; 4 mA to 20 mA; 1 V to 5 V<br>• 0 V to 10 V; 0 mA to 20 mA;<br>• Conversion time (per channel) | <br>11 bits + sign<br>12 Bit max.<br>0.8 ms |
| Transient recovery time<br>• with resistive load<br>• with capacitive load<br>• with inductive load | <br>0.2 ms<br>3.3 ms<br>0.5 ms (1 mH)<br>3.3 ms (10 mH) |



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| Technical specifications | |
|---|---|
| **Interference frequency suppression, error limits** | |
| • Crosstalk between outputs | > 40 dB |
| Operational limit (across entire temperature range, relative to measurement range end value in the selected output range) | |
| • Voltage output<br>• Current output | ±0.5 %<br>± 0.6 % |
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected output range) | |
| • Output voltage<br>• Output current<br>• Temperature error (relative to output range)<br>• Linearity error (relative to output range)<br>• Repeat accuracy (in transient state at 25 °C, relative to output range)<br>• Output ripple; bandwidth 0 kHz to 50 kHz (relative to output range) | ± 0.4 %<br>± 0.5 %<br>± 0.002 %/K<br>+ 0.05 %<br>±0.05 %<br>±0.05 % |
| **Status, interrupts, diagnostics** | |
| Interrupts<br>• Diagnostic interrupt | <br>programmable |
| Diagnostic functions<br>• Group error display<br>• Reading diagnostics information | programmable<br>red LED (SF)<br>supported |
| **Actuator selection data** | |
| Output ranges (rated values) | |
| • Voltage | ± 10 V<br>0 V to 10 V<br>1 V to 5 V |
| • Current | ± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA |
| Load impedance (in the rated output range) | |
| • For voltage outputs<br>– Capacitive load | Min. 1 kΩ<br>Max. 1 µF |
| • For current outputs<br>– at CMV < 1 V<br>– with inductive load | max. 500 Ω<br>max. 600 Ω<br>max. 10 mH |
| Voltage output<br>• Short-circuit protection<br>• Short-circuit current | <br>yes<br>max. 25 mA |



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| Technical specifications | |
|---|---|
| Current output<br>• noload voltage | <br>max. 18 V |
| • Destruction limit against external voltages/currents<br>• Voltage at outputs to $M_{ANA}$<br>• Current | max. 18 V continuous; 75 V for a duration of max. 1 s<br>(duty factor 1:20)<br>max. 50 mA d.c. |
| Wiring of the actuators<br>• for voltage output<br>4–wire connection<br>• for current output<br>2–wire connection | using a 40-pin front connector<br>supported<br><br><br>supported |

### Configuration in RUN

Special considerations must be given if you use the Configuration in RUN function.

SF LED is lit:

Status before re-configuration diagnostics on, SF LEDs lit among others (on CPU, IM or module), although diagnostics are no longer pending and the module is operating correctly.

Solution:

- Only change the configuration when no diagnostics are pending for the module or
- Pulling and plugging the module.

## 6.12.1 SM 332; AO 8 x 12 Bit - Output ranges

### Introduction

You can configure the outputs for operation as voltage or current outputs, or disable them. You program the outputs at the "output type" parameter in *STEP 7*.

Output type "Voltage" and output range "± 10 V" are set by default at the module. You can always use this combination of output type and range without having to program the SM 332; AO 8 x 12 Bit in *STEP 7*.

Table 6- 32 Output ranges

| Selected type of output | Output range |
|---|---|
| Voltage | 1 V to 5 V<br>0 V to 10 V<br>± 10 V |
| Current | 0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA |

### See also

Representation of analog values for analog output channels (Page 279)



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## 6.12.2 Programmable parameters

### Introduction

For general information on programming analog modules, refer to the chapter Programming analog modules (Page 294).

The table below provides an overview of configurable parameters, including defaults:

Table 6- 33 Overview of the parameters of SM 332; AO 8 x 12 Bit

| Parameter | Range of values | | Default | Parameter type | Scope |
|---|---|---|---|---|---|
| Enable<br>• Diagnostic interrupt | yes/no | | no | dynamic | Module |
| Diagnostics<br>• Group diagnostics | Yes/no | | No | static | Channel |
| Output<br>• Output type<br>• Output range | disabled<br>Voltage<br>Current<br>See chapter output ranges (Page 447) | | V<br>± 10 V | dynamic | Channel |
| Reaction to CPU STOP | ASS<br>HLV | Outputs zero current/voltage<br>Hold last value | ASS | dynamic | Channel |

### Assigning parameters to channels

The parameters can be set separately at each output channel of SM 332; AO 8 x 12 Bit. You can assign separate parameters to each output channel.

Assign the parameters you set at the SFCs in the user program to the channel groups. Each output channel of SM 332; AO 8 x 12 Bit is thus assigned to a channel group, i.e. output channel 0 > channel group 0, for example.

**Note**

The output may carry invalid interim values if you modify output ranges while SM 332; AO 8 x 12 bit is in RUN.

### See also

Diagnostic messages of analog output modules (Page 296)



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## 6.12.3 Additional information on SM 332; AO 8 x 12 Bit

### Unused channels

To take unused output channels of SM 332; AO 8 x 12 Bit off power, set the "disabled" argument at the "output type" parameter. Disabled channels do not have to be wired.

### Line continuity check

SM 332; AO 8 x 12 Bit only performs a line continuity check at the current outputs.

In output ranges 0 mA to 20 mA and ± 20 mA, a "reliable" wire-break check is not possible for output values of ± 200 µA.

### Short-circuit test

SM 332; AO 8 x 12 Bit only performs a short-circuit test at the voltage outputs.



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# 6.13 Analog output module SM 332; AO 4 x 16 bit; isochrone; (6ES7332-7ND02-0AB0)

## Order number

6ES7332-7ND02-0AB0

## Order number: "SIPLUS S7-300 module"

6AG1332-7ND02-4AB0

## Properties

- 4 outputs in 4 channel groups
- The output channels can be programmed as
  - Voltage output
  - Current output
- Resolution 16 bits
- Supports isochronous mode
- Supports parameter reassignment in RUN
- Programmable diagnostics and diagnostic interrupt
- Electrical isolation between:
  - backplane bus interface and analog output channel
  - analog output channels
  - analog output and L+, M
  - Backplane bus circuit and L+, M
- Supports parameter reassignment in RUN

## Diagnostics

For information on diagnostic messages at the "group diagnostics" parameter, refer to chapter Diagnostic messages of analog output modules (Page 296).

## Terminal assignment

The diagrams below show various wiring options.

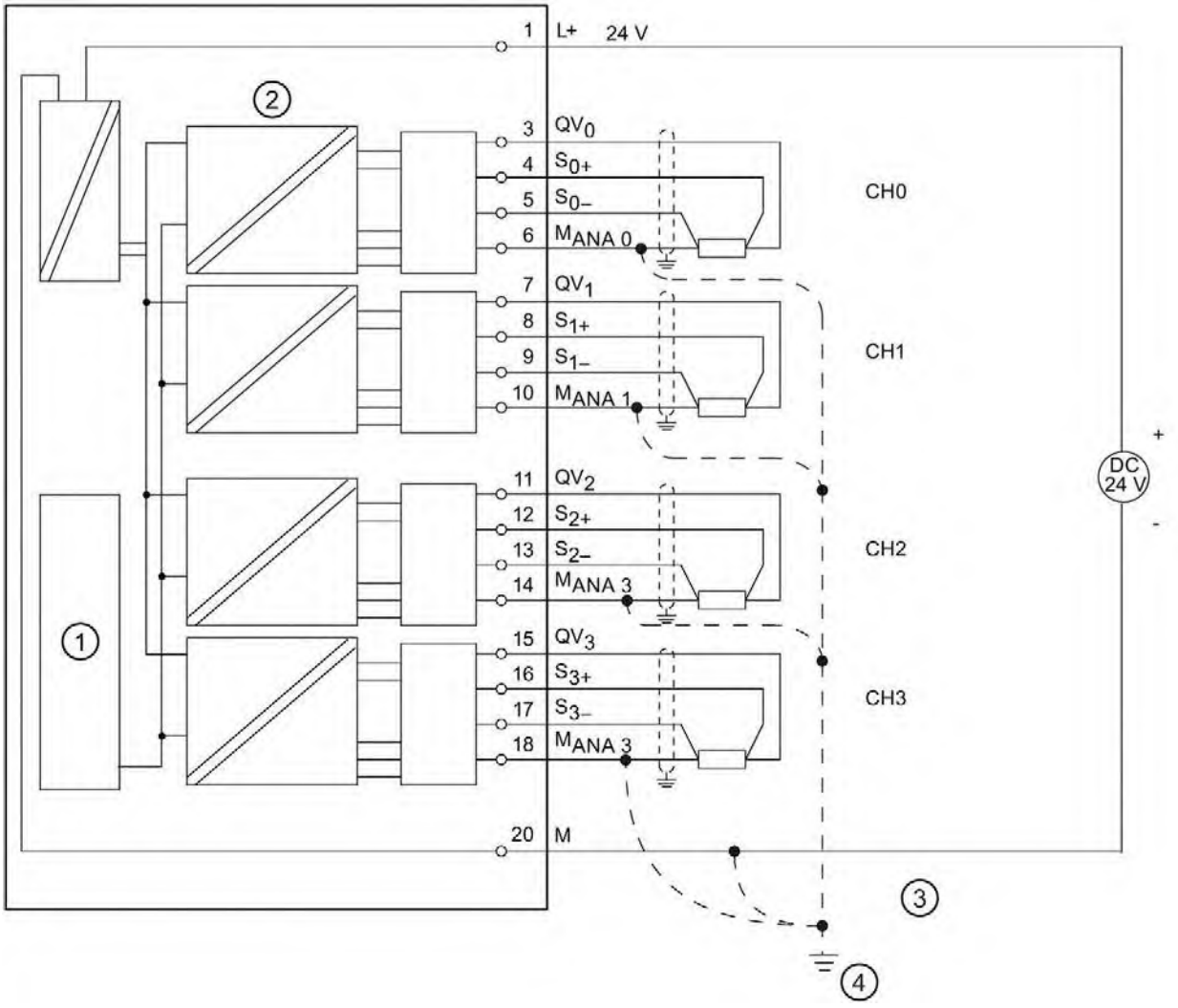
**Note**

When you switch the rated load voltage (L+) off and on, the output may carry invalid interim values for the duration of ca. 10 ms.



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## Wiring: 4-wire connection



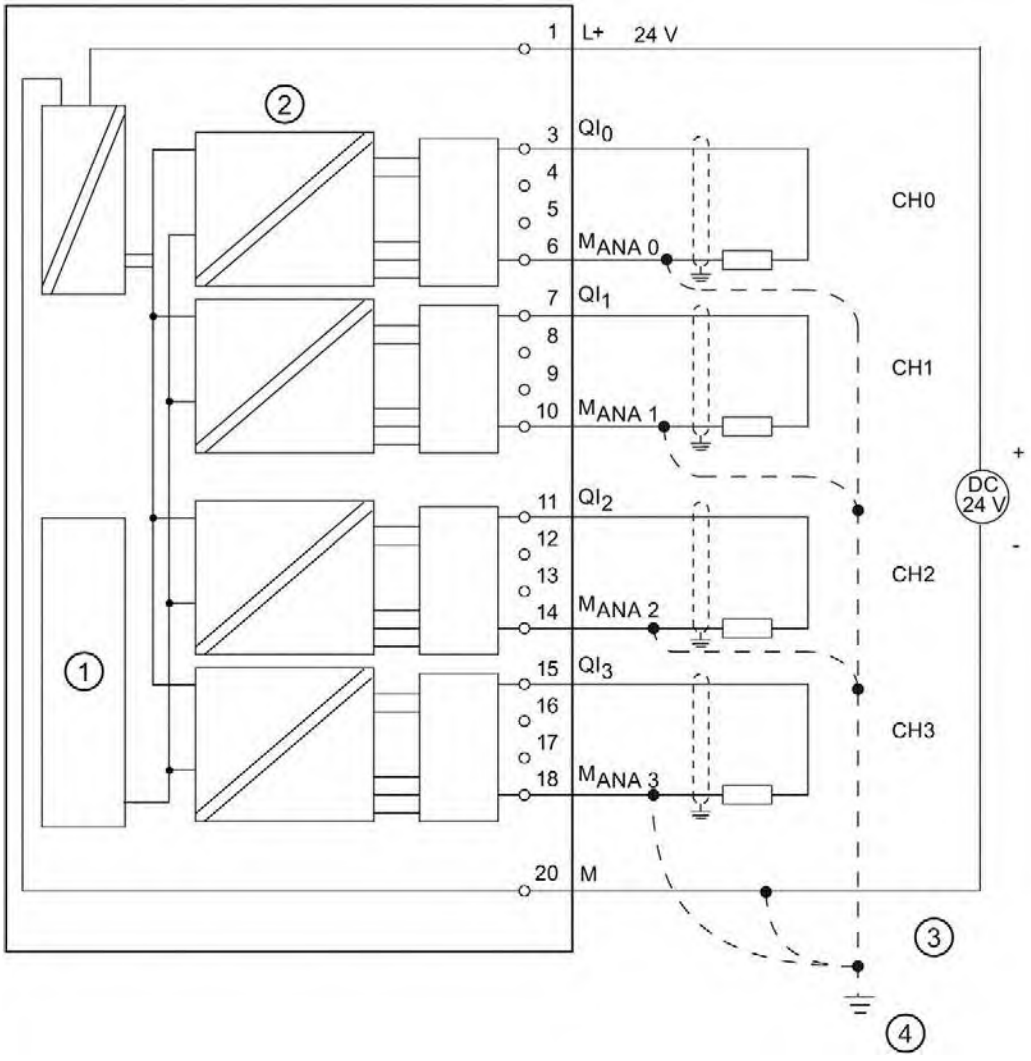

① Backplane bus interface
② Electrical isolation
③ Equipotential bonding
④ Functional ground

Figure 6-43 Wiring and block diagram



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## Wiring: Current output




① Backplane bus interface
② Electrical isolation
③ Equipotential bonding
④ Functional earthing

Figure 6-44 Wiring and block diagram



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## Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 220 g |
| **Module-specific data** | |
| Supports parameter reassignment in RUN<br>• Reaction of non-programmed outputs | yes<br>return the output value which was valid before the parameterization |
| Supports isochronous mode | yes |
| Number of outputs | 4 |
| Cable length<br>• shielded | max. 200 m |
| **Voltages, currents and potentials** | |
| Rated load voltage L+<br>• Reverse polarity protection | 24 V DC<br>yes |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels and electronics power supply<br>• between channels | <br>yes<br>yes<br>yes |
| Maximum potential difference<br>• between outputs (ECM)<br>• between $M_{ANA}$ and $M_{internal}$ ($V_{ISO}$) | <br>200 V DC / 120 V AC<br>200 V DC / 120 V AC |
| Isolation test voltage | 1500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 120 mA<br>max. 290 mA |
| Power loss of the module | typ. 3 W |
| **Generation of analog values** | |
| Resolution (including sign)<br>• ± 10 V<br>• 0 V to 10 V<br>• 1 V to 5 V<br>• ± 20 mA<br>• 0 mA to 20 mA<br>• 4 mA to 20 mA | <br>16 bits<br>15 bits<br>14 bits<br>16 bits<br>15 bits<br>15 bits |
| Conversion time (per channel)<br>• in standard mode<br>• in isochronous mode | <br><200 µs<br>640 µs |



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| **Technical specifications** | |
|---|---|
| Basic execution time of the module (independent of the number of enabled channels)<br>• in standard mode<br>• in isochronous mode | <br><800 µs<br>750 µs |
| Transient recovery time<br>• with resistive load<br>• with capacitive load<br>• with inductive load | <br>0.2 ms<br>3.3 ms<br>0.5 ms (1 mH) / 3.3 ms (10 mH) |
| **Interference suppression, error limits** | |
| Crosstalk between outputs | > 100 dB |
| Operational limit (across entire temperature range, relative to measurement range end value in the selected output range) | |
| • Voltage output<br>• Current output | ±0.12%<br>±0.18% |
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected output range) | |
| • Voltage output<br>± 10 V<br>0 V to 10 V<br>1 V to 5 V | <br>±0.02%<br>±0.02%<br>±0.04% |
| • Current output<br>± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA | <br>±0.02%<br>±0.02%<br>±0.04% |
| Temperature error (relative to output range)<br>• Voltage output<br>• Current output | <br>± 0.0025%/K<br>± 0.004%/K |
| Linearity error (relative to output range) | ±0.004% |
| Repeat accuracy (in transient state at 25°, relative to output range) | ±0.002 % |
| Output ripple; range 0 Hz to 50 kHz (relative to output range) | ±0.05 % |
| **Status, interrupts, diagnostics** | |
| Interrupts<br>• Diagnostic interrupt | <br>programmable |
| Diagnostic functions<br>• Group error display<br>• Reading diagnostic information | programmable<br>red LED (SF)<br>supported |
| Set substitute values | yes, programmable |



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| **Technical specifications** | |
|---|---|
| **Actuator selection data** | |
| Output ranges (rated values) | |
| • Voltage | ± 10 V<br>0 V to 10 V<br>1 V to 5 V |
| • Current | ± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA |
| Load impedance (in the rated range of the output) | |
| • For voltage outputs<br>– Capacitive load | Min. 1 kΩ<br>Max. 1 µF |
| • For current outputs<br>– inductive load | max. 500 Ω<br>max. 1 mH |
| Voltage output<br>• Short-circuit protection<br>• Short-circuit current | <br>yes<br>max. 40 mA |
| Current output<br>• noload voltage | <br>max. 18 V |
| Destruction limit against external voltages/currents<br>• Voltage at outputs to $M_{ANA}$<br>• Current | <br>max. 15 V, continuous<br>75 V for the duration of max. 1 s (duty factor 1:20) 20)<br>max. 50 mA d.c. |
| Wiring of the actuators<br>• for voltage output<br>– 4-wire connection (measuring lead)<br>• for current output<br>– 2-wire connection | using a 20-pin front connector<br>supported<br><br>supported |

## Configuration in RUN

Special considerations must be given if you use the Configuration in RUN function.

SF LED is lit:

Status before re-configuration diagnostics on, SF LEDs lit among others (on CPU, IM or module), although diagnostics are no longer pending and the module is operating correctly.

Solution:

- Only change the configuration when no diagnostics are pending for the module or
- Pulling and plugging the module.



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## 6.13.1 SM 332; AO 4 x 16 Bit - Output ranges

### Introduction

You can configure the outputs for operation as voltage or current outputs, or disable these. You program the outputs at the "output type" parameter in *STEP 7*.

The output type "Voltage" and output range "± 10 V" are set by default at the module. You can always use this combination of output type and range without having to program the SM 332; AO 4 x 16 Bit in *STEP 7*.

### Output ranges

You program the output ranges for voltage and current outputs in *STEP 7*.

Table 6- 34 Output ranges SM 332; AO 4 x 16 Bit

| Selected type of output | Output range |
|---|---|
| Voltage | 1 V to 5 V<br>0 V to 10 V<br>± 10 V |
| Current | 0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA |



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## 6.13.2 Programmable parameters

### Introduction

For general information on programming analog modules, refer to the chapter Programming analog modules (Page 294).

The table below provides overview of programmable parameters and of their defaults.

Table 6- 35 Overview of the parameters of SM 332; AO 4 x 16 Bit

| Parameters | Range of values | | Default | Parameter type | Scope |
|---|---|---|---|---|---|
| Enable<br>• Diagnostic interrupt | yes/no | | no | dynamic | Module |
| Diagnostics<br>• Group diagnostics | yes/no | | no | static | Channel |
| Output<br>• Output type<br>• Output range | disabled<br>Voltage<br>Current<br>See chapter Output ranges for SM 332; AO 4 x 16 Bit (Page 456) | | V<br>± 10 V | dynamic | Channel |
| Reaction to CPU STOP | ASS<br>HLV | Outputs zero current/voltage<br>Hold last value | ASS | dynamic | Channel |

### Assigning parameters to channels

The parameters can be set separately at each output channel of SM 332; AO 4 x 16 Bit. You can assign separate parameters to each output channel.

Assign the parameters you set at the SFCs in the user program to the channel groups. Each output channel of SM 332; AO 4 x 16 Bit is thus assigned to a channel group, i.e. output channel 0 > channel group 0, for example.

**Note**

The output may carry invalid interim values if you modify output ranges while SM 332; AO 4 x 16 bit is in RUN.

### See also

Diagnostic messages of analog output modules (Page 296)



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## 6.13.3 Isochronous mode

### Properties

Reproducible reaction times (i.e. of the same length) are achieved in a SIMATIC system by means of a constant DP bus cycle, and synchronization of the single cyclic processes outlined below:

- Independent user program cycle. The length of the cycle time may vary due to non-cyclic program branching.
- Independent and variable DP cycle on the PROFIBUS subnet
- Cyclic operation of the backplane bus of the DP slave.
- Cyclic signal preparation and conversion at the electronic modules of the DP slave.

The constant DP cycle runs in synchronism and at the same length. The CPU run levels (OB61 to OB64) and isochronous IO are synchronized with this cycle. I/O data are therefore transferred at defined and constant intervals (isochronous mode.) Maximum flutter: ±50 µs.

### Requirements

- The DP master and slave must support isochronous mode. You require *STEP 7* V5.2 or higher.

### Mode of operation: Isochronous mode

Conditions of isochronous mode:

| | |
|---|---|
| Processing and activation time $T_{WA}$ between reading the output value to the transfer buffer and loading it into the D/A converter for output | 750 µs |
| $T_{DPmin}$ | 1100 µs |
| Diagnostic interrupt | max. 4 x $T_{DP}$ |



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### Calculation of filter and processing times

The same time conditions always apply, regardless of the number of configured channels.

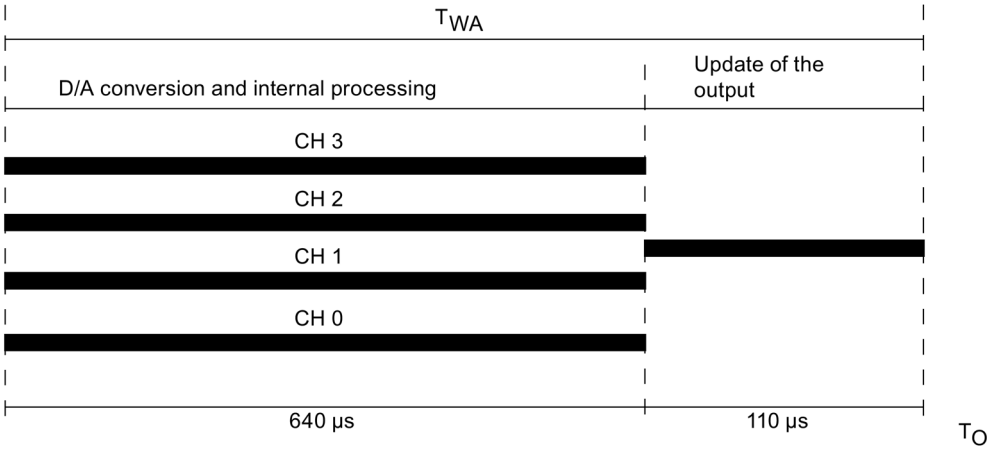



Figure 6-45 Calculation of the processing time and refresh time of the output

### Definition of isochronous mode

During the time $T_O$ - $T_{WA}$, the module reads the output data and saves the data internally. The internal processing time for each channel is used to write the results into the individual D/A converters.

### Further information

You can find additional information on isochronous mode in the online help for *STEP 7,* and in the operating instructions Distributed I/O System ET 200M. (http://support.automation.siemens.com/WW/view/en/1142798)

## 6.13.4 Additional information on SM 332; AO 4 x 16 Bit

### Unused channels

To take unused output channels of SM 332; AO 4 x 16 Bit off power, set the "disabled" argument at the "output type" parameter, and leave the terminal open.

### Substitute values

You can configure the SM 332; AO 4 x 16 Bit for CPU STOP mode as follows: Outputs off power, hold last value or set substitute values. The set substitute values must lie within the output range.



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# 6.14 Analog output module SM 332; AO 4 x 12 Bit; (6ES7332-5HD01-0AB0)

## Order number

6ES7332-5HD01-0AB0

## Order number: "SIPLUS S7-300 module"

6AG1332-5HD01-7AB0

## Properties

- 4 outputs in one group
- The output can be selected by individual channel
  - Voltage output
  - Current output
- Resolution 12 bits
- Programmable diagnostics and diagnostic interrupt
- Electrically isolated to backplane bus interface and load voltage
- Supports parameter reassignment in RUN

## Diagnostics

For information on diagnostic messages at the "group diagnostics" parameter, refer to chapter Diagnostic messages of analog output modules (Page 296).

## Terminal assignment

The diagrams below show various wiring options.

**Note**

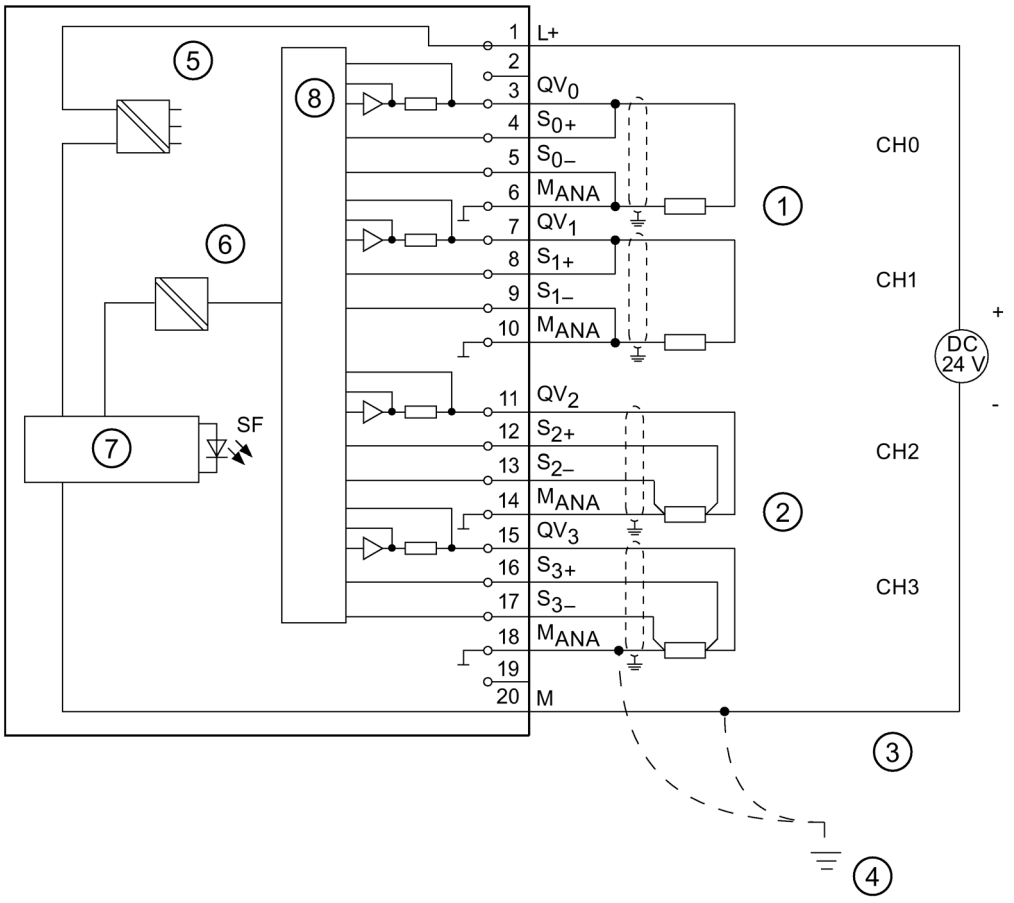
When you switch the rated load voltage (L+) off and on, the outputs can return incorrect voltage/current values for the duration of about 500 ms.



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## Wiring: 2 and 4-wire connection for voltage output

The following Fig. represents the 2-wire connection with no compensation for line resistors and the 4-wire connection with compensation for line resistors.



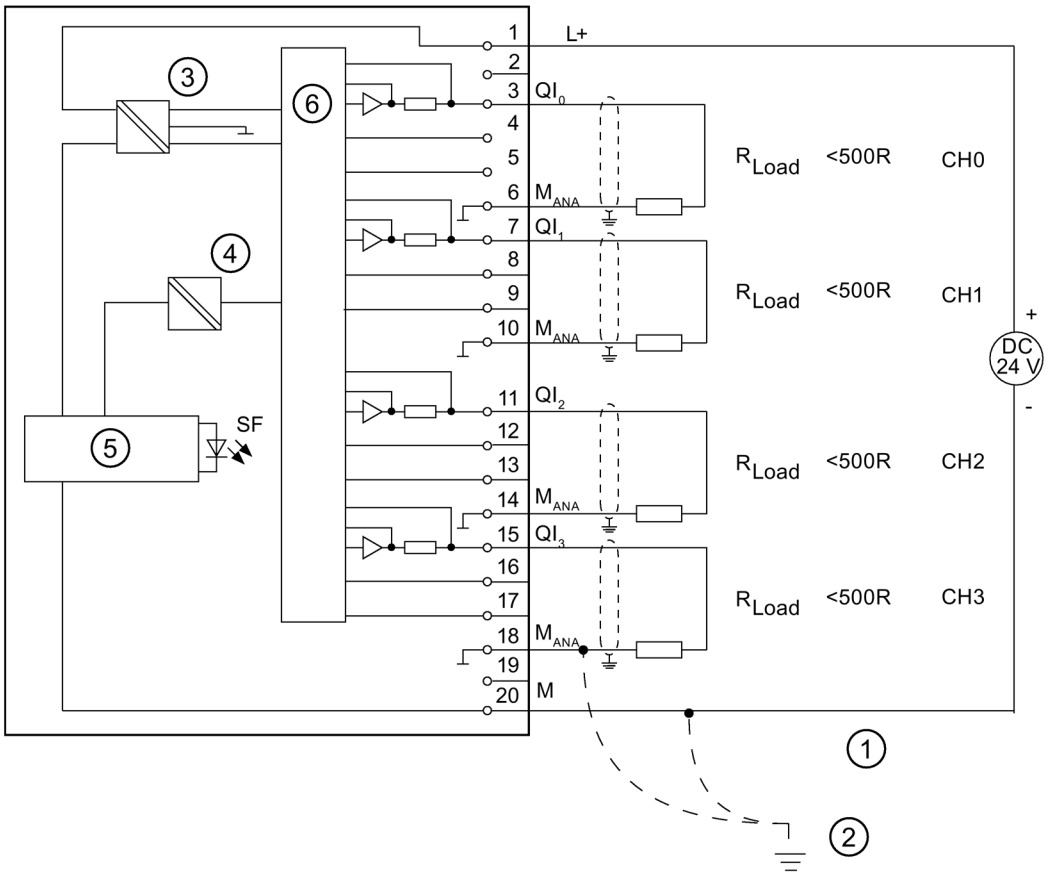

① 2-wire connection, no compensation for line resistors
② 4-wire connection, with compensation for line resistors
③ Equipotential bonding
④ Functional earthing
⑤ Internal supply
⑥ Electrical isolation
⑦ Backplane bus interface
⑧ Analog-to-Digital Converter (ADC)

Figure 6-46 Wiring and block diagram



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## Wiring: Current output




① Equipotential bonding
② Functional earthing
③ Internal supply
④ Electrical isolation
⑤ Backplane bus interface
⑥ Analog-to-Digital Converter (ADC)

Figure 6-47 Wiring and block diagram



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## Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 220 g |
| **Module-specific data** | |
| Supports parameter reassignment in RUN | yes |
| Reaction of non-programmed outputs | Return the output value which was valid before the parameterization |
| Supports isochronous mode | no |
| Number of outputs | 4 |
| Cable length<br>• shielded | <br>max. 200 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+<br>• Reverse polarity protection | 24 V DC<br>Yes |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels and electronics power supply<br>• between channels<br>• between channels and load voltage L+ | <br>Yes<br>Yes<br>no<br>Yes |
| Maximum potential difference<br>• between S- and $M_{ANA}$ (CMV) | <br>3 V DC |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 60 mA<br>max. 240 mA |
| Power loss of the module | typ. 3 W |
| **Generation of analog values** | |
| Resolution (including overshoot range)<br>• ± 10 V; ± 20 mA;<br>• 4 mA to 20 mA; 1 V to 5 V<br>• 0 V to 10 V; 0 mA to 20 mA | <br>11 bits + sign<br><br>12 bits |
| Conversion time (per channel) | max. 0.8 ms |
| Transient recovery time<br>• with resistive load<br>• with capacitive load<br>• with inductive load | <br>0.2 ms<br>3.3 ms<br>0.5 ms (1 mH)<br>3.3 ms (10 mH) |



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| **Technical specifications** | |
|---|---|
| **Interference frequency suppression, error limits** | |
| Crosstalk between outputs | > 40 dB |
| Operational limit (across entire temperature range, relative to measurement range end value in the selected output range) | |
| • Voltage output<br>• Current output | ± 0.5 %<br>± 0.6 % |
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected output range) | |
| • Voltage output<br>• Current output | ± 0.4 %<br>± 0.5 % |
| Temperature error (relative to output range) | ± 0.002 %/K |
| Linearity error (relative to output range) | ± 0.05 % |
| Repeat accuracy (in settled state at 25 °C, relative to output range) | ± 0.05 % |
| Output ripple; range 0 Hz to 50 kHz (relative to output range) | ± 0.05 % |
| **Status, interrupts, diagnostics** | |
| Interrupts<br>• Diagnostic interrupt | <br>Programmable |
| Diagnostic functions<br>• Group fault display<br>• Reading diagnostic information | programmable<br>Red LED (SF)<br>Supported |
| Setting substitute values | Yes, programmable |
| **Actuator selection data** | |
| Output ranges (rated values) | |
| • Voltage | ± 10 V<br>0 V to 10 V<br>1 V to 5 V |
| • Current | ± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA |
| Load impedance (in the rated range of the output) | |
| • For voltage outputs<br>– Capacitive load | Min. 1 kΩ<br>Max. 1 µF |
| • For current outputs<br>– at CMV < 1 V<br>– inductive load | max. 500 Ω<br>max. 600 Ω<br>max. 10 mH |
| Voltage output<br>• Short-circuit protection<br>• Short-circuit current | <br>Yes<br>max. 25 mA |
| Current output<br>• noload voltage | <br>max. 18 V |



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| Technical specifications | |
|---|---|
| Destruction limit against external voltages/currents | |
| • Voltage at outputs to $M_{ANA}$ | max. 18 V continuous;<br>75 V for the duration of max. 1 s (duty factor 1:20) |
| • Current | max. 50 mA d.c. |
| Wiring of the actuators | using a 20-pin front connector |
| • for voltage output | |
| – 4-wire connection (measuring lead) | supported |
| • for current output | |
| – 2-wire connection | supported |

### Parameter reassignment in RUN

If you reassign parameters in RUN, the following special characteristic applies.

SF LED is lit:

If a diagnostics was pending prior to reconfiguration, the SF LEDs (on CPU, IM or module) may be lit even though diagnostics is no longer pending and the module is operating correctly.

Solution:

- Only assign new parameters if no diagnostics is pending, or
- unplug module and plug it in again.

## 6.14.1 Output ranges of SM 332; AO 4 x 12 Bit

### Introduction

You can configure the outputs for operation as voltage or current outputs, or disable them. You program the outputs at the "output type" parameter in *STEP 7*.

The output type "Voltage" and output range "± 10 V" are set by default at the module. You can always use this combination of output type and range without having to program the SM 332; AO 4 x 12 Bit in *STEP 7*.

### Output ranges

Program the voltage and current output ranges in *STEP 7*.

Table 6- 36 Output ranges of SM 332; AO 4 x 12 Bit

| Selected type of output | Output range |
|---|---|
| Voltage | 1 V to 5 V<br>0 V to 10 V<br>± 10 V |
| Current | 0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA |



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## 6.14.2 Programmable parameters

### Introduction

For general information on programming analog modules, refer to the chapter Programming analog modules (Page 294).

The table below provides overview of programmable parameters and of their defaults.

Table 6- 37 Overview of the parameters of SM 332; AO 4 x 12 Bit

| Parameters | Range of values | | Default | Parameter type | Scope |
|---|---|---|---|---|---|
| Enable<br>• Diagnostic interrupt | yes/no | | no | dynamic | Module |
| Diagnostics<br>• Group diagnostics | yes/no | | no | static | Channel |
| Output<br>• Output type<br>• Output range | disabled<br>Voltage<br>Current<br>See table of *Output ranges for SM 332; AO 4 x 12 Bit* | | V<br>± 10 V | dynamic | Channel |
| Reaction to CPU STOP | ASS<br>HLV<br>SSV | Outputs zero current/voltage<br>Hold last value<br>Set substitute value | ASS | dynamic | Channel |

### Assigning parameters to channels

The parameters can be set separately at each output channel of SM 332; AO 4 x 12 Bit. You can assign separate parameters to each output channel.

Assign the parameters you set at the SFCs in the user program to the channel groups. Each output channel of SM 332; AO 4 x 12 Bit is thus assigned to a channel group, i.e. output channel 0 > channel group 0, for example.

**Note**

The output may carry incorrect interim values if you modify output ranges while SM 332; AO 4 x 12 Bit is in RUN.

### See also

Diagnostic messages of analog output modules (Page 296)



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## 6.14.3 Additional information on SM 332; AO 4 x 12 Bit

### Unused channels

To take unused output channels of SM 332; AO 4 x 12 Bit off power, set the "disabled" argument at the "output type" parameter. Disabled channels do not have to be wired.

### Line continuity check

SM 332; AO 4 x 12 Bit only performs a line continuity check at the current outputs.

In output ranges 0 mA to 20mA and ±20 mA, a "reliable" wire-break check is not possible for output values of-20s to ±200 µA.

### Short-circuit test

SM 332; AO 4 x 12 Bit only performs a short-circuit test at the voltage outputs.

### Substitute values

You can configure the SM 332; AO 4 x 12 Bit for CPU STOP mode as follows: Outputs off power, hold last value or set substitute values. The set substitute values must lie within the output range.



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# 6.15 Analog output module SM 332; AO 2 x 12 Bit; (6ES7332-5HB01-0AB0)

### Order number: "Standard module"

6ES7332-5HB01-0AB0

### Order number: "SIPLUS S7-300 module"

6AG1332-5HB01-2AB0

### Properties

- 2 outputs in one group
- The outputs can be set separately as
  - voltage output
  - current output
- Resolution 12 bits
- Programmable diagnostics and diagnostic interrupt
- Electrically isolated to backplane bus interface and load voltage
- Supports parameter reassignment in RUN

### Diagnostics

For information on diagnostic messages at the "group diagnostics" parameter, refer to chapter Diagnostic messages of analog output modules (Page 296).

### Terminal assignment

The diagrams below show various wiring options.

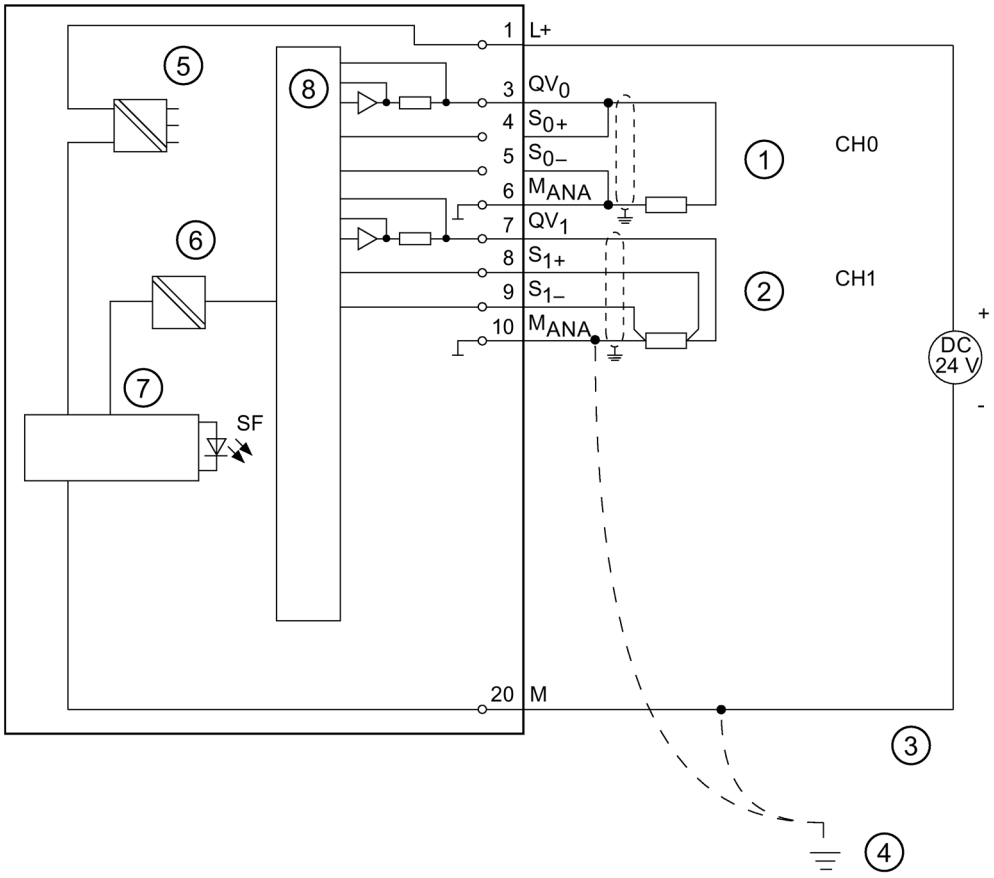
**Note**

When you switch the rated load voltage (L+) off and on, the outputs can return incorrect voltage/current values for the duration of about 500 ms.



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## Wiring: 2 and 4-wire connection for voltage output



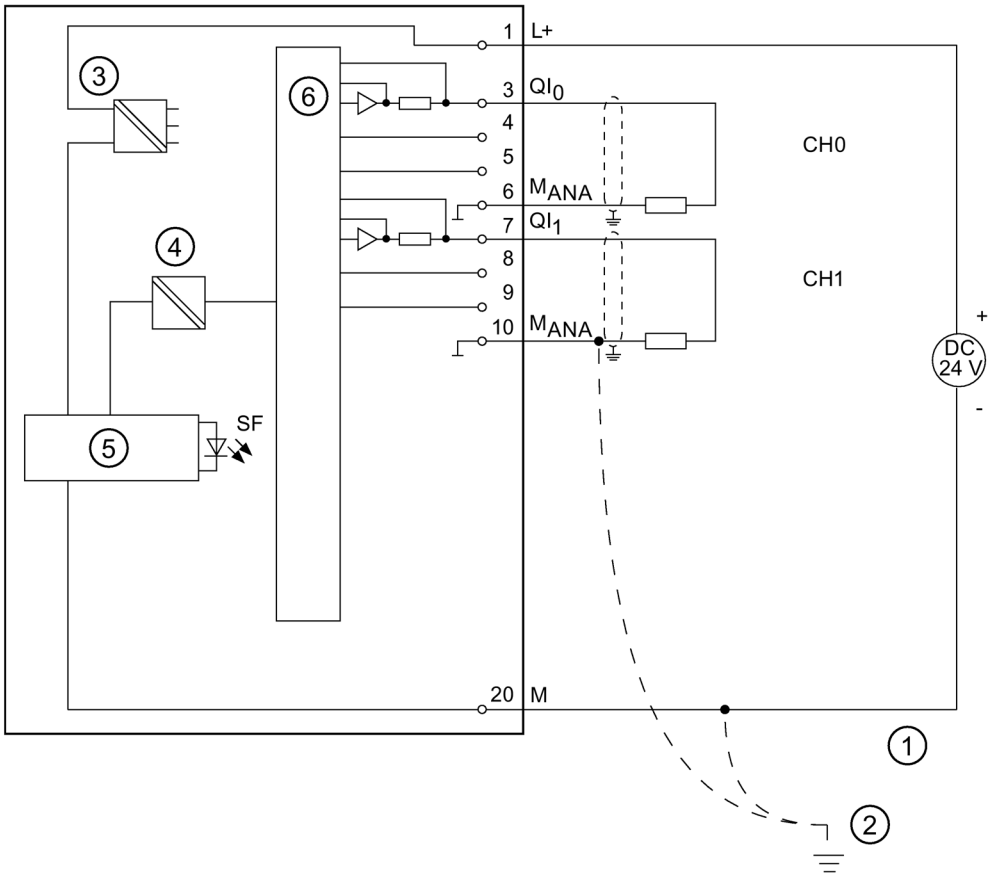

① 2-wire connection: no compensation for line impedance
② 4-wire connection: with compensation for line impedance
③ Equipotential bonding
④ Functional earthing
⑤ Internal supply
⑥ Electrical isolation
⑦ Backplane bus interface
⑧ Analog-to-Digital Converter (ADC)

Figure 6-48 Wiring and block diagram



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## Wiring for current output




① Equipotential bonding
② Functional earthing
③ Internal supply
④ Electrical isolation
⑤ Backplane bus interface
⑥ Digital analog converter (DAC)

Figure 6-49 Wiring and block diagram



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## Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | Approximately 220 g |
| **Module-specific data** | |
| Supports parameter reassignment in RUN | Yes |
| Reaction of non-programmed outputs | Return the output value which was valid before the parameterization |
| Supports isochronous mode | no |
| Number of outputs | 2 |
| Cable length<br>• shielded | <br>max. 200 m |
| **Voltages, currents, electrical potentials** | |
| Rated load voltage L+<br>• Reverse polarity protection | 24 V DC<br>Yes |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels and electronics power supply<br>• between channels<br>• between channels and load voltage L+ | <br>Yes<br>Yes<br>no<br>Yes |
| Maximum potential difference<br>• between S- and $M_{ANA}$ (CMV) | <br>3 V DC |
| Isolation test voltage | 500 V DC |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no-load) | <br>max. 60 mA<br>max. 135 mA |
| Power loss of the module | typ. 3 W |
| **Generation of analog values** | |
| Resolution (including overshoot range)<br>• ± 10 V; ± 20 mA;<br>• 4 mA to 20 mA; 1 V to 5 V<br>• 0 V to 10 V; 0 mA to 20 mA | <br>11 bits + sign<br><br>12 bits |
| Conversion time (per channel) | max. 0.8 ms |
| Transient recovery time<br>• with resistive load<br>• with capacitive load<br>• with inductive load | <br>0.2 ms<br>3.3 ms<br>0.5 ms (1 mH)<br>3.3 ms (10 mH) |



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| **Technical specifications** | |
|---|---|
| **Interference frequency suppression, error limits** | |
| Crosstalk between outputs | > 40 dB |
| Operational limit (across entire temperature range, relative to measurement range end value in the selected output range) | |
| • Voltage output<br>• Current output | ± 0.5 %<br>± 0.6 % |
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected output range) | |
| • Voltage output<br>• Current output | ± 0.4 %<br>± 0.5 % |
| Temperature error (relative to output range) | ± 0.002 %/K |
| Linearity error (relative to output range) | ± 0.05 % |
| Repeat accuracy (in settled state at 25 °C, relative to output range) | ± 0.05 % |
| Output ripple; range 0 Hz to 50 kHz (relative to output range) | ± 0.05 % |
| **Status, interrupts, diagnostics** | |
| Interrupts<br>• Diagnostic interrupt | <br>programmable |
| Diagnostic functions<br>• Group error display<br>• Reading diagnostic information | programmable<br>red LED (SF)<br>supported |
| Setting substitute values | Yes, programmable |
| **Actuator selection data** | |
| Output ranges (rated values) | |
| • Voltage | ± 10 V<br>0 V to 10 V<br>1 V to 5 V |
| • Current | ± 20 mA<br>0 mA to 20 mA<br>4 mA to 20 mA |
| Load impedance (in the rated range of the output) | |
| • For voltage outputs<br>– capacitive load | min. 1 kΩ<br>max. 1 µF |
| • For current outputs<br>– at CMV < 1 V<br>– inductive load | max. 500 Ω<br>max. 600 Ω<br>max. 10 mH |
| Voltage output<br>• Short-circuit protection<br>• Short-circuit current | <br>Yes<br>max. 25 mA |
| Current output<br>• noload voltage | <br>max. 18 V |



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| Technical specifications | |
|---|---|
| Destruction limit against external voltages/currents | |
| • Voltage at outputs to $M_{ANA}$ | max. 18 V continuous;<br>75 V for the duration of max. 1 s (duty factor 1:20) |
| • Current | max. 50 mA DC |
| • Wiring of the actuators | using a 20-pin front connector |
| • for voltage output | |
| – 2-wire connection | supported |
| – 4-wire connection (measuring line) | supported |
| • for current output | |
| – 2-wire connection | supported |

### Reassigning parameters in RUN

If you reassign parameters in RUN, the following special characteristic applies.

SF LED is lit:

If a diagnostics was pending prior to reconfiguration, the SF LEDs (on CPU, IM or module) may be lit even though diagnostics is no longer pending and the module is operating correctly.

Solution:

- Only assign new parameters if no diagnostics is pending, or
- unplug module and plug it in again.

## 6.15.1 Output ranges of SM 332; AO 2 x 12 Bit

### Introduction

You can configure the outputs for operation as voltage or current outputs, or disable them. You program the outputs at the "output type" parameter in *STEP 7*.

Output type "Voltage" and output range "± 10 V" are set by default at the module. You can always use this combination of output type and range without having to program the SM 332; AO 2 x 12 Bit in *STEP 7*.

### Output ranges

Program the voltage and current output ranges in *STEP 7*.

Table 6- 38 Output ranges of SM 332; AO 2 x 12 Bit

| Selected type of output | Output range |
|---|---|
| Voltage | 1 V to 5 V<br>0 V to 10 V<br>± 10 V |
| Current | 0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA |



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## 6.15.2 Programmable parameters

### Introduction

For general information on programming analog modules, refer to the chapter Programming analog modules (Page 294).

The table below provides an overview of configurable parameters, including defaults:

Table 6- 39 Overview of the parameters of SM 332; AO 2 x 12 Bit

| Parameter | Range of values | | Default | Parameter type | Scope |
|---|---|---|---|---|---|
| Enable<br>• Diagnostic interrupt | Yes/no | | No | Dynamic | Module |
| Diagnostics<br>• Group diagnostics | Yes/no | | No | Static | Channel |
| Edition<br>• Output type<br>• Output range | disabled<br>Voltage<br>Current<br>See chapter Output ranges for SM 332; AO 2 x 12 Bit (Page 473) | | V<br>± 10 V | dynamic | Channel |
| Reaction to CPU STOP | ASS<br>HLV<br>SSV | Outputs zero current/voltage<br>Hold last value<br>Set substitute value | ASS | dynamic | Channel |

### Assigning parameters to channels

The parameters can be set separately at each output channel of SM 332; AO 2 x 12 Bit. You can assign separate parameters to each output channel.

Assign the parameters you set at the SFCs in the user program to the channel groups. Each output channel of SM 332; AO 2 x 12 Bit is thus assigned to a channel group, i.e. output channel 0 > channel group 0, for example.

**Note**

The output may carry invalid interim values if you modify output ranges while SM 332; AO 2 x 12 bit is in RUN.

### See also

Diagnostic messages of analog output modules (Page 296)



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## 6.15.3 Additional information on SM 332; AO 2 x 12 Bit

### Unused channels

To take unused output channels of SM 332; AO 2 x 12 Bit off power, set the "disabled" argument at the "output type" parameter. Disabled channels do not have to be wired.

### Line continuity check

SM 332; AO 2 x 12 Bit only performs a line continuity check at the current outputs.

In output ranges 0 mA to 20mA and ±20 mA, a "reliable" wire-break check is not possible for output values of-20s to ±200 µA.

### Short-circuit test

SM 332; AO 2 x 12 Bit only performs a short-circuit test at the voltage outputs.

### Substitute values

You can configure the SM 332; AO 2 x 12 Bit for CPU STOP mode as follows: Outputs off power, hold last value or set substitute values. The set substitute values must lie within the output range.



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# 6.16 Analog IO module SM 334; AI 4/AO 2 x 8/8 Bit; (6ES7334-0CE01-0AA0)

## Order number

6ES7334-0CE01-0AA0

## Properties

- 4 inputs in one group and 2 outputs in one group
- Resolution 8 bits
- Programmable measurement type at each channel group
  - Voltage
  - Current
- Not programmable, measurement and output type defined by hardwiring
- Connected to potential of the backplane bus interface
- Electrically isolated to load voltage

## Terminal assignment

The diagrams below show various wiring options.

**Note**

Note when wiring the SM 334:

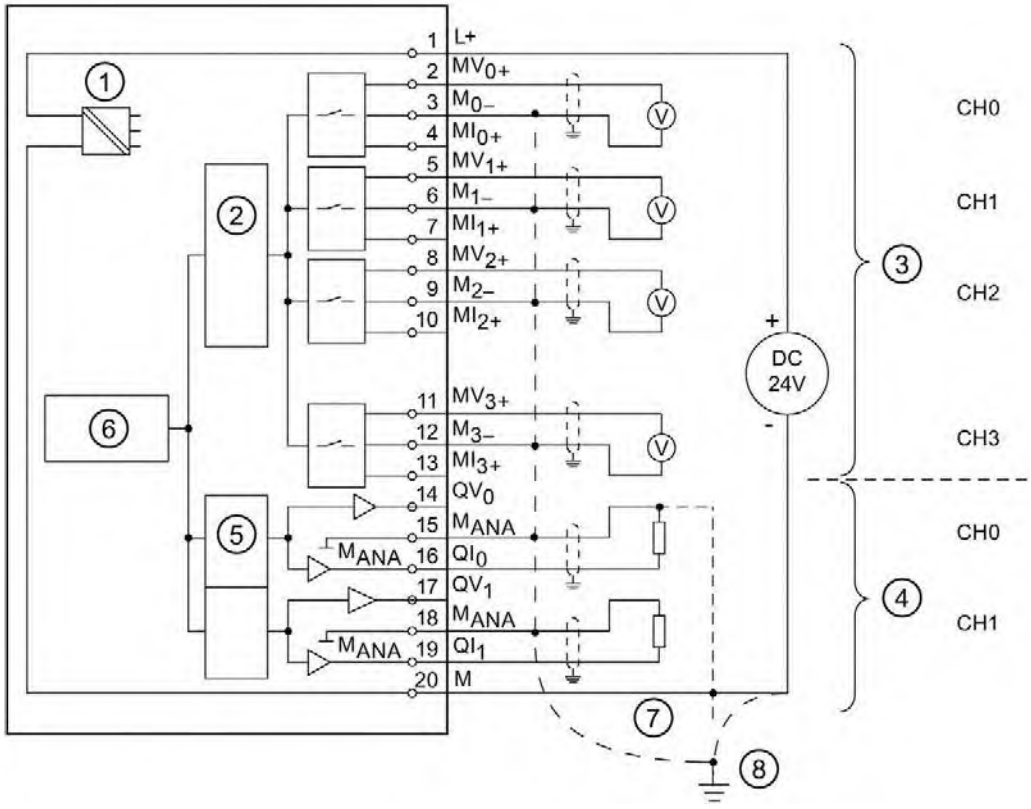
- analog ground **$M_{ANA}$(terminal 15 or 18) is interconnected with chassis ground M of the CPU or interface module IM.** Use a cable with a conductor cross-section of at least 1 $mm^2$.

  The module will shut down if the ground connection between $M_{ANA}$ and M is missing. Inputs are read with $7FFF_H$, and outputs return a value of 0. The module may be destroyed if operated without ground over a longer period of time.
- the **supply voltage for the CPU and/or the interface module (IM) may not be connected with reversed polarity**. Reverse polarity will inevitably lead to the destruction of the module, because $M_{ANA}$ develops an impermissible high potential (+24 V.)



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## Wiring: Voltage measurement and current output



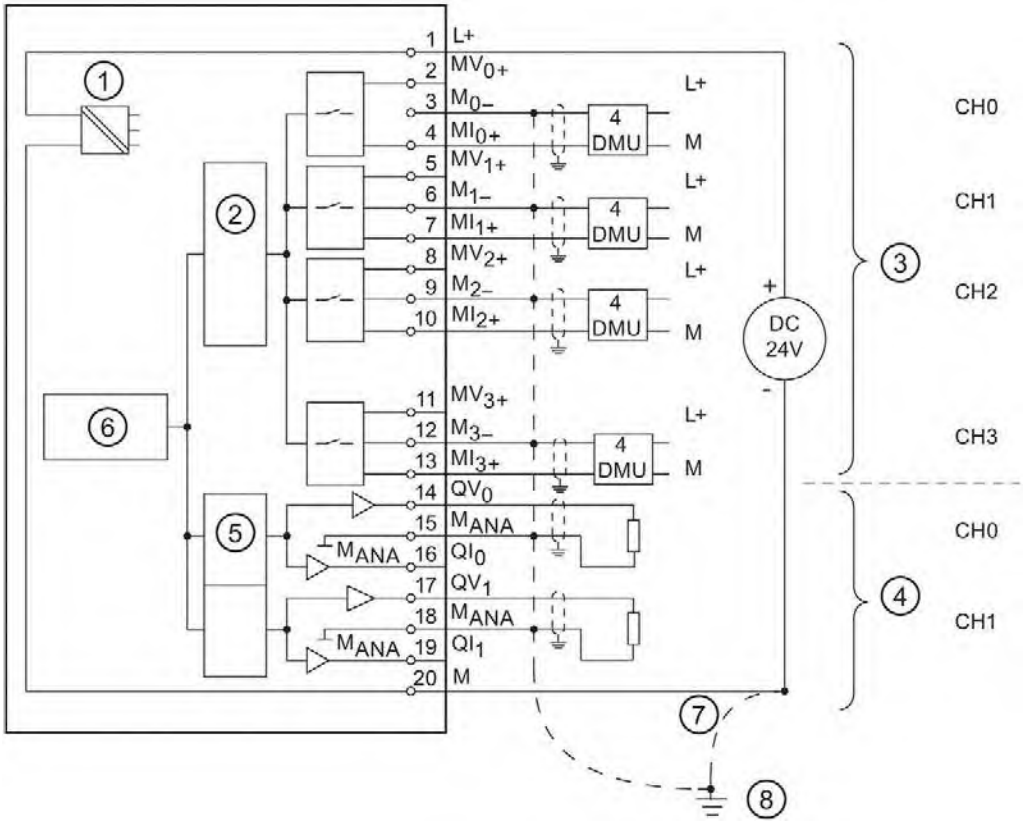

① Internal supply
② Analog-to-Digital Converter (ADC)
③ Inputs: Voltage measurement
④ Outputs: Voltage output
⑤ Digital-to-Analog Converter (DAC)
⑥ Backplane bus interface
⑦ Equipotential bonding
⑧ Functional earthing

Figure 6-50 Wiring and block diagrams



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## Wiring: 4-wire transducers for current measurement and voltage output




① Internal supply
② Analog-to-Digital Converter (ADC)
③ Inputs: Current measurement with 4-wire transducer
④ Outputs: Voltage output
⑤ Digital-to-Analog Converter (DAC)
⑥ Backplane bus interface
⑦ Equipotential bonding
⑧ Functional earthing

Figure 6-51 Wiring and block diagrams



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## Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | ca. 285 g |
| **Module-specific data** | |
| Supports isochronous mode | no |
| Number of inputs | 4 |
| Number of outputs | 2 |
| Cable length<br>• shielded | <br>max. 200 m |
| **Voltages, currents, electrical potentials** | |
| Rated supply voltage of the rated electronics and load voltage L+ | 24 VDC |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels and electronics power supply | <br>no<br>yes |
| between channels | no |
| Maximum potential difference<br>• between inputs and $M_{ANA}$ (CMV)<br>• between inputs (CMV) | <br>1 VDC<br>1 VDC |
| Isolation test voltage | 500 VDC |
| Current consumption<br>• from the backplane bus<br>• from supply and load voltage L+ (no load) | <br>max. 55 mA<br>max. 110 mA |
| Power loss of the module | typ. 3 W |
| **Generation of analog input values** | |
| Measuring principle<br>• Resolution (including overshoot range) | Actual value conversion<br>8 bits |
| Integration/conversion time (per channel)<br>• programmable<br>• Integration time in µs | <br>no<br><500 |
| Basic execution time of inputs | max. 5 ms |
| Time constant of the input filter | 0.8 ms |



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| **Technical specifications** | |
|---|---|
| **Generation of analog output values** | |
| • Resolution (including overshoot range) | 8 bits |
| Conversion time (per channel)<br>• programmable<br>• Conversion time in µs | <br>no<br><500 |
| Basic execution time of outputs | max. 5 ms |
| Transient recovery time<br>• with resistive load<br>• with capacitive load<br>• with inductive load | <br>0.3 ms<br>3.0 ms<br>0.3 ms |
| **Interference frequency suppression, error limits for inputs** | |
| Interference frequency suppression at F = n (f1 ± 1 %) (f1 = interference frequency) | |
| • Common mode interference ($V_{pp}$ < 1 V) | > 60 dB |
| Crosstalk between outputs | > 50 dB |
| Operational limit (across entire temperature range, relative to measurement range end value in the selected input range) | |
| • Voltage input<br>• Current input | ± 0,9 %<br>± 0,8 % |
| Basic error limit (operational limit at 25 °C, relative to measurement range end value of the selected input range) | |
| • Voltage input<br>• Current input | ± 0,7 %<br>± 0,6 % |
| Temperature error (relative to input range) | ± 0.005 %/K |
| Linearity error (relative to input range) | ± 0,05 % |
| Repeat accuracy (in transient state at 25 °C, relative to input range) | ± 0,05 % |
| Output ripple; range 0 Hz to 50 kHz (relative to output range) | ± 0,05 % |
| **Interference frequency suppression, error limits of outputs** | |
| Crosstalk between outputs | > 40 dB |
| Operational limit (across entire temperature range, relative to measurement range end value in the selected output range) | |
| • Voltage output<br>• Current output | ± 0,6 %<br>± 1,0 % |
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected output range) | |
| • Voltage output<br>• Current output | ± 0,5 %<br>± 0,5 % |
| Temperature error (relative to output range) | ± 0.02 %/K |
| Linearity error (relative to output range) | ± 0,05 % |
| Repeat accuracy (in transient state at 25 °C, relative to output range) | ± 0,05 % |
| Output ripple (bandwidth relative to output range) | ± 0,05 % |
| **Status, interrupts, diagnostics** | |
| Interrupts | none |
| Diagnostic functions | none |



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| Technical specifications | |
|---|---|
| **Sensor selection data** | |
| Input ranges (rated values) / input impedance<br>• Voltage<br>• Current | <br>0 V to 10 V/100 k Ω<br>0 mA to 20 mA/50 Ω |
| Maximum voltage at voltage input (destruction limit) | max. 20 V continuous; 75 V for max. duration of 1 s (duty factor 1:20) |
| Maximum current at current input (destruction limit) | 40 mA |
| Wiring of the signal sensors<br>• for voltage measurement<br>• for current measurement<br>as 2-wire transducer<br>as 4-wire transducer | using a 20-pin front connector<br>supported<br><br>supported with external supply |
| **Actuator selection data** | |
| Output ranges (rated values)<br>• Voltage<br>• Current | <br>0 V to 10 V<br>0 mA to 20 mA |
| Load impedance (in the rated output range) | |
| • For voltage outputs<br>– capacitive load<br>• For current outputs<br>– inductive load | min. 5 kΩ<br>max. 1 µF<br>max. 300 Ω<br>max. 1 mH |
| Voltage output<br>• Short-circuit protection<br>• Short-circuit current | <br>yes<br>max. 11 mA |
| Current output<br>• noload voltage | <br>max. 15 V |
| Destruction limit against external voltages/currents<br>• Voltage at outputs to MANA<br>• Current | <br>max. 15 V, continuous<br>max. 50 mA d.c. |
| Wiring of the actuators<br>• for voltage output<br>2-wire connection<br>4-wire connection (measuring line) | using a 20-pin front connector<br><br>supported<br>not supported |



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## 6.16.1 SM 334; AI 4/AO 2 x 8/8 Bit - Function principle

### Introduction

SM 334; AI 4/AO 2 x 8/8 bit is a non-isolated analog IO module. SM 334; AI 4/AO 2 x 8/8 Bit is not programmable.

### Addressing

The I/O of the module are addressed beginning at the module start address.

The address of a channel is derived from the module start address and an address offset.

### Input addresses

Valid input addresses:

| Channel | Address |
|---|---|
| 0 | Module start address |
| 1 | Module start address + 2 bytes address offset |
| 2 | Module start address + 4 bytes address offset |
| 3 | Module start address + 6 bytes address offset |

### Output addresses

Valid output addresses:

| Channel | Address |
|---|---|
| 0 | Module start address |
| 1 | Module start address + 2 bytes address offset |

## 6.16.2 Measurement and output type of SM 334; AI 4/AO 2 x 8/8 bit

### Introduction

SM 334; AI 4/AO 2 x 8/8 Bit is not programmable.

### Defining the measurement and output type

Set the measurement type (voltage, current) by hardwiring the input channel.

Set the output type (voltage, current) by hardwiring the output channel.

### See also

Representation of the values for analog input channels (Page 262)

Representation of analog values for analog output channels (Page 279)



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## 6.16.3 Measurement and output ranges of SM 334; AI 4/ AO 2 x 8/8 bit

### Measuring ranges

SM 334; AI 4/AO 2 x 8/8 Bit provides the 0 V to 10 V and 0 mA to 20 mA measuring ranges.

By contrast to the other analog modules, the SM 334 has a lower resolution and no negative measuring ranges. Make allowances for this feature when reading the measured value tables *Analog value representation in the ± 1 V to ± 10 V measuring ranges* and *Analog value representation in the 0 mA to 20 mA and 4 mA to 20 mA measuring ranges*.

### Output ranges

SM 334; AI 4/AO 2 x 8/8 Bit provides the 0 V to 10 V and 0 mA to 20 mA output ranges.

Compared to the other analog modules, the SM 334 has a lower resolution, and its analog outputs do not have any overshoot ranges. Make allowances for this feature when reading the tables *Analog value representation in the 0 V to 10 V and 1 V to 5 V output ranges* and *Analog value representation in the 0 mA to 20 mA and 4 mA to 20 mA output ranges*.

## 6.16.4 Additional information on SM 334; AI 4/AO2 x 8/8 Bit

### Unused channels

Always short-circuit unused input channels, and connect these to $M_{ANA}$. This optimizes interference immunity of the analog input module.

Leave unused output channels open.



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# 6.17 Analog IO module SM 334; AI 4/AO 2 x 12 bit; (6ES7334-0KE00-0AB0)

### Order number: "Standard module"

6ES7334-0KE00-0AB0

### Order number: "SIPLUS S7-300 module"

6AG1334-0KE00-2AB0

### Properties

- 4 inputs in 2 groups and 2 outputs in one group
- Resolution of 12 bits + sign
- Programmable measurement type at each channel group:
  - Voltage (not adjustable for channel 0 and channel 1)
  - Resistance
  - Temperature
- Electrically isolated to the backplane bus interface
- Electrically isolated to load voltage

### Terminal assignment

The diagrams below show various wiring options.

**Note**

When you switch the rated load voltage supply on/off, the output may assume invalid interim values below the rated load voltage.



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## Wiring: Resistance measurement, voltage measurement and voltage output

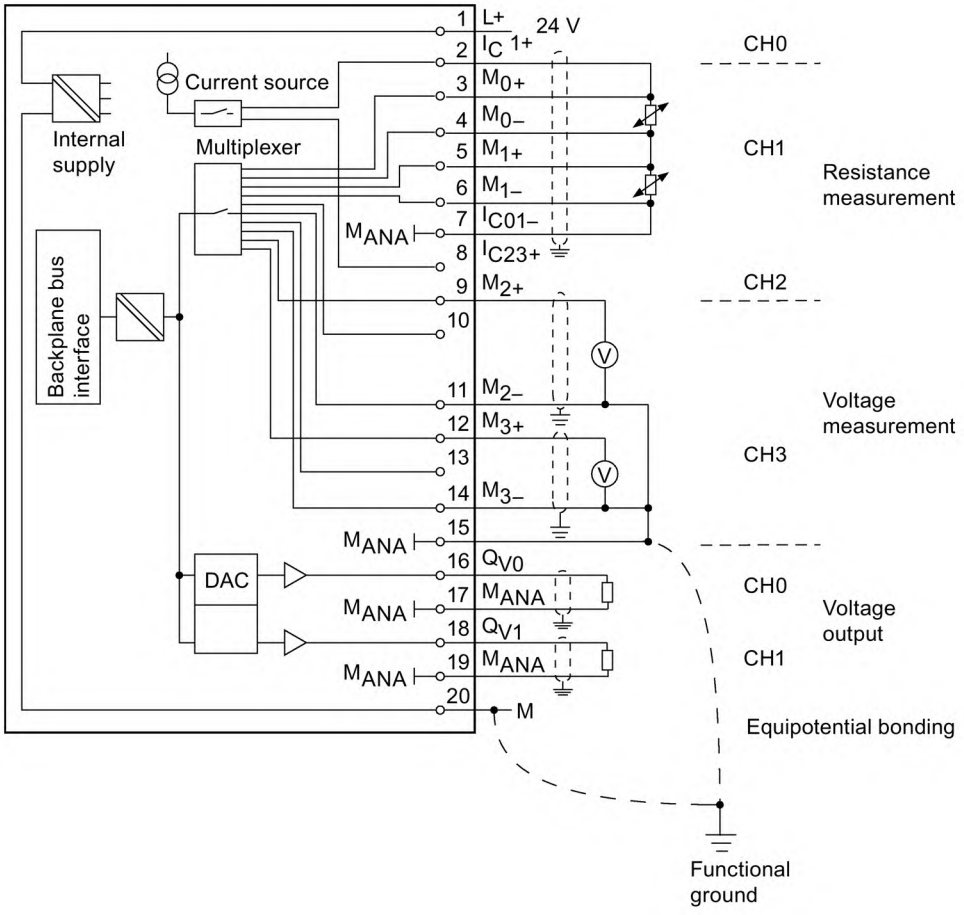



Figure 6-52 Wiring and block diagram



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## Wiring: Resistance measurement and voltage output

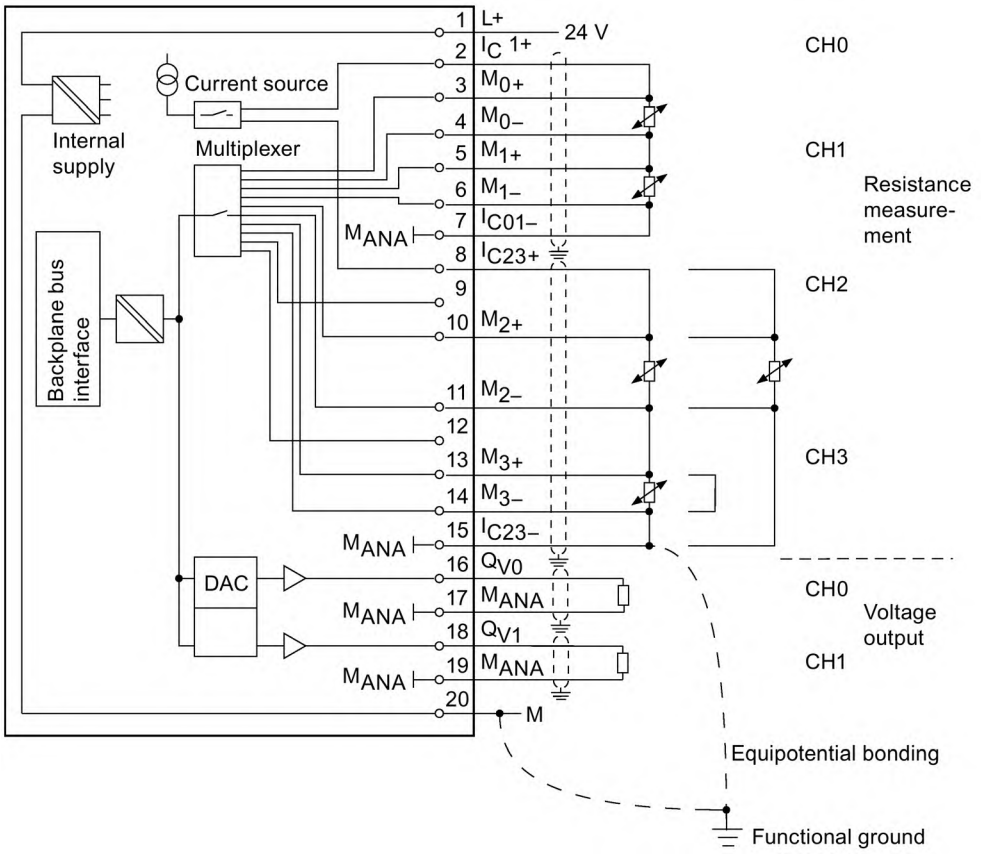



Figure 6-53 Wiring and block diagram

## Technical specifications

| Technical specifications | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 117 |
| Weight | approx. 200 g |
| **Module-specific data** | |
| Supports isochronous mode | No |
| Number of inputs<br>• with resistive transducers | 4<br>4 |
| Number of outputs | 2 |
| Shielded cable length | max. 100 m |



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| **Technical specifications** | | |
|---|---|---|
| **Voltages, currents, electrical potentials** | | |
| Supply voltage of the rated electronics and load voltage L+<br>• Reverse polarity protection | 24 V DC<br>Yes | |
| Constant measuring current for resistive transducers (pulsed)<br>• For PT 100<br>• at 10 kΩ | <br>typ. 490 µA; from product version 06: 1.5 mA<br>typ. 105 µA | |
| Electrical isolation<br>• between channels and the backplane bus<br>• between channels and electronics power supply | <br>Yes<br>Yes | |
| between channels | No | |
| Maximum potential difference<br>• between inputs and $M_{ANA}$ ($V_{CM}$)<br>• between inputs ($V_{CM}$) | <br>1 V<br>1 V | |
| Isolation test voltage | 500 V DC | |
| Current consumption<br>• from the backplane bus<br>• from supply and load voltage L+ (no load) | <br>max. 60 mA<br>max. 80 mA | |
| Power loss of the module | typ. 2 W | |
| **Generation of analog input values** | | |
| Measuring principle | Integrating | |
| Integration/conversion time (per channel) | | |
| • programmable | Yes | |
| • Integration time in ms | $16^2/_3$ | 20 |
| • Basic conversion time, including the integration time in ms | 72 | 85 |
| • Additional conversion time for resistance measurements in ms | 72 | 85 |
| • Resolution in bits (including overshoot range) | 12 bits | 12 bits |
| • Interference frequency suppression at interference frequency f1 in Hz | 60 | 50 |
| Measured value smoothing | programmable, in 2 stages | |
| Time constant of the input filter | 0.9 ms | |
| Basic execution time of the module (all channels enabled) | 350 ms | |
| **Generation of analog output values** | | |
| Resolution (including overshoot range) | 12 bits | |
| Conversion time (per channel) | 500 µs | |
| Transient recovery time<br>• with resistive load<br>• with capacitive load | <br>0.8 ms<br>0.8 ms | |



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| | | |
|---|---|---|
| **Technical specifications** | | |
| **Interference frequency suppression, error limits for inputs** | | |
| Interference frequency suppression at F = n (f1 ± 1 %) (f1 = interference frequency) | | |
| • Common mode interference ($V_{pp}$ < 1 V)<br>• Seriesmode interference (peak interference value < rated input range) | > 38 dB<br>> 36 dB | |
| Crosstalk between inputs | > 88 dB | |
| Operational limit (across entire temperature range, relative to the measurement range end value in the selected input range) | | |
| • Voltage input | 0 V to 10 V | ± 0.7 % |
| • Resistance input | 10 kΩ | ± 3.5 % |
| • Temperature input | Pt 100 | ± 1 % |
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected input range) | | |
| • Voltage input | 0 V to 10 V | ±0.5 % |
| • Resistance input | 10 kΩ | ± 2.8 % |
| • Temperature input | Pt 100 | ± 0.8 % |
| Temperature error (relative to input range) | ± 0.01 %/K | |
| Linearity error (relative to input range) | ±0.05 % | |
| Repeat accuracy (in settled state at 25 °C, relative to input range) | ± 0.05 % | |
| **Interference frequency suppression, error limits of outputs** | | |
| Crosstalk between outputs | > 88 dB | |
| Operational limit (across entire temperature range, relative to measurement range end value in the selected output range) | | |
| • Voltage output | ± 1.0 % | |
| Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected output range) | | |
| • Voltage output | ± 0.85 % | |
| Temperature error (relative to output range) | ± 0.01 %/K | |
| Linearity error (relative to output range) | ± 0.01 % | |
| Repeat accuracy (in transient state at 25 °C, relative to output range) | ± 0.01 % | |
| Output ripple; range 0 Hz to 50 kHz (relative to output range) | ± 0.1 % | |
| **Status, interrupts, diagnostics** | | |
| Interrupts | none | |
| Diagnostic function | none | |
| **Encoder selection data** | | |
| Input ranges (rated values) / input impedance | | |
| • Voltage | 0 V to 10 V | 100 kΩ |
| • Resistance | 10 kΩ | 10 MΩ |
| • Temperature | Pt 100 | 10 MΩ |
| Maximum voltage at voltage input (destruction limit) | max. 20 V continuous; 75 V for max. duration of 1 s (duty factor 1:20) | |



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| **Technical specifications** | |
|---|---|
| Wiring of the signal transmitters<br>• for voltage measurement<br>• for resistance measurement<br>with 2-wire connection<br>with 3-wire connection<br>with 4-wire connection | <br>supported<br><br>supported<br>supported<br>supported |
| Characteristics linearization<br>• for resistance thermometers | programmable<br>Pt 100 (Climatic range) |
| Technical unit of data formats | degrees Centigrade |
| **Actuator selection data** | |
| Output range (rated value)<br>• Voltage | <br>0 V to 10 V |
| Load impedance (in the rated output range) | |
| • For voltage outputs<br>– capacitive load | min. 2.5 kΩ *<br>max. 1.0 µF |
| Voltage output<br>• Short-circuit protection<br>• Short-circuit current | <br>Yes<br>max. 30 mA |
| Destruction limit against external voltages/currents<br>• Voltage at outputs to MANA | <br>max. 15 V, continuous |
| Wiring of the actuators<br>• for voltage output<br>2-wire connection<br>4-wire connection (measuring line) | using a 20-pin front connector<br><br>supported<br>not supported |

* the error limits specified for the outputs are only valid when there is a high-ohm connection. In the entire load resistance range, an additional error of <0.9 % can result.



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## 6.17.1 Programmable parameters

### Introduction

For general information on programming analog modules, refer to the chapter Programming analog modules (Page 294).

The table below provides an overview of configurable parameters, including defaults:

Table 6- 40 Summary of parameters SM 334; AI 4/AO 2 x 12 Bit

| Parameters | Range of values | | Default | Parameter type | Scope |
|---|---|---|---|---|---|
| **Input**<br>Measurement<br>• Measurement type | disabled | | RTD-4L | | |
| | V<br>R-4L<br><br>RTD-4L | Voltage<br>Resistance<br>(4-wire connection)<br>Thermal resistance<br>(linear, 4-wire connection) | | dynamic | Channel |
| • Measuring range | 0 V to 10 V<br>10000 Ω<br>Pt 100 Klima | | Pt 100 Klima | | |
| **Output**<br>• Output type<br><br><br>• Output range | disabled<br>Voltage<br>0 V to 10 V | | V<br><br>0 V to 10 V | dynamic | Channel |

## 6.17.2 Measurement types and ranges

### Introduction

You can configure the outputs for operation as voltage or current outputs, or disable these.

You can wire the outputs as voltage outputs, or disable these.

Program the outputs at the "measurement type" AND output type" parameters in *STEP 7*.

### Input defaults

The "thermoelectric resistance (linear, 4-wire connection)" measurement type and "Pt 100 Klima" measuring range are set by default at the module. You can use these default settings without having to program the SM 334; AI 4/AO 2 x12 Bit in *STEP 7*.



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## Options of wiring the input channels

You can wire the input channels of SM 334; AI 4/AO 2 x 12 Bit in the following combinations:

| Channel | Wiring versions |
|---|---|
| Channels 0 and 1 | • 2 x temperature or<br>• 2 x resistance |
| Channels 2 and 3 | • 2 x voltage,<br>• 2 x resistance,<br>• 2 x temperature,<br>• 1 x temperature and 1 x voltage, or<br>• 1 x resistance and 1 x voltage |

**Note**

Wiring both a temperature sensor and a resistor to channels 0 and 1 or 2 and 3 is not allowed.

Reason: Common current source for both channels.

## Measuring ranges

Program the measuring ranges in *STEP 7*.

Table 6- 41 Measurement types and ranges

| Selected type of measurement | Measuring range |
|---|---|
| V: Voltage | 0 V to 10 V |
| R-4L: resistance (4-wire connection) | 10 kΩ |
| RTD-4L: Thermoresistor (linear, 4-wire connection) (temperature measurement) | Pt 100 Klima |

## Output ranges of SM 334; AI 4/ AO 2 x 12 bit

The "voltage" output type and "0 V to 10 V" output range are set by default at the module. You can always use this combination of the output type and range without having to program the SM 334; AO 4 x 2 Bit in *STEP 7*.

Table 6- 42 Output ranges

| Selected type of output | Output range |
|---|---|
| Voltage | 0 V to 10 V |

## See also

Representation of analog values for analog output channels (Page 279)



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## 6.17.3 Additional information on SM 334; AI 4/ AO 2 x 12 bit

### Unused channels

Set the "disabled" value at the "measurement type" parameter for unused input channels. This setting reduces module cycle times.

Always short-circuit unused input channels, and connect these to $M_{ANA}$. This optimizes interference immunity of the analog input module.

To take the unused output channels of SM 334; AI 4/AO 2 x 12 Bit off power, always set "disabled" argument at the "output type" parameter, and leave the connection open.



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# Other signal modules

# 7

## Signal modules

This chapter describes the technical data and properties of the S7-300 signal modules.

## 7.1 Module overview

### Introduction

The table below summarizes the essential features of the signal modules described in this chapter. This overview supports you in selecting a module to suit your requirements.

Table 7- 1 Special signal modules: Overview of properties

| Properties | Simulator module SM 374; IN/OUT 16 | Dummy module DM 370 | Position decoder module SM 338; POS-INPUT |
|---|---|---|---|
| Number of inputs/outputs | • max. 16 inputs or outputs | 1 slot reserved for non-programmable module | • 3 inputs for absolute encoders (SSI)<br>• 2 digital inputs for freezing encoder values |
| Suitable for... | Simulation of:<br>• 16 inputs or<br>• 16 outputs or<br>• 8 inputs and 8 outputs | Dummy for:<br>• Interface modules<br>• non-programmable signal modules<br>• modules which occupy 2 slots | Position detection using up to three absolute encoders (SSI)<br>Encoder types: Absolute encoder (SSI), message frame length 13 bits, 21 bits or 25 bits<br>Data formats: Gray code or binary code |
| Isochronous mode supported | no | no | yes |
| Programmable diagnostics | no | no | no |
| Diagnostics interrupt | no | no | programmable |
| Special features | Function adjustable with screwdriver | the mechanical structure and addressing of the overall configuration remains unchanged when DM 370 is replaced with a different module. | SM 338 does not support absolute encoders with a monoflop time > 64 µs |



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# 7.2 Simulator module SM 374; IN/OUT 16; (6ES7374-2XH01-0AA0)

## Order number

6ES7374-2XH01-0AA0

## Properties

Properties of simulator module SM 374; IN/OUT 16:

- Simulation of:
  - 16 inputs or
  - 16 outputs or
  - 8 inputs and 8 outputs (each with the same start addresses!)
- Status displays for the simulation of inputs and outputs
- Function adjustable with screwdriver

**Note**

Do not operate the function selection switch in RUN!

## Configuration in *STEP 7*

The simulator module SM 374; IN/OUT 16 is not included in the *STEP 7* module catalog. *STEP 7* therefore does not recognize the SM 374 order number. "Simulate" the simulator module function required for your configuration as follows:

- To use the SM 374 **with 16 inputs**, define the order number of a digital input module with 16 inputs in *STEP 7*,

  for example: 6ES7321-1BH02-0AA0
- To use the SM 374 **with 16 outputs**, define the order number of a digital output module with 16 outputs in *STEP 7*,

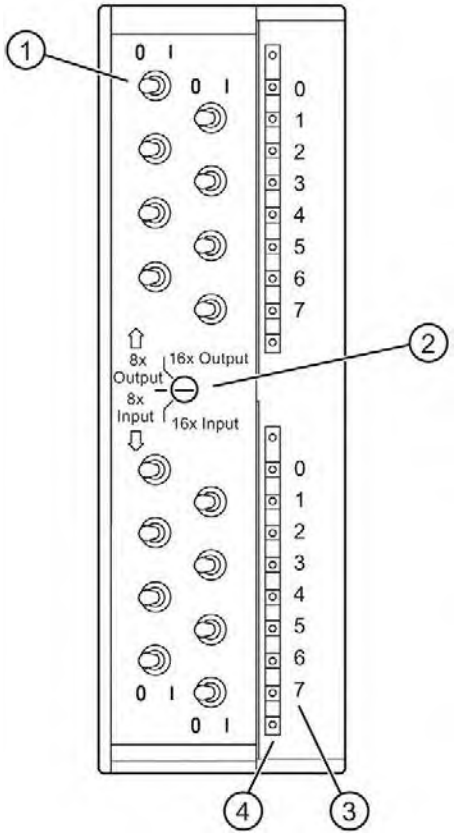
  for example: 6ES7322-1BH01-0AA0
- To use the SM 374 **with 8 inputs and 8 outputs**, define the order number of a digital input/output module with 8 inputs and 8 outputs in *STEP 7*,

  for example: 6ES7323-1BH00-0AA0



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## Module view (without front panel door)




① Input status selector switch
② Function selector switch
③ Channel number
④ Status displays - green

## Technical data of SM 374; IN/OUT 16

| **Technical data** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 110 |
| Weight | approx. 190 g |
| **Module-specific data** | |
| Optional simulation of | 16 inputs<br>16 outputs<br>8 inputs and 8 outputs |
| **Voltages, currents, electrical potentials** | |
| Current consumption from the backplane bus | max. 80 mA |
| Power loss of the module | typ. 0.35 W |
| **Status, interrupts, diagnostics** | |
| Status display | yes, green LED for each channel |
| Interrupts | no |
| Diagnostics functions | no |



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# 7.3 Dummy module DM 370; (6ES7370-0AA01-0AA0)

## Order number

6ES7 370-0AA01-0AA0

## Properties

The dummy module DM 370 reserves a slot for a non-configured module. It can be used as dummy module for:

- Interface modules (without reservation of address space)
- Non-configured signal modules (with reservation of address space)
- Modules which occupy 2 slots (with reservation of address space)

When replacing the dummy module with another S7-300 module, the mechanical assembly and address assignment/addressing of the entire configuration remain unchanged.

## Configuration in *STEP 7*

Configure the DM 370 dummy module in *STEP 7* only if you module for a programmed signal module. If the module reserves the slot for an interface module, you can discard module configuration in *STEP 7*.

## Modules which occupy 2 slots

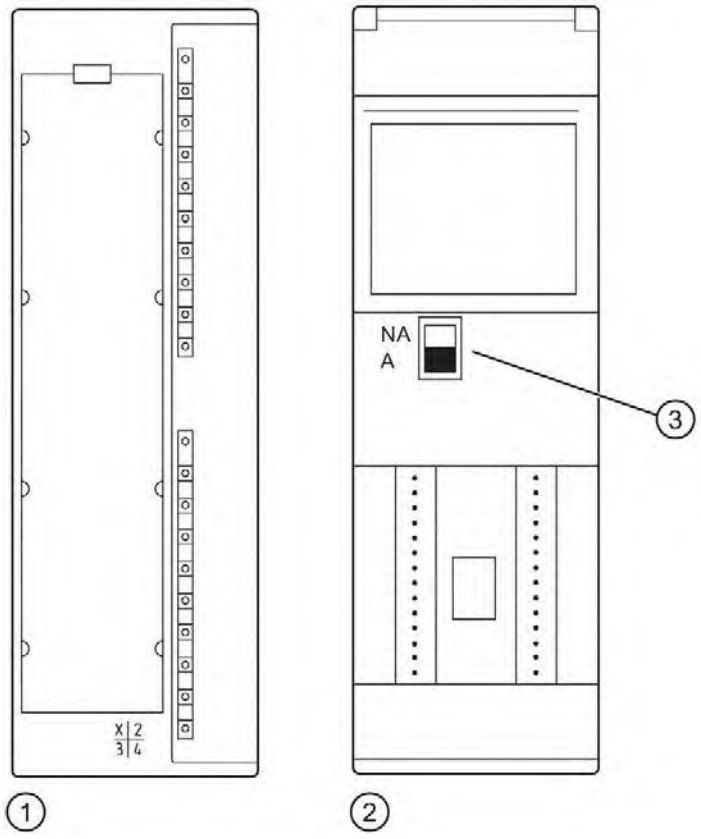
Install two dummy modules for modules which occupy 2 slots. You only reserve the address space using the dummy module in slot "x", rather than the dummy module in slot "x + 1". For details of the procedure, see the table below.

The rack can receive up to 8 modules (SM/FM/CP.) When using two dummy modules to reserve a slot for a module of 80 mm width, you may still install 7 further modules (SM/FM/CP) because the dummy module only uses the address space for one module.



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## Module view




① Front view
② Rear view
③ Address selector switch

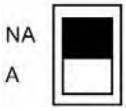
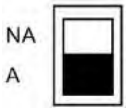


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## Switch settings for addressing

The table below shows how to set the switch on the rear panel of the module, according to the module type.

Table 7- 2 Meaning of the switch settings of dummy module DM 370

| Switch setting | Meaning | Use |
|---|---|---|
|  | The dummy module reserves one slot.<br>The module will not be configured, and does not use any address space. | • Without active backplane bus: For configurations where a single slot is physically reserved, with electrical connection to the S7-300 bus.<br>• With active backplane bus: no |
|  | The dummy module reserves one slot.<br>The module must be configured and occupies 1 byte in the input address space (system default: not in the process image.) | For configurations where an addressed slot is reserved. |

## Technical data of DM 370

| Technical data | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 120 |
| Weight | approx. 180 g |
| **Voltages, currents, electrical potentials** | |
| Current consumption from the backplane bus | approx. 5 mA |
| Power loss | typ. 0.03 W |



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# 7.4 Position decoder module SM 338; POS-INPUT; (6ES7338-4BC01-0AB0)

## Order number

6ES7 338-4BC01-0AB0

## Properties

Properties of position decoder module SM 338; POS-INPUT:

- 3 inputs for the connection of up to three absolute value encoders (SSI), and 2 digital inputs to freeze encoder values
- Allows direct reaction to encoder values in motion systems
- Processing of encoder values recorded by SM 338 in the user program
- Supports isochronous mode
- Selectable encoder value acquisition mode:
  - cyclic
  - isochronous
- Rated input voltage 24 VDC
- Nonisolated to the CPU
- Fast Mode selectable; with faster transducer action and compressed feedback interface. The Fast Mode is available from firmware version V2.0.0 in SM 338; POS-INPUT and can be selected from STEP 7 V5.3+SP2.

## Supported encoder types

Encoder types supported by SM 338; POS-INPUT:

- Absolute value encoder (SSI), frame length 13 bit
- Absolute value encoder (SSI), frame length 21 bit
- Absolute value encoder (SSI), frame length 25 bit

## Supported data formats

SM 338; POS-INPUT supports gray code and binary code.



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### Firmware update

To extend functions and for troubleshooting, it is possible with the help of STEP 7 HW-Config to load firmware updates in the operating system memory of the SM 338; POS-INPUT.

**Note**

When you boot the firmware update, the old firmware is deleted. If the firmware update is interrupted or terminated for some reason, thereafter the SM 338; POS-INPUT ceases to function properly. Reboot the firmware update and wait until this has completed successfully.

**Note**

The firmware update is only possible in remote operation if the header assembly (slave circuit) employed supports the system services required for this.

## 7.4.1 Isochronous mode

**Note**

For basic information on isochronous mode, refer to the *SIMATIC; isochronous mode* function manual.

### Hardware requirements

To operate SM 338 in isochronous mode, you need:

- a CPU which supports isochronous mode
- a DP master which supports the constant bus cycle
- a slave interface (IM 153-x) which supports isochronous mode

### Properties

SM 338 operates in non-isochronous or isochronous mode, depending on system parameters.

In isochronous mode, data are exchanged between the DP master and SM 338 in synchronism to the PROFIBUS DP cycle.

In isochronous mode, all 16 bytes of the feedback interface are consistent.

If synchronism is lost due to disturbance or failure/delay of Global Control (GC), the SM 338 resumes isochronous mode at the next cycle without error reaction.

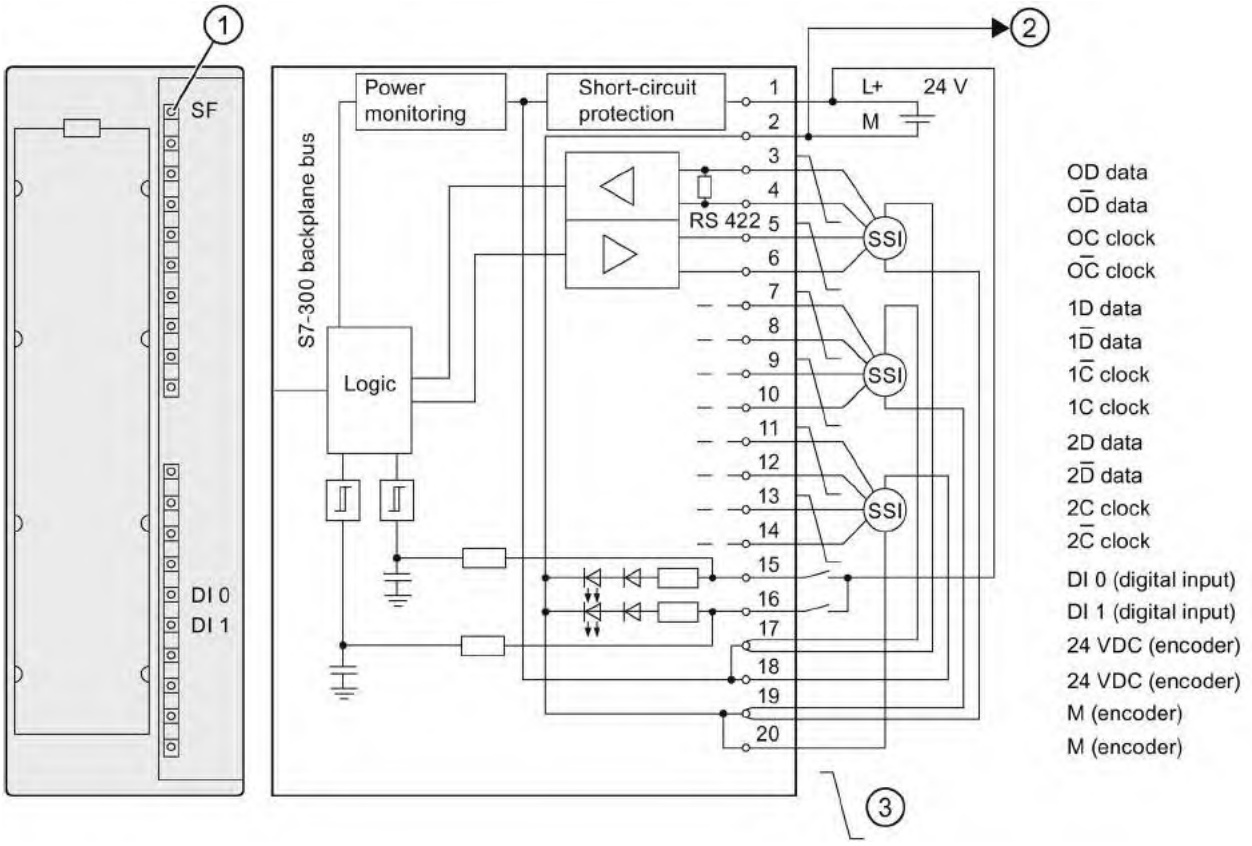
If synchronism is lost, the feedback interface is not updated.



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## 7.4.2 Wiring and block diagrams

### Wiring and block diagrams




① Error LED - red
② Connection to CPU ground
③ Twisted-pair cables

### Wiring rules

Important rules to observe wiring the module:

- Ground of the encoder supply is connected to CPU ground potential. Thus, establish a low impedance connection between pin 2 of SM 338 (M) and CPU ground.
- Always use shielded twisted-pair cable to wire encoder signals (pins 3 to 14.) Connect both ends of the shielding.

  Use the shield connection element to terminate the shielding on SM 338 (order number 6ES7390-5AA00-0AA0).
- Connect an external power supply if the maximum output current (900 mA) of the encoder supply is exceeded.



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## 7.4.3 Functions of SM 338; POS-INPUT; encoder value acquisition

### 7.4.3.1 Encoder value acquisition

The absolute value encoder transfers its values in frames to the SM 338. The SM 338 initiates the frame transfer.

- In non-isochronous mode, the encoder values are acquired cyclically.
- In isochronous mode, the encoder values are acquired in synchronism with the PROFIBUS DP cycle at each $T_i$.

#### Cyclic encoder value acquisition

The SM 338 always initiates a frame transfer at the end of the programmed monoflop time.

Asynchronously to these cyclic frames, the SM 338 processes the acquired encoder values cyclically, based on its refresh rate (refer to the chapter "Technical data of SM 338; POS-INPUT (Page 512)").

Thus, cyclic acquisition returns encoder values of different ages. The difference between the min./max. age represents the jitter (refer to the chapter "Technical data of SM 338; POS-INPUT (Page 512)".)

#### Isochronous encoder value acquisition

Isochronous encoder values acquisition is automatically set when the DP master system operates with active constant bus cycle, and the DP slave is in synchronism with the DP cycle.

SM 338 initiates a frame transfer in each
PROFIBUS DP cycle, at the time $T_i$.

The SM 338 processes the transferred encoder values in synchronism with the PROFIBUS DP cycle.

### 7.4.3.2 Gray code/binary code converter

When Gray code is set, the Gray code value returned by the absolute value encoder is converted into binary code. When binary code is set, the values returned by the encoder remain unchanged.

**Note**

When you set Gray code, the SM 338 always converts the entire encoder value (13, 21, 25 bits). As a result, any leading special bits will influence the encoder value, and the appended bits may be corrupted.



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### 7.4.3.3 Transferred encoder value and scaling

The transferred encoder value contains the encoder position of the absolute value encoder. In addition to the encoder position, the encoder transfers additional bits located before and after the encoder position, depending on the encoder used.

The SM 338 determines the encoder position based on the following settings:

- Scaling, places (0..12), or
- scaling, steps / revolution

#### Scaling, places

Scaling determines the position of the encoder value at the feedback interface.

- "Places" = 1, 2....12 indicates that appended irrelevant bits in the encoder value are shifted out, and the encoder value is right-aligned in the address area (see the example below.)
- "Places" = 0 determines that appended bits are retained and available for evaluation. This may be useful when the absolute value encoder used transfers information in the appended bits (see manufacturer specifications) which you want to evaluate. Refer also to chapter "Gray code/binary code converter (Page 502)".

#### Steps per revolution parameter

Up to 13 bits are available for the steps per revolution parameter. The resultant number of steps per revolution is displayed automatically according to the "Places" setting.

#### Example of encoder value scaling

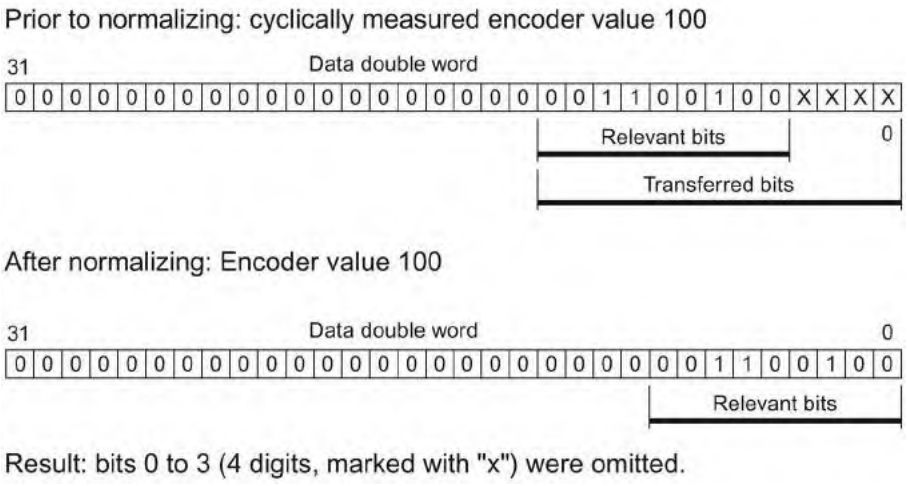
You are using a single-turn encoder with
$2^9$ steps = 512 steps per revolution (resolution/360°.)

Your configuration in *STEP 7*:

- Absolute encoder: 13 bits
- Scaling: 4 places
- Steps per revolution: 512



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### 7.4.3.4 Freeze function

The freeze function "freezes" the actual encoder values of SM 338. The freeze function is coupled to the digital inputs DI 0 and DI 1 of SM 338.

The freeze function is triggered by a signal transition (positive edge) a DI 0 or DI 1. Bit 31 = 1 (output address) identifies a frozen encoder value. You can freeze one, two or three encoder values using one digital input.

Enable the freeze function by setting the corresponding parameters in *STEP 7* .

To allows their event-triggered evaluation, the encoder values are retained until the freeze function is terminated.

#### Terminating the freeze function

The freeze function must be terminated separately at each encoder input. You acknowledge the function in the user program by using STEP 7 operation T PAB to set bit 0, 1 or 2 to "xyz" according to the channel (Program example: refer to chapter "AUTOHOTSPOT").

The acknowledgement resets bit 31 of the corresponding encoder value, and initiates a refresh of the encoder values. You can freeze the encoder values again after you cleared the ACK bit at the output address of the module.

In isochronous mode, the acknowledgement is processed at the time $T_o$. From this point on, you can freeze the encoder values again by setting the digital inputs.

**Note**

The Freeze function is acknowledged automatically when you assign new parameters with different arguments to the relevant
channel (refer to chapter "AUTOHOTSPOT").
If the parameter are identical the Freeze function remains unaffected.



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## 7.4.4 Parametrization SM 338 POS-INPUT

You parameterize the SM 338; POS-INPUT in *STEP 7*. Always parameterize the module while the CPU is in STOP mode.

After you completed the parameter assignment, download the parameters from the PG to the CPU. At its next STOP → RUN transition, the CPU transfers the parameters to the SM 338.

New parameters can not be assigned by the user program.

### Parameters of SM 338; POS-INPUT

The table below provides an overview of configurable parameters and defaults for the SM 338.

The defaults apply if you have not set any parameters in *STEP 7* (default setting bold).

Table 7- 3 Parameters of SM 338; POS-INPUT

| Parameters | Range of values | Note |
|---|---|---|
| Enable<br>• Fast-Mode | yes / **no** | Enable parameter.<br>Applies to all 3 channels. |
| Enable<br>• Diagnostic interrupt | yes / **no** | Enable parameter.<br>Applies to all 3 channels. |
| Absolute value encoder (SSI) [1)] | none; **13 bits**; 21 bits; 25 bits | none: The encoder input is switched off. |
| Code type [1)] | **Gray**; Binary | Code returned by the encoder. |
| Baud rate [1.3)] | **125 kHz**; 250 kHz; 500 kHz; 1 MHz | Data transfer rate of the SSI position detection. Observe the relationship between cable lengths and the transmission rate (refer to chapter "Technical data of SM 338; POS-INPUT (Page 512)") |



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| Parameters | Range of values | Note |
|---|---|---|
| Monoflop time [1),2),3)] | 16 µs; 32 µs; 48 µs; **64 µs** | The monoflop time represents the minimum interval between two SSI frames.<br>The configured monoflop time must be greater than the monoflop time of the absolute value encoder. |
| Scaling<br>• Places<br>• Steps per revolution [4] | <br>**0** to 12<br>2 to **8192** | Scaling right-aligns the encoder value in the address space; irrelevant places are discarded. |
| Enabling the Freeze function | **off**; 0; 1 | Definition of the digital input that initiates freezing of the encoder value at the positive edge. |

1 Refer to the technical specifications of the absolute value encoder

2 The monoflop time represents the interval between two SSI frames. The configured monoflop time must be greater than the monoflop time of the absolute value encoder (see the technical data of the manufacturer). The time 2 x (1 / transmission rate) is added to the value set in HW Config. A transmission rate of 125 kHz and configured monoflop time of 16 µs sets an effective monoflop time of 32 µs.

3 Restriction of the monoflop time of the absolute value encoder:
(1 / transmission rate) < monoflop time of the absolute value encoder < 64 µs + 2 x (1 / transmission rate)

4 to powers of two

**Note**

Please note that in asynchronous mode, the transmission rate and monoflop time affect the accuracy and update quality of the encoder values. In isochronous mode, the transmission rate and monoflop time have an influence on the accuracy of the freeze function.



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## 7.4.5 Addressing SM 338 POS-INPUT

### Data areas for encoder values

The SM 338 inputs and outputs are addressed beginning at the module start address. The input and output address is determined in your configuration of SM 338 in *STEP 7*.

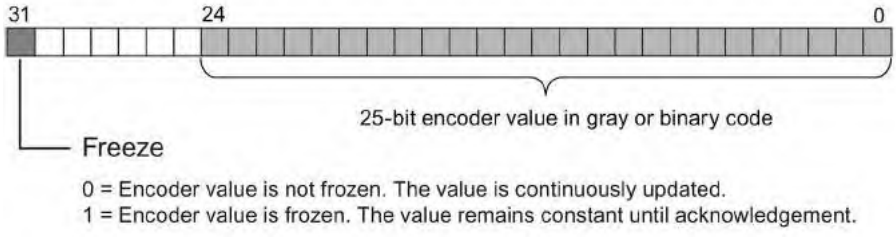
### Input addresses

Table 7- 4 SM 338; POS-INPUT: Input addresses

| Encoder input | Input address (derived from configuration) + address offset |
|---|---|
| 0 | "Module start address" |
| 1 | "Module start address" + 4 byte address offset |
| 2 | "Module start address" +8 byte address offset |

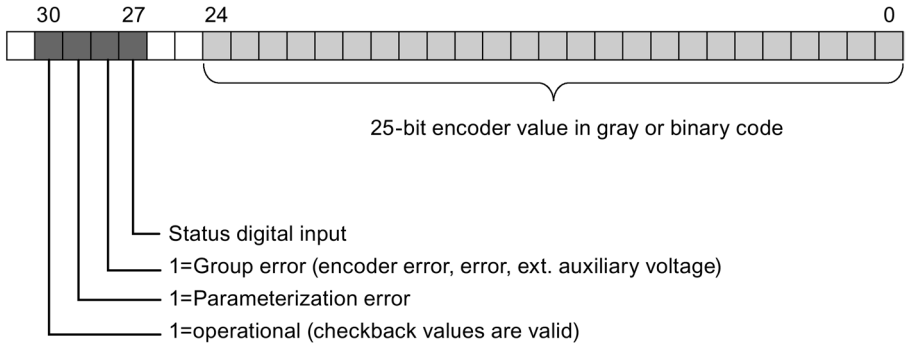
### Structure of double data word in Standard Mode

Double data word structure of the encoder inputs:




### Structure of double data word in Fast Mode

Double data word structure of the encoder inputs:




In the double data word from channel 0, the status of digital input I0 is reported to bit 27 (digital input status) and the double data word from channel 1 is reported to digital input I1.

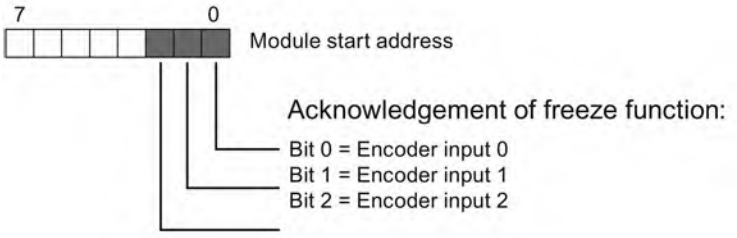
In the double data word from channel 2, the bit is always = 0.



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## Output address in Standard Mode

no output data are supported in Fast Mode.




## Reading data areas

You can read the data areas in your user program using the *STEP 7* operation L PED "xyz."

## Example of access to encoder values and use of the freeze function

You want to read and evaluate the values at the encoder inputs. The module start address is 256.

```
STL                              Explanation
L     PED     256                // Read encoder value in the address area for encoder
                                 input 0

T     MD      100                // Save encoder value to memory double word
A     M       100.7              // Freeze state for subsequent acknowledgement
=     M       99.0               // Determine and save

L     PED     230                // Read encoder value in the address area for encoder
                                 input 1

T     MD      104                // Save encoder value to memory double word
A     M       104.7              // Freeze state for subsequent acknowledgement
=     M       99.1               // Determine and save

L     PED     264                // Read encoder value in the address area for encoder
                                 input 2

T     MD      108                // Save encoder value to memory double word
A     M       108.7              // Freeze state for subsequent acknowledgement
=     M       99.2               // determine and save

L     MB      99                 // Load freeze state and
T     POB     256                // acknowledge (SM 338: output address 256)
```

You can then process the encoder values from the bit memory address areas MD 100, MD 104 and MD 108. The encoder value is set in bits 0 to 30 of the memory double word.



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## 7.4.6 Diagnostics of SM 338; POS-INPUT

### Introduction

The SM 338 provides diagnostics messages, i.e. it always provides all diagnostics messages without user intervention.

### Reactions to a diagnostic message in *STEP 7*

Actions initiated by diagnostic messages:

- The diagnostic message is entered in the diagnosis of the module and forwarded to the CPU.
- The SF LED on the module is lit.
- If you have set "Enable Diagnostic Interrupt" in *STEP 7*, the system triggers a diagnostic interrupt and calls OB 82.

### Reading diagnostic messages

You can read detailed diagnostic messages using SFCs in the user program (refer to section Diagnostics data of SM 338; POS-INPUT (Page 596)).

You can view the cause of the error in the module diagnostics data in *STEP 7* (refer to the *STEP 7* Online Help.)

### Diagnostic message using the SF LED

The SM 338 indicates errors at its SF LED (group error LED.) The
SF LED lights up when the SM 338 generates a diagnostic message. It goes dark after all error states are cleared.

The SF LED also lights up to indicate external errors (short-circuit at the encoder supply), regardless of the CPU operating state (at POWER ON.)

The SF LED lights up temporarily at startup, during the self test of SM 338.



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## Diagnostic messages of SM338; POS-INPUT

The table below provides an overview of the diagnostic messages of SM 338; POS-INPUT.

Table 7- 5 Diagnostic messages of SM 338; POS INPUT

| Diagnostic message | LED | Scope of diagnostics |
|---|---|---|
| Module error | SF | Module |
| Internal error | SF | Module |
| External error | SF | Module |
| Channel error | SF | Module |
| External auxiliary voltage missing | SF | Module |
| Module not programmed | SF | Module |
| Incorrect parameters | SF | Module |
| Channel information available | SF | Module |
| Watchdog time-out | SF | Module |
| Channel error | SF | Channel (encoder input) |
| Configuration / programming error | SF | Channel (encoder input) |
| External channel error (encoder error) | SF | Channel (encoder input) |

## Causes of error and troubleshooting

Table 7- 6 Diagnostic messages of SM 338, causes of error and troubleshooting

| Diagnostic message | Possible cause of error | To correct or avoid error |
|---|---|---|
| Module error | Any, the module has detected an error. | |
| Internal error | Module has detected an error within the automation system. | |
| External error | Module has detected an error outside of the automation system. | |
| Channel error | Indicates that only specific channels are faulty. | |
| External auxiliary voltage missing | Supply voltage L+ of the module is missing | Feed supply L+ |
| Module not programmed | Module requires information whether it should operate with default system parameters or user parameters. | Message present after power on, until the CPU has completed the transfer of parameters; configure the module as required. |
| Incorrect parameters | One parameter, or the combination of parameters, is not plausible | Program the module |
| Channel information available | Channel error; module can provide additional channel information. | |
| Watchdog time-out | Infrequent high electromagnetic interference | Eliminate interference |
| Channel error | Any, the module has detected an error at the encoder input. | |
| Configuration / programming error | Illegal parameter transferred to module | Program the module |
| External channel error (encoder error) | Wire-break at encoder cable, encoder cable not connected, or encoder defective. | Check connected encoder |



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## 7.4.7 SM 338; POS INPUT - Interrupts

### Introduction

This chapter describes the interrupt reaction of SM 338; POS-INPUT. The SM 338 can trigger diagnostic interrupts.

For detailed information on the OBs and SFCs mentioned below, refer to the *STEP 7* Online Help.

### Enabling interrupts

There is no default interrupt setting, i.e. interrupts are disabled if not set accordingly. You configure the interrupt enable parameter in *STEP 7* (refer to chapter "Parametrization SM 338 POS-INPUT (Page 505)").

### Diagnostic interrupt

If you have enabled diagnostic interrupts, the incoming error events (initial occurrence of the error) and outgoing error events (message after troubleshooting) are reported by means of interrupts.

The CPU interrupts user program execution, and executes diagnostic interrupt OB82.

You can call SFC 51 or 59 in OB82 in the user program to view detailed diagnostic data output by the module.

Diagnostics data remain consistent until the program exits OB 82. The module acknowledges the diagnostic interrupt when the program exits OB82.



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## 7.4.8 Technical data of SM 338; POS-INPUT

### Technical data of SM 338; POS-INPUT

| **Technical data** | | | |
|---|---|---|---|
| **Dimensions and weight** | | | |
| Dimensions W x H x D (mm) | 40 x 125 x 120 | | |
| Weight | Approx. 235 g | | |
| **Voltages, currents, electrical potentials** | | | |
| Rated load voltage L+<br>• Range<br>• Reverse polarity protection | 24 VDC<br>20.4 ... 28.8 V<br>No | | |
| Electrical isolation | No, only to shield | | |
| Maximum potential difference<br>• Between the input (M terminal) and CPU grounding bus-bar | 1 VDC | | |
| Encoder supply<br>• Output voltage<br>• Output current | <br>L+ -0.8 V<br>Max. 900 mA, short circuit-proof | | |
| Current consumption<br>• from the backplane bus<br>• from load voltage L+ (no load) | <br>Max. 160 mA<br>max. 10 mA | | |
| Power loss of the module | Typ. 3 W | | |
| **Encoder inputs POS-INPUT 0 to 2** | | | |
| Position detection | Absolute | | |
| Difference signals for SSI data and SSI clock | To RS422 standard | | |
| Data transfer rate and cable (twisted-pair and shielded) length of absolute value encoders | • 125 kHz max. 320 m<br>• 250 kHz max. 160 m<br>• 500 kHz max. 60 m<br>• 1 MHz max. 20 m | | |
| SSI frame transfer rate<br>• 125 kHz<br>• 250 kHz<br>• 500 kHz<br>• 1 MHz | 13 bits<br>112 µs<br>56 µs<br>28 µs<br>14 µs | 21 bits<br>176 µs<br>88 µs<br>44 µs<br>22 µs | 25 bits<br>208 µs<br>104 µs<br>52 µs<br>26 µs |
| Monoflop time[2] | 16 µs, 32 µs, 48 µs, 64 µs | | |



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| **Technical data** | |
|---|---|
| **Digital inputs DI 0, DI 1** | |
| Electrical isolation | No, only to shield |
| Input voltage | 0 signal -3 V ... 5 V<br>1 signal 11 V ... 30.2 V |
| Input current | 0 signal ≤ 2 mA (standby current)<br>1 signal 9 mA (typ.) |
| Input delay | 0 > 1: max. 300 µs<br>1 > 0: Max. 300 µs |
| Maximum repetition rate | 1 kHz |
| Connection of a two-wire BEROS, type 2 | Supported |
| Shielded cable length | 600 m |
| Unshielded cable length | 32 m |
| **Status, interrupts, diagnostics** | |
| Interrupts<br>• Diagnostics interrupt | <br>programmable |
| Status display for digital inputs<br>Group error | LED (green)<br>LED (red) |
| **Inaccuracy of the encoder value** | |
| Free-running transducer capture (Standard Mode) | |
| • maximum age [1]<br>• minimum age [1]<br>• Jitter | (2 × frame transfer rate) + monoflop time + 580 µs<br>Frame transfer rate + 130 µs<br>Frame transfer rate + monoflop time + 450 µs |
| Refresh rate | Frame evaluation at intervals of 450 µs |
| Free-running transducer capture (Fast Mode) | |
| • maximum age [1]<br>• minimum age [1]<br>• Jitter | (2 × frame transfer rate) + monoflop time + 400 µs<br>Frame transfer rate + 100 µs<br>Frame transfer rate + monoflop time + 360 µs |
| Refresh rate | Frame evaluation at intervals of 360 µs |
| Isochronous encoder value acquisition | |
| • Age | Encoder value at time $T_i$ of the current PROFIBUS DP cycle |
| **Inaccuracy of the frozen encoder value (Freeze)** | |
| Cyclic encoder value acquisition (Standard Mode) | |
| • maximum age [1]<br>• minimum age [1]<br>• Jitter | (2 × frame transfer rate) + monoflop time + 580 µs<br>Frame transfer rate + 130 µs<br>Frame transfer rate + monoflop time + 450 µs |
| Isochronous encoder value acquisition | |
| • Jitter | Max. (frame transfer rate $_n$ + programmed Monoflop time $_n$) =0, 1, 2, (channel) |



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| **Technical data** | | |
|---|---|---|
| **Isochronous times for the module** | | |
| In Standard Mode | TCI | 850 µs |
| | TCO | 620 µs |
| | ToiMin | 90 µs |
| | TDPMin | 1620 µs |
| In Fast Mode | TCI | 700 µs |
| | TCO | 0 µs |
| | ToiMin | 0 µs |
| | TDPMin | 900 µs |

[1] Age of the encoder values determined by the transfer process and the processing

[2] Restriction of the monoflop time of the absolute value encoder:
(1 / transmission rate) < monoflop of the absolute value encoder < 64 µs + 2 x (1 / transmission rate)



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# Interface modules

# 8

### Interface modules

This chapter described the technical data and properties of the S7-300 interface modules.

## 8.1 Module overview

### Introduction

The table below summarizes the essential features of the interface modules described in this chapter. This overview supports you in selecting a module to suit your requirements.

Table 8- 1 Interface modules: Overview of properties

| Properties | Interface module IM 360 | Interface module IM 361 | Interface module IM 365 |
|---|---|---|---|
| Suitable for installation in S7-300 racks | • 0 | • 1 to 3 | • 0 and 1 |
| Data transfer | • from IM 360 to IM 361 via connecting cable 386 | • from IM 360 to IM 361, or from IM 361 to IM 361, via connecting cable 386 | • from IM 365 to IM 365 via connecting cable 386 |
| Distance between... | • max. 10 m | • max. 10 m | • 1 m, permanently connected |
| Special features | --- | --- | • Preassembled module pair<br>• Rack 1 supports only signal modules<br>• IM 365 does not route the communication bus to rack 1 |



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# 8.2 Interface module IM 360; (6ES7360-3AA01-0AA0)

## Order number

6ES7360-3AA01-0AA0

## Properties

Special features of interface module IM 360:

- Interface for rack 0 of the S7-300
- Data transfer from IM 360 to IM 361 via connecting cable 368
- Maximum distance between IM 360 and IM 361 is 10 m

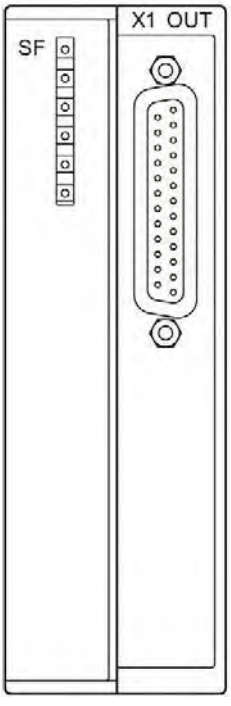
## Status and error LEDs

Interface module IM 360 is equipped with the following status and error LEDs.

| Display element | Meaning | Explanations |
|---|---|---|
| SF | Group error | The LED lights up if<br>• the connecting cable is missing.<br>• IM 361 is switched off. |

## Front view

The figure below shows the front view of interface module IM 360






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## Technical data

The overview below shows the technical data of interface module IM 360.

| **Technical data** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 40 x 125 x 120 |
| Weight | approx. 250 g |
| **Module-specific data** | |
| Cable length<br>• Maximum length to next IM | 10 m |
| Current consumption<br>• from the backplane bus | 350 mA |
| Power loss | typ. 2 W |
| Status and error LEDs | yes |



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# 8.3 Interface module IM 361; (6ES7361-3CA01-0AA0)

## Order number

6ES7361-3CA01-0AA0

## Properties

Special features of interface module IM 361:

- 24 VDC power supply
- Interface for racks 1 to 3 of the S7-300
- Current output via the S7-300 backplane bus: max. 0.8 A
- Data transfer from IM 360 to IM 361, or from IM 361 to IM 361 via connecting cable 368
- Maximum distance between IM 360 and IM 361 is 10 m
- Maximum distance between IM 361 and IM 361 is 10 m

## Status and error LEDs

Interface module IM 361 is equipped with the following status and error LEDs.

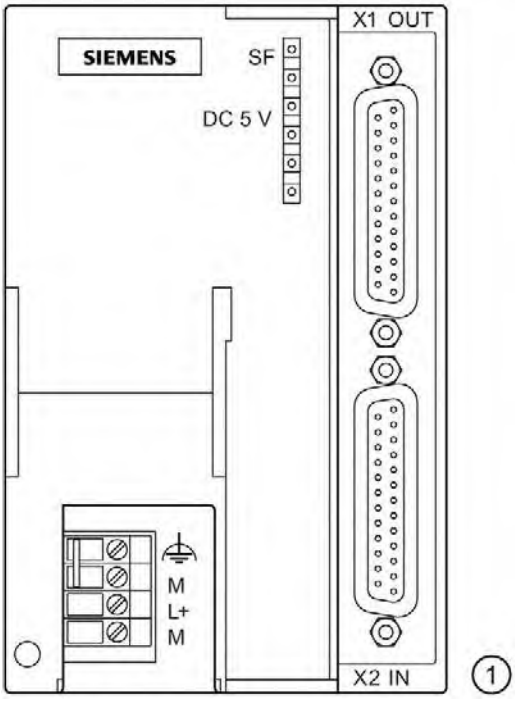
| Display element | Meaning | Explanations |
|---|---|---|
| SF | Group error | The LED lights up if<br>• the connecting cable is missing<br>• the IM 361 connected in series is switched off<br>• the CPU is in POWER OFF state |
| 5 VDC | 5 VDC supply for the S7-300 backplane bus | - |



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## Front view

The figure below shows the front view of interface module IM 361




① Front view

## Technical data

The overview below shows the technical data of interface module IM 361.

| Technical data | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) | 80 x 125 x 120 |
| Weight | 505 g |
| **Module-specific data** | |
| Cable length<br>Maximum length to next IM | <br>10 m |
| Current consumption<br>from 24 VDC<br>Power loss | <br>0.5 A<br>typ. 5 W |
| Current sinking at backplane bus | 0.8 A |
| Status and error LEDs | yes |

## See also

Spare parts and accessories for S7-300 modules (Page 616)



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# 8.4 Interface module IM 365; (6ES7365-0BA01-0AA0)

### Order number: "Standard module"

6ES7365-0BA01-0AA0

### Order number: "SIPLUS S7-300 module"

6AG1365-0BA01-2AA0

### Properties

Special features of interface module IM 365:

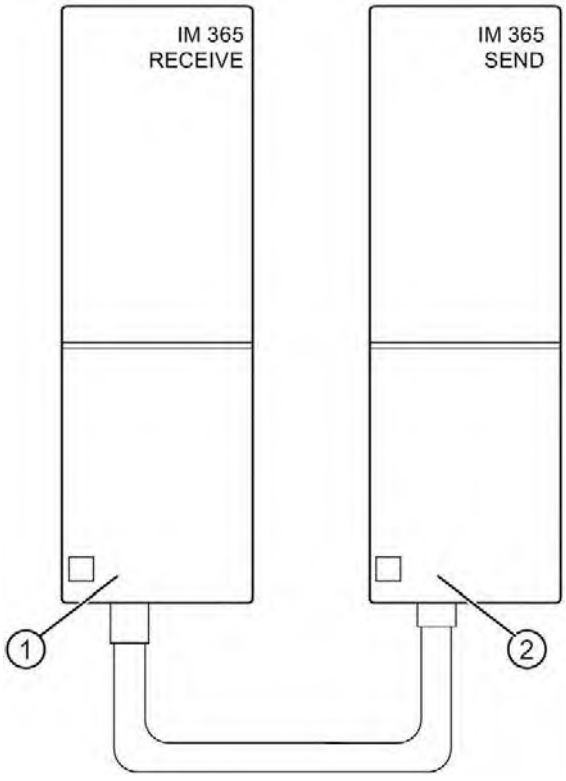
- Preassembled pair of modules for rack 0 and rack 1
- Total power supply of 1.2 A, of which up to 0.8 A may be used per rack.
- Connecting cable with a length of 1 m already permanently connected
- IM 365 does **not** route the communication bus to rack 1, i.e. you cannot install FMs with communication bus function in rack 1.



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## Front view

The figure below shows the front view of interface module IM 365




① In rack 1
② In rack 0

## Technical specifications

The overview below shows the technical data of interface module IM 365.

| **Technical data** | |
|---|---|
| **Dimensions and weight** | |
| Dimensions W x H x D (mm) per module | 40 x 125 x 120 |
| Total weight | 580 g |
| **Module-specific data** | |
| Cable length<br>Maximum length to next IM | <br>1 m |
| Current consumption<br>from the backplane bus<br>Power loss | <br>100 mA<br>typ. 0.5 W |
| Current sinking<br>per module | max. 1.2 A<br>0.8 A |
| Status and error LEDs | no |



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# Parameter sets of signal modules

# A

## A.1 Principles of programming signal modules in the user program

### Parameter assignment in the user program

You have programmed the modules in *STEP 7*.

In the user program, you can use a SFC:

- to assign new parameters to the module, and
- transfer the parameters from the CPU to the addressed signal module

### Parameters are stored in data records

The signal module parameters are written to data records 0 and 1; for certain analog input modules, these are also written to data record 128.

### Editable parameters

You can edit the parameters of data record 1, and then transfer these to the signal module using SFC55. The CPU parameters are not changed by this action!

You cannot modify any parameters of data record 0 in the user program.

### SFCs for programming

SFCs available for programming signal modules in the user program:

Table A- 1 SFCs for programming signal modules

| SFC no. | Identifier | Application |
|---|---|---|
| 55 | WR_PARM | Transfer the programmable parameters (data record 1 and 28) to the addressed signal module. |
| 56 | WR_DPARM | Transfer the parameters (data record 0, 1 **or** 128) from the CPU to the addressed signal module. |
| 57 | PARM_MOD | Transfer all parameters (data record 0, 1 **and** 128) from the CPU to the addressed signal module. |



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## Description of the parameters

The next chapters describe all modifiable parameters of the various module classes. For information on signal module parameters, refer to:

- the *STEP 7* Online Help
- to this Reference Manual

  The chapters dealing with the various signal modules also show you the corresponding configurable parameters.

## Further references

For detailed information on programming signal modules in the user program and on corresponding SFCs, refer to the *STEP 7* manuals.



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# A.2 Parameters of digital IO modules

## Parameter

The table below lists the parameters you can set for digital input modules.

**Note**

For details on parameters of programmable digital IO modules, see the chapter dealing with the relevant module.

The comparison illustrates the parameters you can edit:

- in *STEP 7*
- using SFC55 "WR_PARM"
- using SFB53 "WRREC" (for GSD, for example).

Parameters set in *STEP 7* may also be transferred to the module using SFCs 56 and 57, and SFB53 (refer to the *STEP 7*) Online Help).

Table A- 2 Parameters of digital IO modules

| Parameters | Data record number | Programmable, using ... | |
|---|---|---|---|
| | | ... SFC55, SFB53 | ... PG |
| Input delay | 0 | no | yes |
| Diagnostics of missing encoder supply | | no | yes |
| Wire-break diagnostics | | no | yes |
| Hardware interrupt enable | 1 | yes | yes |
| Diagnostics interrupt enable | | yes | yes |
| Hardware interrupt at positive edge | | yes | yes |
| Hardware interrupt at negative edge | | yes | yes |

**Note**

To enable diagnostics interrupts in the user program at data record 1, you first need to enable diagnostics at data record 0 in *STEP 7*.



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## Structure of data record 1

The figure below shows the structure of data record 1 for the parameters of digital input modules.

You enable a parameter by setting a logical "1" at the corresponding bit.

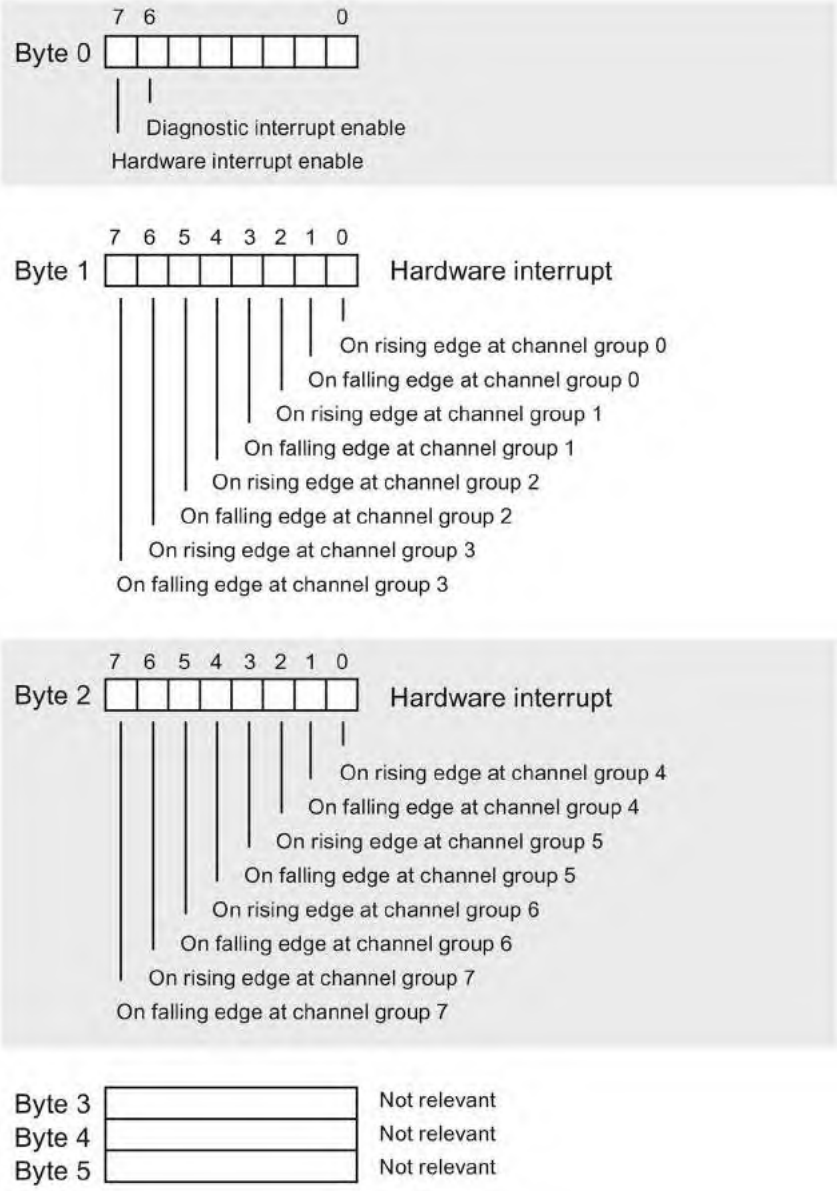



Figure A-1 Data record 1 for parameters of digital input modules

## See also

Diagnostics of digital modules (Page 59)



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# A.3 Parameters of the digital input module SM 321; DI 16 x DC 24/125 V

## Parameters

The table below lists the parameters you can set for digital input modules.

**Note**

For details on parameters of programmable digital IO modules, see the chapter dealing with the relevant module.

The comparison illustrates the parameters you can edit:

- in *STEP 7*
- using SFC55 "WR_PARM"
- using SFB53 "WRREC" (for GSD, for example).

Parameters set in *STEP 7* may also be transferred to the module using SFCs 56 and 57, and SFB53 (refer to the *STEP 7*) Online Help).

Table A- 3 Parameters of the digital input module SM 321; DI 16 x DC 24/125 V

| Parameters | Data record number | Programmable, using ... | |
|---|---|---|---|
| | | ... SFC55, SFB53 | ... PG |
| Input delay | 0 | No | Yes |
| Wire-break diagnostics | | No | Yes |
| Hardware interrupt enable | 1 | **Yes** | Yes |
| Diagnostic interrupt enable | | **Yes** | Yes |
| Hardware interrupt at positive edge | | **Yes** | Yes |
| Hardware interrupt at negative edge | | **Yes** | Yes |

**Note**

To enable diagnostic interrupts in the user program at data record 1, you first need to enable diagnostics at data record 0 in *STEP 7*.

## Structure of data record 1

The figure below shows the structure of data record 1 for the parameters of digital input modules.

You enable a parameter by setting a logical "1" at the corresponding bit.



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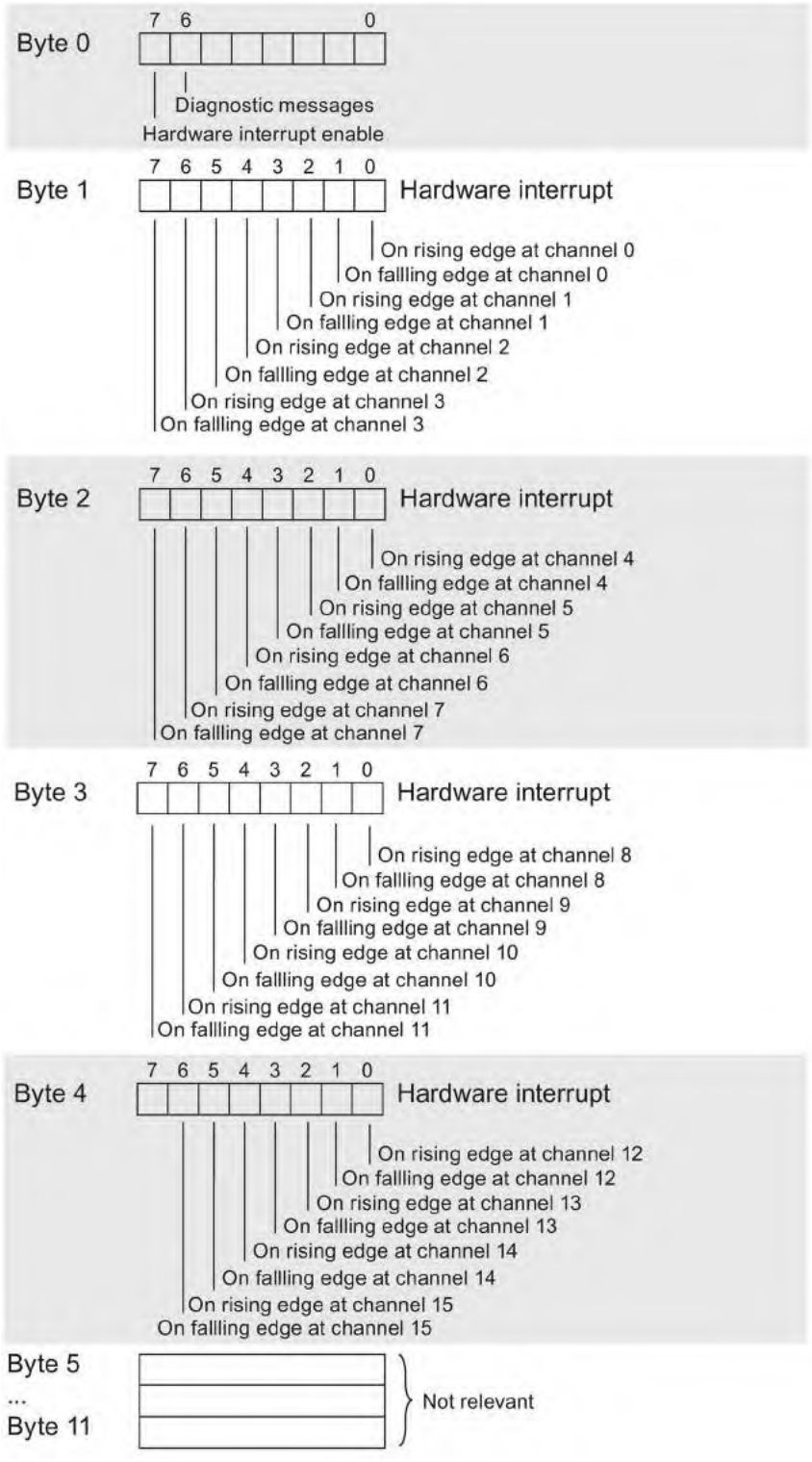



Figure A-2 Data record 1 for parameters of digital input modules



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# A.4 Parameters of digital output modules

## Parameter

The table below contains all parameters you can set for digital output modules.

**Note**

For details on the parameters of programmable digital IO modules, see the chapter dealing with the relevant module.

The comparison illustrates the parameters you can edit:

- in *STEP 7*
- using SFC55 "WR_PARM"
- using SFB53 "WRREC" (for GSD, for example).

Parameters set in *STEP 7* may also be transferred to the module using SFCs 56 and 57, and SFB 53 (refer to the *STEP 7*) Online Help).

Table A- 4 Parameters of digital output modules

| Parameter | Data record number | Programmable, using ... | |
|---|---|---|---|
| | | ... SFC55, SFB53 | ... PG |
| Diagnostics of missing load voltage L+ | 0 | no | yes |
| Wire-break diagnostics | | No | Yes |
| Diagnostics of short-circuit to M | | No | Yes |
| Diagnosis of short-circuit to L+ | | No | Yes |
| Diagnostics interrupt enable | 1 | **Yes** | Yes |
| Reaction to CPU STOP | | **Yes** | Yes |
| Set substitute value "1" | | **Yes** | Yes |

**Note**

To enable diagnostic interrupts in the user program at data record 1, you first need to enable diagnostics at data record 0 in *STEP 7*.



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## Structure of data record 1

The figure below shows the structure of data record 1 for the parameters of digital output modules.

You enable a parameter by setting a logic "1" at the corresponding bit of byte 0.

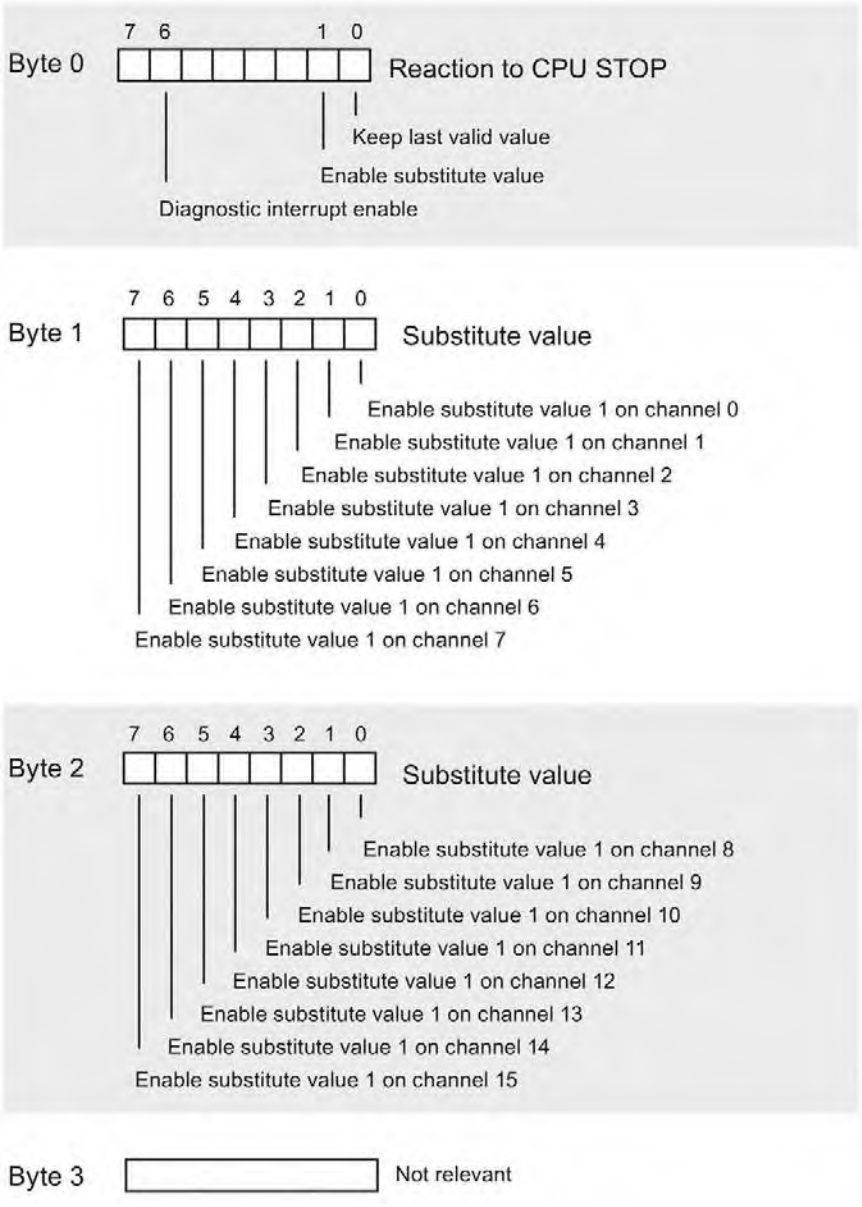



Figure A-3 Data record 1 for parameters of digital output modules

### Note

The "hold last valid value" and "set substitute value" parameters should only be enabled at byte 0 as an alternative.



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# A.5 Settings from the digital output module SM 322; DO 16 x DC 24 V/0.5 A (6ES7322-8BH10-0AB0)

## Parameter

The table below contains all parameters you can set for digital output modules.

The comparison illustrates the parameters you can edit:

- in*STEP 7*
- using SFC55 "WR_PARM"
- using SFB53 "WRREC" (for GSD, for example).

Parameters set in *STEP 7* can also be transferred to the module using SFC 56 and SFC 57 (refer to the *STEP 7* Online Help).

Table A- 5 Digital output module SM 322; 6ES7322-8HB10-0AB0

| Parameter | Data record number | Programmable, using ... | |
|---|---|---|---|
| | | ... SFC55, SFB53 | ... PG |
| Diagnostics: Group diagnostics | 1 | Yes | Yes |
| Diagnostics: Load voltage L+ missing | | | |
| Diagnostics: Discrepancy error | | | |
| Diagnostics interrupt enable | | | |
| Behavior at CPU/master STOP | | | |
| Substitute a value | | | |

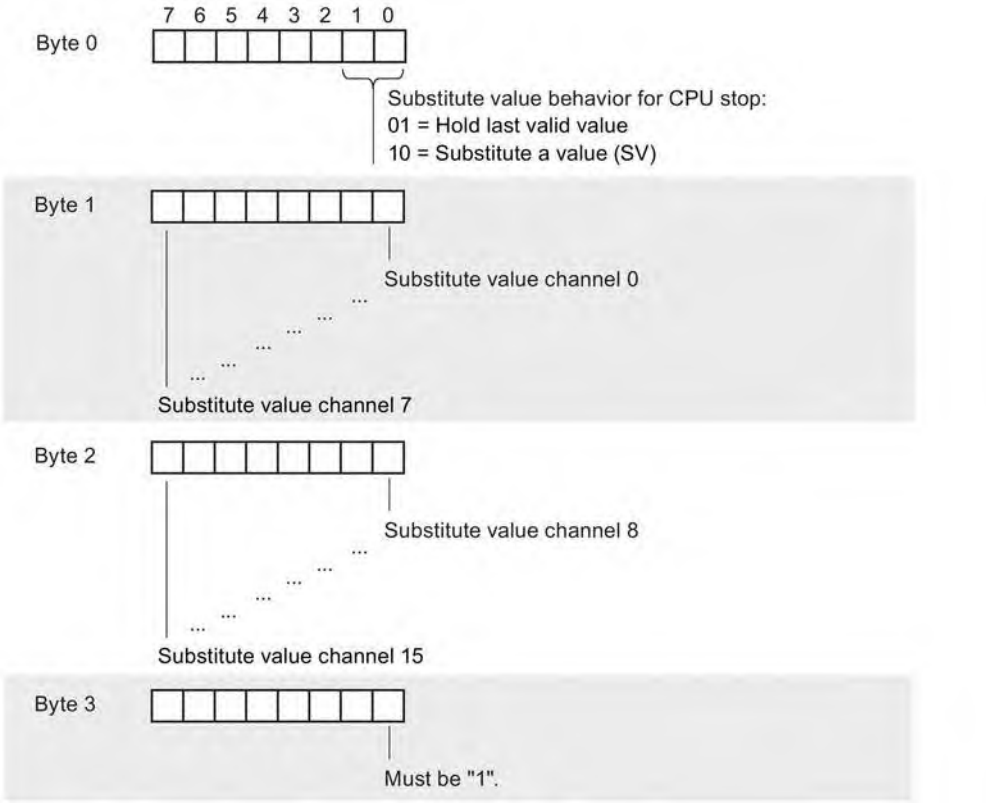


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## Structure of data record 1

The figure below shows the structure of data record 1 for the parameters of digital output modules.

You enable a parameter by setting a logic "1" at the corresponding bit of byte 0.






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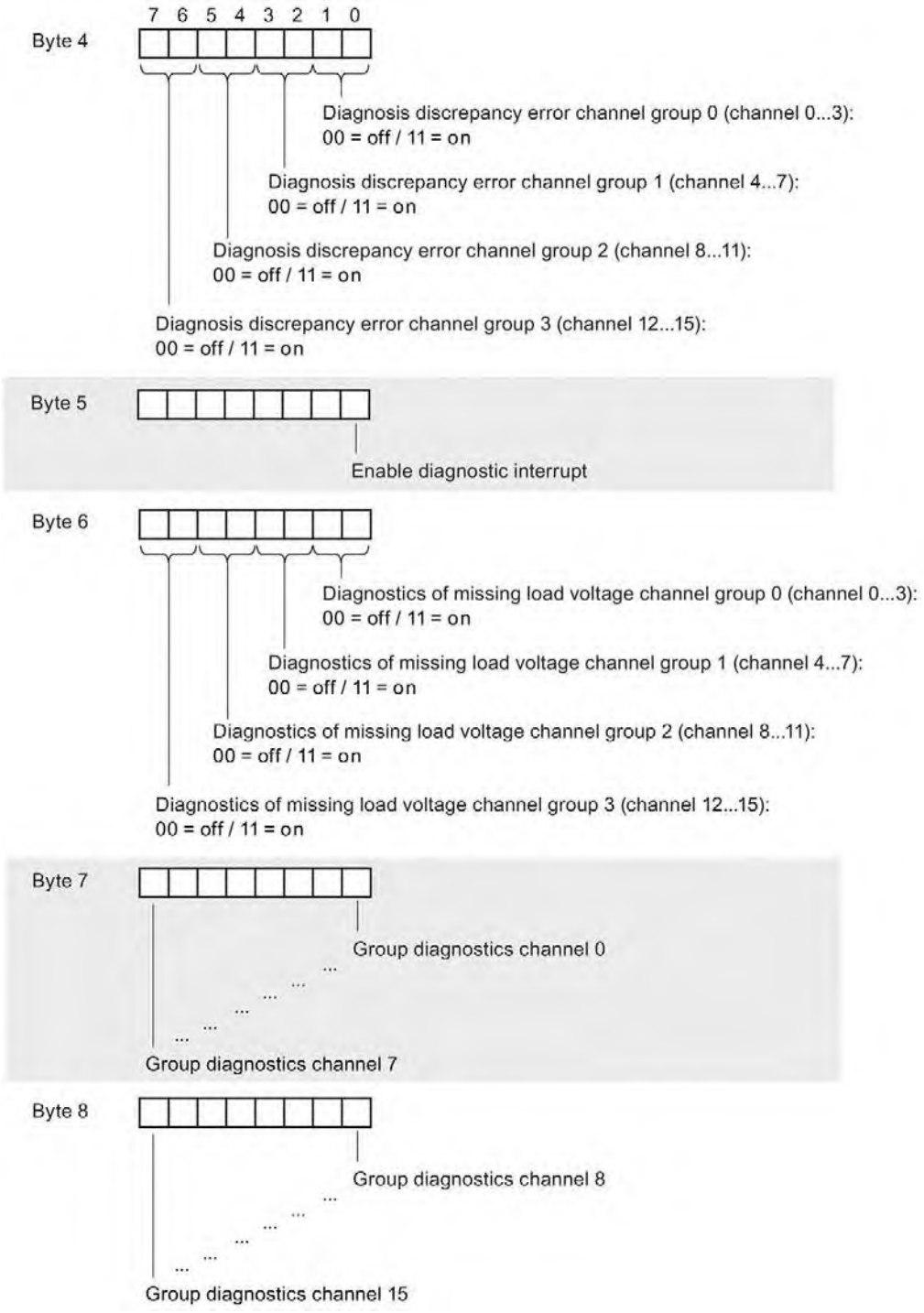



Figure A-4 Structure of data record 1

**Note**

The "hold last valid value" and "set substitute value" parameters should only be enabled at byte 0 as an alternative.



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## See also

Parameters of digital output modules (Page 152)



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# A.6 Parameters of analog input modules

## Parameter

The table below lists all parameters you can set for analog input modules.

The comparison illustrates the parameters you can edit:

- in *STEP 7*
- using SFC55 "WR_PARM"

Parameters set in *STEP 7* can also be transferred to the module using SFC56 and SFC57 (refer to the *STEP 7* manuals).

Table A- 6 Parameters of analog input modules

| Parameters | Data record number | Programmable, using ... | |
|---|---|---|---|
| | | ... SFC55 | ... PG |
| Diagnostics: Group diagnostics | 0 | No | Yes |
| Diagnostics: with wirebreak monitoring | | no | yes |
| Temperature unit | | no | yes |
| Temperature coefficient | | no | yes |
| Smoothing | | no | yes |
| Diagnostic interrupt enable | 1 | yes | yes |
| Hardware interrupt when limit exceeded | | yes | yes |
| End of cycle interrupt enable | | yes | yes |
| Interference frequency suppression | | yes | yes |
| Measurement type | | yes | yes |
| Measuring range | | yes | yes |
| High limit | | yes | yes |
| Low limit | | yes | yes |

**Note**

To enable diagnostic interrupts in the user program at data record 1, you first need to enable diagnostics at data record 0 in *STEP 7*.



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## Structure of data record 1

The figure below shows the structure of data record 1 of the parameters for an analog input module with 8 channels in 4 groups (e.g. AI 8 x 12 bits). The structure of a module whose channels are not grouped together is documented in the relevant module description.

You enable a parameter by setting a logic "1" at the corresponding bit of byte 0.

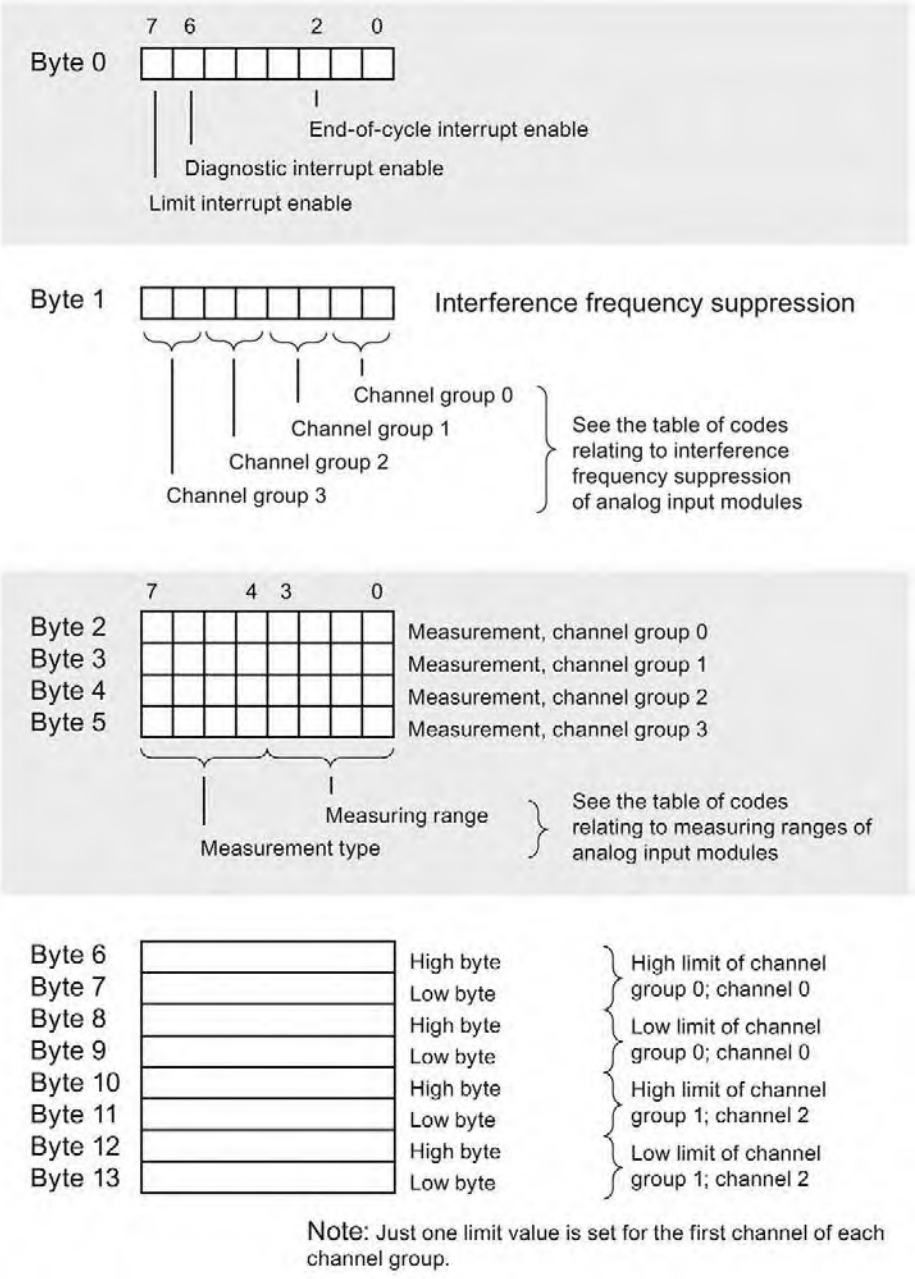



Figure A-5 Data record 1 for the parameters of analog input modules



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**Note**

The representation of limits matches the analog value representation (see chapter 4.) Observe range limits when setting the limit values.

## Interference frequency suppression

The table below contains the coding at byte 1 of data record 1 for the various frequencies (see the previous figure.) Make allowances for the resultant integration time at each channel!

Table A- 7 Interference frequency suppression codes of analog input modules

| Interference frequency suppression | Integration time | Code |
|---|---|---|
| 400 Hz | 2.5 ms | 2#00 |
| 60 Hz | 16.7 ms | 2#01 |
| 50 Hz | 20 ms | 2#10 |
| 10 Hz | 100 ms | 2#11 |

## Measurement types and measuring ranges

The table below shows all measurement types and measuring ranges of the analog input module, including their codes. Enter these codes at bytes 2 to 5 in data record 1 (refer to the previous figure.)

**Note**

You may have to reposition a measuring range module of the analog input module to suit the measuring range.

Table A- 8 Measuring range codes of analog input modules

| Measurement type | Code | Measuring range | Code |
|---|---|---|---|
| disabled | 2#0000 | disabled | 2#0000 |
| Voltage | 2#0001 | ± 80 mV | 2#0001 |
| | | ± 250 mV | 2#0010 |
| | | ± 500 mV | 2#0011 |
| | | ± 1 V | 2#0100 |
| | | ± 2.5 V | 2#0101 |
| | | ± 5 V | 2#0110 |
| | | 1 V to 5 V | 2#0111 |
| | | 0 V to 10 V | 2#1000 |
| | | ± 10 V | 2#1001 |
| | | ± 25 mV | 2#1010 |
| | | ± 50 mV | 2#1011 |



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| Measurement type | Code | Measuring range | Code |
|---|---|---|---|
| 4-wire transducer | 2#0010 | ±3.2 mA | 2#0000 |
| | | ±10 mA | 2#0001 |
| | | 0 to 20 mA | 2#0010 |
| | | 4 to 20 mA | 2#0011 |
| | | ±20 mA | 2#0100 |
| | | ±5 mA | 2#0101 |
| 2-wire transducer | 2#0011 | 4 to 20 mA | 2#0011 |
| Resistance (4-wire connection) | 2#0100 | 150 Ω | 2#0010 |
| | | 300 Ω | 2#0100 |
| | | 600 Ω | 2#0110 |
| | | 10 k Ω | 2#1001 |
| Resistance 4-wire connection; 100 Ω compensation | 2#0110 | 52 Ω to 148 Ω | 2#0001 |
| | | 250 Ω | 2#0011 |
| | | 400 Ω | 2#0101 |
| | | 700 Ω | 2#0111 |
| Thermal resistance + linearization 4-wire connection | 2#1000 | Pt 100 Klima | 2#0000 |
| | | Ni 100 Klima | 2#0001 |
| | | Pt 100 Standard range | 2#0010 |
| | | Pt 200 Standard range | 2#0011 |
| | | Pt 500 Standard range | 2#0100 |
| | | Pt 1000 Standard range | 2#0101 |
| | | Ni 1000 standard range | 2#0110 |
| | | Pt 200 Klima | 2#0111 |
| | | Pt 500 Klima | 2#1000 |
| | | Pt 1000 Klima | 2#1001 |
| | | Ni 1000 Klima | 2#1001 |
| | | Ni 100 standard range | 2#1011 |
| Thermocouples with internal comparator | 2#1010 | Type B [PtRh - PtRh] | 2#0000 |
| Thermocouples with external comparison | 2#1011 | Type N [NiCrSi-NiSi] | 2#0001 |
| Thermocouples + linearization internal comparison | 2#1101 | Type E [NiCr-CuNi] | 2#0010 |
| Thermocouples + linearization external comparison | 2#1110 | Type R [PtRh -Pt] | 2#0011 |
| | | Type S [PtRh -Pt] | 2#0100 |
| | | Type J [Fe - CuNi IEC] | 2#0101 |
| | | Type L [Fe-CuNi] | 2#0110 |
| | | Type T [Cu - CuNi] | 2#0111 |
| | | Type K [NiCr-Ni] | 2#1000 |
| | | Type U [Cu -Cu Ni] | 2#1001 |

## See also

Analog modules (Page 300)



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# A.7 Parameters of analog input module SM 331; AI 8 x RTD

## Parameters

The table below shows all parameters you can set at analog input module SM 331; AI 8 x RTD.

The comparison illustrates the parameters you can edit:

- in *STEP 7*
- using SFC55 "WR_PARM"

Parameters set in *STEP 7* can also be transferred to the module using SFC56 and SFC57 (refer to the *STEP 7* manuals).

Table A- 9 Parameters of SM 331; AI 8 x RTD

| Parameters | Data record number | Programmable, using ... | |
|---|---|---|---|
| | | ... SFC55 | ... PG |
| Diagnostics: Group diagnostics | 0 | no | yes |
| Diagnostics: with wirebreak monitoring | | no | yes |
| Diagnostic interrupt enable | 1 | yes | yes |
| Hardware interrupt when limit exceeded | | yes | yes |
| End of cycle interrupt enable | | yes | yes |
| Temperature unit | | yes | yes |
| Measurement type | 128 | yes | yes |
| Measuring range | | yes | yes |
| Operating mode | | yes | yes |
| Temperature coefficient | | yes | yes |
| Interference frequency suppression | | yes | yes |
| Smoothing | | yes | yes |
| High limit | | yes | yes |
| Low limit | | yes | yes |

**Note**

To enable diagnostic interrupts in the user program at data record 1, you first need to enable diagnostics at data record 0 in *STEP 7*.



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## Structure of data record 1

The diagram below shows the structure of data record 1 of SM 331; AI 8 x RTD. You enable a parameter by setting a logical "1" at the corresponding bit.

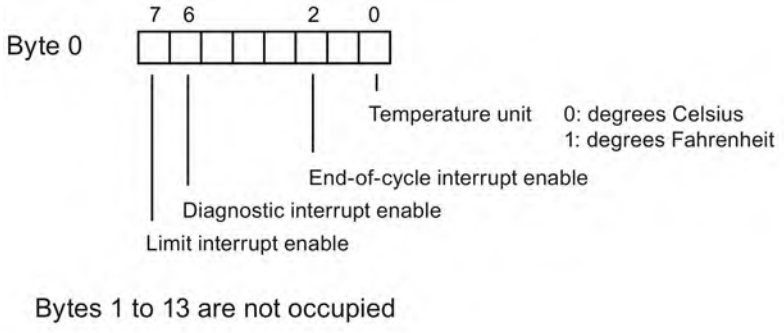



Figure A-6 Data record 1 for the parameters of SM 331; AI 8 RTD



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## Structure of data record 128

The diagram below shows the structure of data record 128 of SM 331; AI 8 x RTD.

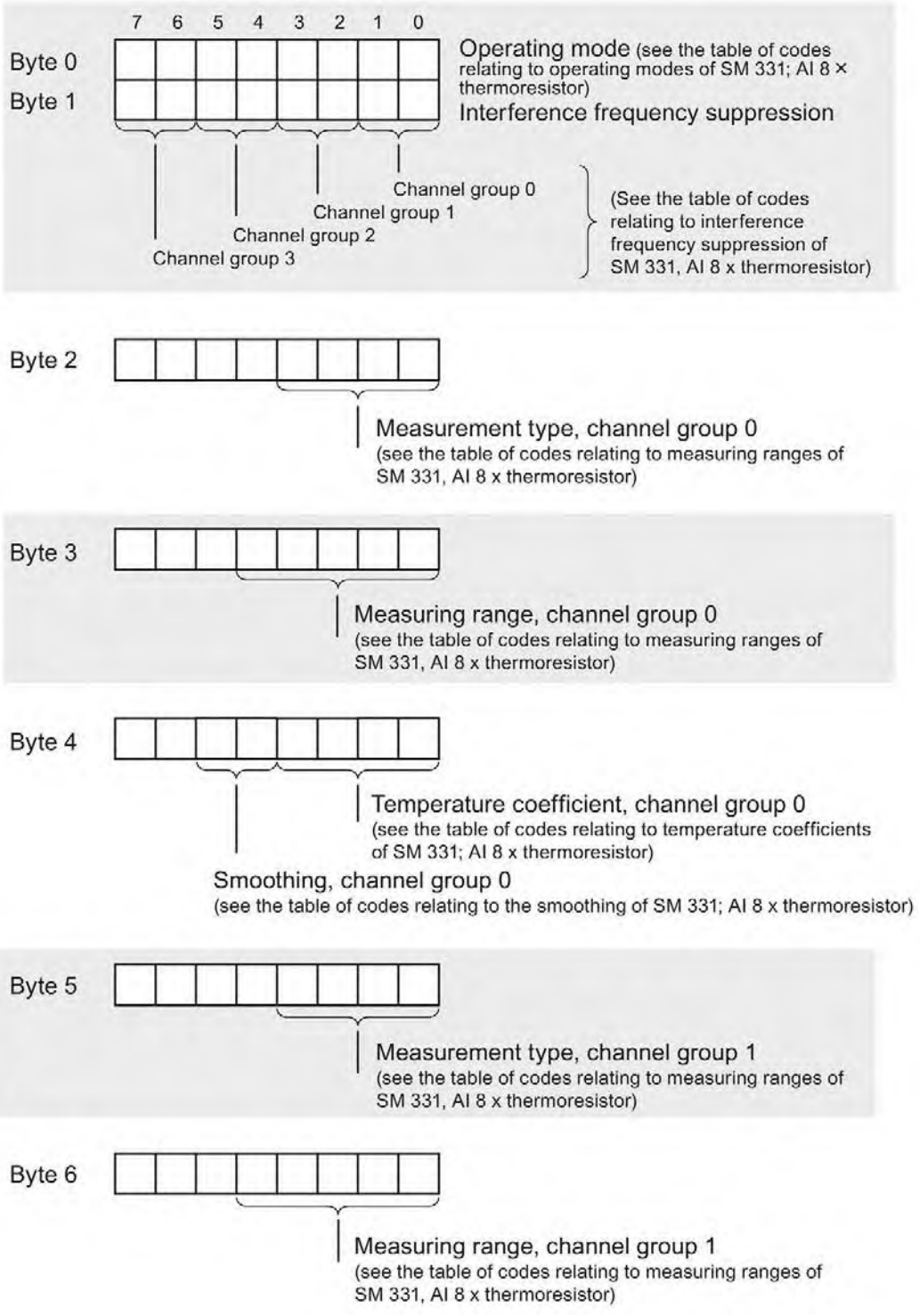



Figure A-7 Data record 128 of SM 331; AI 8 x RTD



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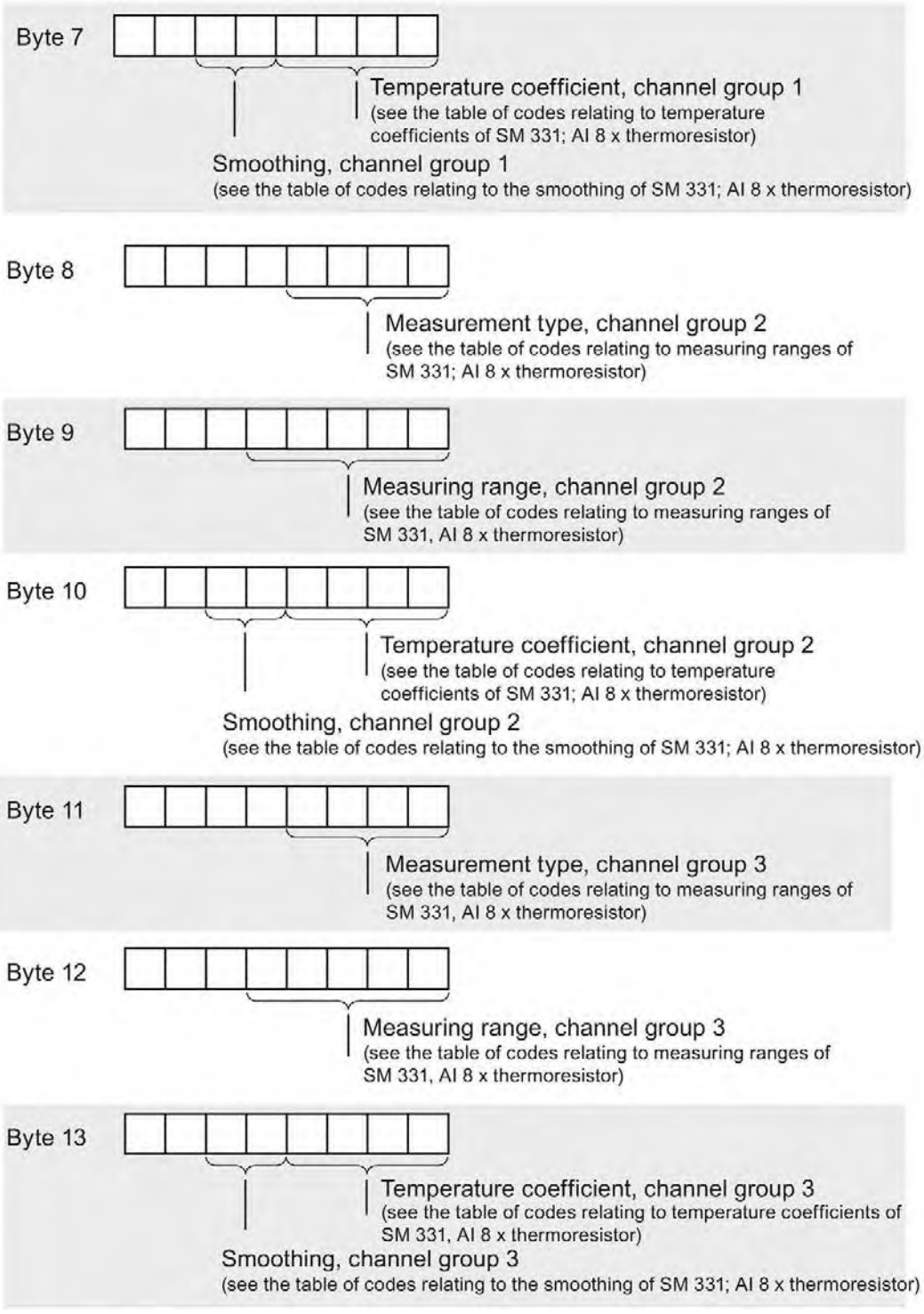



Figure A-8 Data record 128 of SM 331; AI 8 x RTD (continued)



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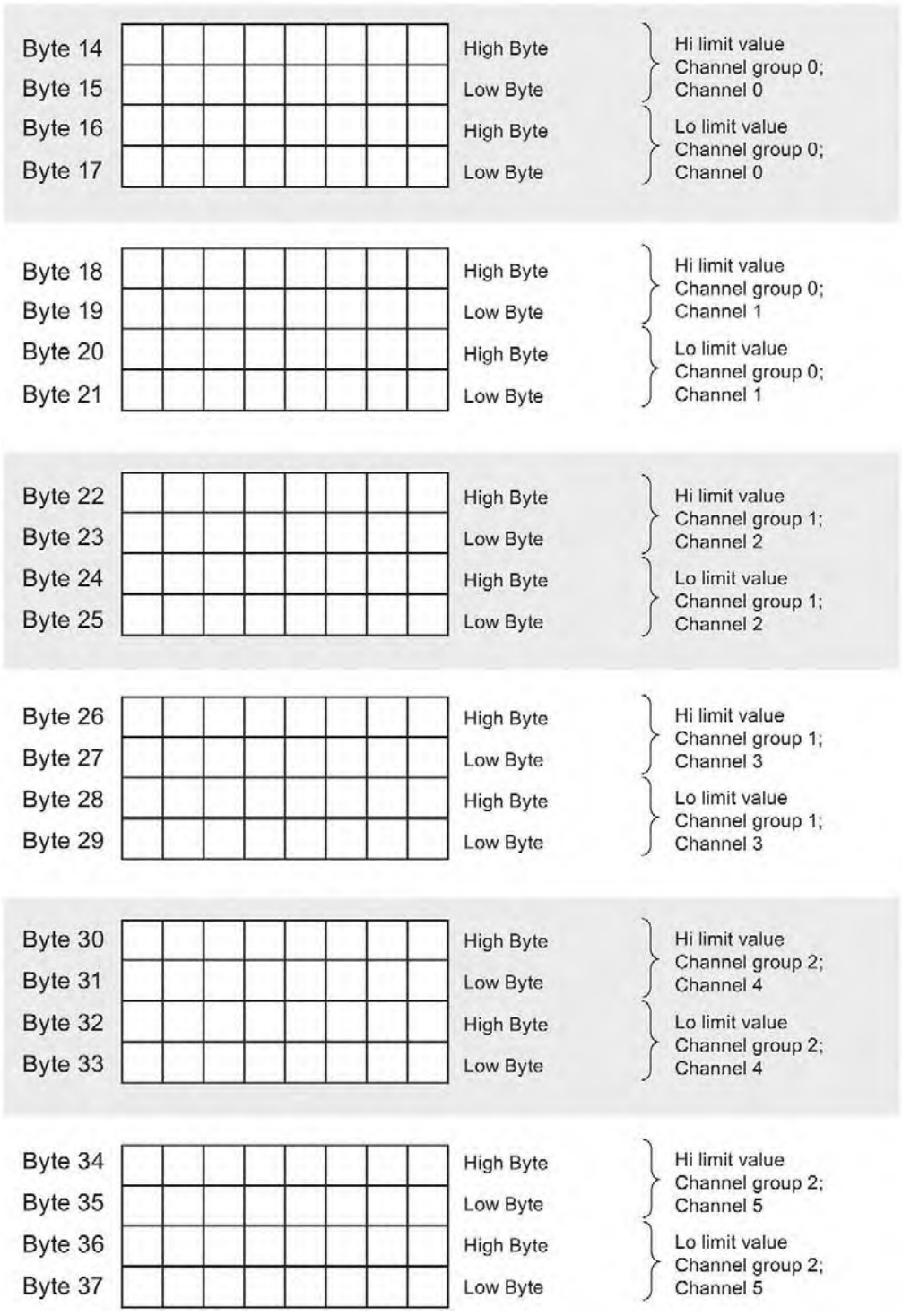



Figure A-9 Data record 128 of SM 331; AI 8 x RTD (continued)



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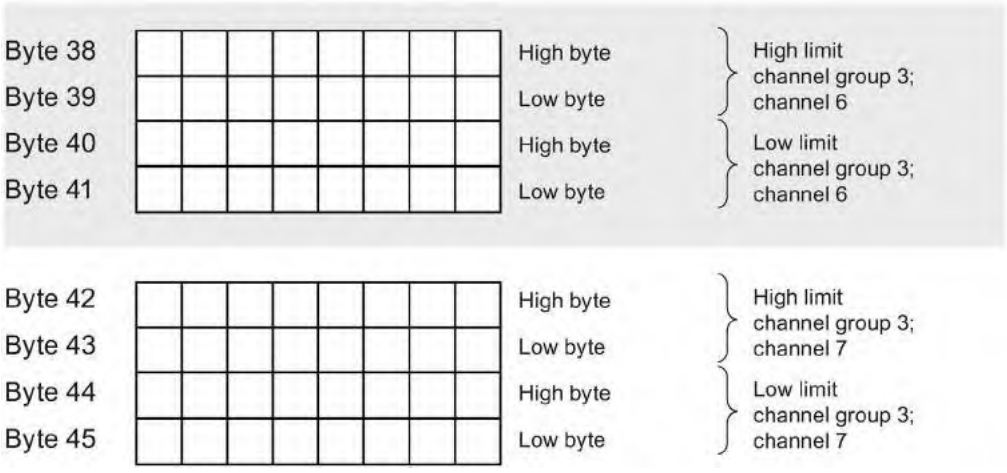



Figure A-10 Data record 128 of SM 331; AI 8 x RTD (continued)

**Note**

The representation of limits matches the analog value representation. Observe range limits when setting the limit values.

## Modes of operation of SM 331; AI 8 x RTD

The table below contains the coding at byte 0 of data record 128 for the various modes of operation (see the previous figure.)

Table A- 10 Operating mode coding of SM 331; AI 8 x RTD

| Operating mode | Code |
|---|---|
| 8 channels, hardware filter | 2#00000000 |
| 8 channels, software filter | 2#00000001 |
| 4 channels, hardware filter | 2#00000010 |



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## Interference frequency suppression at SM 331; AI 8 x RTD

The table below contains the frequency codes to be entered at byte 1 of data record 128 (see the previous figure.) The 50 Hz, 60 Hz and 400 Hz only apply to 8channel software filter mode. The 50 Hz, 60 Hz and 400 Hz settings only apply to 4- and 8-channel hardware filter mode.

Table A- 11 Interference suppression coding of SM 331; AI 8 x RTD

| Interference frequency suppression | Code |
|---|---|
| 400 Hz | 2#00 |
| 60 Hz | 2#01 |
| 50 Hz | 2#10 |
| 50/60/400 Hz | 2#11 |

## Measurement types and measuring ranges of SM 331; AI 8 x RTD

The table below shows all measurement types and measuring ranges of the module, including their codes. Enter these codes at the corresponding bytes of data record 128 (see the figure *Data record 1 for the parameters of analog input modules*).

Table A- 12 Measuring range codes of SM 331; AI 8 x RTD

| Measurement type | Code | Measuring range | Code |
|---|---|---|---|
| disabled | 2#0000 | disabled | 2#0000 |
| Resistance (4-wire connection) | 2#0100 | 150 Ω | 2#0010 |
| | | 300 Ω | 2#0100 |
| | | 600 Ω | 2#0110 |
| Resistance (3-wire connection) | 2#0101 | 150 Ω | 2#0010 |
| | | 300 Ω | 2#0100 |
| | | 600 Ω | 2#0110 |



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| Measurement type | Code | Measuring range | Code |
|---|---|---|---|
| Thermal resistance + linearization 4-wire connection | 2#1000 | Pt 100 Climatic | 2#00000000 |
| | | Ni 100 Climatic | 2#00000001 |
| | | Pt 100 Standard | 2#00000010 |
| | | Ni 100 Standard | 2#00000011 |
| | | Pt 500 Standard | 2#00000100 |
| | | Pt 1000 Standard | 2#00000101 |
| | | Ni 1000 Standard | 2#00000110 |
| | | Pt 200 Climatic | 2#00000111 |
| | | Pt 500 Climatic | 2#00001000 |
| | | Pt 1000 Climatic | 2#00001001 |
| | | Ni 1000 Climatic | 2#00001010 |
| | | Pt 200 Standard | 2#00001011 |
| | | Ni 120 Standard | 2#00001100 |
| | | Ni 120 Climatic | 2#00001101 |
| | | Cu 10 Climatic | 2#00001110 |
| | | Cu 10 Standard | 2#00001111 |
| | | Ni 200 Standard | 2#00010000 |
| | | Ni 200 Climatic | 2#00010001 |
| | | Ni 500 Standard | 2#00010010 |
| | | Ni 500 Climatic | 2#00010011 |
| | | Pt 10 GOST Climatic | 2#00010100 |
| | | Pt 10 GOST Standard | 2#00010101 |
| | | Pt 50 GOST Climatic | 2#00010110 |
| | | Pt 50 GOST Climatic | 2#00010111 |
| | | Pt 100 GOST Climatic | 2#00011000 |
| | | Pt 100 GOST Standard | 2#00011001 |
| | | Pt 500 GOST Climatic | 2#00011010 |
| | | Pt 500 GOST Standard | 2#00011011 |
| | | Cu 10 GOST Climatic | 2#00011100 |
| | | Cu 10 GOST Standard | 2#00011101 |
| | | Cu 50 GOST Climatic | 2#00011110 |
| | | Cu 50 GOST Standard | 2#00011111 |
| | | Cu 100 GOST Climatic | 2#00100000 |
| | | Cu 100 GOST Standard | 2#00100001 |
| | | Ni 100 GOST Climatic | 2#00100010 |
| | | Ni 100 GOST Standard | 2#00100011 |



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| Measurement type | Code | Measuring range | Code |
|---|---|---|---|
| Thermal resistance + linearization 3-wire connection | 2#1001 | Pt 100 climatic | 2#00000000 |
| | | Ni 100 climatic | 2#00000001 |
| | | Pt 100 standard | 2#00000010 |
| | | Ni 100 standard | 2#00000011 |
| | | Pt 500 standard | 2#00000100 |
| | | Pt 1000 standard | 2#00000101 |
| | | Ni 1000 standard | 2#00000110 |
| | | Pt 200 climatic | 2#00000111 |
| | | Pt 500 climatic | 2#00001000 |
| | | Pt 1000 climatic | 2#00001001 |
| | | Ni 1000 climatic | 2#00001010 |
| | | Pt 200 standard | 2#00001011 |
| | | Ni 120 standard | 2#00001100 |
| | | Ni 120 climatic | 2#00001101 |
| | | Cu 10 climatic | 2#00001110 |
| | | Cu 10 standard | 2#00001111 |
| | | Ni 200 standard | 2#00010000 |
| | | Ni 200 climatic | 2#00010001 |
| | | Ni 500 standard | 2#00010010 |
| | | Ni 500 climatic | 2#00010011 |
| | | Pt 10 GOST climatic | 2#00010100 |
| | | Pt 10 GOST standard | 2#00010101 |
| | | Pt 50 GOST climatic | 2#00010110 |
| | | Pt 50 GOST standard | 2#00010111 |
| | | Pt 100 GOST climatic | 2#00011000 |
| | | Pt 100 GOST standard | 2#00011001 |
| | | Pt 500 GOST climatic | 2#00011010 |
| | | Pt 500 GOST standard | 2#00011011 |
| | | Cu 10 GOST climatic | 2#00011100 |
| | | Cu 10 GOST standard | 2#00011101 |
| | | Cu 50 GOST climatic | 2#00011110 |
| | | Cu 50 GOST standard | 2#00011111 |
| | | Cu 100 GOST climatic | 2#00100000 |
| | | Cu 100 GOST standard | 2#00100001 |
| | | Ni 100 GOST climatic | 2#00100010 |
| | | Ni 100 GOST standard | 2#00100011 |



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## Temperature coefficient of SM 331; AI 8 x RTD

The table below contains the temperature coefficient codes to be entered at the corresponding byte of data record 128 (refer to the previous figure.)

Table A- 13 Temperature coefficient codes of SM 331; AI 8 x RTD

| Temperature coefficient | Code |
|---|---|
| Pt 0.003850 Ω/Ω/°C (IPTS-68) | 2#0000 |
| Pt 0,003916 Ω/Ω/°C | 2#0001 |
| Pt 0.003902 Ω/Ω/°C | 2#0010 |
| Pt 0.003920 Ω/Ω/°C | 2#0011 |
| Pt 0.003850 Ω/Ω/°C (ITS-90) | 2#0100 |
| Pt 0.003910 Ω/Ω/°C | 2#0101 |
| Pt 0.006170 Ω/Ω/°C | 2#0111 |
| Ni 0.006180 Ω/Ω/°C | 2#1000 |
| Ni 0.006720 Ω/Ω/°C | 2#1001 |
| 0.005000 Ω/Ω/ °C (LG Ni 1000) | 2#1010 |
| Cu 0.004260 Ω/Ω/°C | 2#1011 |
| Cu 0.004270 Ω/Ω/°C | 2#1100 |
| Cu 0.004280 Ω/Ω/°C | 2#1101 |

## Smoothing function at SM 331; AI 8 x RTD

The table below lists all smoothing codes to be entered at the corresponding byte of data record 128 (refer to the previous figure.)

Table A- 14 Smoothing codes at SM 331; AI 8 x RTD

| Smoothing | Code |
|---|---|
| None | 2#00 |
| Low | 2#01 |
| Average | 2#10 |
| High | 2#11 |

## See also

Analog modules (Page 300)

Parameters of analog input modules (Page 534)



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# A.8 Parameters of SM 331; AI 8 TC

## Parameter

The table below shows all parameters you can set at analog input module SM 331; AI 8 x TC.

The comparison illustrates the parameters you can edit:

- in *STEP 7*
- using SFC55 "WR_PARM"

Parameters set in *STEP 7* can also be transferred to the module using SFC56 and SFC57 (refer to the *STEP 7* manuals).

Table A- 15 Parameters of SM 331; AI 8 TC

| Parameters | Data record number | Programmable, using ... | |
|---|---|---|---|
| | | ... SFC 55 | ... PG |
| Diagnostics: Group diagnostics | 0 | no | yes |
| Diagnostics: with wirebreak monitoring | | no | yes |
| Diagnostic interrupt enable | 1 | yes | yes |
| Hardware interrupt when limit exceeded | | yes | yes |
| End of cycle interrupt enable | | yes | yes |
| Temperature unit | | yes | yes |
| Measurement type | 128 | yes | yes |
| Measuring range | | yes | yes |
| Operating mode | | yes | yes |
| Response to open thermocouple | | yes | yes |
| Interference frequency suppression | | yes | yes |
| Smoothing | | yes | yes |
| High limit | | yes | yes |
| Low limit | | yes | yes |

**Note**

To enable diagnostic interrupts in the user program at data record 1, you first need to enable diagnostics at data record 0 in *STEP 7*.



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## Structure of data record 1

The figure below shows the structure of data record 1 of SM 331; AI 8 x TC. You enable a parameter by setting a logical "1" at the corresponding bit.

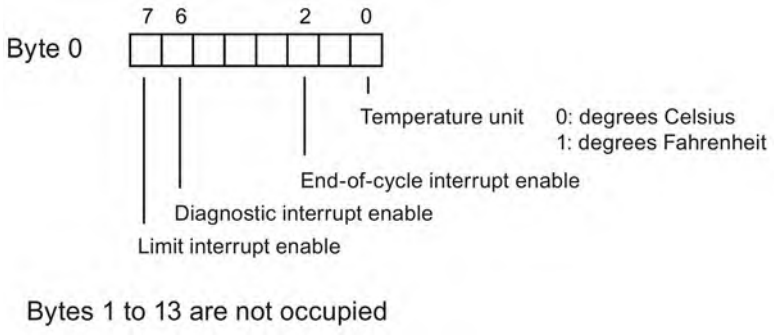



Figure A-11 Data record 1 for the parameters of SM 331; AI 8 x TC



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## Structure of data record 128

The figure below shows the structure of data record 128 of SM 331; AI 8 x TC.

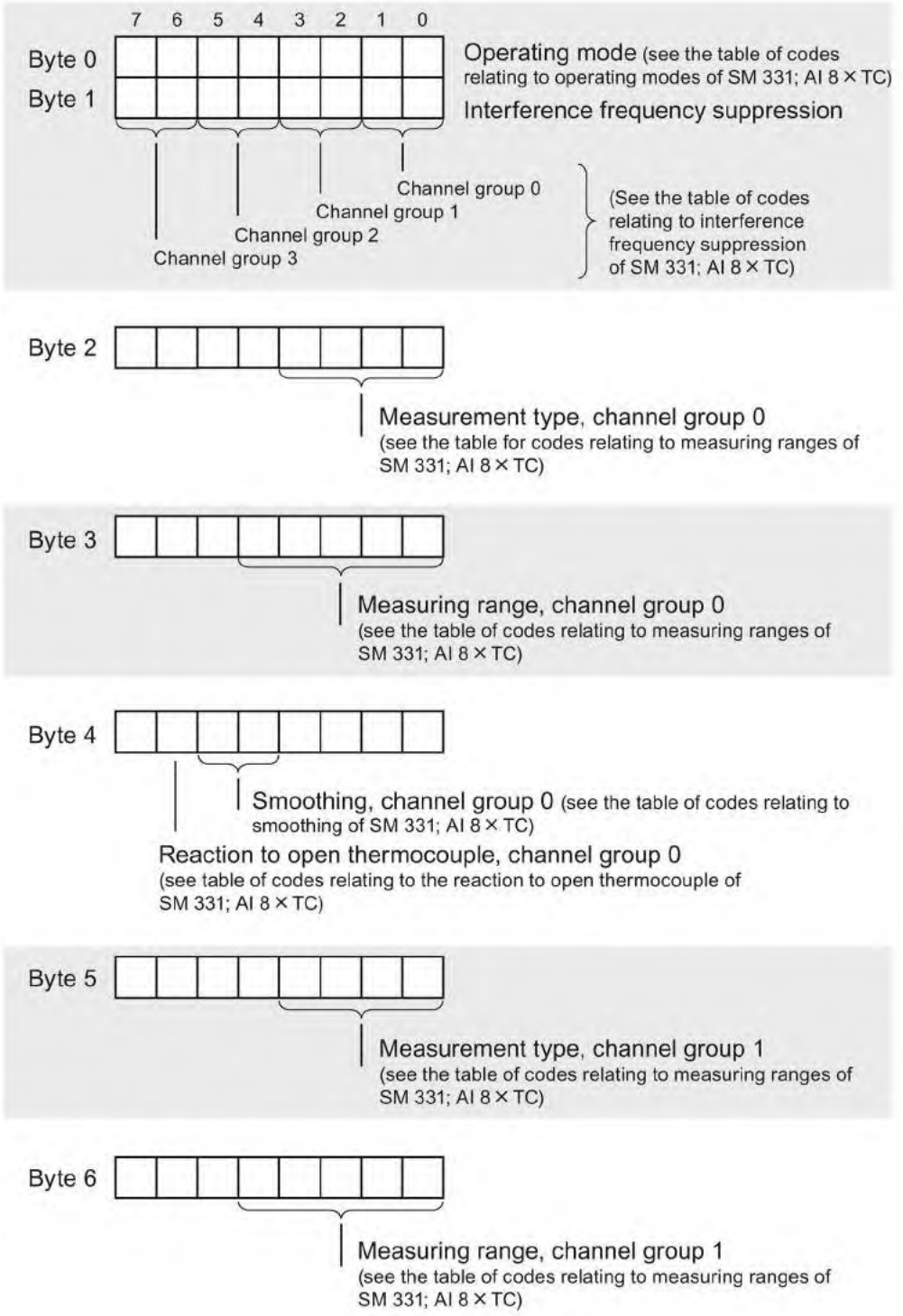



Figure A-12 Fig. A-10 Data record 128 of SM 331; AI 8 x TC (continued)



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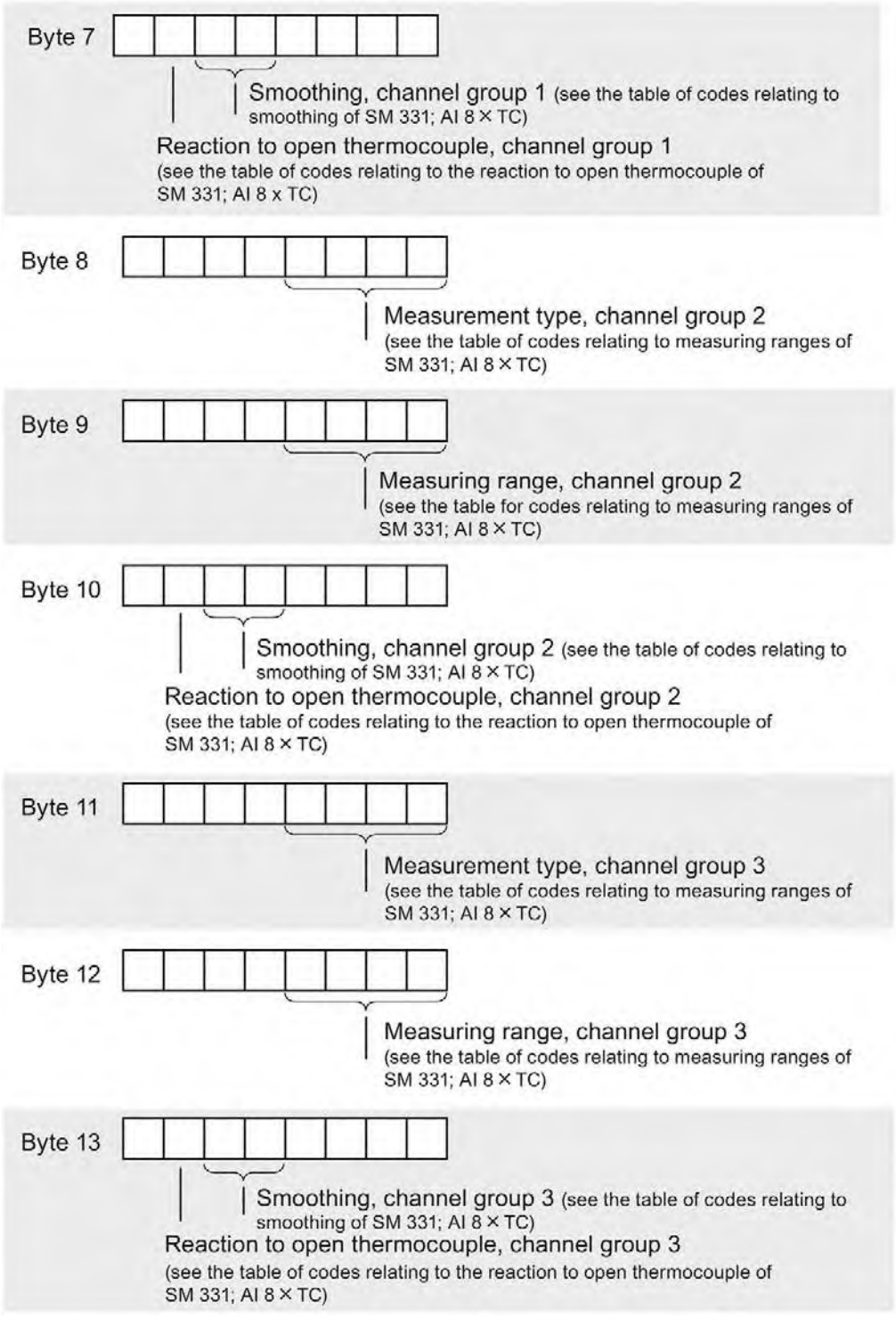



Figure A-13 Data record 128 of SM 331; AI 8 TC (continued)



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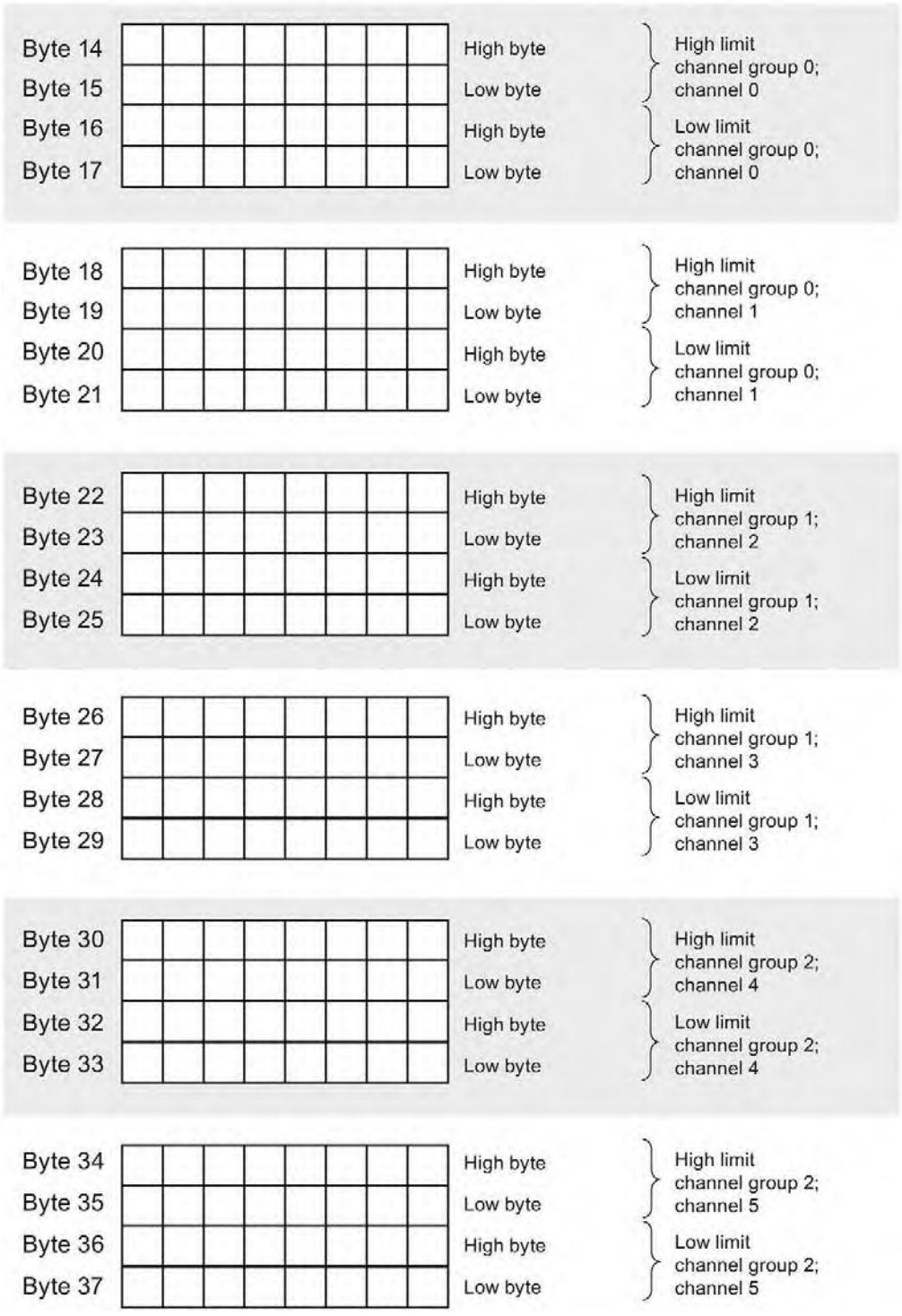



Figure A-14 Data record 128 of SM 331; AI 8 TC (continued)



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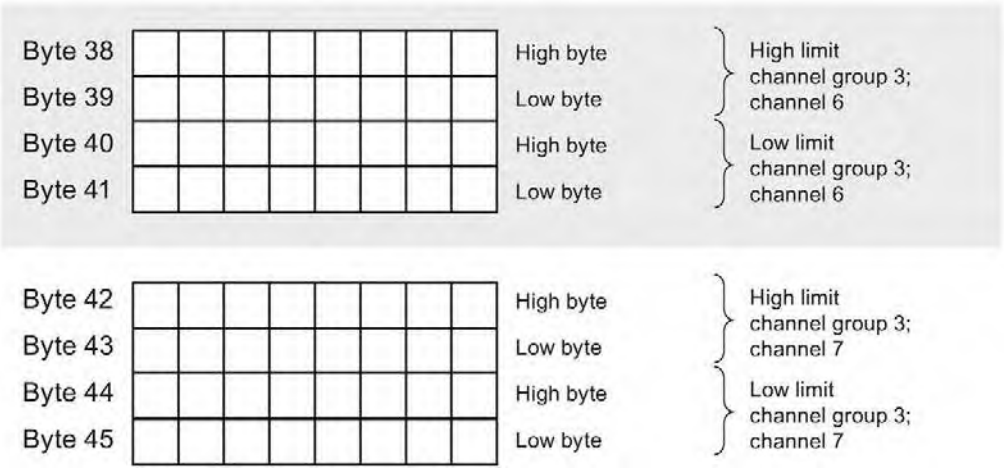



Figure A-15 Data record 128 of SM 331; AI 8 x TC (continued)

**Note**

The representation of limits matches the analog value representation. Observe range limits when setting the limit values.

## Modes of operation of SM 331; AI 8 x TC

The table below contains the coding at byte 0 of data record 128 for the various modes of operation (see the previous figure.)

Table A- 16 Operating mode codes of SM 331; AI 8 x TC

| Operating mode | Code |
|---|---|
| 8 channels, hardware filter | 2#00000000 |
| 8 channels, software filter | 2#00000001 |
| 4 channels, hardware filter | 2#00000010 |



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## Interference frequency suppression at SM 331; AI 8 x TC

The table below contains the frequency codes to be entered at byte 1 of data record 128 (see the previous figure.) The 400 Hz, 60 Hz and 50 Hz settings only apply to 8channel software filter mode. The 50 Hz, 60 Hz and 400 Hz settings only apply to 4- and 8-channel hardware filter mode.

Table A- 17 Interference frequency suppression codes of SM 331; AI 8 x TC

| Interference frequency suppression | Code |
|---|---|
| 400 Hz | 2#00 |
| 60 Hz | 2#01 |
| 50 Hz | 2#10 |
| 50/60/400 Hz | 2#11 |

## Measurement types and measuring ranges of SM 331; AI 8 x TC

The table below shows all measurement types and measuring ranges of the module, including their codes. Enter these codes at the corresponding bytes of data record 128 (see the figure *Data record 1 for the parameters of analog input modules*).

Table A- 18 Measuring range codes of SM 331; AI 8 x TC

| Measurement type | Code | Measuring range | Code |
|---|---|---|---|
| disabled | 2#0000 | disabled | 2#0000 |
| TC-L00C: (thermocouple, linear, 0 °C reference temperature) | 2#1010 | B<br>N<br>E<br>R<br>S<br>J<br>L<br>T<br>K<br>U<br>C<br>TXK/XK(L) | 2#0000<br>2#0001<br>2#0010<br>2#0011<br>2#0100<br>2#0101<br>2#0110<br>2#0111<br>2#1000<br>2#1001<br>2#1010<br>2#1011 |
| TC-L50C: (thermocouple, linear, 50 °C reference temperature) | 2#1011 | B<br>N<br>E<br>R<br>S<br>J<br>L<br>T<br>K<br>U<br>C<br>TXK/XK(L) | 2#0000<br>2#0001<br>2#0010<br>2#0011<br>2#0100<br>2#0101<br>2#0110<br>2#0111<br>2#1000<br>2#1001<br>2#1010<br>2#1011 |



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| Measurement type | Code | Measuring range | Code |
|---|---|---|---|
| TC-IL: (thermocouple, linear, internal comparison) | 2#1101 | B<br>N<br>E<br>R<br>S<br>J<br>L<br>T<br>K<br>U<br>C<br>TXK/XK(L) | 2#0000<br>2#0001<br>2#0010<br>2#0011<br>2#0100<br>2#0101<br>2#0110<br>2#0111<br>2#1000<br>2#1001<br>2#1010<br>2#1011 |
| TC-EL: (thermocouple, linear, external comparison) | 2#1110 | B<br>N<br>E<br>R<br>S<br>J<br>L<br>T<br>K<br>U<br>C<br>TXK/XK(L) | 2#0000<br>2#0001<br>2#0010<br>2#0011<br>2#0100<br>2#0101<br>2#0110<br>2#0111<br>2#1000<br>2#1001<br>2#1010<br>2#1011 |

## Reaction to open thermocouple of the SM 331; AI 8 x TC

The table below lists the codes for the reaction to an open thermocouple to enter at the corresponding byte of data record 128 (refer the previous figure.)

Table A- 19 Codes of the reaction to open thermocouple of SM 331; AI 8 x TC

| Response to open thermocouple | Code |
|---|---|
| Overflow | 2#0 |
| Underflow | 2#1 |



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## Smoothing of SM 331; AI 8 x TC

The table below lists all smoothing codes to be entered at the corresponding byte of data record 128 (refer to the previous figure.)

Table A- 20 Smoothing codes at SM 331; AI 8 x TC

| Smoothing | Code |
|---|---|
| None | 2#00 |
| Low | 2#01 |
| Average | 2#10 |
| High | 2#11 |

## See also

Analog modules (Page 300)

Parameters of analog input modules (Page 534)



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# A.9 Parameters of analog input module SM 331; AI 8 x 13 Bit

## Structure of data record 1

The figure below shows the structure of data record 1 for the parameters of the analog input module.

You enable a parameter by setting a logical "1" at the corresponding bit in the bytes.

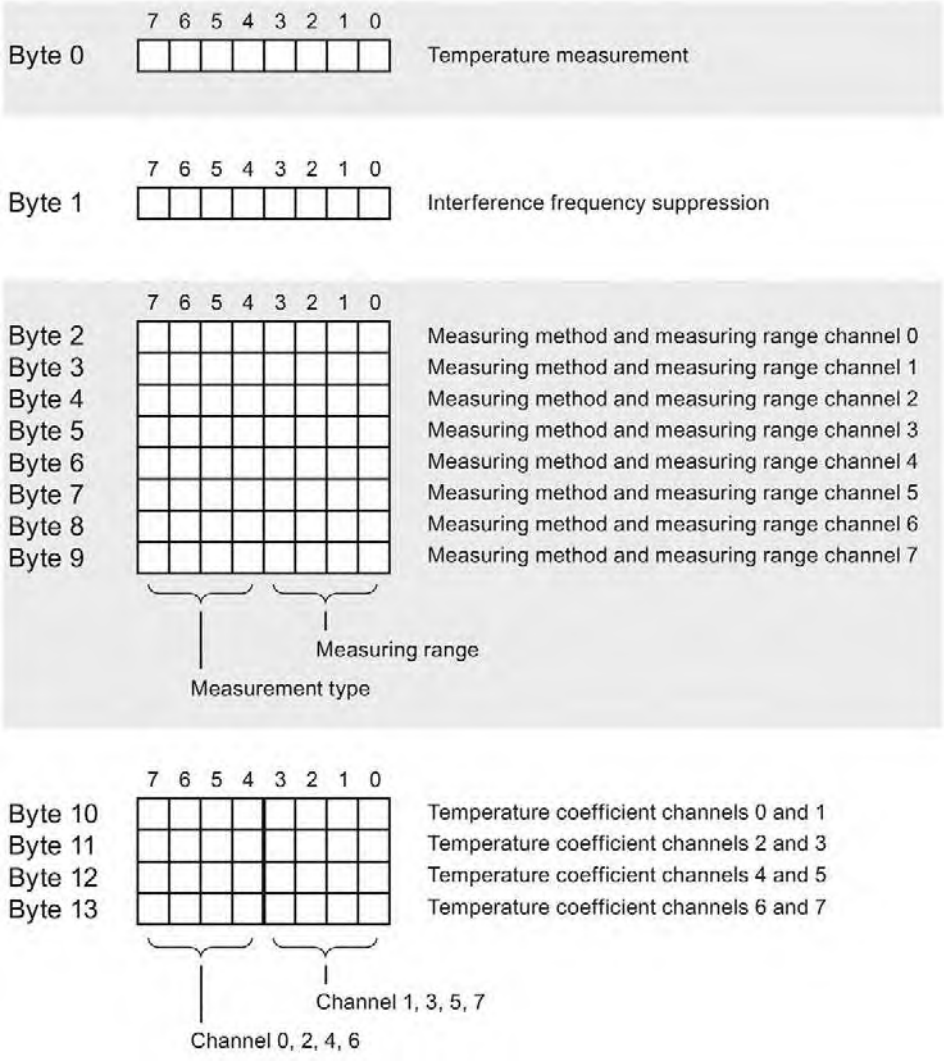



Figure A-16 Data record 1 for the parameters of analog input modules



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## Temperature measurement

The table below lists the temperature measurement codes to be enterd at byte 0 of data record 1 (see the previous figure.)

Table A- 21 Temperature measurement codes of the analog input module

| Temperature unit for linearization | Code |
|---|---|
| degrees Celsius | 2#0000 0000 |
| Degrees Fahrenheit | 2#0000 1000 |
| Kelvin | 2#0001 0000 |

## Interference frequency suppression

The table below contains the frequency codes to be entered at byte 1 of data record 1 (see the previous figure.) Make allowances for the resultant integration time at each module!

Table A- 22 Interference frequency suppression codes of the analog input module

| Interference frequency suppression | Integration time | Code |
|---|---|---|
| 60 Hz | 50 ms | 2#01 |
| 50 Hz | 60 ms | 2#10 |

## Measurement types and measuring ranges

The table below contains all the measurement types and measuring ranges of the analog input module, including their codes. Enter these codes at bytes 2 to 13 in data record 1 (refer to the previous figure.)

**Note**

The front connector of the analog input module must be wired in accordance with the measuring range!



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Table A- 23 Measuring ranges codes of the analog input module

| Measurement type | Code | Measuring range | Code |
|---|---|---|---|
| disabled | 2#0000 | disabled | 2#0000 |
| Voltage | 2#0001 | ± 50 mV | 2#1011 |
| | | ± 500 mV | 2#0011 |
| | | ± 1 V | 2#0100 |
| | | ± 5 V | 2# 0110 |
| | | 1 V to 5 V | 2#0111 |
| | | 0 V to 10 V | 2#1000 |
| | | ± 10 V | 2#1001 |
| Current | 2#0010 | 0 mA to 20 mA | 2#0010 |
| | | 4 mA to 20 mA | 2#0011 |
| | | ± 20 mA | 2#0100 |
| Resistance | 2#0101 | 600 Ω | 2#0110 |
| | | 6 kΩ | 2#1000 |
| | | PTC | 2#1111 |
| Thermoelectric resistance (linear) | 2#1001 | Pt 100 Klima | 2#0000 |
| | | Pt 100 Standard | 2#0010 |
| | | Ni 100 Klima | 2#0001 |
| | | Ni 100 Standard | 2#0011 |
| | | Ni 1000 / LG-Ni 1000 Klima | 2#1010 |
| | | Ni 1000 / LG-Ni 1000 Standard | 2#0110 |
| | | KTY83/110 | 2#1100 |
| | | KTY84/130 | 2#1101 |

## Temperature coefficient

The table below lists the temperature coefficient codes to be entered at bytes 10 to 13 of data record 1 (refer to previous figure.)

Table A- 24 Temperature measurement codes of the analog input module

| Temperature coefficient | Measuring range | Code |
|---|---|---|
| Pt 0.003850 Ω/Ω/°C (ITS-90) | Pt 100 | 2#0100 |
| Ni 0.006180 Ω/Ω/°C | Ni 100 / Ni 1000 | 2#1000 |
| Ni 0.005000 Ω/Ω/°C | LG-Ni 1000 | 2#1010 |



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# A.10 Setting of the analog input module SM 331; AI 8 x 16 Bit (6ES7331-7NF10-0AB0)

## Parameter

The table below contains all settings you can set for isolated digital output modules SM 331; AI 8 ×16 Bit (6ES7331-7NF10-0AB0). This comparison shows which specific method you can use to configure the various parameters:

- SFC55 "WR_PARM"
- *STEP 7* programming device

Parameters set in *STEP 7* can also be transferred to the module using SFC56 or SFC57.

Table A- 25 Parameters for the electrically isolated analog input module SM 331; AI 8 x 16 Bit

| Parameters | Data record no. | Configurable using... | |
|---|---|---|---|
| | | ... SFC55 | ...Programming device |
| Diagnostics: Group diagnostics | 0 | no | yes |
| Diagnostics: with wirebreak monitoring | | no | yes |
| Hardware interrupt when limit exceeded | 1 | yes | yes |
| Diagnostics interrupt enable | | yes | yes |
| End-of-cycle alarm enable | | yes | yes |
| Module operating mode | 128 | yes | yes |
| Noise suppression | | yes | yes |
| Measuring method | | yes | yes |
| Measuring range | | yes | yes |
| Smoothing | | yes | yes |
| High limit | | yes | yes |
| Low limit | | yes | yes |

**Note**

To enable diagnostic interrupts in the user program at data record 1, you first need to enable diagnostics at data record 0 in *STEP 7*.



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## Structure of data record 1

The figure below shows the structure of data record 1 for the parameters of the electrically isolated analog input module SM 331; AI 8 x 16 bit.

You enable a parameter by setting a logical "1" at the corresponding bit in byte 0.

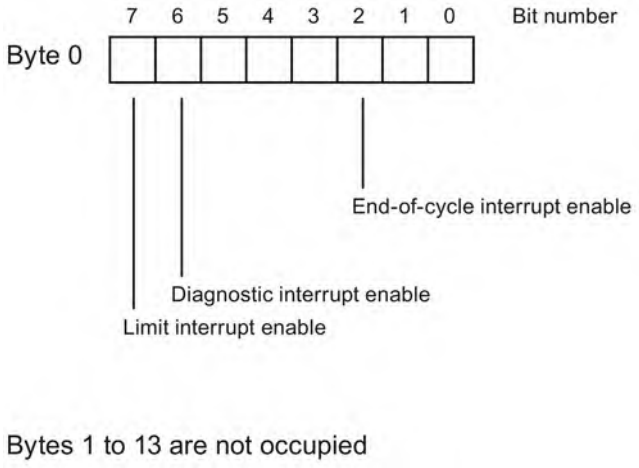



Figure A-17 Data record 1 for parameters of SM 331; AI 8 x 16 Bit



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## Structure of data record 128

The figure below shows the structure of data record 128 for the parameters of the electrically isolated analog input module SM 331; AI 8 x 16 bit.

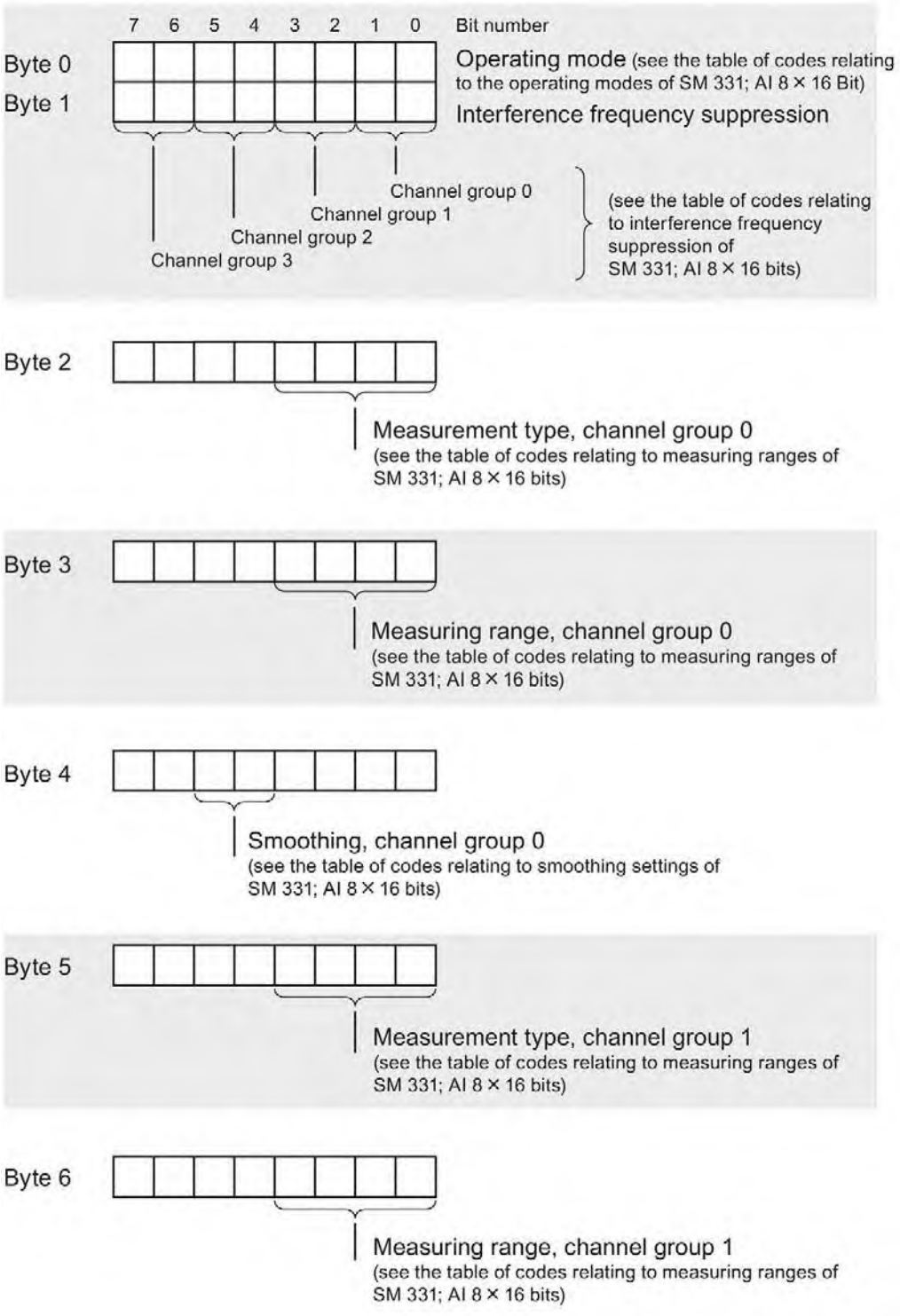



Figure A-18 Data record 128 for parameters of SM 331; AI 8 x 16 Bit



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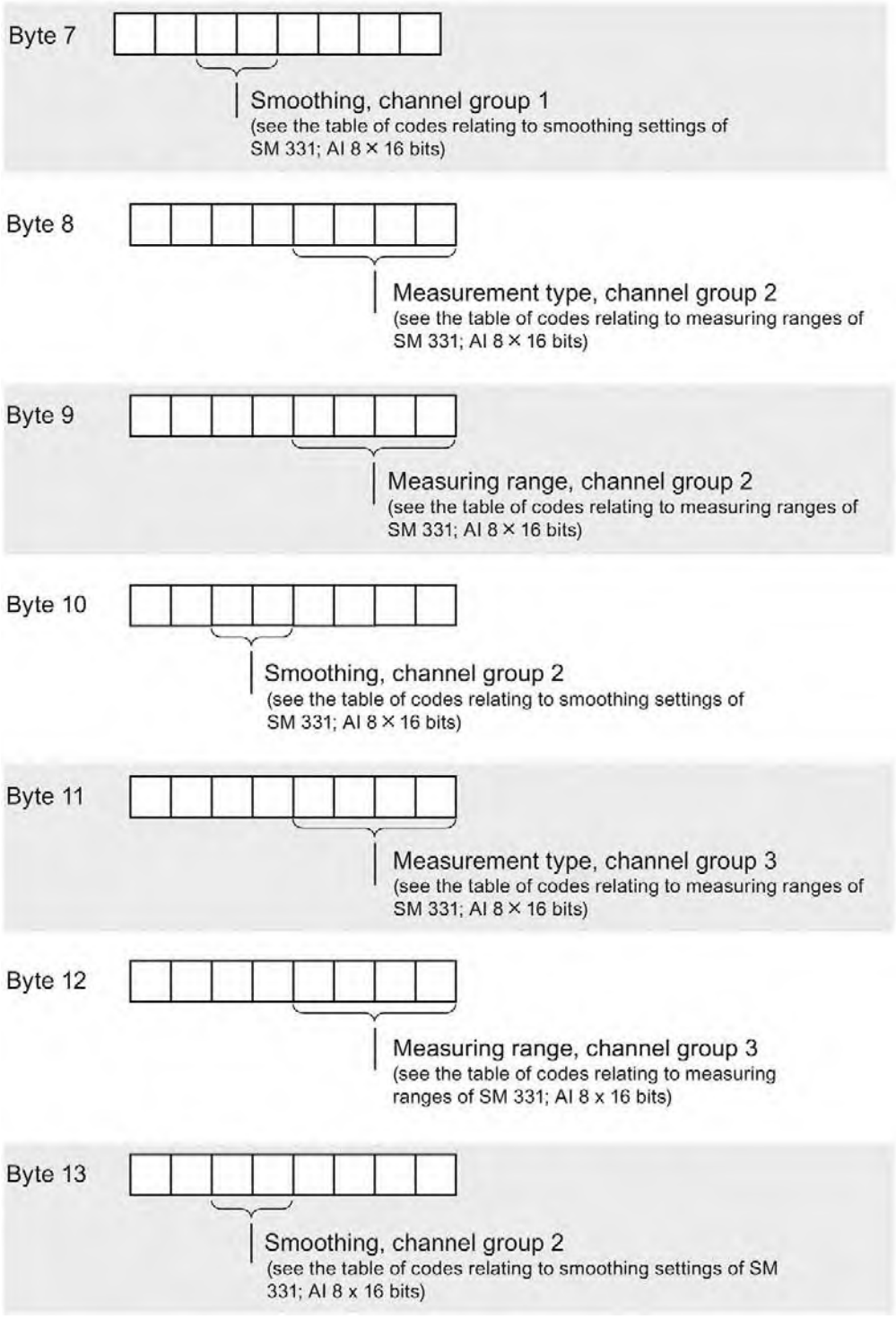



Figure A-19 Data record 128 for parameters of SM 331; AI 8 x 16 Bit (continued)



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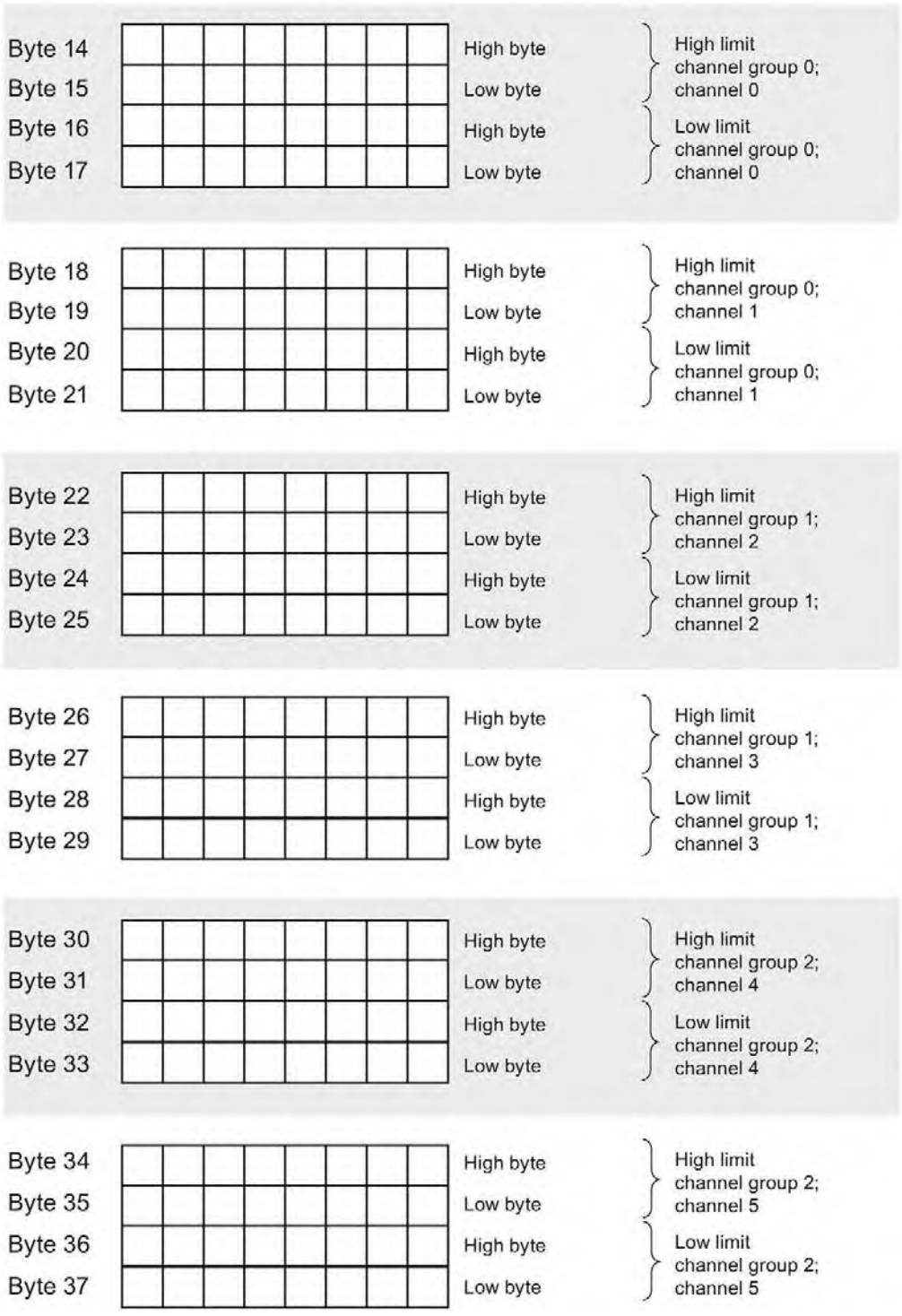



Figure A-20 Data record 128 for parameters of SM 331; AI 8 x 16 Bit (continued)



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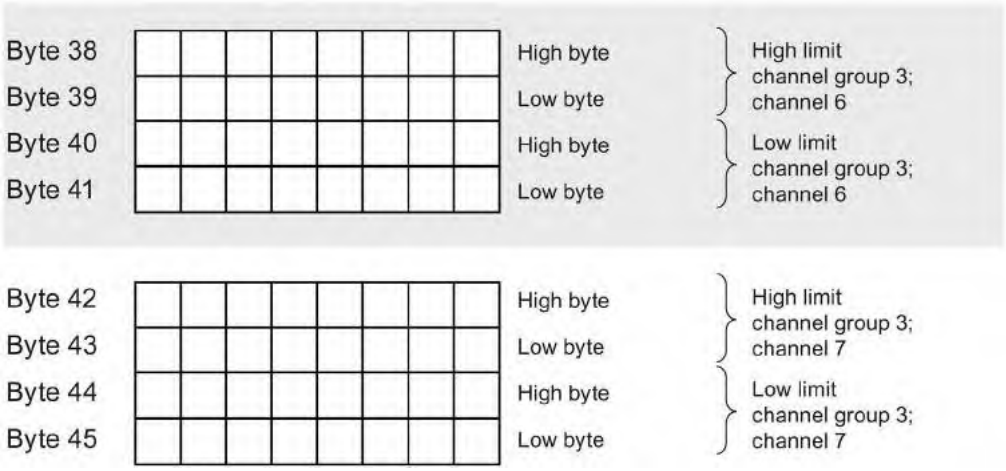



Figure A-21 Data record 128 for parameters of SM 331; AI 8 x 16 Bit (continued)

**Note**

The representation of limits matches the analog value representation. Observe range limits when setting the limit values.

## Module operating modes

The table below lists the operating mode codes to be entered at byte 0 of data record 128 (see the previous figure.)

Table A- 26 Operating mode codes of SM 331; AI 8 x 16 Bit

| Module operating mode | Code |
|---|---|
| 8 channels | 2#00000000 |
| 4 channels | 2#00000001 |

## Noise suppression

The table below lists the frequency codes to be entered at byte 1 of data record 128 (see the previous figure.) 4-channel mode only works if 50 Hz, 60 Hz and 400 Hz noise suppression is set.

Table A- 27 Noise suppression codes of SM 331; AI 8 x 16 Bit

| Noise suppression | Code |
|---|---|
| 400 Hz | 2#00 |
| 60 Hz | 2#01 |
| 50 Hz | 2#10 |
| 50 Hz, 60 Hz and 400 Hz | 2#11 |



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## Measuring methods and ranges

The table below lists the measuring ranges of the electrically isolated analog input module SM 331; AI 8 x 16 bit. The table below shows the measuring method and range codes. Enter these codes according to the required measuring range at the relevant byte of data record 128 (see previous figure.)

Table A- 28 Measuring range codes of SM 331; AI 8 x 16 Bit

| Measuring method | Code | Measuring range | Code |
|---|---|---|---|
| Disabled | 2#0000 | Disabled | 2#0000 |
| Voltage | 2#0001 | ±5 V<br>1 V to 5 V<br>±10 V | 2#0110<br>2#0111<br>2#1001 |
| Current (4-wire transducer) | 2#0010 | 0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA | 2#0010<br>2#0011<br>2#0100 |

## Settings of input smoothing

The table below lists the smoothing settings of the electrically isolated analog input module SM 331; AI 8 x 16 Bit. Enter these codes according to the required smoothing at the relevant byte of data record 128 (see previous figure.)

Table A- 29 Smoothing codes of SM 331; AI 8 x 16 Bit

| Smoothing settings | Code |
|---|---|
| None | 2#00 |
| Low | 2#01 |
| Average | 2#10 |
| High | 2#11 |

## See also

Analog modules (Page 300)



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# A.11 Parameters of analog input module SM 331; AI 6 x TC isolated

## Parameter

The table below shows all parameters you can set at analog input module SM 331; AI 6 x TC.

The comparison illustrates the parameters you can edit:

- In *STEP 7*
- Using SFC55 "WR_PARM"

Parameters set in *STEP 7* can also be transferred to the module using SFC56 and SFC57 (refer to the STEP 7 manuals).

| Parameters | Data record number | Programmable, using ... | |
|---|---|---|---|
| | | ... SFC55 | ... PG |
| Diagnostics: Channel | 0 | No | Yes |
| Diagnostics: For wire break | 0 | No | Yes |
| Hardware interrupt when limit exceeded | 1 | Yes | Yes |
| Diagnostic interrupt enable | 1 | Yes | Yes |
| Temperature unit | 1 | Yes | Yes |
| Activation of auto-calibration | 1 | Yes | Yes |
| Interference frequency suppression | 1 | Yes | Yes |
| Measurement type | 1 | Yes | Yes |
| Measuring range | 1 | Yes | Yes |
| Measured value smoothing | 1 | Yes | Yes |
| Response to open thermocouple | 1 | Yes | Yes |
| External reference junction | 1 | Yes | Yes |
| Temperature coefficient | 1 | Yes | Yes |
| High limit | 128 | Yes | Yes |
| Low limit | 128 | Yes | Yes |

**Note**

To enable diagnostic interrupts in the user program at data record 1, you first need to enable diagnostics at data record 0 in *STEP 7*.



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## Structure of data record 1

The figure below shows the structure of data record 1 for the parameters of analog input module SM 331; AI 6 x TC. You enable a parameter by setting a logical "1" at the corresponding bit.

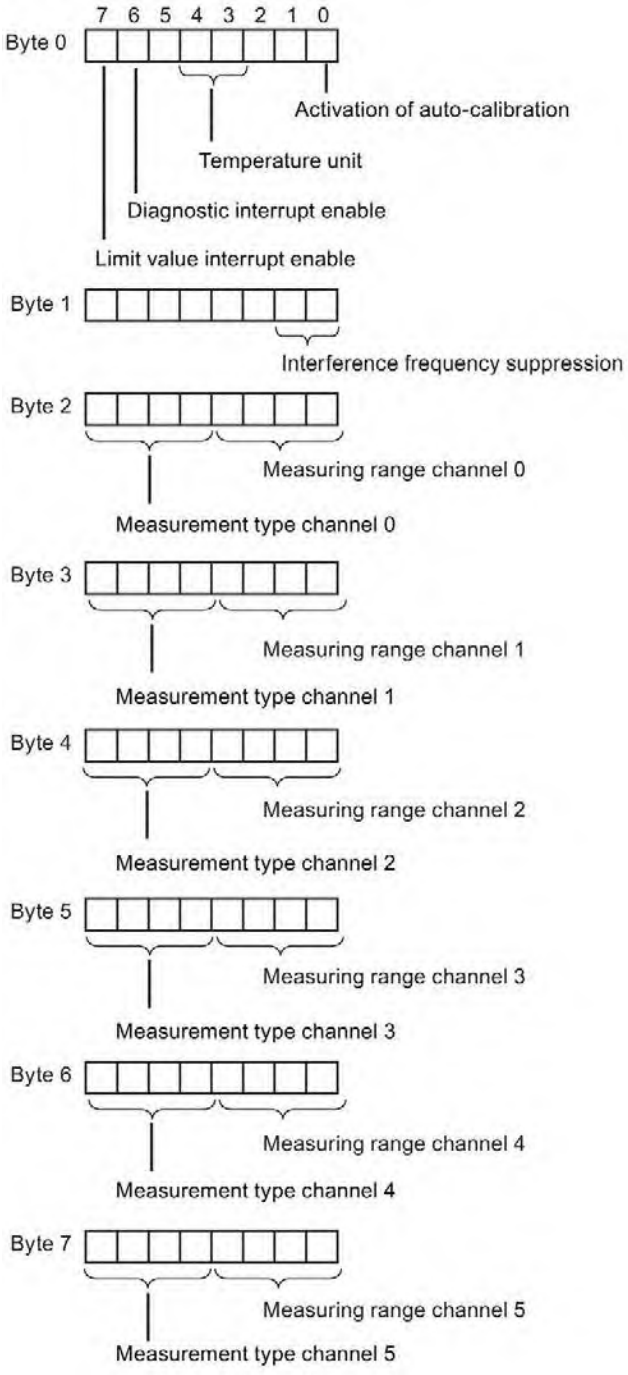



Figure A-22 Structure of data record 1 for AI 6 x TC



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## Structure of data record 128

The figure below shows the structure of data record 128 for the parameters of analog input module SM 331; AI 6 x TC.

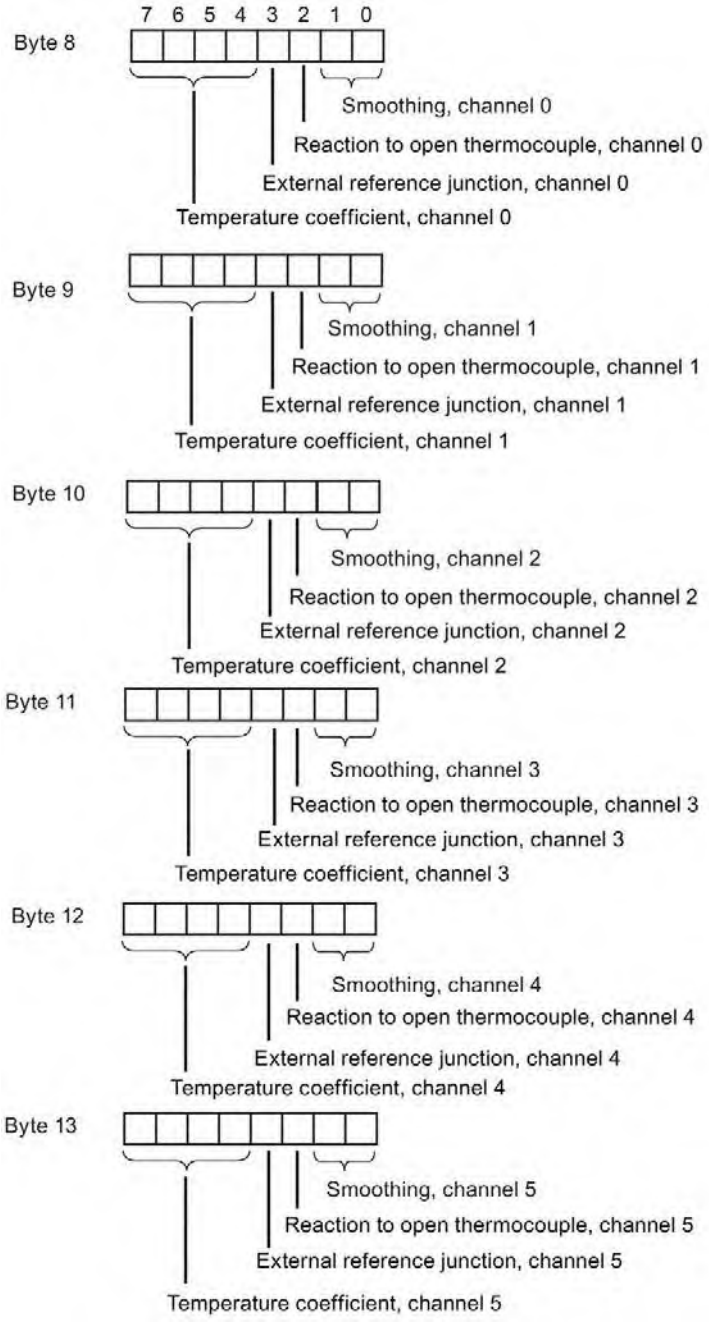



Figure A-23 Structure of data record 1 for AI 6 x TC (cont.)



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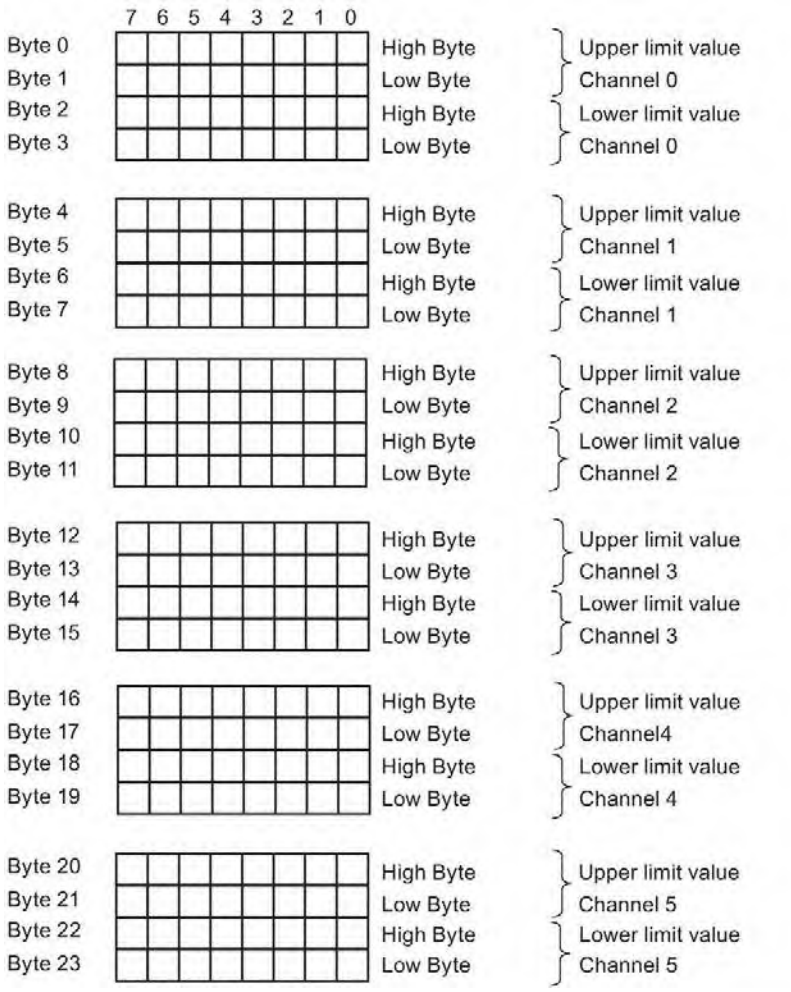



Figure A-24 Data record 128 for AI 6 x TC

**Note**

The representation of limits matches the analog value representation. When defining limit values, take the measuring range limits into account.

## Temperature measurement

The table below contains the coding you must enter at byte 0 of data record 1 for the various temperature measurements.

| Temperature unit for linearization | Code |
|---|---|
| Celsius | 2#00 |
| Fahrenheit | 2#01 |
| Kelvin | 2#10 |



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## Interference frequency suppression

The table below contains the coding you must enter at byte 1 of data record 1 for the various frequencies.

| Interference frequency suppression | Code |
|---|---|
| 400 Hz | 2#00 |
| 60 Hz | 2#01 |
| 50 Hz | 2#10 |
| 10 Hz | 2#11 |

## Measurement types and measuring ranges

The table below contains all measuring ranges for the module, together with the associated codes. Enter these codes at the corresponding bytes of data record 1.

| Measurement type | Code | Measuring range | Code |
|---|---|---|---|
| disabled | 2#0000 | disabled | 2#0000 |
| Voltage | 2#0001 | ± 80 mV<br>± 250 mV<br>± 500 mV<br>± 1 V<br>± 25 mV<br>± 50 mV | 2#0001<br>2#0010<br>2#0011<br>2#0100<br>2#1010<br>2#1011 |
| TC-L00C<br>Thermocouple, linear, 0 °C reference temperature | 2#1010 | B<br>N<br>E<br>R<br>S<br>J<br>L<br>T<br>K<br>U<br>C<br>TxK/XK(L) | 2#0000<br>2#0001<br>2#0010<br>2#0011<br>2#0100<br>2#0101<br>2#0110<br>2#0111<br>2#1000<br>2#1001<br>2#1010<br>2#1011 |
| TC-L50C<br>Thermocouple, linear, 50 °C reference temperature | 2#1011 | B<br>N<br>E<br>R<br>S<br>J<br>L<br>T<br>K<br>U<br>C<br>TxK/XK(L) | 2#0000<br>2#0001<br>2#0010<br>2#0011<br>2#0100<br>2#0101<br>2#0110<br>2#0111<br>2#1000<br>2#1001<br>2#1010<br>2#1011 |



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| Measurement type | Code | Measuring range | Code |
|---|---|---|---|
| TC-IL<br>Thermocouple, linear, internal comparison | 2#1101 | B<br>N<br>E<br>R<br>S<br>J<br>L<br>T<br>K<br>U<br>C<br>TxK/XK(L) | 2#0000<br>2#0001<br>2#0010<br>2#0011<br>2#0100<br>2#0101<br>2#0110<br>2#0111<br>2#1000<br>2#1001<br>2#1010<br>2#1011 |
| TC-EL:<br>Thermocouple, linear, external comparison | 2#1110 | B<br>N<br>E<br>R<br>S<br>J<br>L<br>T<br>K<br>U<br>C<br>TxK/XK(L) | 2#0000<br>2#0001<br>2#0010<br>2#0011<br>2#0100<br>2#0101<br>2#0110<br>2#0111<br>2#1000<br>2#1001<br>2#1010<br>2#1011 |

## Smoothing

The table below lists all smoothing codes to be entered at the corresponding byte of data record 1.

| Smoothing | Code |
|---|---|
| None | 2#00 |
| Low | 2#01 |
| Average | 2#10 |
| High | 2#11 |

## Response to open thermocouple

The table below lists the codes for the reaction to an open thermocouple to be entered at the corresponding byte of data record 1.

| Response to open thermocouple | Code |
|---|---|
| Overflow | 2#0 |
| Underflow | 2#1 |



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## External reference junction

The table below lists the codes for the external reference junction, to be entered at the corresponding byte of data record 1.

| Selection of an external reference junction | Code |
|---|---|
| Local thermoresistor | 2#0 |
| Remote thermoresistor | 2#1 |

## Temperature coefficient

The table below lists the codes for the temperature coefficient, to be entered at the corresponding byte of data record 1.

| Temperature coefficient | Code |
|---|---|
| Pt 0.003850 Ω/Ω/°C (IPTS-68) | 2#0000 |
| Pt 0.003916 Ω/Ω/°C | 2#0001 |
| Pt 0.003902 Ω/Ω/°C | 2#0010 |
| Pt 0.003920 Ω/Ω/°C | 2#0011 |
| Pt 0.003850 Ω/Ω/°C (ITS-90) | 2#0100 |
| Pt 0.003910 Ω/Ω/°C (GOST) | 2#0101 |

**Note**

When selecting a temperature coefficient by writing data record 1 via an SFC or a GSD file, the same temperature coefficient must be specified for every channel which uses the external reference junction. If you select different temperature coefficients, this will lead to a parameter fault.



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# A.12 Parameters of analog output modules

## Parameters

The table below lists all parameters you can set for analog output modules. The comparison shows:

- which parameters you can edit in *STEP 7*, and
- which parameters you can change using SFC55 "WR_PARM".

Parameters set in *STEP 7* can also be transferred to the module using SFC56 and SFC57.

Table A- 30 Parameters of analog output modules

| Parameters | Data record number | Programmable, using ... | |
|---|---|---|---|
| | | ... SFC55 | ... PG |
| Diagnostics: Group diagnostics | 0 | No | Yes |
| Diagnostic interrupt enable | 1 | **Yes** | Yes |
| Reaction to CPU STOP | | **Yes** | Yes |
| Output type | | **Yes** | Yes |
| Output range | | **Yes** | Yes |
| Substitute value | | **Yes** | Yes |

**Note**

To enable diagnostic interrupts in the user program at data record 1, you first need to enable diagnostics at data record 0 in *STEP 7*.



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## Structure of data record 1

The figure below shows the structure of data record 1 for the parameters of analog output modules.

You enable diagnostic interrupts by setting a logic "1" at the corresponding bit of byte 0.

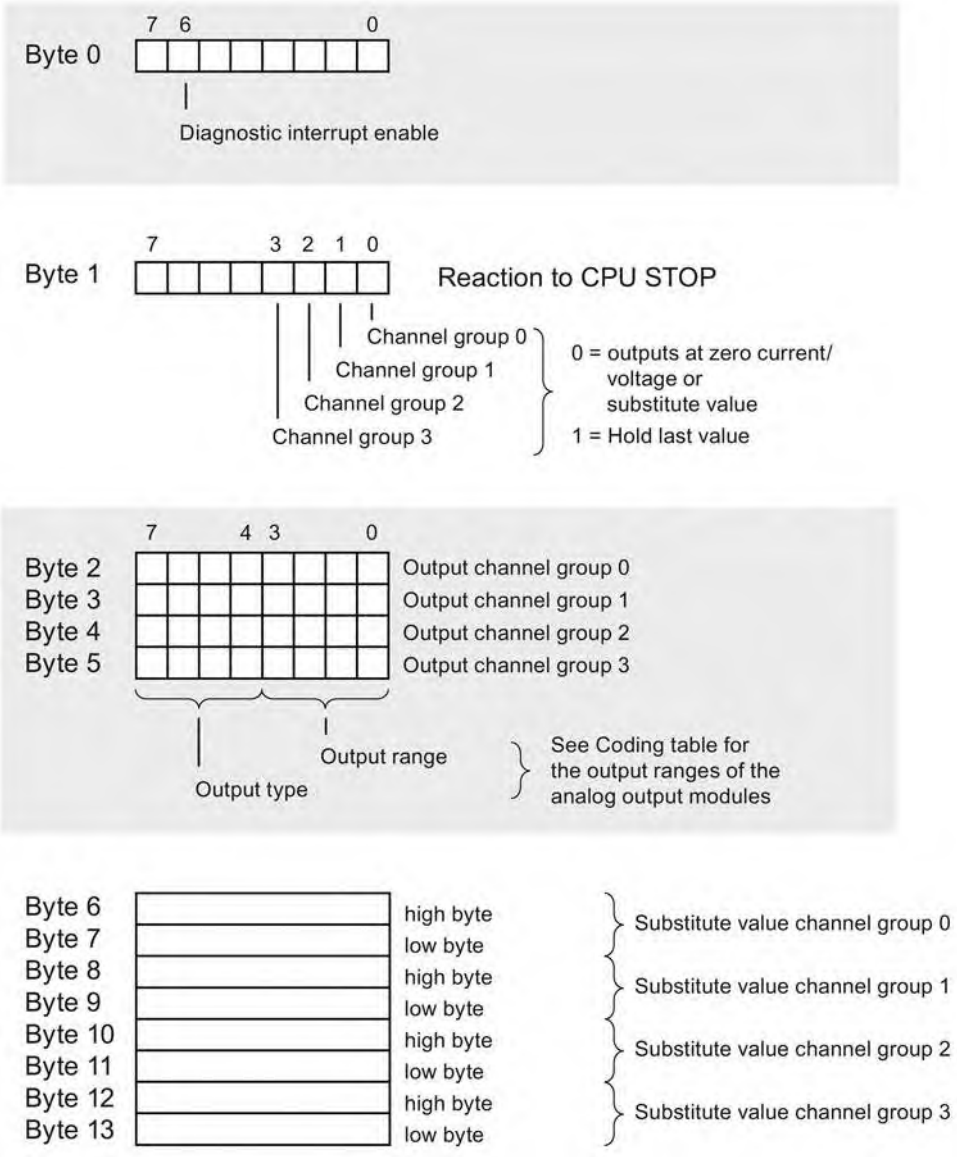



Figure A-25 Data record 1 for the parameters of analog output modules



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## Output types and output ranges

The table below lists all output types/ranges of the analog output modules, including their codes. Enter these codes at bytes 2 to 5 in data record 1 (refer to the previous figure.)

Table A- 31 Output range codes of analog output modules

| Output type | Code | Output range | Code |
|---|---|---|---|
| disabled | 2#0000 | disabled | 2#0000 |
| Voltage | 2#0001 | 1 V to 5 V | 2#0111 |
| | | 0 V to 10 V | 2#1000 |
| | | ± 10 V | 2#1001 |
| Current | 2#0010 | 0 mA to 20 mA | 2#0010 |
| | | 4 mA to 20 mA | 2#0011 |
| | | ± 20 mA | 2#0100 |

## See also

Analog modules (Page 300)



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# A.13 Parameters of analog output module SM 332; AO 8 x 12 Bit

## Parameter

The table below shows all parameters you can set at analog output module SM 332; AO 8 x 12 Bit. The comparison shows:

- which parameters you can edit in *STEP 7*, and
- which parameters you can change using SFC 55 "WR_PARM".

Parameters set in *STEP 7* can also be transferred to the module using SFC 56 and SFC 57.

Table A- 32 Parameters of SM 332; AO 8 x 12 Bit

| Parameters | Data record number | Programmable, using ... | |
|---|---|---|---|
| | | ... SFC 55 | ... PG |
| Diagnostics: Group diagnostics | 0 | no | yes |
| Diagnostics interrupt enable | 1 | yes | yes |
| Reaction to CPU STOP | | yes | yes |
| Output type | | yes | yes |
| Output range | | yes | yes |

**Note**

To enable diagnostics interrupts in the user program at data record 1, you first need to enable diagnostics at data record 0 in *STEP 7*.



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## Structure of data record 1

The figure below shows the structure of data record 1 for the parameters of SM 332; AO 8 x 12 Bit.

You enable diagnostics interrupts by setting a logic "1" at the corresponding bit of byte 0.

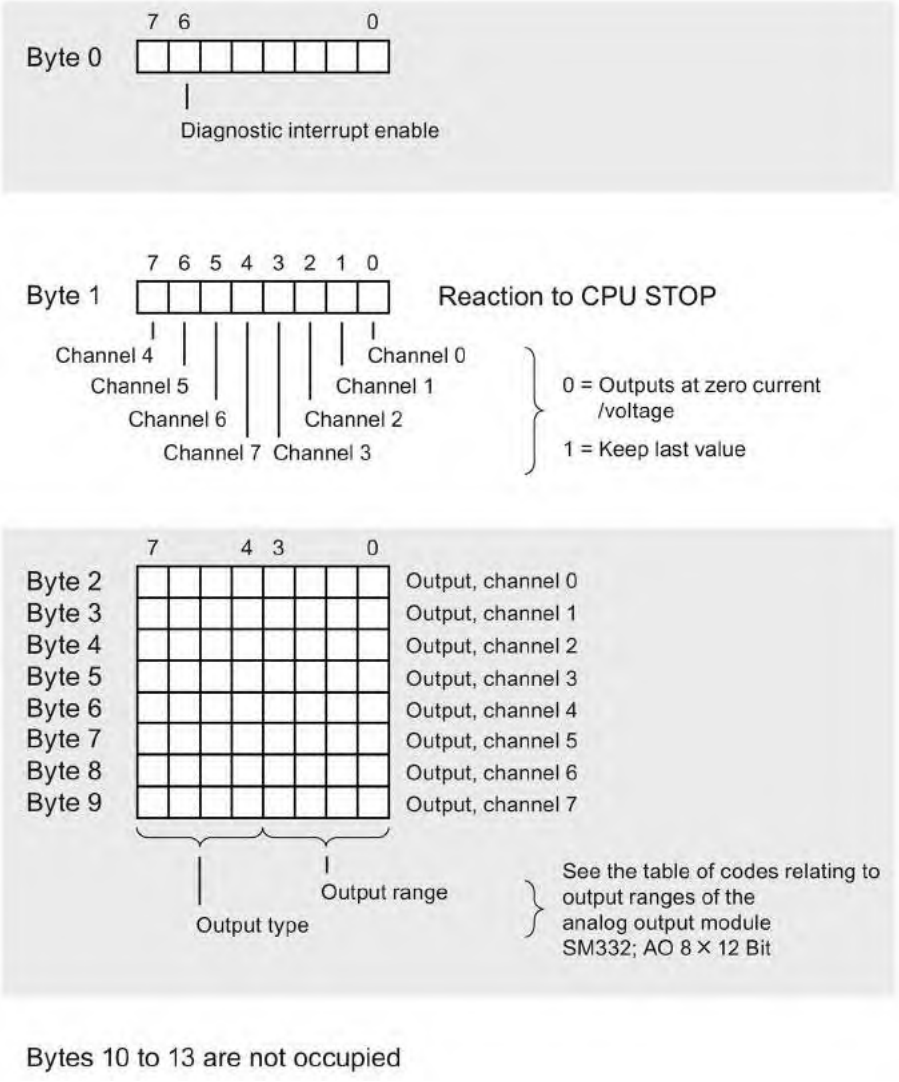



Figure A-26 Data record 1 for the parameters of analog output modules



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## Output type and output range

The table lists the output types/ranges of SM 332; AO 8 x 12 Bit, including their codes. Enter these codes at bytes 2 to 9 in data record 1 (refer to the previous figure.)

Table A- 33 Output range codes of analog output module SM 332; AO 8 x 12 Bit

| Output type | Code | Output range | Code |
|---|---|---|---|
| Disabled | 2#0000 | Disabled | 2#0000 |
| Voltage | 2#0001 | 1 V to 5 V<br>0 V to 10 V<br>± 10 V | 2#0111<br>2#1000<br>2#1001 |
| Current | 2#0010 | 0 mA to 20 mA<br>4 mA to 20 mA<br>± 20 mA | 2#0010<br>2#0011<br>2#0100 |



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# A.14 Parameters of analog IO modules

## Parameter

The table below lists all parameters you can set for analog IO modules.

The comparison illustrates the parameters you can edit:

- in *STEP 7*
- using SFC 55 "WR_PARM"

Parameters set in *STEP 7* can also be transferred to the module using SFC 56 and SFC 57 (refer to the *STEP 7* manuals).

Table A- 34 Parameters of analog IO modules

| Parameters | Data record number | Programmable, using ... | |
|---|---|---|---|
| | | ... SFC 55 | ... PG |
| Measuring method | 1 | yes | yes |
| Measuring range | | yes | yes |
| Integration time | | yes | yes |
| Output type | | yes | yes |
| Output range | | yes | yes |



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## Structure of data record 1

The figure below shows the structure of data record 1 for the parameters of analog IO modules.

You enable a parameter by setting a logic "1" at the corresponding bit of byte 0.

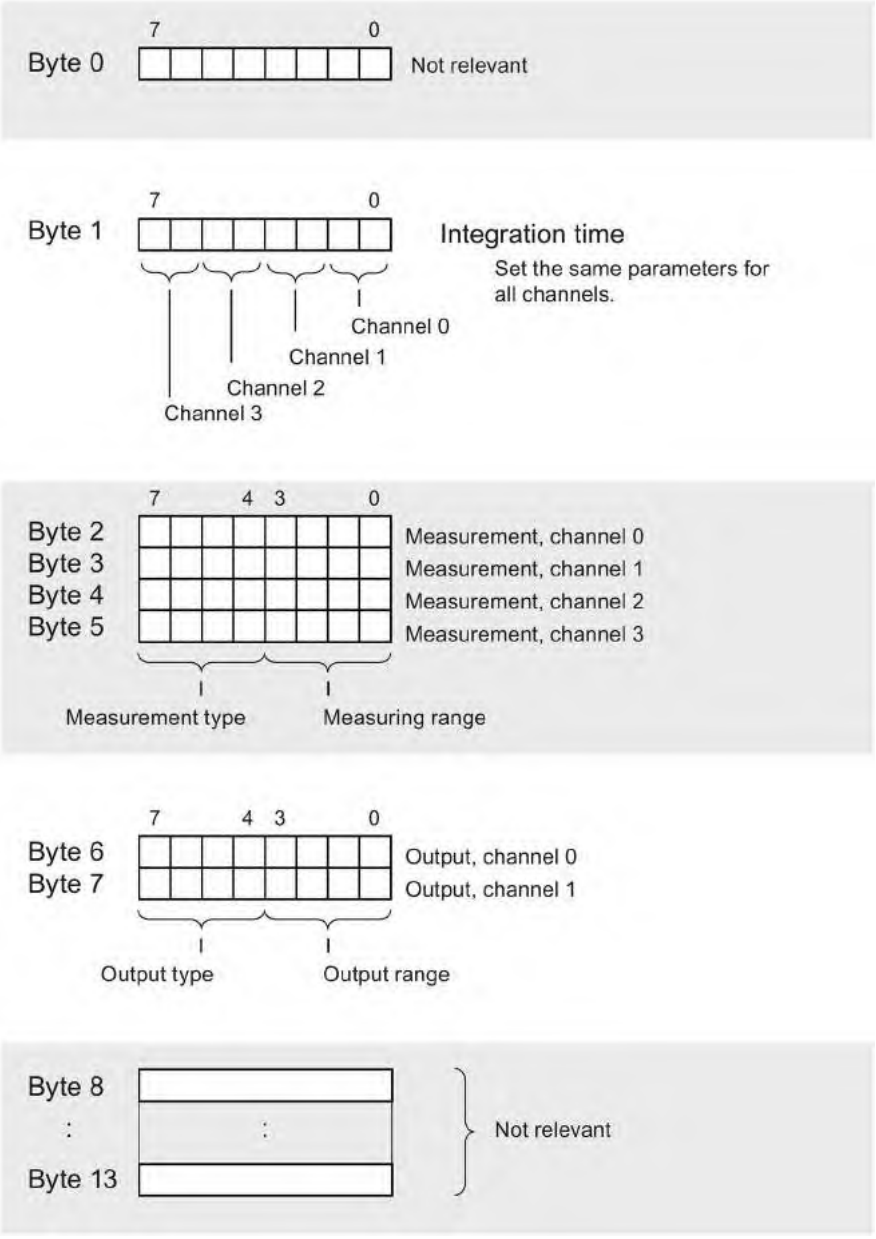



Figure A-27 Data record 1 for the parameters of analog IO modules



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## Measuring methods and ranges

The table below lists all measuring methods/ranges of analog IO modules, including their codes. Enter these codes at bytes 2 to 5 in data record 1 (refer to the previous figure.)

Table A- 35 Measuring range codes of analog IO modules

| Measuring method | Code | Measuring range | Code |
|---|---|---|---|
| disabled | 2#0000 | disabled | 2#0000 |
| Voltage | 2#0001 | 0 V to 10 V | 2#1000 |
| Resistance (4-wire connection) | 2#0100 | 10 kΩ | 2#1001 |
| Thermal resistance + linearization 4-wire connection | 2#1000 | Pt 100 Klima | 2#0000 |

## Output types and output ranges

The table below lists all output types/ranges of analog IO modules, including their codes. Enter these codes at bytes 6 and 7 of data record 1 (refer to the previous figure.)

Table A- 36 Output range codes of analog IO modules

| Output type | Code | Output range | Code |
|---|---|---|---|
| disabled | 2#0000 | disabled | 2#0000 |
| Voltage | 2#0001 | 0 V to 10 V | 2#1000 |



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# Diagnostics data of signal modules

# B

## B.1 Evaluating diagnostic data of signal modules in the user program

### Introduction

This appendix describes the diagnostic data structure in system data. You should be sufficiently familiar with this structure if you want to evaluate the diagnostics data of the signal module in the *STEP 7* user program.

### Diagnostics data are saved to data records

The diagnostics data for a module is stored in data records 0 and 1.

- Data record 0 contains 4 bytes of diagnostics data describing the current state of the module.
- Data record 1 contains the 4 bytes of diagnostics data also stored in data record 0, **plus** additional module-specific diagnostics data, which describes the status of a channel or a channel group.

### Further references

For detailed information on the evaluation of the diagnostics data of signal modules in the user program and on corresponding SFCs, refer to the *STEP 7* manuals.



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# B.2 Structure and content of diagnostics data, byte 0 and up

## Introduction

The section below describes the structure and content of the various bytes in diagnostics data. General rule: A fault is indicated by a logic "1" at the relevant bit.

## Bytes 0 and 1 (data records 0 and 1)

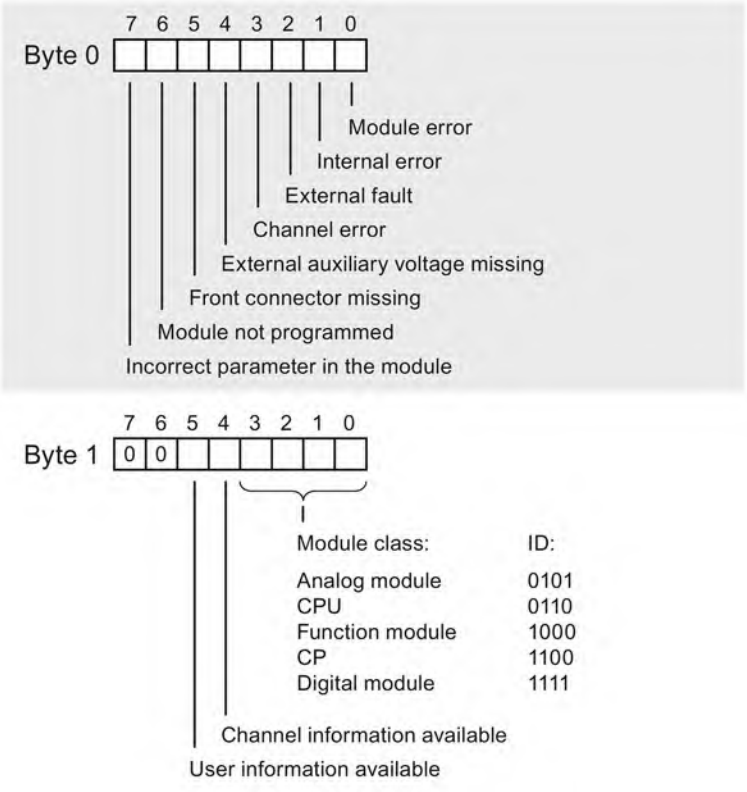



Figure B-1 Bytes 0 and 1 of diagnostics data



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## Bytes 2 and 3 (data records 0 and 1)

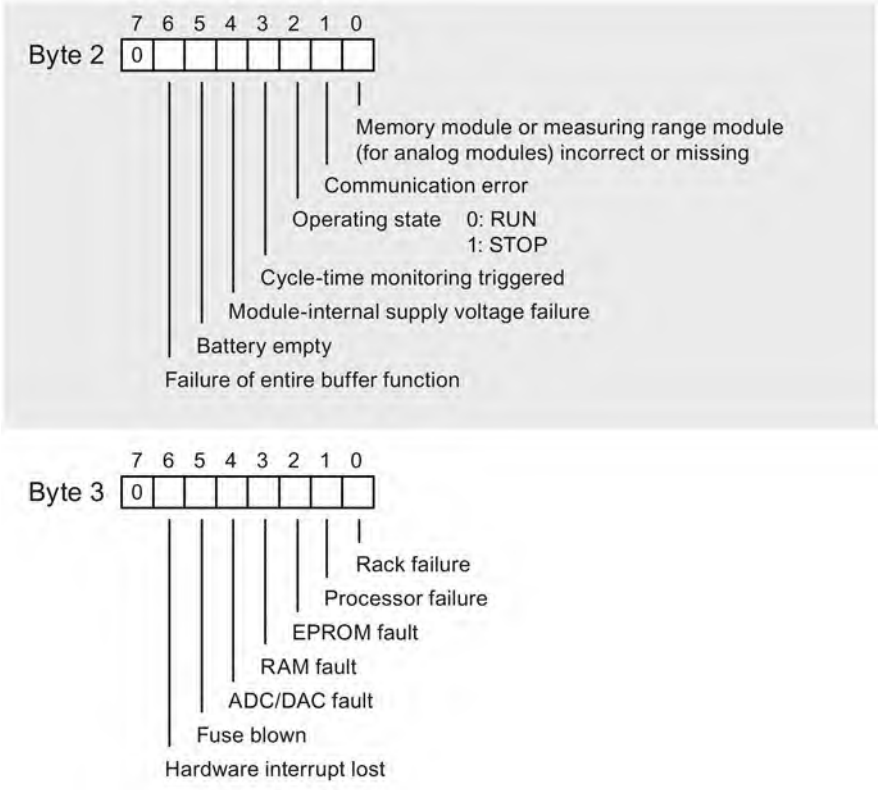


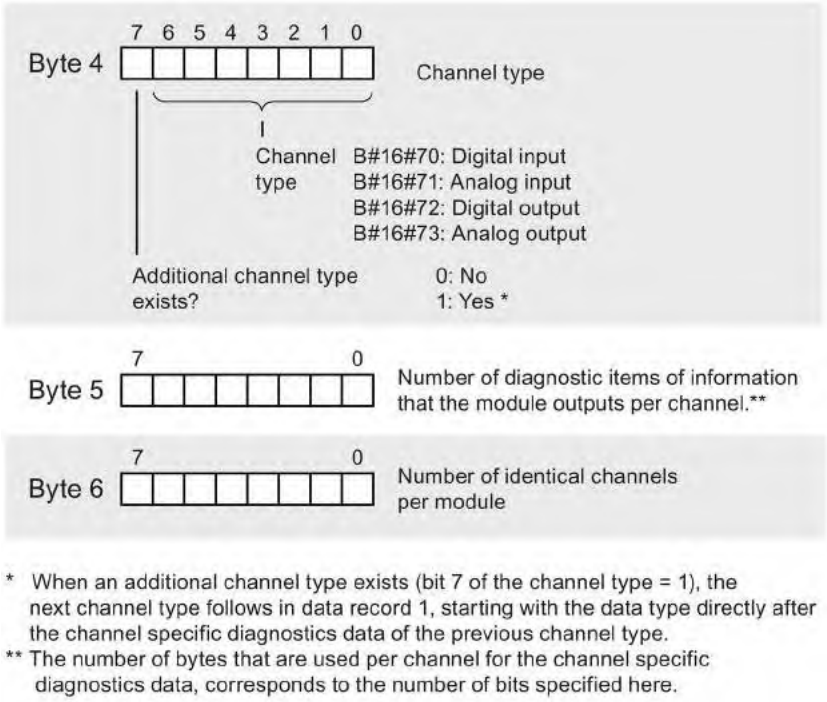

Figure B-2 Bytes 2 and 3 of diagnostics data



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## Bytes 4 to 6 info block (data record 1)

Bytes 4 to 6 form the info block, which contains information relating to the channel type, the length of the diagnostic information, and the number of channels.




* When an additional channel type exists (bit 7 of the channel type = 1), the next channel type follows in data record 1, starting with the data type directly after the channel specific diagnostics data of the previous channel type.
** The number of bytes that are used per channel for the channel specific diagnostics data, corresponds to the number of bits specified here.

Figure B-3 Bytes 4 to 6 of diagnostics data



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## Byte 7 channel fault vector and up (data record 1)

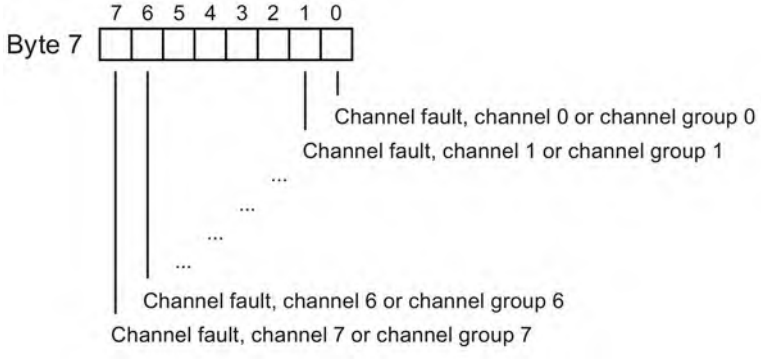



Figure B-4 Byte 7 of diagnostics data

The channel fault vector is at least 1 byte long. For modules with more than 8 channels, the channel fault vector occupies several bytes.

The channel-specific diagnostics data comes after the channel fault vector; refer to section Channel-specific diagnostics data (Page 588).

If another channel type is available (see Figure "Bytes 4 to 6 of diagnostics data"), the channel type with the same structure as that described above (channel type, length of diagnostics data, number of channels of the same type, channel fault vector, channel-specific diagnostics data of the channel type) follows after the channel-specific diagnostics data.



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# B.3 Channel-specific diagnostics data

## Introduction

The channel-specific diagnostic data follow the channel error vector. The number of bytes used per channel for channel-specific diagnostics depends on the number of bits entered in byte 5 "Length of the diagnostic information".

The following figures show the assignment of the diagnostic byte for a channel or a channel group of the special module. The following generally applies: When an error occurs, the corresponding bit is set to "1".

A description of possible causes of the fault and corresponding corrective measures can be found in the section "Diagnostics of the modules".

## Digital input channel of the SM 321; DI 16 x 24 V DC; with process and diagnostic interrupt

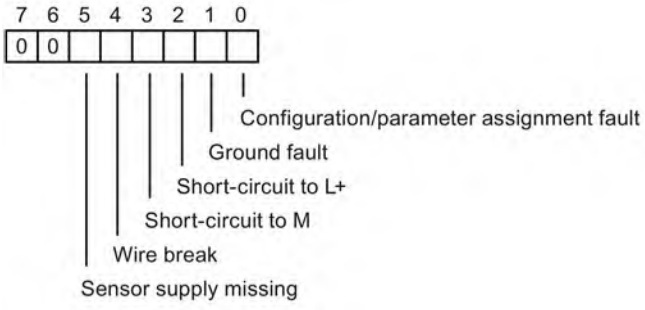



Figure B-5 Diagnostic byte for a digital input channel der SM 321; DI 16 x DC 24 V

## Digital output channel of the SM 322; DO DC 8 x 24 V/0.5 A; with diagnostic interrupt

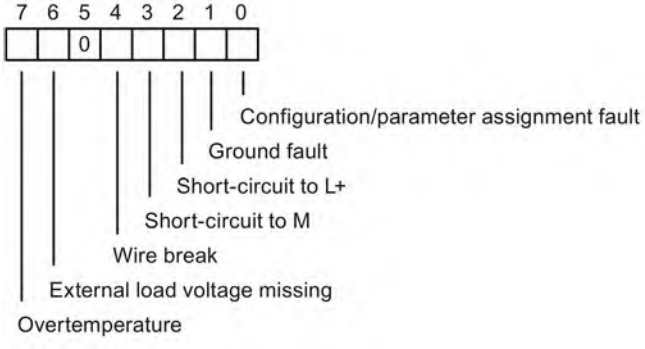



Figure B-6 Diagnostic byte for a digital output channel of the SM 322; DO DC 8 x 24 V/0.5 A



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## Analog input channel of the SM 331 module with diagnostic capability

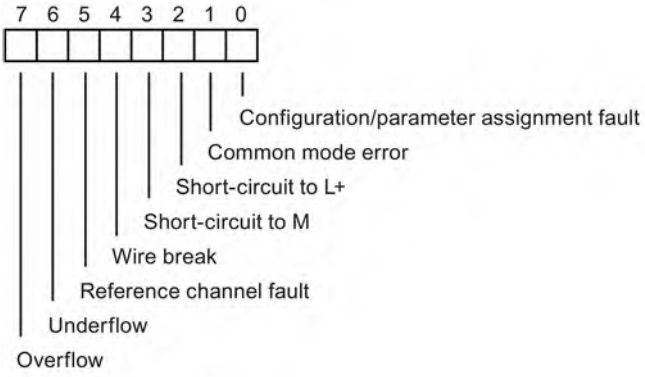



Figure B-7 Diagnostic byte for an analog input channel of an SM 331 with diagnostic capability

## Analog output channel of the SM 332 module with diagnostic capability

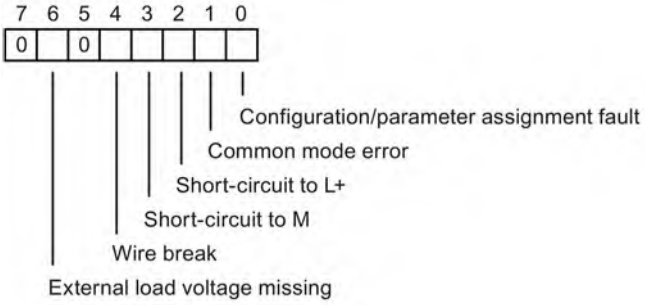



Figure B-8 Diagnostic byte for an analog output channel of an SM 332 with diagnostic capability



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# B.4 Diagnosis data from the SM 322; DO 16 x DC24 V/0.5 A (6ES7322-8BH10-0AB0)

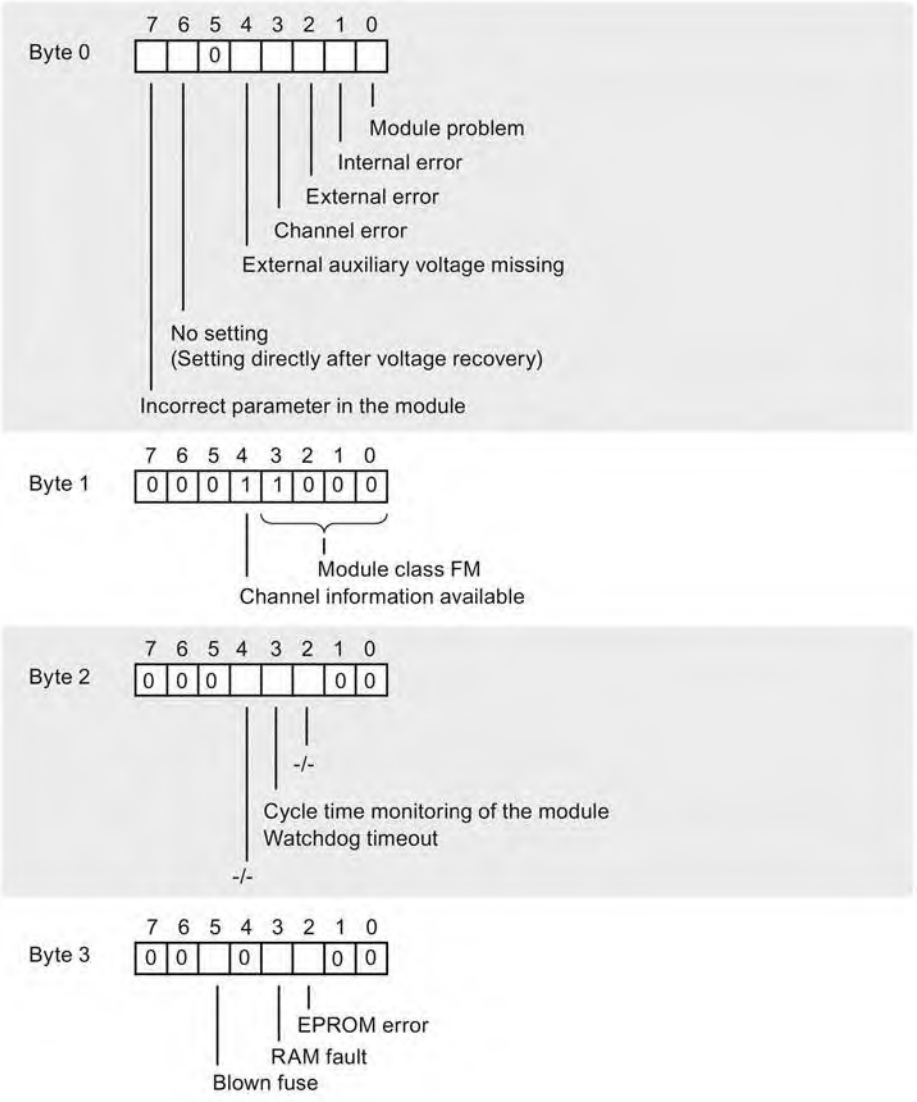
## Introduction

The section below describes the structure and content of the various bytes in diagnostics data. In the bytoes 0...3, module errors are reported - errors that affect the entire module. Starting at byte 4, channel-specific errors are reported.

General rule: A fault is indicated by a logic "1" at the relevant bit.

## Byte 0 to byte 3 (diagnostic data records 0 and 1)

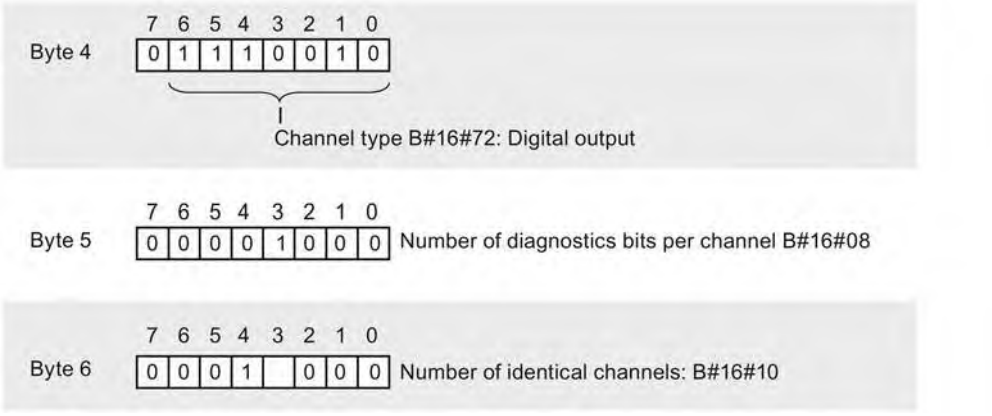
Through entries in the diagnostic bytes byte 0 (bit 4...7) byte 2 and byte 3, module errors are reported, which cannot be turned off through the setting of the module.



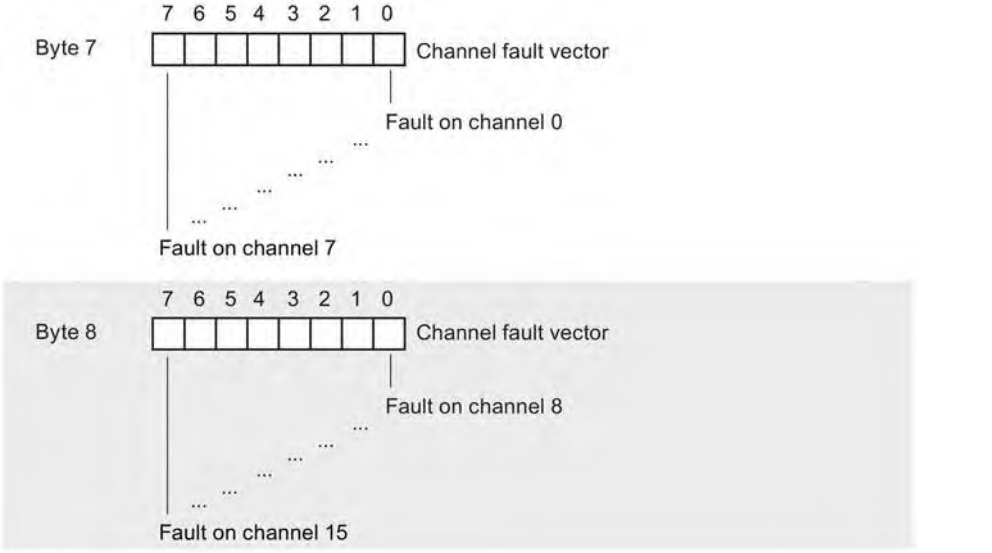



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### Byte 4 to byte 6 infoblock (diagnostic data record 1)




### Byte 7 and 8 channel error vector (Diagnostic data record 1)

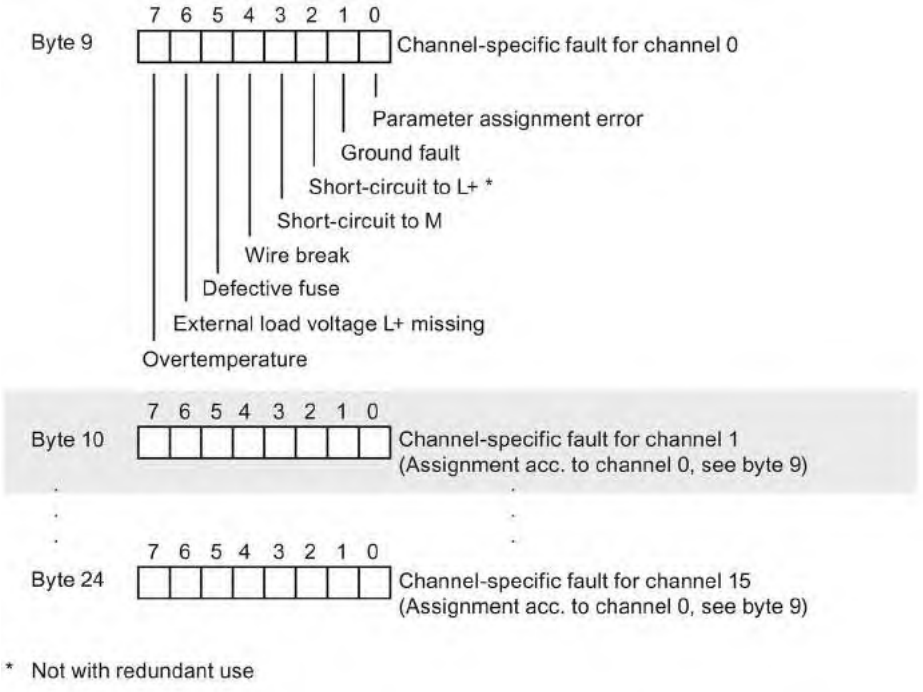





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## Byte 9 to byte 24 cable diagnostics (diagnostic data record 1)

Through byte 9 to byte 24 channel-specific errors are reported.




* Not with redundant use



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# B.5 Diagnostics data of SM 331; AI 6 x TC isolated

## Introduction

The section below describes the structure and content of the various bytes in diagnostics data. General rule: A fault is indicated by a logic "1" at the relevant bit.

## Byte 0 to byte 3 (diagnostic data records 0 and 1)

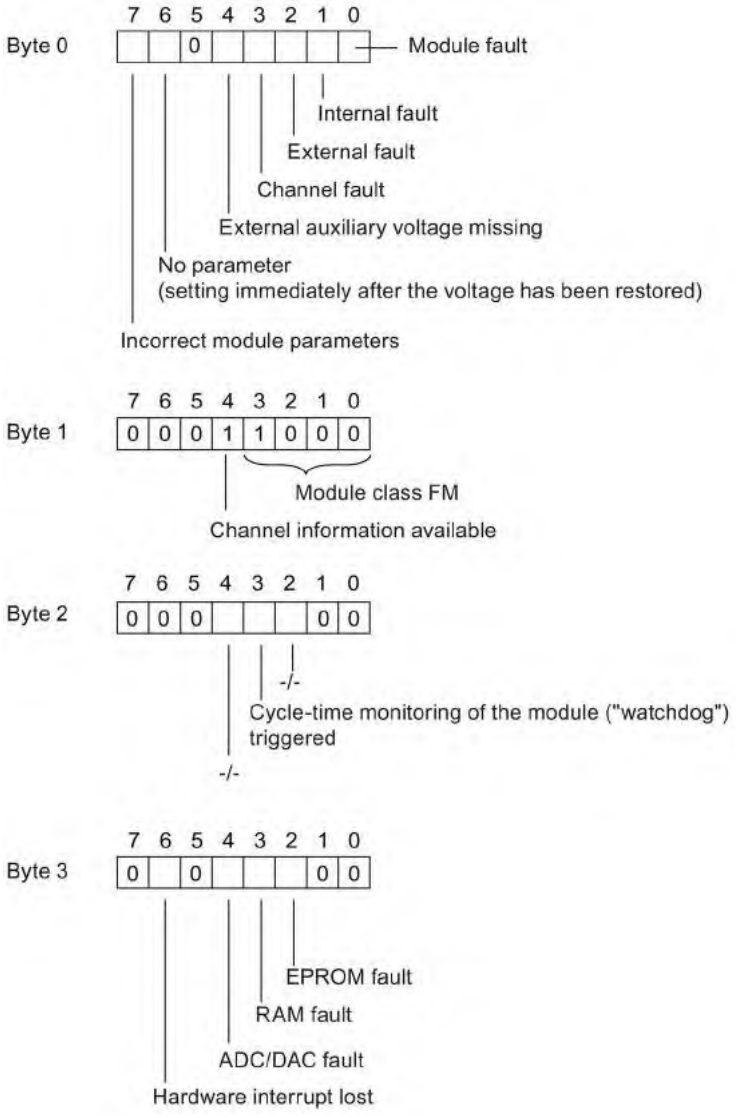



Figure B-9 Diagnostic data records 0 and 1



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## Byte 4 to byte 13 (diagnostic data record 1)

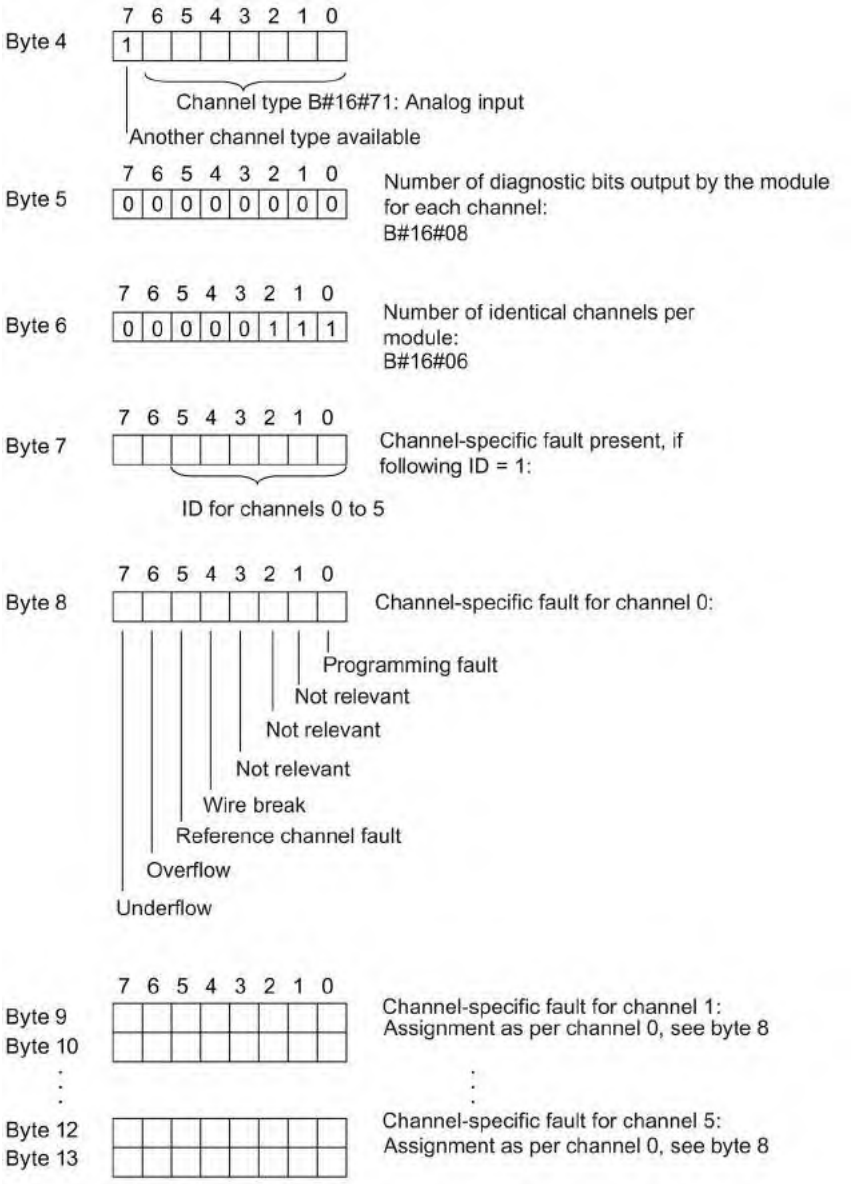



Figure B-10 Diagnostic data record 1



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## Byte 14 to byte 23 (diagnostic data record 1)

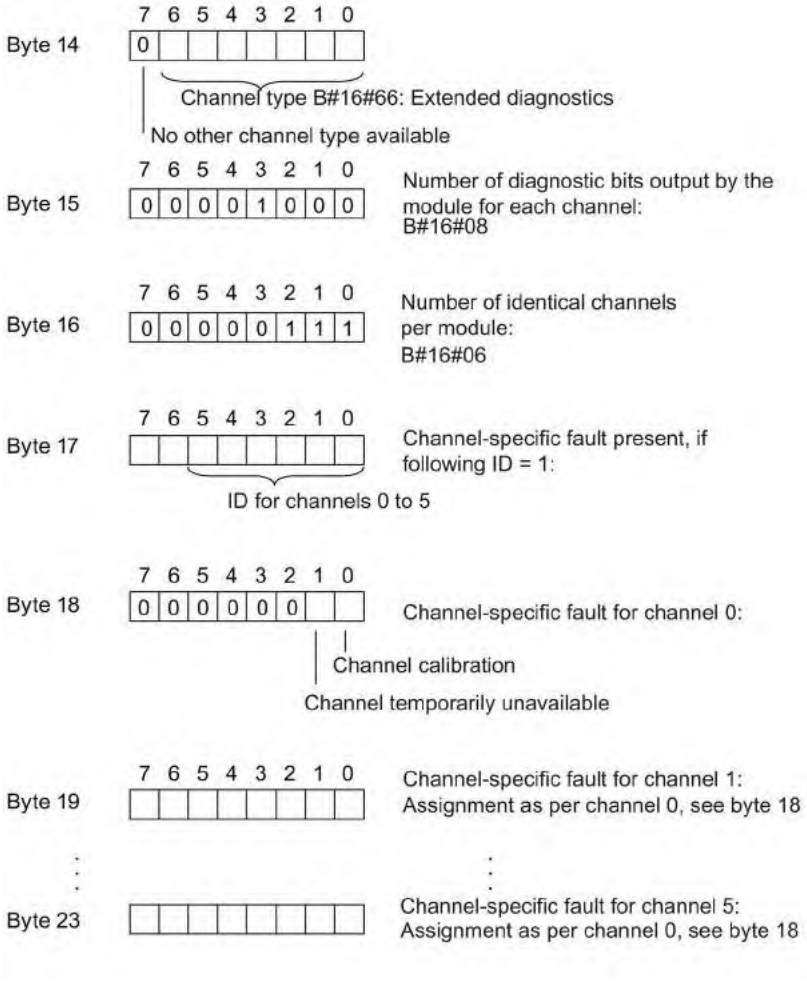



Figure B-11 Diagnostic data record 1 (continued)



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# B.6 Diagnostics data of SM 338; POS-INPUT

## Introduction

The next section describes the structure and contents of the various bytes in diagnostic data of the position detection module SM 338; POS-INPUT. General rule: A fault is indicated by a logic "1" at the relevant bit.

You will find a description of possible causes of problems and appropriate remedies in the section titled *Position detection module SM 338; POS-INPUT*.

## Bytes 0 and 1

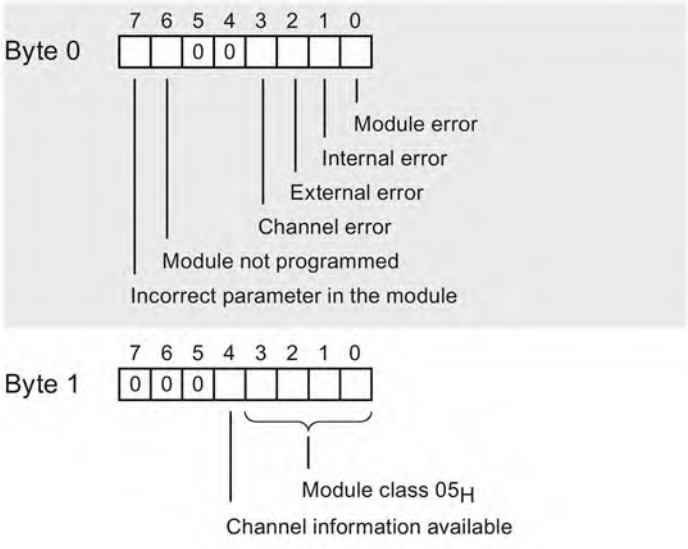



Figure B-12 Bytes 0 and 1 in diagnostics data of SM 338; POS-INPUT



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## Bytes 2 to 7

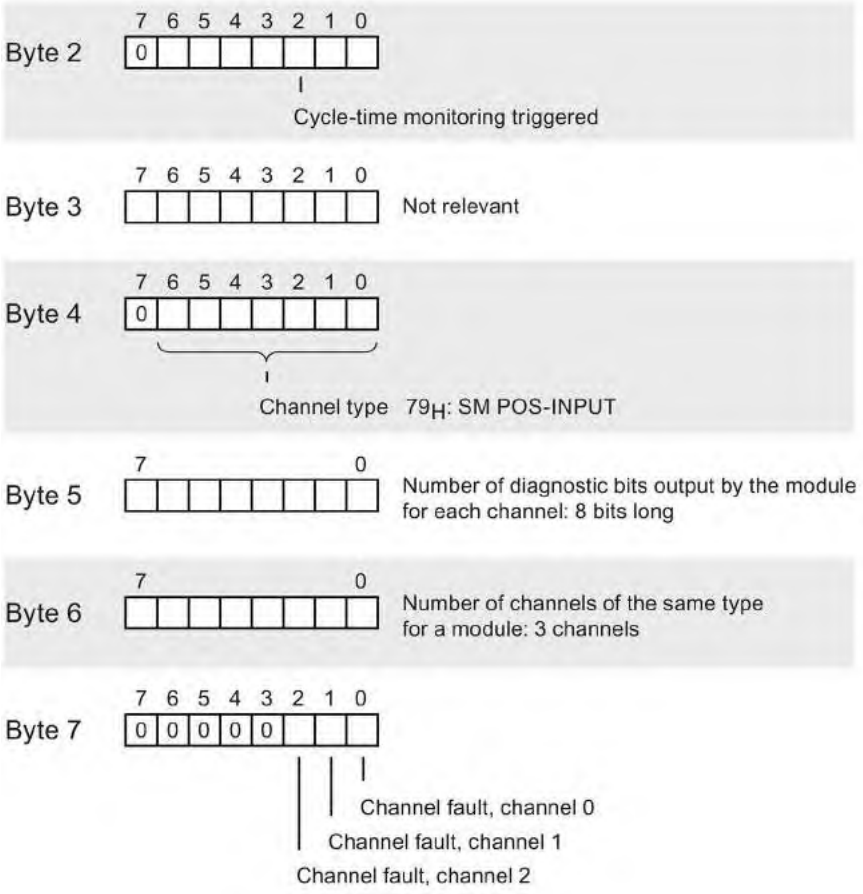



Figure B-13 Bytes 2 and 7 in diagnostics data of SM 338; POS-INPUT

## Bytes 8 to 10

Data record 1 contains the channel-specific diagnostic data, starting at bytes 8 to 10. The figure below shows the assignment of the diagnostic byte for a channel of SM 338; POS-INPUT.

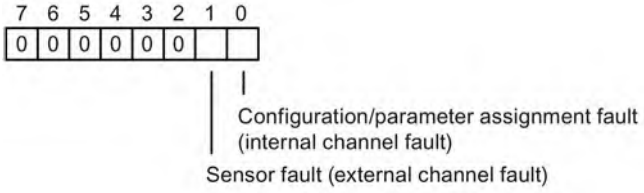



Figure B-14 Diagnostics byte for a channel of SM 338; POS-INPUT



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# Dimensional drawings

C

## Introduction

This appendix contains the dimensional drawings of the most important components of an S7-300. The specified dimensions are required to determine the dimensions of an S7-300 configuration. Make allowances for the dimensions of an S7-300 configuration when you install the system in cabinets, control rooms, etc. This appendix does not include the dimensional drawings of S7-300 or M7-300 CPUs, or of IM 153-1. These are included in the relevant manuals.

## Contents

This appendix contains the dimensional drawings of the S7-300 components listed below.

- Mounting rails
- Power supply modules
- Interface modules
- Signal modules
- Accessories



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# C.1 Dimensional drawings of the mounting rails

## Standard mounting rail 483 mm

The figure below shows the dimensional drawing of the 483 mm standard rail.

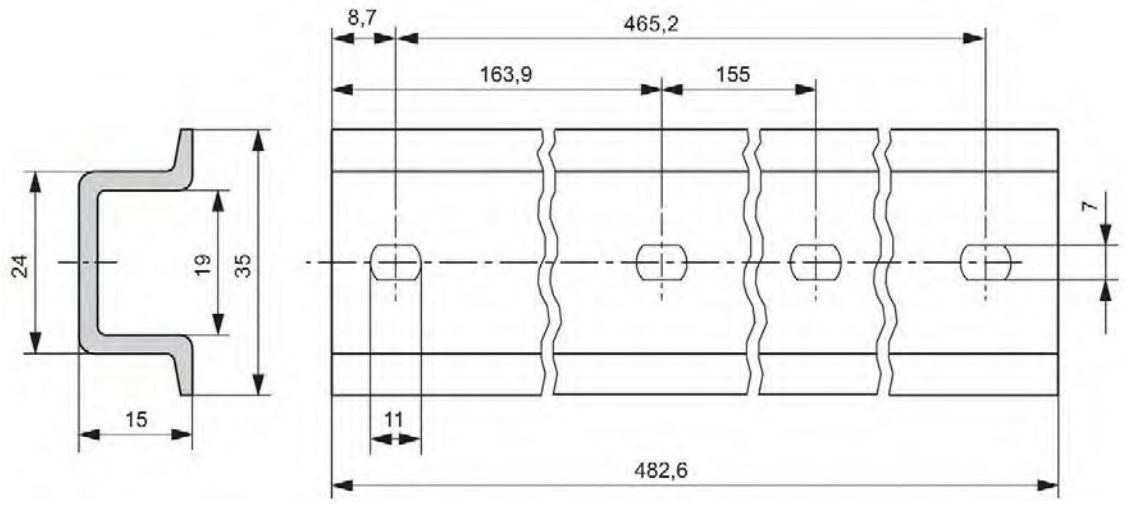



Figure C-1 Dimensional drawing of the 483 mm standard rail

## Standard mounting rail 530 mm

The figure below shows the dimensional drawing of the 530 mm standard rail.

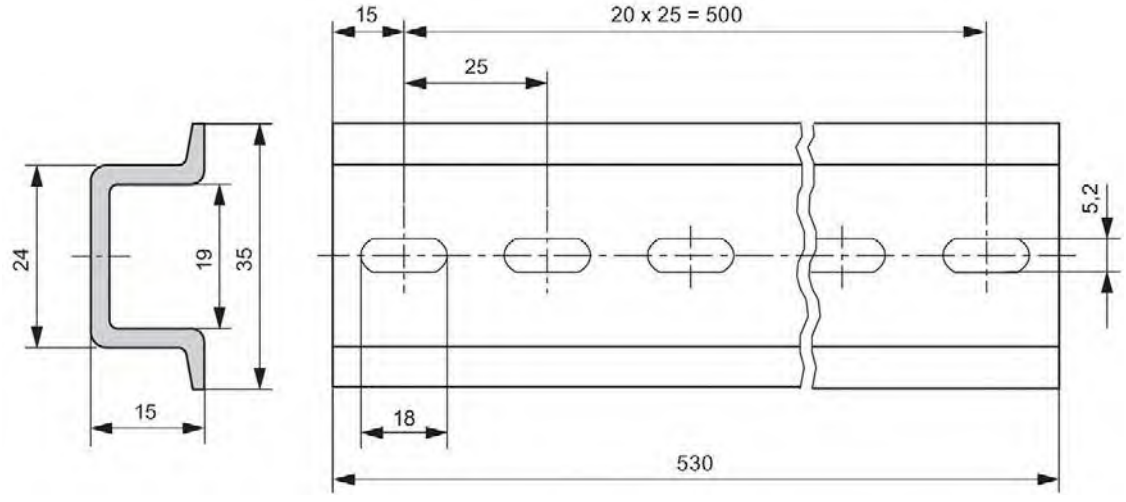



Figure C-2 Dimensional drawing of the 530 mm standard rail



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## Standard mounting rail 830 mm

The figure below shows the dimensional drawing of the 830 mm standard rail.

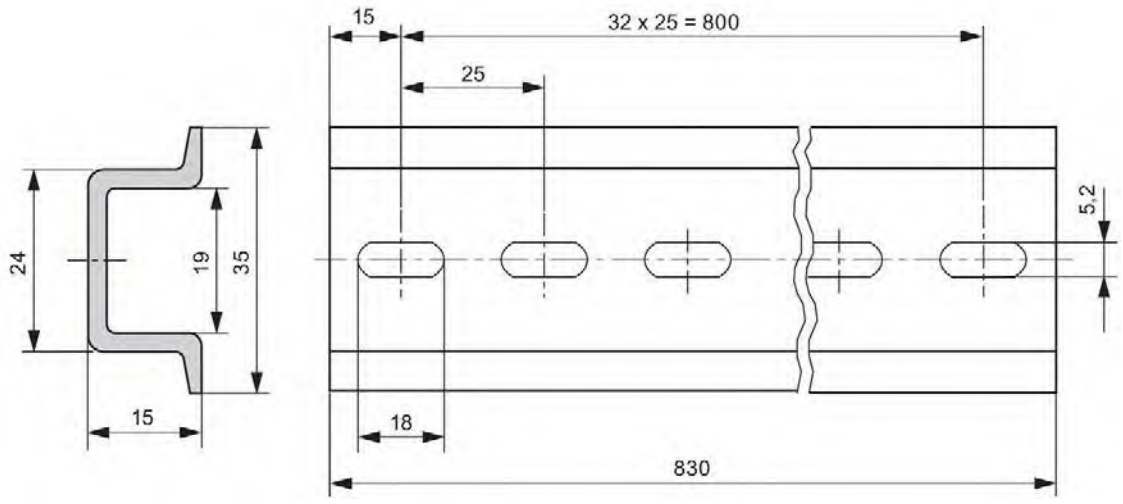



Figure C-3 Dimensional drawing of the 830 mm standard rail

## Standard mounting rail 2000 mm

The figure below shows the dimensional drawing of the 2000 mm standard rail.

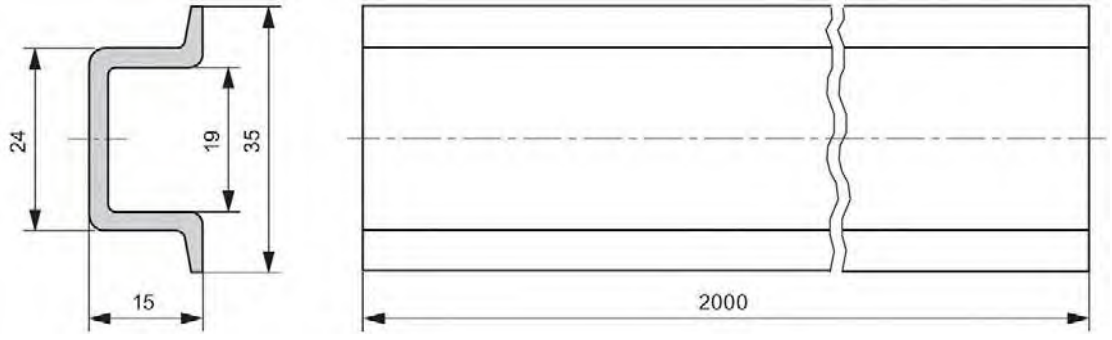



Figure C-4 Dimensional drawing of the 2000 mm standard rail



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## Mounting rail 160 mm

The figure below shows the dimensional drawing of the 160 mm mounting rail.

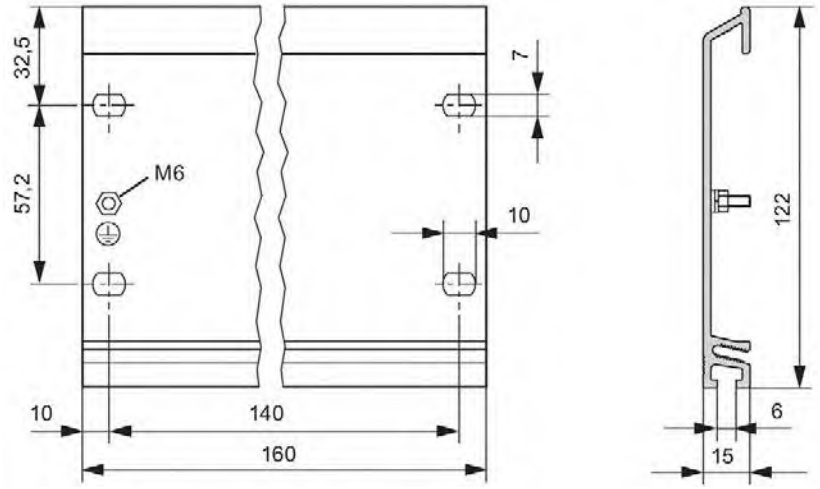



Figure C-5 Dimensional drawing of the mounting rail with standard width of 160 mm.

## Mounting rail 482.6 mm

The figure below shows the dimensional drawing of the 482.6 mm mounting rail.

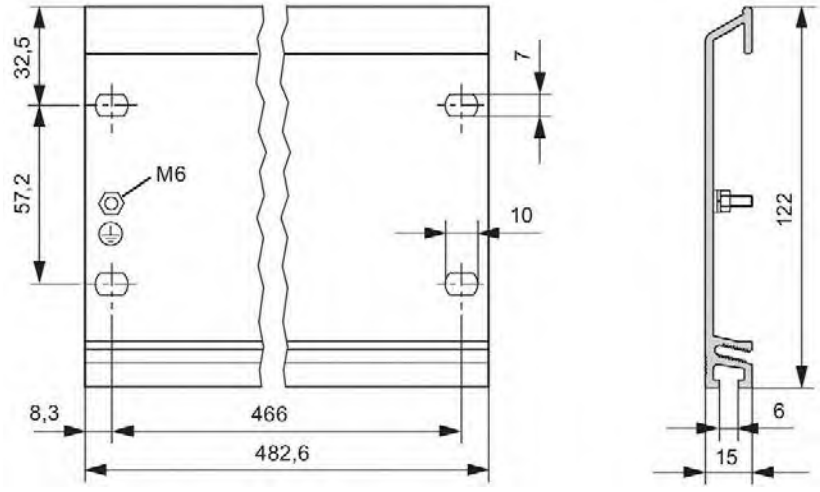



Figure C-6 Dimensional drawing of the mounting rail with standard width of 482.6 mm.



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## Mounting rail 530 mm

The figure below shows the dimensional drawing of the 530 mm mounting rail.

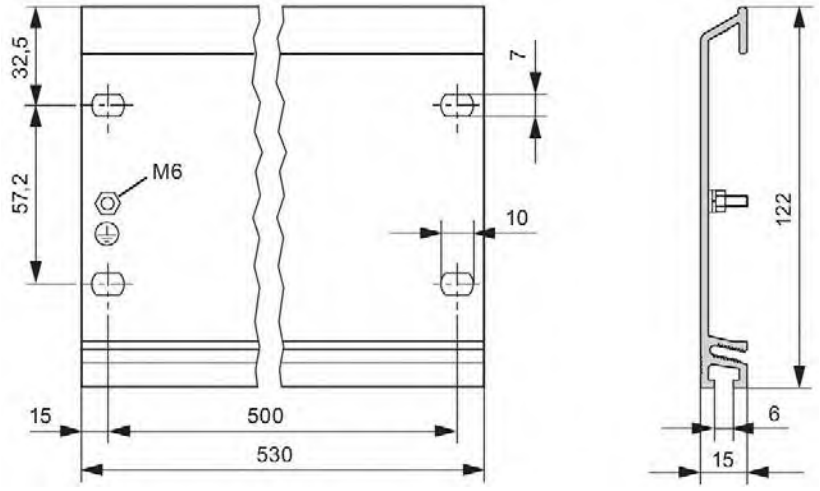



Figure C-7 Dimensional drawing of the mounting rail with standard width of 530 mm.

## Mounting rail 830 mm

The figure below shows the dimensional drawing of the 830 mm mounting rail.

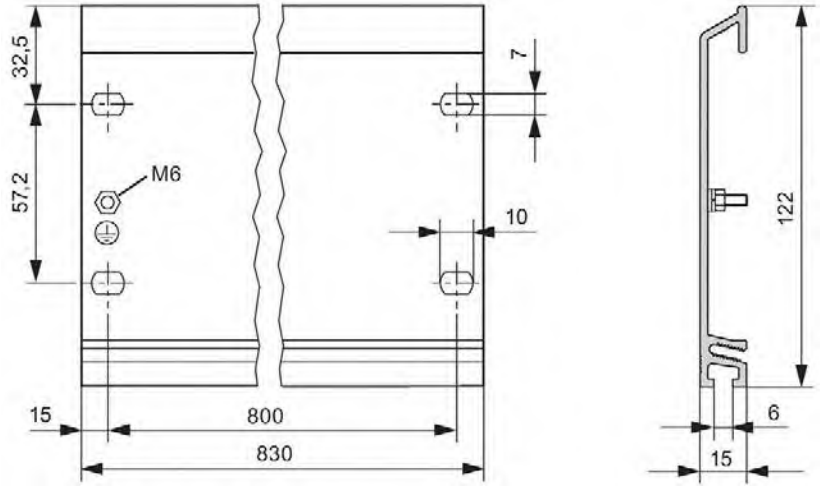



Figure C-8 Dimensional drawing of the mounting rail with standard width of 830 mm.



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## Mounting rail 2000 mm

The figure below shows the dimensional drawing of the 2000 mm mounting rail.

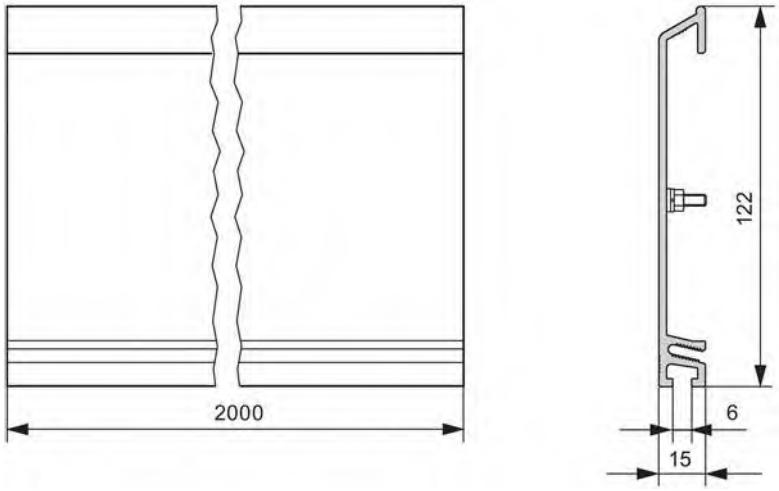


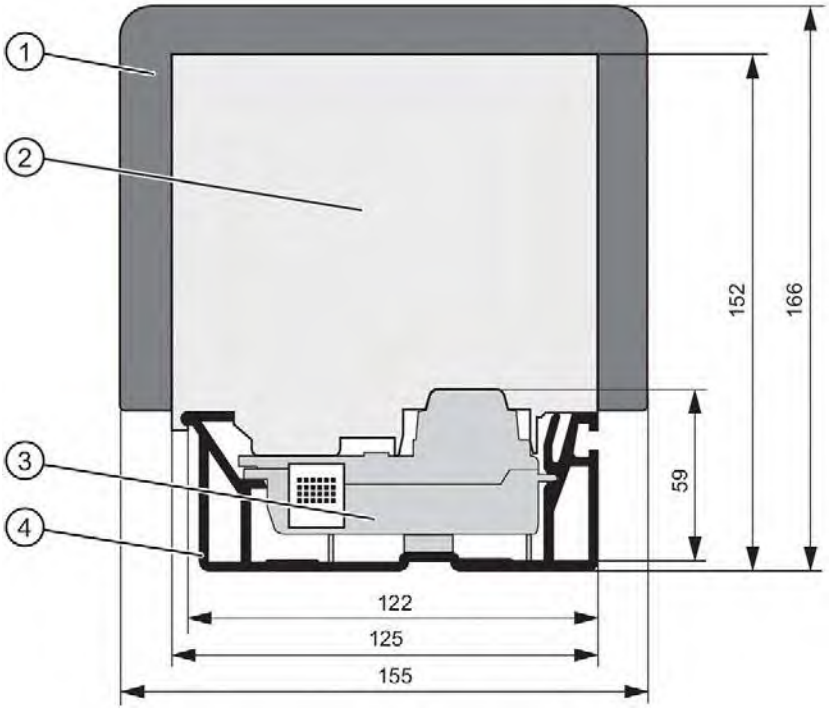

Figure C-9 Dimensional drawing of the 2000 mm mounting rail



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## Mounting rail for the "Insertion and Removal" function

The figure below shows the dimensional drawing of the mounting rail for the "Insertion and Removal" function with active bus module, S7-300 module and explosion-proof partition. The mounting rail has a length of 482.6 mm or 530 mm.



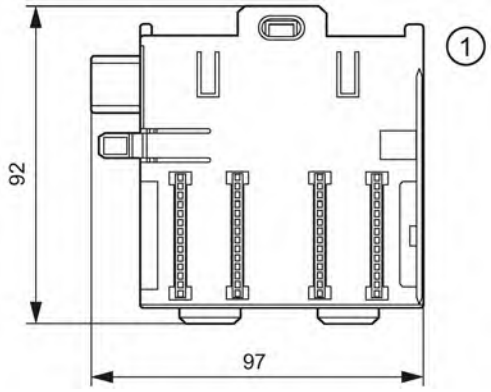

① Explosion-proof partition
② S7-300 module
③ active bus module
④ Mounting rail for the "Insertion and Removal" function



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## C.1.1 Bus modules

The figure below shows the dimension drawing of the active bus module for the "Insertion and Removal" function.




① Bus modules
BM PS/IM (...7HA)
BM IM/IM (...7HD)
BM 2 x 40 (...7HB)
BM 1 x 80 (...7HC)



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# C.2 Dimensional drawings of the power supply modules

## PS 307 2 A

The drawing below shows the dimensions of power supply module PS 307; 2 A.

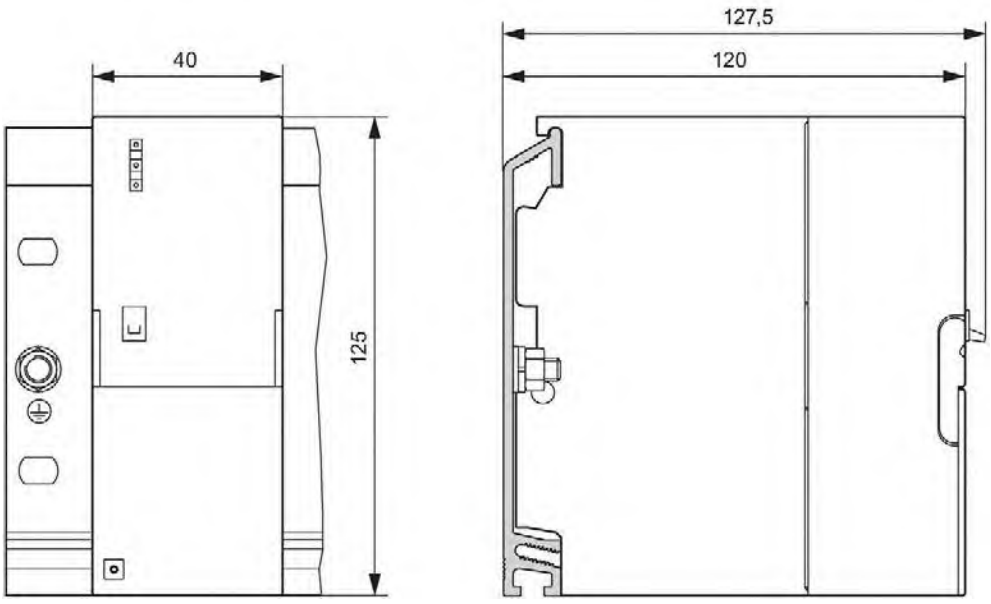



Figure C-10 Power supply module PS 307; 2 A



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## PS 307 5 A (6ES7307-1EA01-0AA0)

The drawing below shows the dimensions of power supply module PS 307; 5 A.

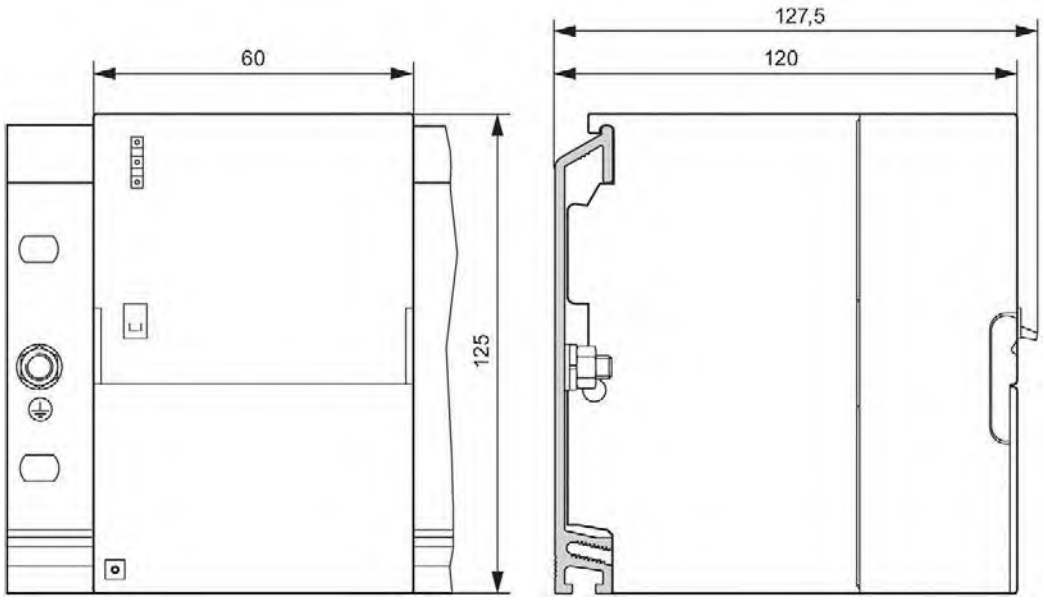



Figure C-11 Power supply module PS 307; 5 A

## PS 307; 10 A with 313/314/315/ 315-2 DP CPU

The figures below show the dimensional drawings of a configuration consisting of a power supply module PS 307; 10 A and a 313/314/315/315-2 DP CPU. Observe the dimensions derived from the use of a power connector when wiring the PS 307; 10 A to the CPU.

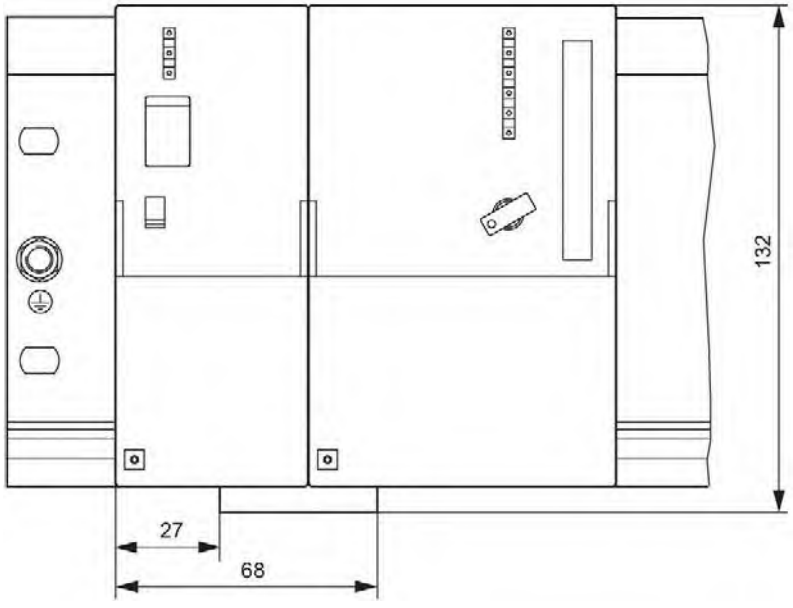



Figure C-12 Dimensional drawing of power supply module PS 307; 10 A with CPU 313/314/315/315-2 DP, front view



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## PS 307; 10 A with 313/314/315/ 315-2 DP CPU

The side view drawing below shows the dimensions of power supply module PS 307; 10 A with 313/314/315/315-2 DP CPU.

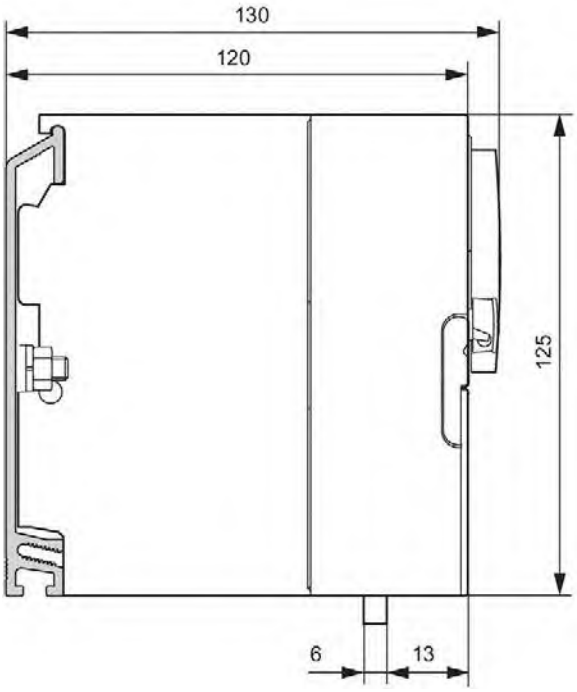



Figure C-13 Dimensional drawing power supply module PS 307; 10 A with CPU 313/314/315/315-2 DP, side view



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## PS 305 2 A, PS 307 5 A (6ES7307-1EA80-0AA0) and PS 307 10 A

The following image shows the drawing of the power supply modules PS 305; 2 A, PS 307 5 A and PS 307; 10 A.

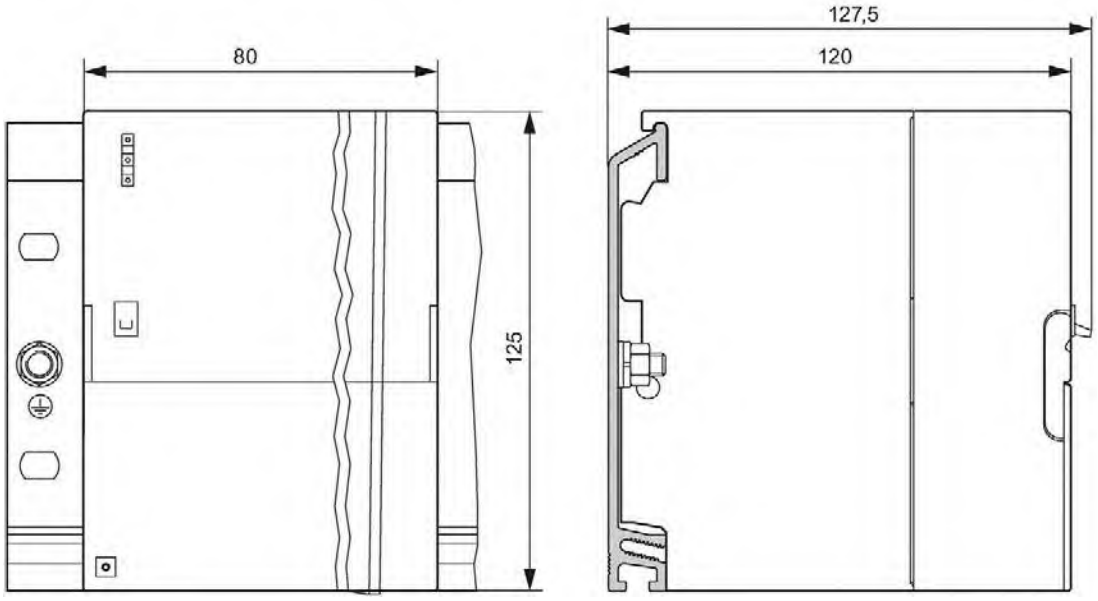



Figure C-14 Power supply module PS 307; 10 A



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# C.3 Dimensional drawings of the interface modules

## IM 360

The figure below shows the dimensional drawing of interface module IM 360.

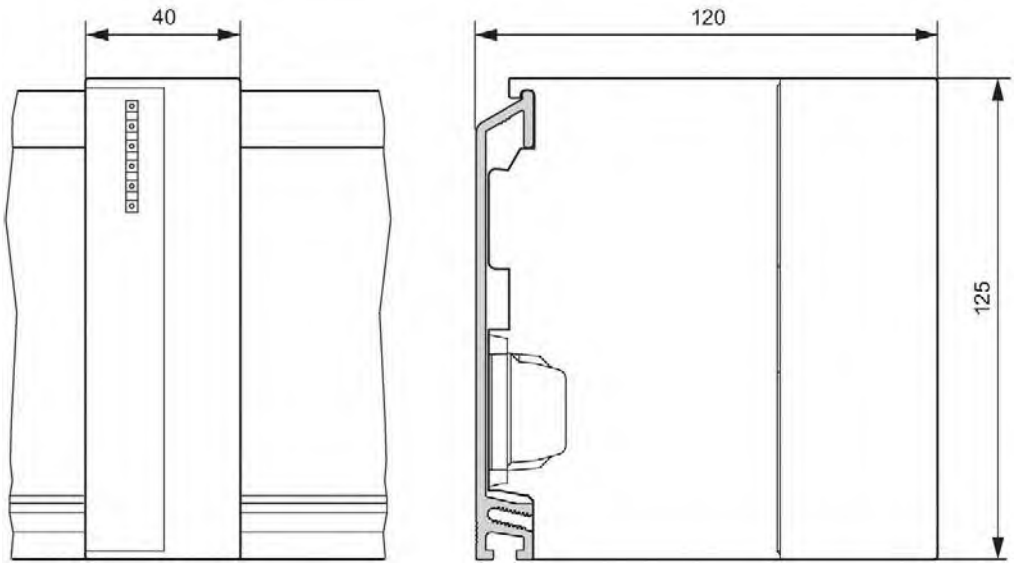



Figure C-15 Interface module IM 360

## IM 361

The figure below shows the dimensional drawing of interface module IM 361.

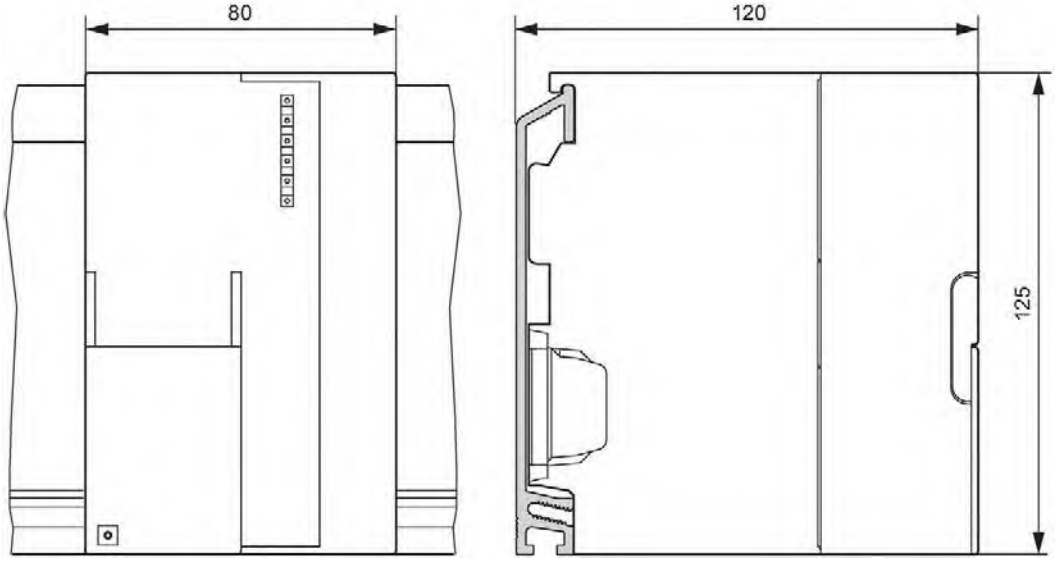



Figure C-16 Interface module IM 361



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## IM 365

The figure below shows the dimensional drawing of interface module IM 365.

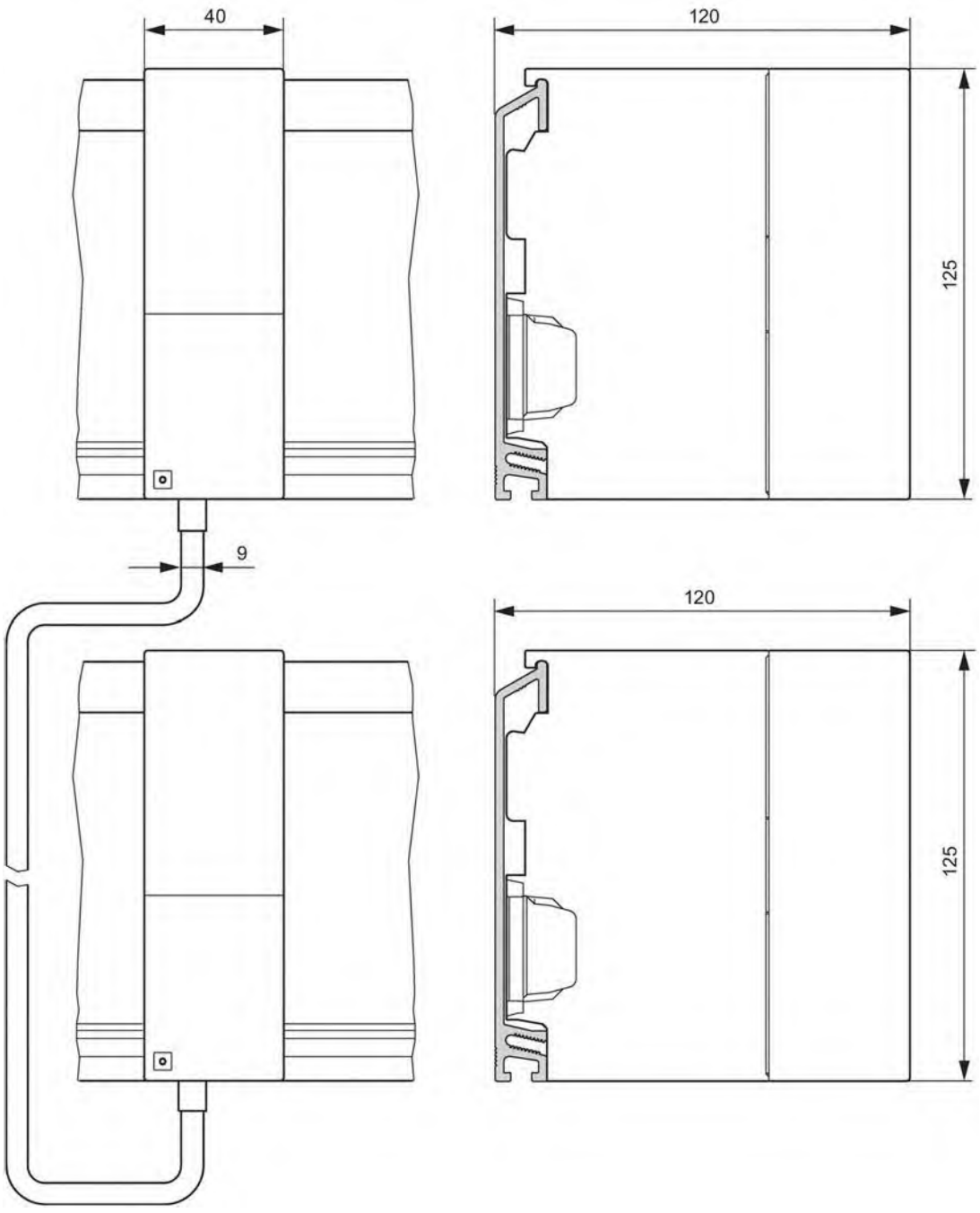



Figure C-17 Interface module IM 365

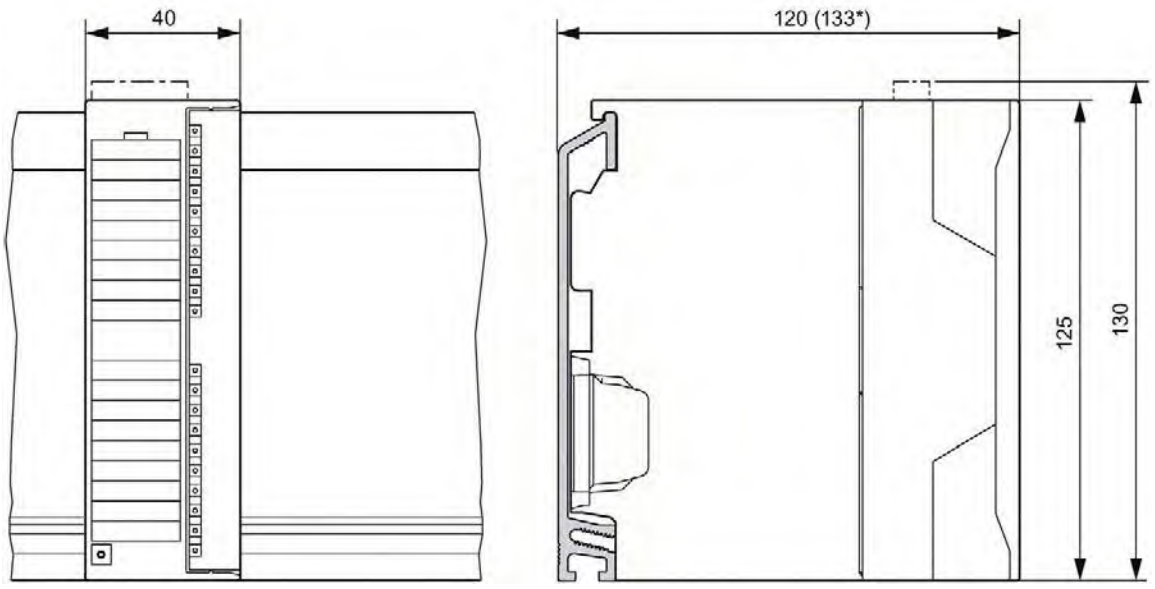


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# C.4 Dimensional drawings of the signal modules

## Signal module

The figure below shows the dimensional drawing of the signal module.
The signal module design may differ. The specified dimensions are always the same.




* With front door, elevated design

Figure C-18 Signal module



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## 64-channel signal module

The figure below shows the dimension drawing for 64-channel I/O modules.

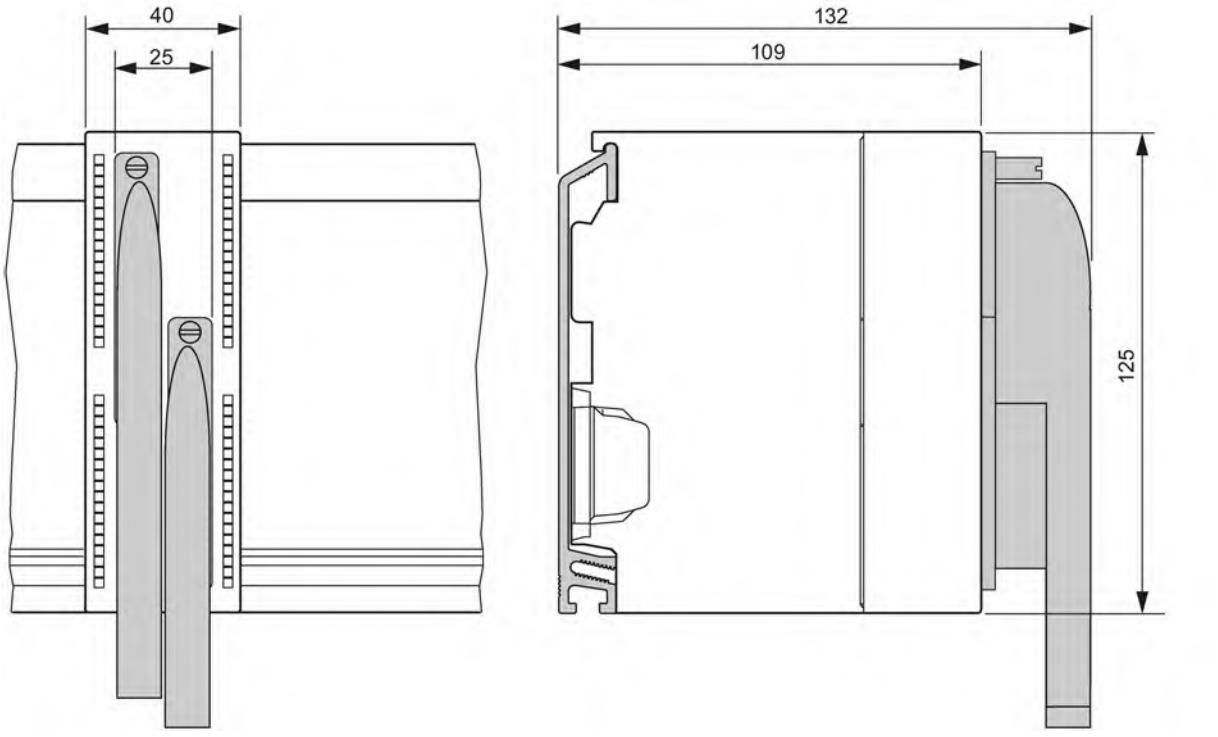



Figure C-19 64-channel signal module



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# C.5 Dimensional drawings of accessories

## Shield connection element

The figure below shows the dimensional drawing of the shield connecting element used two signal modules.

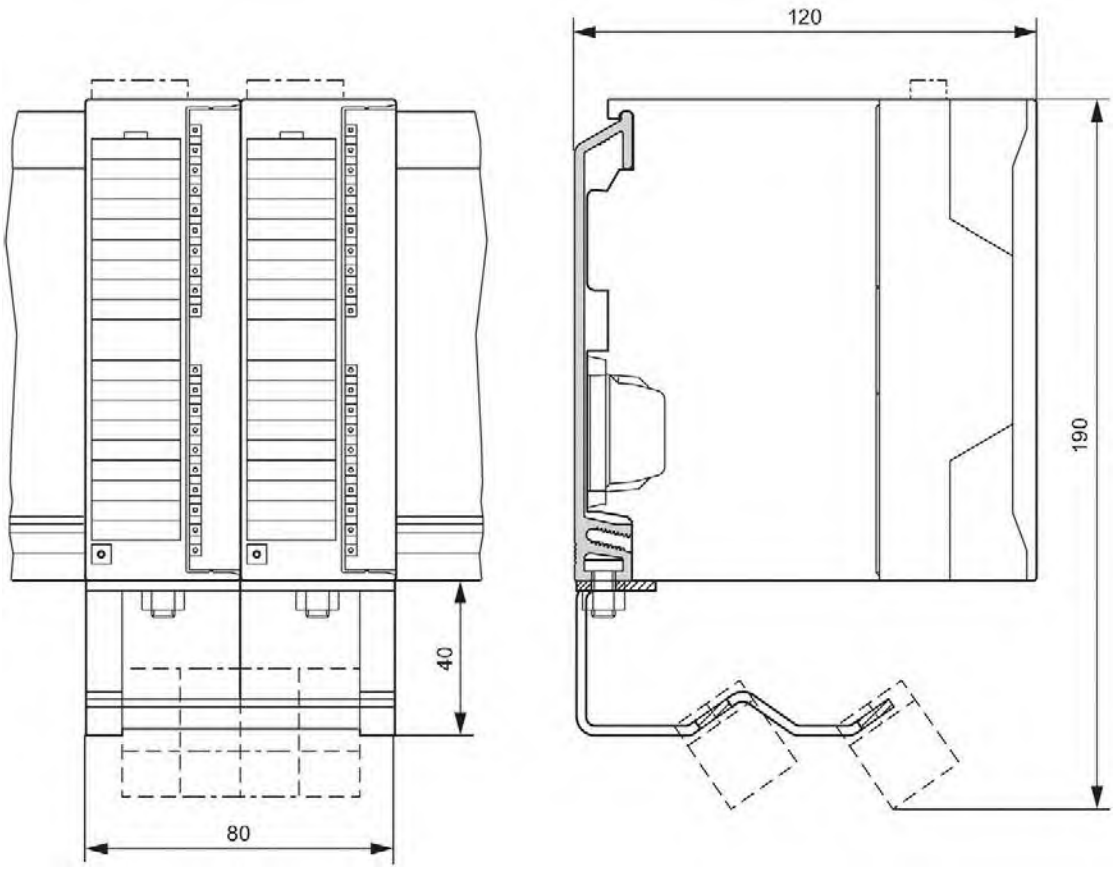



Figure C-20 2 signal modules with shield connecting element



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## 40-pin terminal block

The figure below shows the dimension drawing of the 40-pin terminal block for 64-channel signal modules.

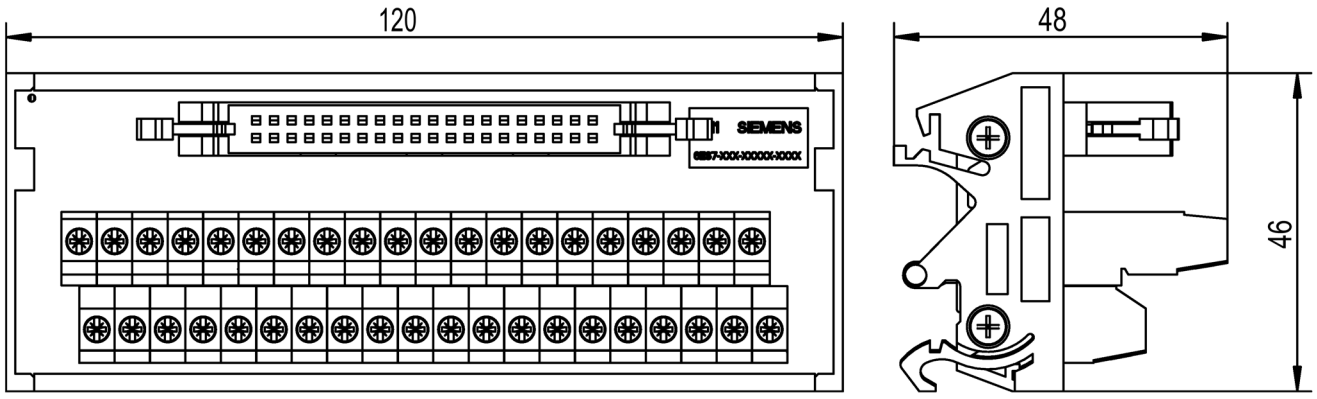



Figure C-21 40-pin terminal block



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# Spare parts and accessories for S7-300 modules

D

## Spare parts

The table below lists the S7-300 parts you can order separately or later.

Table D- 1 Accessories and spare parts

| S7-300 parts | Order number |
|---|---|
| Bus connector | 6ES7390-0AA00-0AA0 |
| Connection comb between power supply and CPU (older generation, before 2003) | 6ES7390-7BA00-0AA0 |
| Labeling strips for<br>• Modules with 20-pin front connector:<br>– (petrol)<br>– (light beige)<br>– (yellow)<br>– (red) | <br>6ES7392-2AX00-0AA0<br>6ES7392-2BX00-0AA0<br>6ES7392-2CX00-0AA0<br>6ES7392-2DX00-0AA0 |
| Labeling strips for<br>• Modules with 40-pin front connector:<br>– (petrol)<br>– (light beige)<br>– (yellow)<br>– (red) | <br>6ES7392-2AX10-0AA0<br>6ES7392-2BX10-0AA0<br>6ES7392-2CX10-0AA0<br>6ES7392-2DX10-0AA0 |
| • Instructions for printing labeling strips using print templates | On the Internet (http://www.siemens.com/automation/service&support)<br>Entry ID: 11978022 |
| Slot number plate | 6ES7912-0AA00-0AA0 |
| Front connector 20-pin<br>• Screw terminal technology (1 unit)<br>• Screw technology (100 units)<br>• Spring clamp technology (1 unit)<br>• Spring clamp technology (100 units) | <br>6ES7392-1AJ00-0AA0<br>6ES7392-1AJ00-1AB0<br>6ES7392-1BJ00-0AA0<br>6ES7392-1BJ00-1AB0 |
| Front connector 40-pin<br>• Screw technology (1 unit)<br>• Screw technology (100 units)<br>• Spring clamp technology (1 unit)<br>• Spring clamp technology (100 units) | <br>6ES7392-1AM00-0AA0<br>6ES7392-1AM00-1AB0<br>6ES7392-1BM01-0AA0<br>6ES7392-1BM01-1AB0 |



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| S7-300 parts | Order number |
|---|---|
| Front connector for 2 ribbon cable connections<br>• screw terminal technology<br>• Spring clamp technology | <br>6ES7921-3AB00-0AA0<br>6ES7921-3AA00-0AA0 |
| Front connector for 4 ribbon cable connections<br>• Spring clamp technology | <br>6ES7921-3AA20-0AA0 |
| Round-sheath ribbon cable (16-pole)<br>• Unshielded 30 m<br>• Unshielded 60 m<br>• Shielded 30 m<br>• Shielded 60 m | <br>6ES7923-0CD00-0AA0<br>6ES7923-0CG00-0AA0<br>6ES7923-0CD00-0BA0<br>6ES7923-0CG00-0BA0 |
| Connectors, 16-pin, set of 8 (insulation displacement terminals) | 6ES7921-3BE10-0AA0 |
| Shield connection element | 6ES7390-5AA00-0AA0 |
| Shield terminal element for<br>• 2 cables, each with a shield diameter of 2 to 6 mm<br>• 1 cable with a shield diameter of 3 to 8 mm<br>• 1 cable with a shield diameter of 4 to 13 mm | <br>6ES7390-5AB00-0AA0<br>6ES7390-5BA00-0AA0<br>6ES7390-5CA00-0AA0 |
| Measuring range module for analog modules | 6ES7974-0AA00-0AA0 |
| Fuse set for digital output modules<br>- 6ES7322-1FF01-0AA0<br>- 6ES7322-1FH00-0AA0<br>- 6AG1322-1FF01-2AA0<br>(contains 10 fuses and 2 fuse holders) | 6ES7973-1HD00-0AA0 |
| Fuse set for digital output module<br>• 6ES7322-1CF00-0AA0 (contains 10 fuses) | 6ES7973-1GC00-0AA0 |
| Connecting cable for IM 360 and IM 361, or IM 361 and IM 361<br>• 1 m<br>• 2.5 m<br>• 5 m<br>• 10 m | <br>6ES7368-3BB01-0AA0<br>6ES7368-3BC51-0AA0<br>6ES7368-3BF01-0AA0<br>6ES7368-3CB01-0AA0 |
| Connecting cable between the 64-channel modules:<br>SM 321, 6ES7321-1BP00-0AA0 sinking/sourcing,<br>SM 322, 6ES7322-1BP00-0AA0 sourcing,<br>SM 322, 6ES7322-1BP50-0AA0 sinking<br>and 40-pin terminal block (screw terminal, spring clamp technology)<br>• 1.0 m<br>• 2.5 m<br>• 5.0 m | <br><br><br><br>6ES7392-4BB00-0AA0 (2 units)<br>6ES7392-4BC50-0AA0 (2 units)<br>6ES7392-4BF00-0AA0 (2 units) |



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| S7-300 parts | Order number |
|---|---|
| Terminal block 40-pin for 64-channel modules<br>• Screw terminal technology<br>• Spring clamp technology | 6ES7392-1AN00-0AA0 (2 units)<br>6ES7392-1BN00-0AA0 (2 units) |
| Front door, elevated design for 32-channel modules (5 units) incl. labeling strips and connection diagram | 6ES7328-0AA00-7AA0 |

## Information about front connector selection

Your can find more information on front connector selection for the various SIMATIC S7-300 modules on the Internet (http://support.automation.siemens.com/WW/view/en/23060726).



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# Directive on handling Electrostatic-Sensitive Devices (ESD)

E

### Introduction

In this appendix, we explain

- the meaning of "electrostatic-sensitive devices"
- the precautions you must take when handling and working with electrostatic sensitive modules.

## E.1 Definition of ESD

### Definition

All electronic modules are equipped with large-scale integrated ICs or components. Due to their design, these electronic elements are highly sensitive to overvoltage, and thus to any electrostatic discharge.

These **E**lectrostatic **S**ensitive **D**devices/**M**odules are commonly abbreviated **ESD**. The common international designation **ESD** stands for **E**lectrostatic **S**ensitive **D**evice.

### ESD modules are identified by the following symbol:



**CAUTION**

ESD devices can be destroyed by voltages well below the threshold of human perception. These static voltages develop when you touch a component or electrical connection of a device without having drained the static charges present on your body. The electrostatic discharge current may lead to latent failure of a module, that is, this damage may not be significant immediately, but in operation may cause malfunction.



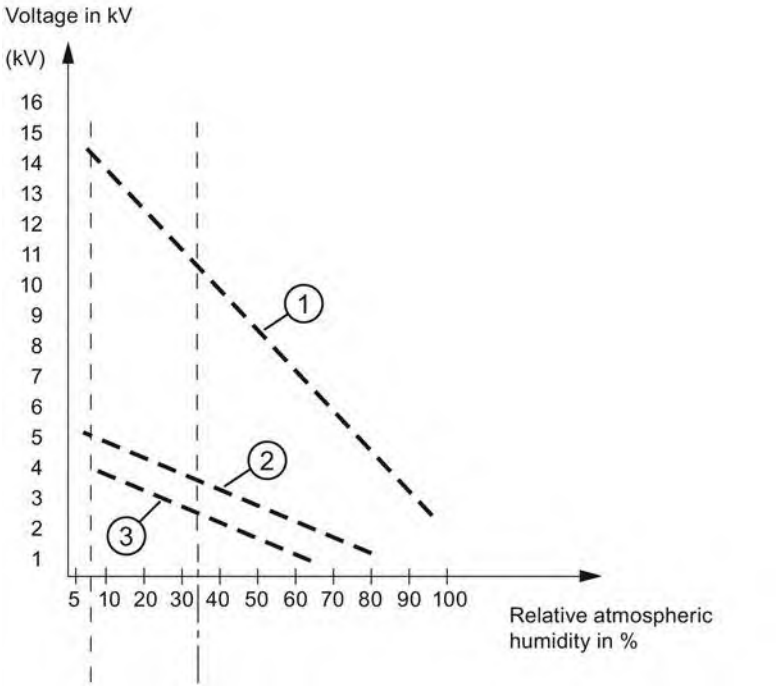
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# E.2 Electrostatic charging of the body

## Electrostatic charging

Any person with a non-conductive connection to the electrical potential of its surroundings may be exposed to electrostatic charge.

The figure below shows the maximum electrostatic voltage which may build up on a person coming into contact with the materials indicated. These values correspond to IEC 801-2 specifications.




① Synthetic material
② Wool
③ antistatic materials, such as wood or concrete



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# E.3 Basic protective measures against electrostatic discharge

## Ensure sufficient grounding

Make sure all persons, workplaces and packaging are sufficiently grounded when handling ESD components. This prevents electrostatic charge.

## Avoid direct contact

You should only touch ESD components if unavoidable (for example, during maintenance work). Handle the modules without touching any chip pins or PCB traces. In this way, the discharged energy can not affect the sensitive devices.

Discharge your body before you start taking any measurements on a module. Do so by touching grounded metallic parts. Always use grounded measuring instruments.



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# Service & support

F

## F.1 Service & support

### Technical support

You can contact Technical Support for all Industry Automation products by means of the Internet Web form for the Support Request on the Internet (http://www.siemens.com/automation/support-request)

Additional information on our technical support is available on the Internet (http://www.siemens.com/automation/service).

### Service & support on the Internet

In addition to our documentation, we offer a comprehensive knowledge base on the Internet.

On the Internet (http://www.siemens.com/automation/service&support).

There you will find:

- Our Newsletter, which constantly provides you with the latest information about your products.
- The documents you require, via our service & support search facility.
- A forum, where users and experts from all over the world exchange their experiences.
- Your local contact for Automation & Drives from our contact database.
- Information about on-site service, repairs, spare parts, and much more.

### Additional support

If you have any questions relating to the products described in this manual and cannot find the answers in this documentation, please contact your Siemens partner at the appropriate office or sales and service location.

The contact details for your partner are available on the Internet (http://www.automation.siemens.com/partner/).

A guide to the technical documentation provided for the various SIMATIC products and systems is available on the Internet (http://www.siemens.com/simatic-tech-doku-portal).

The online catalog and order system is available on the Internet (http://www.siemens.com/automation/mall).

### Training center

Siemens offers various courses to get you started with the S7-300 and the SIMATIC S7 automation system. Please contact your regional training center or the central training center in Nuremberg (ZIP code: 90327).
Additional information is available on the Internet (http://www.siemens.com/sitrain).



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# Safety-relevant symbols

# G

## G.1 Safety-related symbols for devices without Ex protection

The following table contains an explanation of the symbols located in your SIMATIC device, its packaging or the accompanying documentation.

| Symbol | Meaning |
|---|---|
|  | General warning sign **Caution/Notice**<br>You must read the product documentation. The product documentation contains information about the potential risks and enable you to recognize risks and implement countermeasures. |
|  | Read the information provided by the product documentation.<br>ISO 7010 M002 |
|  | Ensure the device is only installed by electrically skilled person.<br>IEC 60417 No. 6182 |
|  | Note that connected mains lines must be designed according to the expected minimum and maximum ambient temperature. |
|  | Note that the device must be constructed and connected in accordance with EMC regulations. |
|  | Note that a 230 V device can be exposed to electrical voltages which can be dangerous.<br>ANSI Z535.2 |
|  | Note that a device of Protection Class III may only be supplied with a protective low voltage according to the standard SELV/PELV.<br>IEC 60417-1-5180 "Class III equipment" |
|  | Be aware that the device is only approved for the industrial field and only for indoor use. |
|  | Note that an enclosure is required for installing the device. Enclosures are considered:<br>• Standing control cabinet<br>• Serial control cabinet<br>• Terminal boxes<br>• Wall enclosure |



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## G.2 Safety-related symbols for devices with Ex protection

The following table contains an explanation of the symbols located in your SIMATIC device, its packaging or the accompanying documentation.

| Symbol | Meaning |
|---|---|
|  | The assigned safety symbols apply to devices **with Ex approval**.<br>You must read the product documentation. The product documentation contains information about the potential risks and enable you to recognize risks and implement countermeasures. |
|  | Read the information provided by the product documentation.<br>ISO 7010 M002 |
|  | Ensure the device is only installed by electrically skilled person.<br>IEC 60417 No. 6182 |
|  | Observe the mechanical rating of the device. |
|  | Note that connected mains lines must be designed according to the expected minimum and maximum ambient temperature. |
|  | Note that the device must be constructed and connected in accordance with EMC regulations. |
|  | When the device is under voltage, note that it may not be installed or removed, or plugged or pulled. |
|  | Note that a 230 V device can be exposed to electrical voltages which can be dangerous.<br>ANSI Z535.2 |
|  | Note that a device of Protection Class III may only be supplied with a protective low voltage according to the standard SELV/PELV.<br>IEC 60417-1-5180 "Class III equipment" |
|  | Be aware that the device is only approved for the industrial field and only for indoor use. |



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| Symbol | Meaning |
|---|---|
|  | For Zone 2 potentially explosive atmospheres, be aware that the device may only be used when it is installed in an enclosure with a degree of protection ≥ IP54. |
|  | For Zone 22 potentially explosive atmospheres, be aware that the device may only be used when it is installed in an enclosure with a degree of protection ≥ IP6x. |



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# List of abbreviations

H

## H.1 List of abbreviations

| Abbreviations | Explanations |
|---|---|
| AC | Alternating current |
| ADC | Analog-to-Digital Converter |
| AI | Analog input |
| AO | Analog output |
| AS | Automation system |
| COMP+ / - | Compensation line (positive / negative) |
| CP | Communications processor |
| CPU | Central Processing Unit of the PLC |
| DAC | Digital-to-Analog Converter |
| DB | Data block |
| DC | Direct current |
| DI | Digital input |
| DO | Digital output |
| ESD | Electrostatic sensitive devices |
| EMC | Electromagnetic Compatibility |
| EPROM | Erasable Programmable Read-Only Memory |
| SSV | Set substitution value |
| FB | Function block |
| FC | Function |
| FEPROM | Flash Erasable Programmable Read-Only Memory |
| ES | Encoder supply |
| I+ | Measuring line for current input |
| $I_C$+ / - | Constantcurrent line (positive negative) |
| KV+ / - | Cold spot comparison (positive / negative) |
| L+ | Power supply 24 VDC |
| HLV | Hold last valid value |
| FOC | Fiber-optic conductor |
| M | Ground |
| M+ / - | Measuring line (positive / negative) |
| $M_{ANA}$ | Reference potential of the analog measuring circuit |
| MPI | Multipoint interface |
| OB | Organization block |
| OP | Operator panel |



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| Abbreviations | Explanations |
|---|---|
| OS | Operator system |
| P5V | Power supply for module logic |
| PIO | Process Image of Outputs |
| PII | Process Image of Inputs |
| PG | Programming device |
| PS | Power supply |
| $Q_I$: | Analog output current |
| $Q_V$: | Analog output voltage |
| RAM | Random Access Memory |
| $R_L$: | Load impedance |
| S + / - | Sensor line (positive / negative) |
| SF | "Group error" LED |
| SFB | System function block |
| SFC | System function |
| SM | Signal module |
| PLC | Programmable logic controller |
| SSI | Synchronous serial interface |
| TD | HMI (Text Display) |
| U+ | Measuring line for voltage input |
| CMV | Common Mode Voltage |
| Viso | Potential difference between $M_{ANA}$ and local ground |
| sign | Sign |



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# Glossary

### 2-/3-/4-wire connection

Methods of connecting resistance thermometers / resistances to the front connector of the module, or loads to the voltage output of an analog input module.

### 2-wire transducer (passive sensor) / 4-wire transducer (active sensor)

Type of transducer ( 2-wire transducers: power supply via terminals of the analog input module; 4-wire transducers: power supply via separate terminals of the transducer.)

### Absolute encoder

Determines the distance traveled by reading a numerical value: When using absolute encoders with serial interface (SSI), the path information is transferred synchronously and serially according to the SSI protocol (synchronous serial interface).

### Address

Represents the identifier of a specific address or address range. Examples: input I 12.1; flag word MW 25; data block DB 3.

### Article number

→ Order number

### Backplane bus

Serial data bus for module intercommunication, and power distribution to the modules. Bus connectors interconnect the modules.

### Basic conversion time

Time required for the actual coding of a channel (integration time, plus all times required by the internal control, i.e. the channel is fully processed when this time has expired.

### Basic error limit

Represents the operational limit at 25 °C, relative the module's rated range.

### Basic execution time

Cycle time of an analog IO module when all of its channels are enabled. Equivalent to "number of channels x basic conversion time."



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### Bus

A transfer medium that interconnects several nodes. Data may be transferred in serial or parallel mode, using electrical or fiber-optic conductors.

### Bus segment

Self-contained part of a bus system. Bus segments are coupled by means of → Repeater.

### Calibration

Refers to the process of determining the relationship between the measured or expected value of the output variable and the associated true or correct value of the measured variable provided as the input variable, for a specific measuring device and under particular circumstances.

### Common mode voltage (CMV)

The voltage common to all terminals of a group, measured between this group and any reference point (usually ground potential.)

### Communications processor

Programmable communications module, used for networking, PtP coupling, for example.

### Compensating box

Can be used for temperature measurements using thermocouples connected to analog input modules. Represents a compensation circuit used to compensate temperature fluctuation at the → Reference junction.

### Configuring

Refers to the selection and assembly of automation system components, or to software installation and adaptation to a specific process (by programming the modules, for example.)

### CP

→ Communications processor

### CPU

Central Processing Unit of the → Automation System. A CPU stores and executes the user program. It contains the operating system, memory, processing unit and communications interfaces.



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### Cycle time

Denotes the time a → CPU requires for a single execution of the → user program.

### Default setting

A useful setting which is used whenever the user does not enter a different value.

### Destruction limit

Permissible limit of the input voltage / output current. The accuracy of measurements may deteriorate if this limit is violated. If the destruction limit is considerably exceeded, this may destroy the internal measuring circuit.

### Diagnostic interrupt

Module diagnostics function report errors to the → CPU by means of diagnostic interrupts. The CPU operating system calls OB 82 when a diagnostic interrupt is generated.

### Diagnostics

Generic term for → System diagnostics, hardware error diagnostics, and user-specific diagnostics.

### Diagnostics buffer

The diagnostics buffer represents a backup memory in the CPU, used to store diagnostics events in their order of occurrence.

In STEP 7 (PLC → Module status), the user can read data from the diagnostics buffer to determine the precise cause of error.

### Diagnostics data

All diagnostics events are logged at the CPU and entered in → Diagnostics buffer. If an error OB exists, the buffer is started.

### Direct access

Denotes access of the CPU to a module via the → backplane bus, while bypassing the → Process image.

### electrically disconnected

The reference potential of the control and load voltage circuits at electrically isolated IO modules are isolated galvanically, for example, using optocouplers, relay contacts or transformers. IO circuits can be connected to a common reference potential.



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### electrically interconnected

The reference potential of the control and load voltage circuits of non-isolated IO modules are electrically interconnected.

### Equipotential bonding

Electrical connection (equipotential conductor) of electrical equipment and external conductive objects to the same or near to same potential, in order to prevent the development of disturbance and dangerous potentials between those objects.

### FREEZE

STEP 7 parameter for the SM 338; POS-INPUT position detection module. FREEZE is a control command (function), used to freeze actual encoder values of SM 338.

### Ground

The conductive earth whose electrical potential can be set equal to zero at any point.

Ground potential may be different from zero in the area of grounding electrodes. The term "reference ground" is frequently used to describe this situation.

### grounding

Grounding means, to connect an electrically conductive component via an equipotential grounding system to a grounding electrode (one or several conductive components with low impedance contact to earth.)

### Hardware interrupt

Function initiated by interrupt-triggering modules, based on specific events in the process (high or low limit violated, module has completed cyclic conversion of channels.)

The hardware interrupt is reported to the CPU, The CPU executes the assigned → Organization block according to interrupt priority.

### Hold last value (HLV)

The module retains the last value output before the CPU went into STOP.



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### Input delay

STEP 7 parameter for digital input modules. The input delay function is used to suppress coupled disturbance. This includes pulse-shaped disturbance within the range from 0 ms to the set input delay

The input delay tolerance is defined in the technical data of the module. The length of suppressed pulse-shaped disturbance is determined by the length of the input delay.

The permissible input delay is determined by the line length between the encoder and the module. Unshielded encoder supply lines of a grater length (more than 100 m) require a long delay setting.

### Integration time

STEP 7 parameter for analog input modules. The integration time is equivalent to the inverse value of the → noise suppression frequency in ms.

### Interface, multi-point

→ MPI

### Interference frequency suppression

STEP 7 parameter for analog input modules. The frequency of AC mains may corrupt measured values, in particular in the low voltage ranges, and when thermocouples are being used. At this parameter, the user defines the mains frequency prevailing on his system.

### Interrupt

SIMATIC S7 knows 28 different priority classes which control user program execution. These priority classes include interrupts, such as hardware interrupts. When an interrupt occurs, the operating system automatically calls an assigned organization block, in which the user can program the desired response (e.g. in an FB).

### Interrupt, diagnostics

→ Diagnostic interrupt

### Interrupt, end of cycle

→ hardware interrupt

### Interrupt, hardware

→ hardware interrupt



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### Linearity error

Denotes the maximum deviation of the measured/output value from the ideal linear relationship between the measured/output signal and the digital value. Defined as a percentage, relative to the rated range of the analog module.

### Logic block

A SIMATIC S7 logic block contains elements of the *STEP 7* user program. In contrast, a data block only contains data. Available logic blocks: Organization Blocks (OBs), Function Blocks (FBs), Functions (FCs), System Function Blocks (SFBs), System Functions (SFCs).

### Measuring range module

Modules installed on analog input modules for the adaptation to different measuring ranges.

### Monoflop time

STEP 7 parameter for the SM 338; POS-INPUT position detection module. The monoflop time is equivalent to interval between two SSI message frames ( → Absolute encoder.)

### MPI

Multi-Point Interface. SIMATIC S7 interface for programming devices. Allows central access to remote programmable modules (CPUs, CPs), Text Displays und Operator Panels. MPI nodes can intercommunicate.

### OB

→ Organization Block

### Operating mode

Definition of this term:

1. selection of a CPU operating state using the mode selector switch or a PG
2. the type of program execution at the CPU
3. an analog input module parameter in *STEP 7*

### Operating state

Operating states known to SIMATIC S7 automation systems: STOP, → STARTUP, RUN and STOP.

### Operational limit

Represents the measuring/output error of an analog module across the entire permissible temperature range, based on the module's rating.



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### Organization block

OBs form the interface between the CPU operating system and the user program. The sequential order of user program execution is defined in the organization blocks.

### Parameters

1. Tag of a → Code block
2. Tag used to set one or several properties of a module. Each module is supplied with default parameters which users may edit in *STEP 7*.

### PG

→ Programming device

### Process image

The CPU saves the signal states of analog IO modules to a process image.

We distinguish between the process image of inputs (PII) and outputs (PIO). The input modules read the process image of inputs (PII) before the operating system executes the user program. The operating system transfers the process image of outputs (PIO) to the output modules at the end of program execution.

### Product version

Differentiates products of the same order number. The product version is incremented in the case of upwards compatible enhancements of functionality, production-specific changes (use of new components/parts), and fixes.

### Programming device

A programming device (PG) is a special compact PC (Personal Computer) suitable for use in industry. A PG is fully equipped for programming SIMATIC automation systems.

### Reference junction

When operating thermocouples on analog input modules: point of known temperature (for example, → compensating box.)

### Reference potential

Potential from which the voltages of participating circuits are derived and measured.

### Repeat accuracy

Denotes the maximum deviation between measured/output values, if the same input or output signal is repeatedly set. Repeat accuracy refers to the rated range of the module, and applies to its settled temperature state.



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### Repeater

Equipment used to amplify bus signals, and couple → bus segments across greater distances

### Resolution

Number of bits representing the value of analog modules in binary format. The resolution is module-specific. It is also determined by the → integration time of analog input modules. The precision of the measured value resolution increases with the length of the integration time. The maximum resolution is 16 bits + sign.

### Response to open thermocouple

STEP 7 parameter for analog input modules operating with thermocouples. This parameter defines whether the module outputs an "Overflow" (7FFFH) or "Underflow" (8000H) value when it detects an open thermocouple.

### Restart

At its restart (initiated by setting the mode selector switch from STOP to RUN, or after POWER ON), the CPU first executes restart OB 100, and then continues with cyclic program execution (OB1.)

During its restart, the CPU reads the → Process image of inputs (PIO), and then executes the STEP 7 user program, starting at the first statement in OB1.

### Retentivity

Data areas in data blocks (DBs), timers, counters and flags are considered retentive if their content is not lost as a result of restart or power off.

### Scaling

STEP 7 parameter for the SM 338; POS-INPUT position detection module. Scaling right-aligns the → Absolute encoder value in the address space; irrelevant places are discarded.

### Segment

→ Bus segment

### SFC

→ System Function

### Signal module

Signal modules (SMs) form the interface between the process and the automation system. These are available as digital and analog input/output and IO modules.



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### Smoothing

STEP 7 parameter for analog input modules. The measured values are smoothed by digital filtering. Users can select module-specific filter properties, i.e. none, low, medium or high. The time constant of the digital filter increases in proportion to the degree of smoothing.

### STARTUP

STARTUP mode initiates the transition from STOP to RUN mode. STARTUP can be triggered by setting the → mode selector, by power on, or by an operator action on the programming device. S7-300 performs a → restart.

### Substitution value

Values output by faulty signal output modules to the process, or used to substitute a process value of a faulty signal input module in the user program.

Users can program the substitute values in STEP 7 (hold last value, substitution value 0 or 1.) Those values must be set at the outputs when the CPU goes into STOP.

### System diagnostics

Denotes the detection, evaluation and reporting of error events within the automation system. Examples of such errors are: program errors, or module failure. System errors may be indicated by LED displays, or in *STEP 7*.

### System Function

A System Function (SFC) is an integral function of the CPU operating system, and can be called in the STEP 7 user program as required.

### Temperature coefficient

*STEP 7* parameter for analog input modules, for temperature measurements taken with resistance thermometers (RTD.) The selected temperature coefficient is specific to the resistance thermometer being used (to DIN standard.)

### Temperature error

Denotes the drift of measured/output values, caused by fluctuation of the ambient temperature at an analog module. It is defined in % per Kelvin, relative to the rated range of the analog module.

### Temperature error of internal compensation

Only applies to the measurement of thermocouples. Defines the error to add to the actual temperature error, when "internal comparison" mode is selected. The error is defined either as a percentile value relative to the physical rated range of the analog module, or as an absolute value in °C.



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### Total current

Total current of all output channels of a digital output module.

### ungrounded

no galvanic connection to ground potential

### User program

Contains statements, tags and data for processing signals which can control a plant or process. It is assigned to a programmable module (CPU, FM, for example) and can be organized in smaller units (blocks).

### Wirebreak

Parameter in *STEP 7*. A wirebreak check is used to monitor line continuity between the encoder and input, or between the actuator and output. The module detects a wirebreak based on a current flow at the appropriately programmed input/output.



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