SIEMENS

SIMATIC

S7-400
S7-400 Automation System Module Data

Reference Manual

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04/2023
A5E00850736-AL

Legal information

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⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

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Qualified Personnel

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

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Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

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Disclaimer of Liability

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

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GERMANY

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Ⓟ 05/2023 Subject to change

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Preface

Purpose of this manual

The information contained in this manual can be used as a reference for operating, for descriptions of the functions, and for the specifications of the signal modules, power supply modules and interface modules of the S7-400.

How to configure, assemble and wire these modules in an S7-400 system is described in the installation manuals for each system.

Basic knowledge required

This manual requires general knowledge of automation engineering.

In addition, you are required to know how to use computers or devices with similar functions (e. g. programming devices) under Windows 2000 or XP operating systems. Since S7-400 is configured with the *STEP 7* basic software, you have to have a good working knowledge of the software. You can acquire this knowledge in the manual *"Programming with STEP 7"*. Read the notes on the safety of electronic controllers in the appendix of the Installation manual – especially when using an S7-400 in safety-relevant areas.

Target group

This manual is aimed at people with the required qualifications to commission, operate and maintain the products described.

Scope of the manual

The manual applies to the S7-400 automation system.

Changes compared to the previous version

The following changes have been made compared to the previous version of this manual S7-400 Automation System; Module Specifications, Edition 05/2007 (A5E00850735-04):

- Standards and approvals have been updated

Approvals

You can find details on the standards and approvals in the General specifications (Page 13)"General technical specifications" chapter.

Position in the information landscape

This manual forms part of the S7-400 documentation.

System	Documentation package
S7-400	• *S7-400 automation system, installation* • *S7-400 automation system, module specifications* • *S7-400 automation system, CPU specifications* • *S7-400 instruction list*

Further Information

You can find further and additional information on the topics in this manual in the following manuals:

Programming with STEP 7 (https://support.industry.siemens.com/cs/ww/en/view/18652056)

Configuring hardware and communication connections with STEP 7 (https://support.industry.siemens.com/cs/ww/en/view/18652631)

System and standard functions (https://support.industry.siemens.com/cs/ww/en/view/44240604)

PROFINET system description (https://support.industry.siemens.com/cs/ww/en/view/19292127)

Recycling and disposal

The S7-400 is environmentally friendly and is thus recyclable. For environmentally compliant recycling and disposal of your discarded device, please contact a company certified for the disposal of electronic waste.

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.

You will find information on who to contact at:

Contact (https://www.siemens.com/automation/partner)

A guide to the technical documents for the various SIMATIC products and systems is available at:

Documentation (https://new.siemens.com/global/en/products/automation/process-control/simatic-pcs-7/technical-documentation.html)

You can find the online catalog and order system under:

Catalog (https://mall.industry.siemens.com/)

Training center

We offer a range of relevant courses to help you to get started with the SIMATIC S7 automation system. Please contact your regional training center or our central training center in 90327 Nuremberg, Germany for details:

Training (https://www.sitrain-learning.siemens.com/)

Technical support

You can contact Technical Support for all Industry Automation products using the Web form for Support Request
Support Request (https://support.industry.siemens.com/cs/ww/en/my)

Service & Support on the Internet

In addition to our documentation, we offer a comprehensive knowledge base online on the Internet at:

Service & Support (https://support.industry.siemens.com/cs/ww/en/)

There you will find:

- Our newsletter containing up-to-date information on your products.
- The latest documents via our search function in Service & Support.
- An international forum where users and specialists can exchange their experiences.
- Your local contact partner for automation and drive technology in our contacts database.
- Information about on-site service, repairs and spare parts. Much more can be found under "Services".
- Applications and tools for optimizing operations with SIMATIC S7. Performance measurements for DP and PN, for example, are also published here.

See also

Standards, certificates and approvals (Page 13)

Security information

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

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

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

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https://www.siemens.com/industrialsecurity.

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

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https://www.siemens.com/cert.

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General specifications

1

1.1 Standards, certificates and approvals

Information on the nameplate

Note

Granted approvals on the nameplate of the device

The specified approvals apply only when the corresponding marking is printed on the product. You can check which of the following approvals have been granted for your product by the markings on the nameplate.

⚠ WARNING

Open Equipment

Death, serious injury or substantial material damage can occur.

S7 400 modules are classified as open equipment, This means that the S7 400 should only be installed in an enclosure or cabinet.

Access to the enclosures or cabinets should only be possible with a key or with a tool, and access should only be permitted for trained or approved personnel.

IEC 61131-2

The S7-400 automation system meets the requirements and criteria of standard IEC 61131-2 (Programmable Controllers, Part 2: Equipment Requirements and Tests.)

CE marking

CE

Our products meet the requirements and protective objectives of the following EU Directives and comply with the corresponding European standards (EN):

- **2011/65/EU** Directive of the European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive)
- Directive **2014/35/EU** of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits (Low Voltage Directive)

- Directive **2014/30/EU** of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC Directive)
- Directive **2014/34/EU** of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (ATEX Directive)

The EC Declaration of Conformity can be downloaded from the Customer Support Internet pages (keyword "declaration of conformity").

UKCA marking

UKCA

UK CA

Our products meet the requirements and protection goals of the following regulations and related supplements:

- Electrical Equipment (Safety) Regulations 2016 (Low Voltage)
- Electromagnetic Compatibility Regulations 2016 (EMC)
- Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016 (Explosion Protection)
- Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (RoHS)

The UK Declaration of Conformity can be downloaded from the Customer Support Internet pages (keyword "declaration of conformity").

UKEX mark

UKEX



DEKRA 21UKEX0012 X

EN IEC 60079-0

EN IEC 60079-7 + A1

II 3 G Ex ec IIC T4 Gc

Importer UK:

Siemens plc

Manchester M20 2UR

CCC marking



CCC

GB/T 3836.3 (Explosive atmospheres-Part 3: Equipment protection by type of protection "e")

GB/T 3836.1 (Explosive atmospheres - Part 1: Equipment - General requirements)

Ex ec IIC T4 Gc

EMC directive

SIMATIC products are designed for industrial applications.

Table 1-1 Use in industry

Area of application	Noise emission requirements	Noise immunity requirements
Industry	EN 61000-6-4	EN 61000-6-2

Low voltage directive

The products in the following table meet the requirements of EU Directive 2014/35/EU "Low Voltage Directive". Compliance with this EU directive has been checked in accordance with DIN EN 61131-2 (corresponds to IEC 61131-2).

Table 1-2 Products that fulfill the requirements of the low-voltage directive

Name	Order number
Digital input module SM 421;DI 32 x UC 120 V	6ES7 421-1EL00-0AA0
Digital output module SM 422;DO 16 x AC 120/230 V/2A	6ES7 422-1FH00-0AB0
Relay output module SM 422;DO 16 x UC30/230 V/Rel5A	6ES7 422-1HH00-0AA0
Digital input module SM 421;DI 16 x UC 120/230 V	6ES7421-1FH20-0AA0
PS 407 4A	6ES7 407-0DA02-0AA0
PS 407 10A	6ES7 407-0KA02-0AA0
PS 407 20A	6ES7 407-0RA02-0AA0
PS 407 10A R	6ES7 407-0KR02-0AA0

Note

In the new releases, some of the devices listed above fulfill the requirements of the explosion protection guidelines instead of those of the low-voltage directive. Please note the information on the nameplate.

ATEX approvals DEKRA 17ATEX0079 X, DEKRA 21ATEX0010 X, and DEKRA 21ATEX0049 X

Type examination certificate number	DEKRA 17ATEX0079 X	DEKRA 21ATEX0010 X	DEKRA 21ATEX0049 X
Standards	EN IEC 60079-0	EN 60079-0	EN IEC 60079-0
	EN 60079-15	EN 60079-7	EN IEC 60079-7 + A1
Marking	II 3 G Ex nA IIC T4 Gc	II3G Ex ec IIC T4 Gc	II 3 G Ex ec IIC T4 Gc
	The DEKRA 17ATEX0079 X certificate is valid for the "ATEX DEKRA 17ATEX0079 X (https://support.industry.siemens.com/cs/ww/en/view/109795684)" products listed in the certificate.	The DEKRA 21ATEX0010 X certificate is valid for the "ATEX DEKRA 21ATEX0010 X (https://support.industry.siemens.com/cs/ww/en/view/109795940)" products listed in the certificate.	The DEKRA 21ATEX0049 X certificate is valid for the "ATEX DEKRA 21ATEX0049 X (https://support.industry.siemens.com/cs/ww/en/view/109811860)" products listed in the certificate.

IECEx approvals IECEx DEK 17.0039X, IECEx DEK 21.0008X, and IECEx DEK 21.0031X

Certificate number	IECEx DEK 17.0039 X	IECEx DEK 21.0008X	IECEx DEK 21.0031 X
Standards	IEC 60079-0	IEC 60079-0	IEC 60079-0
	IEC 60079-15	IEC 60079-7	IEC 60079-7
Marking	Ex nA IIC T4 Gc	Ex ec IIC T4 Gc	Ex ec IIC T4 Gc
	The IECEx DEK 17.0039X certificate is valid for the "IECEx DEK 17.0039X (https://support.industry.siemens.com/cs/ww/en/view/109795682)" products listed in the certificate.	The IECEx DEK 21.0008X certificate is valid for the "IECEx DEK 21.0008X (https://support.industry.siemens.com/cs/ww/en/view/109795939)" products listed in the certificate.	The IECEx DEK 21.0031X certificate is valid for the "IECEx DEK 21.0031X (https://support.industry.siemens.com/cs/ww/en/view/109811862)" products listed in the certificate.

Special conditions in potentially explosive atmospheres (applies to UKEX/CCC/ATEX/ IECEx):

- Within the operating range of the device, the maximum permissible pollution degree is 2 according to EN 60664-1 or GB/T 16935.1.
- The device must be installed in a suitable housing with at least protection class IP54 according to EN IEC 60079-0 or GB/T 3836.1. The ambient conditions must be taken into account during use.
- Precautions must be taken to prevent the rated voltage from being exceeded by more than 119 V due to short-term mains disturbances.

Marking for Australia and New Zealand



Our products meet the requirements of standard EN 61000-6-4.

cULus approval

Note

The markings on the nameplate indicate which cULus approvals have been issued for your product.



Underwriters Laboratories Inc., complying with

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

or cULus approval, Hazardous Location



CULUS Listed E248953 INT. CONT. EQ. FOR HAZ. LOC.

Underwriters Laboratories Inc., complying with

- UL 508 (Industrial Control Equipment)
- CSA C22.2 No. 142 (Process Control Equipment)
- ISA 12.12.01 (Hazardous Location)
- CSA-213 (Hazardous Location)

APPROVED for Use in

- Cl. 1, Div. 2, GP. A, B, C, D T4A
- Cl. 1, Zone 2, GP. IIC T4

Note the following information.

or cULus Approvals, Hazardous Location for Relay Modules



CULUS Listed E223122 INT. CONT. EQ. FOR HAZ. LOC.

Underwriters Laboratories Inc., complying with

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

APPROVED for Use in

- Cl. 1, Div. 2, GP. A, B, C, D T4A
- Cl. 1, Zone 2, GP. IIC T4
- Cl. 1, Zone 2, AEx nC IIC T4

Note the following information.

Note

This product must be installed according to the NEC (National Electric Code) stipulations.

When used in environments according to class I, division 2 (see above), S7-400 must be mounted in an enclosure that corresponds to at least IP54 according to EN 60529.

You can find information about the use of S7-400 in hazardous areas of zone 2 in a separate document, which is included in this documentation package.

⚠ WARNING

Installation Instructions according cULus

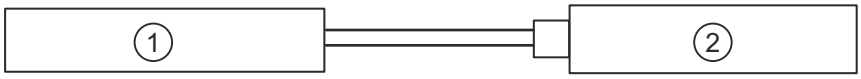
WARNING – Explosion Hazard - Do not disconnect while circuit is live unless area is known to be non-hazardous.

WARNING – Explosion Hazard - Substitution of components may impair suitability for Class I, Division 2 or Class I, Zone 2

This equipment is suitable for use in Class I, Division 2, Groups A, B, C or D; Class I, Zone 2, Group IIC, or non-hazardous locations only.

CuULu requirements for hazardous location on the battery power supply for CPUs

The backup voltage for a CPU must be supplied over a non-incendive plug connection. The figure below shows such a plug connection.



(1) Battery or supply voltage

(2) CPU with "Ext. Batt." connector

Figure 1-1 Back-up voltage supply

The following conditions apply to the performance characteristics of this connection:

Voc (no load voltage) = 15 V	Vmax = 15 V
Isc (short-circuit current)= 50 mA	Imax = 50 mA
Ca = Battery/voltage supply capacity	Ci = 25 nF maximum
La = Battery/voltage supply inductance	Li = 2 mH maximum

The battery/power supply that powers the non-incendive connection must comply with the following ratings:

Battery/Power supply		CPU input "Ext. Batt." with cable
Voc	≤	Vmax (15 V)
Isc	≤	Imax (50 mA)
Ca	≥	Ci + Cc (25 nF + Cc)
La	≥	Li + Lc (2 mH + Lc)
Cc = Cable capacity Lc = Cable inductance		

Note

If you do not know the capacity and inductance of the cable, you can use the following values:

Cc = 197 pF/m (60 pF/ft.), Lc = 0.66 mH/m (0.2 mH/ft)

Example

The Varta 4022 battery together with a 1.5 m long cable and a Leonhardy 02-02.1500 plug meet these conditions.

FM Approval

FM
APPROVED

Factory Mutual Approval Standard Class Number 3611, Class I, Division 2, Group A, B, C, D.

Temperature class: T4 at 60° C ambient temperature

WARNING

Personal injury or property damage can result.

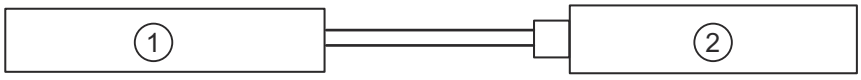
In hazardous areas, personal injury or property damage can result if you create or break an electrical circuit during operation of an S7-400 (for example, by means of plug-in connections, fuses, switches).

Do not create or break live electrical circuits unless you are certain there is no danger of explosion.

When used in FM conditions, the S7-400 must be fitted in an enclosure that corresponds to at least IP54 in accordance with EN 60529.

NEC (National Electric Code) and CEC (Canadian Electric Code) requirements for Hazardous Locations for battery power supply for CPUs

The backup voltage for a CPU must be supplied over a non-incendive plug connection. The figure below shows such a plug connection.



(1) Battery or supply voltage

(2) CPU with "Ext. Batt." connector

Figure 1-2 Back-up voltage supply

The following conditions apply to the performance characteristics of this connection:

Voc (no load voltage) = 15 V	Vmax = 15 V
Isc (short-circuit current)= 50 mA	Imax = 50 mA
Ca = Battery/voltage supply capacity	Ci = 25 nF maximum
La = Battery/voltage supply inductance	Li = 2 mH maximum

The battery/power supply that powers the non-incendive connection must comply with the following ratings:

Battery/power supply		CPU input "Ext. Batt." with cable
Voc	≤	Vmax (15 V)
Isc	≤	Imax (50 mA)
Ca	≥	Ci + Cc (25 nF + Cc)
La	≥	Li + Lc (2 mH + Lc)
Cc = Cable capacity Lc = Cable inductance		

Note

The concept of non-incendive field wiring allows the interconnection of devices with non-incendive field wiring using any wiring method approved for unclassified sites.

If you do not know the capacity and inductance of the cable, you can use the following values:

Cc = 197 pF/m (60 pF/ft.), Lc = 0.66 mH/m (0.2 mH/ft)

Marine Approvals

Classification societies:

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

Safety requirements for installation

The S7-400 automation system is "open-type equipment" in accordance with standard IEC 61131-2 and therefore EU Directive 2014/35/EU (Low Voltage Directive), and "open type" in accordance with UL/CSA certification.

To fulfill requirements for safe operation with regard to mechanical stability, flame retardation, stability, and shock-hazard protection, the following alternative types of installation are specified:

- Installation in a suitable cabinet
- Installation in a suitable housing
- Installation in a suitably equipped, enclosed operating area.

1.2 Electromagnetic compatibility

Introduction

This section provides details of the immunity of S7-400 modules and information on RFI suppression.

All components of the S7-400 automation system meet the requirement of the standards applicable in Europe provided the system is installed in accordance with all applicable regulations (see *Installation manual, sections 2 and 4*).

"EMC" definition

Electromagnetic compatibility (EMC) is the ability of an electrical device or system to operate satisfactorily in its electromagnetic environment without affecting that environment.

⚠ WARNING

Personal injury or property damage can result.

Installing expansions that are not approved for the S7-400 can breach the requirements and regulations governing safety and electromagnetic compatibility.

Only use expansions that are approved for the system.

Pulse-shaped interference

The table below shows the electromagnetic compatibility of the modules with pulse shaped interference. The system S7-400 system must meet the requirements and guidelines for electrical assembly.

Table 1-3 Pulse-shaped interference

Pulse-shaped interference	Test voltage		Corresponds to immunity test level
Electrostatic discharge in accordance with IEC 61000-4-2	Air discharge: Contact discharge:	±8 kV ±6 kV	3
Burst (electrical fast transient) in accordance with IEC 61000-4-4	2 kV (power supply line) 2 kV (signal line >30 m) 1 kV (signal line <30 m)		3
Surge in accordance with IEC 61000-4-5			3
• Asymmetrical connection	2 kV (supply line) DC with protective components 2 kV (signal line/data line only > 30 m), where applicable with protective components		
• Symmetrical connection	1 kV (supply line) DC with protective components 1 kV (signal line only > 30 m), where applicable with protective components		

Sinusoidal interference

The table below shows S7-400 module EMC for sinusoidal interference.

Table 1-4 Sinusoidal interference

Sinusoidal interference	Test values	Corresponds to immunity test level
High frequency radiation (electromagnetic fields) in accordance with IEC 61000-4-3	80 MHz to 1 GHz and 1.4 GHz to 2 GHz 10 V/m with 80 % amplitude modulation at 1 kHz 2 GHz to 2.7 GHz 3 V/m with 80 % amplitude modulation at 1 kHz	3
HF currents on cables and cable shielding in accordance with IEC 61000-4-6	Test voltage 10 V with 80 % amplitude modulation of 1 kHz in a range of 10 kHz to 80 MHz	3

Emission of radio frequency interference

Emissions from electromagnetic fields in accordance with EN 61000-6-4.

Emissions over main AC supply in accordance with 61000-6-4.

Line harmonics

The AC power modules for S7-400 comply with the following standards for line harmonics:

Harmonic current: EN 61000-3-2

Voltage supply fluctuations and flicker: EN 61000-3-3

Additional measures

If you want to connect an S7-400 system to the public network, you must ensure compliance with **class B pursuant to EN 55032.**

Appropriate additional measures are to be taken if you need to increase the immunity of the system in the light of high external interference.

1.3 Shipping and storage conditions for modules and backup batteries

Transport and storage of modules

S7-400 modules exceed the requirements of IEC 61131-2 with regard to transport and storage conditions. The following specifications apply for modules that are transported or stored in their original packaging.

Table 1-5 Transport and storage conditions for modules

	Permitted range
Free fall	≤ 1 m (up to 10 kg)
Temperature	-40°C to +70 °C
Air pressure	1080 to 660 hPa (corresponds to a height of -1000 to 3500 m)
Relative humidity (at +25 °C)	5% to 95%, non-condensing
Sinusoidal oscillations according to IEC 60068-2-6	5 - 9 Hz: 3.5 mm 9 - 500 Hz: 9.8 m/s^2
Shock according to IEC 60068-2-29	250 m/s^2, 6 ms, 1000 shocks

Transport and buffer batteries

If possible, transport buffer batteries in their original packaging. No special measures are required for the transport of the buffer batteries used in the S7-400 system. The lithium content of the buffer battery is less than 0.5 g.

Storage of buffer batteries

Buffer batteries must be stored in a cool and dry place. The maximum storage period is 10 years.

⚠ WARNING

Danger of personal injury and property damage, danger of irritation by harmful substances.

Incorrect handling can cause a lithium battery to explode, and incorrect disposal of old lithium batteries can release harmful substances. It is therefore essential that you observe the following instructions:

Do not throw new or discharged batteries into fire and do not solder on the cell body (max. temperature 100 °C), also do not recharge - danger of explosion! Do not open batteries, only replace them with identical types. Only obtain replacements from Siemens (for order number, see *Reference Manual "Module Data"*, Appendix C (Page 365)). This ensures that you have a short-circuit-proof type.

If possible, old batteries should be given to battery manufacturers/recyclers or disposed of as hazardous waste.

1.4 Mechanical and ambient conditions for S7-400 operation

Conditions of use

Without additional measures, the S7-400 must **not** be used, for example:

- 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 installations in potentially hazardous areas

An additional measure can be installation of the S7-400 in a cabinet or in a housing, for instance.

Mechanical environmental conditions

The following table shows the mechanical environmental conditions for S7-400 modules in the form of sinusoidal vibrations.

Table 1-6 Mechanical environmental conditions

Frequency range in Hz	Test values
$10 \leq f \leq 58$	0.075 mm amplitude
$58 \leq f \leq 500$	1 g constant acceleration

Reduction of vibrations

If the S7-400 is subject to big shocks or vibrations appropriate measures must be taken to reduce the acceleration or the amplitude.

We recommend fixing the S7-400 on damping materials (rubber-metal anti-vibration mountings, for example).

Checking mechanical environmental conditions

The following table provides information on the type and scope of checks regarding mechanical environmental conditions.

Table 1-7 Checking Mechanical Environmental Conditions

Checking for ...	Test standard	Comments
vibrations	Vibration test according to IEC 60068-2-6 (sine)	Type of vibration: Frequency sweeps with a sweep rate of 1 octave/minute. 10 Hz ≤ f ≤ 58 Hz, constant amplitude 0.075 mm 58 Hz ≤ f ≤ 500 Hz, constant acceleration 1g Period of oscillation: 10 frequency sweeps per axis in each of the 3 axis which are vertical to each other.
Shock	Shock test according to IEC 60068-2-29	Type of shock: half-sine Strength of shock: 10g peak value, 6 ms duration Shock direction: 100 frequency sweeps per axis in each of the 3 axis which are vertical to each other.

Climatic environmental conditions

The S7-400 can be used in the following climatic ambient conditions:

Table 1-8 Climatic environmental conditions

Ambient conditions	Permitted range	Remark
Temperature	0 to +60 °C	
Temperature change	Max. 10 °C/h	
Relative humidity	Max. 95 % at +25 °C	No condensation
Air pressure	1080 to 795 hPa (corresponds to a height of -1000 to 2000 m)	
Contaminant concentration	SO_2: < 0.5 ppm; RH < 60 %, no condensation H_2S: < 0.1 ppm; RH < 60 %, no condensation	Test: 10 ppm; 21 days Test: 1 ppm; 21 days
	ISA-S71.04 severity level G1; G2; G3	-

1.5 Information on insulation tests, protection class and degree of protection

Test voltages

Where required, insulation resistance is proved in routine testing with test voltages in accordance with IEC 61131-2.

Protection class

Protection class I in accordance with IEC 61140, i.e. protective conductor connection to power module required!

Protection from foreign objects and water

IP20 in accordance with IEC 60529, i.e. protection against contact with standard probes.

There is no water ingress protection.

Rack

2

2.1 Function and design of the racks

Introduction

The racks for the S7-400 have the following functions:

- They physically hold the modules.
- They supply the modules with operating voltage.
- They connect the individual modules to each other via the signal busses.

Design of the racks

A rack consists of the following elements:

- Mounting rail with threaded bolts for fixing the modules and lateral cutouts for mounting the rack
- Plastic parts that function, among other things, as guides when swinging the modules into place
- A backplane bus, an I/O bus and, if necessary, a communication bus with bus connector
- Connection for local ground

The following figure shows the mechanical configuration of a rack (UR1).

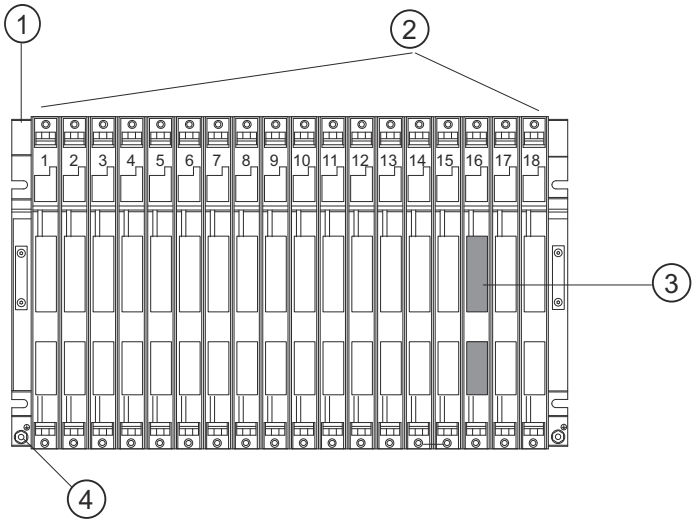


Figure 2-1 Configuration of a rack with 18 slots

(1) Mounting rail

(2) Plastic parts

(3) Bus connector (covered when shipped)

(4) Connection for local ground

UL/CSA note

Special requirements should be taken into consideration in the area of influence of the UL/CSA; these may be fulfilled by installing the system in a cabinet.

2.2 The racks UR1 (6ES7400-1TAx1-0AA0) and UR2 (6ES7400-1JAx1-0AA0)

Order number

The "x" variable has the following meaning for order numbers 6ES7400-1TAx1-0AA0 and 6ES7400-1JAx1:

- x=0: Mounting rail made of sheet steel
- x=1: Mounting rail made of aluminum

Introduction

The UR1 and UR2 racks are used for setting up central racks and expansion racks. The UR1 and UR2 racks have both an I/O bus and a communication bus.

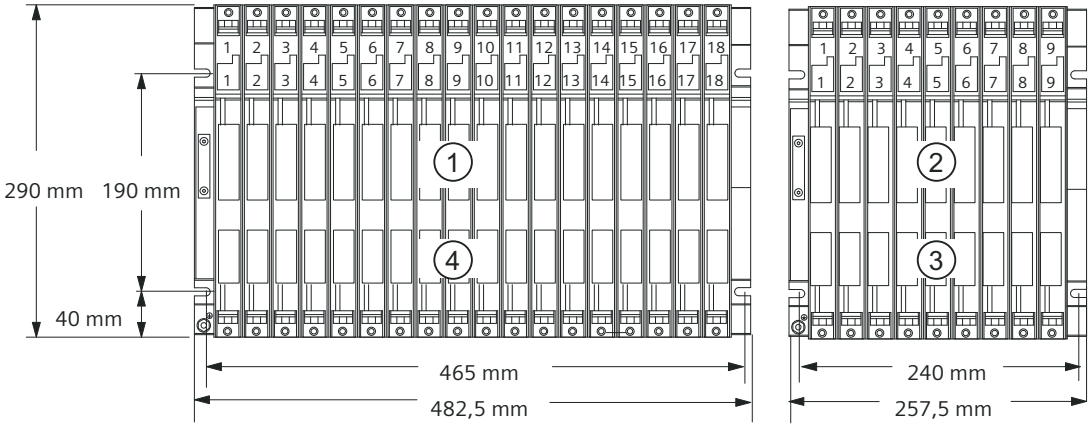
Suitable modules for UR1 and UR2

You can use the following modules in the UR1 and UR2 racks:

- When the UR1 or UR2 is used as a central rack:
  All S7-400 modules except receive IMs
- When the UR1 or UR2 is used as an expansion rack:
  All S7-400 modules except CPUs and send IMs

Special case: Power supply modules must not be used together with the receive IM IM 461-1.

Design of the UR1 and UR2



(1)+(2) I/O bus

(3)+(4) Communication bus

Figure 2-2 UR1 rack with 18 slots and UR2 with 9 slots

Specifications of the UR1 and UR2 racks

Article number	6ES7400-1TA01-0AA0	6ES7400-1TA11-0AA0	6ES7400-1JA01-0AA0	6ES7400-1JA11-0AA0
General information				
Product type designation	UR1		UR2	
Hardware configuration				
Rack				
• Communication bus	Yes			
• P bus	Yes			
Slots				
• Number of slots	18		9	
Standards, approvals, certificates				
CE mark	Yes			
UKCA mark	Yes			
UL approval	Yes			
FM approval	Yes			
RCM (formerly C-TICK)	Yes			
KC approval	Yes			
EAC (formerly Gost-R)	Yes			
CCC	Yes			
Ambient conditions				
Ambient temperature during operation				
• min.	0 °C			
• max.	60 °C			
Ambient temperature during storage/transportation				
• min.	0 °C			
• max.	70 °C			
Mechanics/material				
rack profile material		aluminum		aluminum
Dimensions				
Width	482.5 mm		257.5 mm	
Height	290 mm			
Depth	27.5 mm			
Weights				
Weight, approx.	4.1 kg	3 kg	2.15 kg	1.5 kg

2.3 The UR2-H rack (6ES7400-2JAx0-0AA0)

Order number

In order number 6ES7400-2JAx0-0AA0, the "x" placeholder has the following meaning:

- x=0: Mounting rail made of sheet steel
- x=1: Mounting rail made of aluminum

Introduction

The UR2-H rack is used for setting up two central racks or expansion racks in one rack. In functional terms, the UR2-H rack represents two electrically isolated UR2 racks on the same mounting rail. The UR2-H is mainly used for compact setup of redundant S7-400H systems (two devices or systems in one rack).

Suitable modules for UR2-H

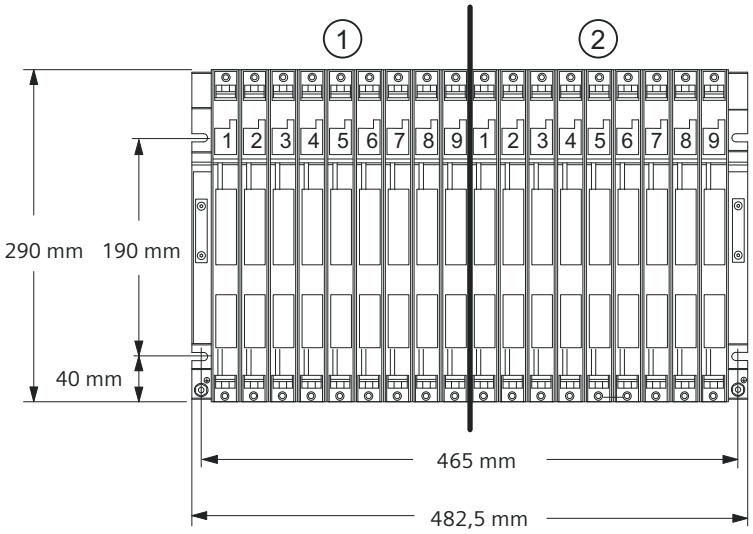
You can use the following modules in the UR2-H rack:

- When the UR2-H is used as a central rack:
  All S7-400 modules except receive IMs
- When the UR2-H is used as an expansion rack:
  All S7-400 modules except CPUs, send IMs, the IM 463-2 and the adapter module.

Special case: Power supply modules must not be used together with the receive IM IM 461-1.

Design of the UR2-H

The following figure shows the design of the UR2-H rack with 2x9 slots.



(1) Device I

(2) Device II

Figure 2-3 Dimensions of the rack

CAUTION

Property damage may occur.

If you plug a power supply module in a slot that is not intended for power supply modules, the module may be damaged. Slots 1 to 4 are permitted, whereby the power supply modules must be plugged in starting from slot 1 without leaving gaps.

Make sure that power supply modules are only plugged into permitted slots. Pay particular attention to the possibility of confusion between slot 1 in device II and slot 9 in device I.

Technical specifications of the UR2-H rack

Article number	6ES7400-2JA00-0AA0	6ES7400-2JA10-0AA0
General information		
Product type designation	UR2-H	
Hardware configuration		
Rack		
• Communication bus	Yes; Separated	
• P bus	Yes; Separated	
Slots		
• Number of slots	18; 2 segments with 9 slots each	
Standards, approvals, certificates		
CE mark	Yes	
UKCA mark	Yes	
UL approval	Yes	
FM approval	Yes	
RCM (formerly C-TICK)	Yes	
KC approval	Yes	
EAC (formerly Gost-R)	Yes	
CCC	Yes	
Ambient conditions		
Ambient temperature during operation		
• min.	0 °C	
• max.	60 °C	
Ambient temperature during storage/ transportation		
• min.	0 °C	
• max.	70 °C	
Mechanics/material		
rack profile material		aluminum
Dimensions		
Width	482.5 mm	
Height	290 mm	
Depth	27.5 mm	
Weights		
Weight, approx.	4.1 kg	3 kg

2.4 Rack CR2 (6ES7401-2TA01-0AA0)

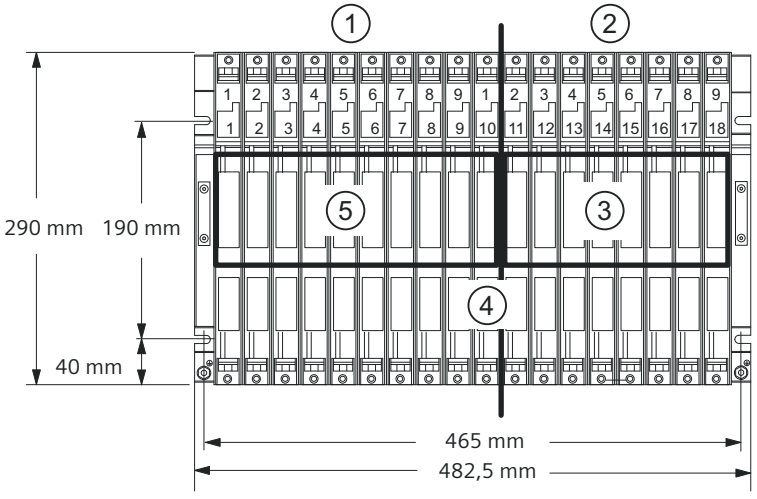
Introduction

The CR2 rack is used for setting up segmented central racks. The CR2 has both an I/O bus and a communication bus. The I/O bus is divided into two local bus segments with 10 and 8 slots respectively.

Suitable modules for CR2

You can use all S7-400 modules except receive IMs in the CR2 rack.

Design of the CR2



(1) Segment 1
(2) Segment 2
(3) I/O bus segment 2
(4) Communication bus
(5) I/O bus segment 1

Technical specifications of the CR2 rack

Article number	6ES7401-2TA01-0AA0
General information	
Product type designation	CR2
Hardware configuration	
Rack	
• Communication bus	Yes; Throughout both segments
• P bus	Yes; Separated
Slots	
• Number of slots	18; 2 segments with 8 or 10 slots
Standards, approvals, certificates	
CE mark	Yes
UKCA mark	Yes
UL approval	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
KC approval	Yes
EAC (formerly Gost-R)	Yes
CCC	Yes
Ambient conditions	
Ambient temperature during operation	
• min.	0 °C
• max.	60 °C
Ambient temperature during storage/transportation	
• min.	0 °C
• max.	70 °C
Dimensions	
Width	482.5 mm
Height	290 mm
Depth	27.5 mm
Weights	
Weight, approx.	4.1 kg

2.5 Rack CR3 (6ES7401-1DA01-0AA0)

Introduction

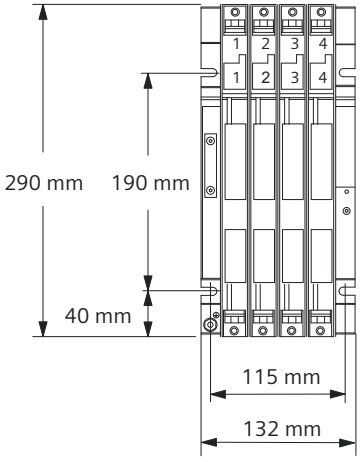
The CR3 rack is used for setting up central racks in standard systems (not in high-availability systems). The CR3 has both an I/O bus and a communication bus.

Suitable modules for CR3

You can use the following modules in the CR3:

- All S7-400 modules except receive IMs
- A CPU 41x-4H may only be used in stand-alone operation.

Design of the CR3



Technical specifications of the CR3 rack

Article number	6ES7401-1DA01-0AA0
General information	
Product type designation	CR3
Hardware configuration	
Rack	
• Communication bus	Yes
• P bus	Yes
Slots	
• Number of slots	4
Standards, approvals, certificates	
CE mark	Yes
UKCA mark	Yes
UL approval	Yes
FM approval	Yes
RCM (formerly C-TICK)	Yes
KC approval	Yes
EAC (formerly Gost-R)	Yes
CCC	Yes
Ambient conditions	
Ambient temperature during operation	
• min.	0 °C
• max.	60 °C
Ambient temperature during storage/transportation	
• min.	0 °C
• max.	70 °C
Dimensions	
Width	130 mm
Height	290 mm
Depth	27.5 mm
Weights	
Weight, approx.	750 g

2.6 The ER2 rack (6ES7403-1JAx1-0AA0)

Order number

In the article number 6ES7403-1JAx1-0AA0, the "x" placeholder has the following meaning:

- x=0: Mounting rail made of sheet steel
- x=1: Mounting rail made of aluminum

Introduction

The ER2 rack is used for setting up extension racks.

The ER2 rack has only one I/O bus with the following restrictions:

- Interrupts from the ER2 module have no effect because there are no interrupt lines.
- Modules in ER2 are not supplied with 24 V. Modules that require a 24 V supply are not intended for use in ER2.
- Modules in ER2 are not backed up by the battery in the power supply module or by the voltage supplied externally to the CPU module or the receive IM (EXT. BATT socket).
  There is therefore no advantage in using backup batteries in the ER2 power supply modules. Battery failures and backup voltage errors are not reported to the CPU. Therefore, battery monitoring should always be switched off for a power supply module installed in ER2.

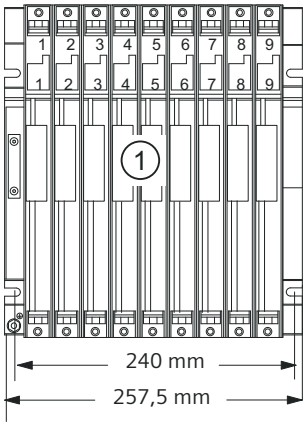
Suitable modules for ER2

You can use the following modules in the ER2:

- All power supply modules
- Receive IMs
- All signal modules, provided that the above restrictions are observed.

Special case: Power supply modules must not be used together with the receive IM IM 461-1.

Design of the ER2



(1) I/O bus

Technical specifications of the ER2 rack

Article number	6ES7403-1JA01-0AA0	6ES7403-1JA11-0AA0
General information		
Product type designation	ER2	
Hardware configuration		
Rack		
• Communication bus	No	
• P bus	Yes	
Slots		
• Number of slots	9	
Standards, approvals, certificates		
CE mark	Yes	
UKCA mark	Yes	
UL approval	Yes	
FM approval	Yes	
RCM (formerly C-TICK)	Yes	
KC approval	Yes	
EAC (formerly Gost-R)	Yes	
CCC	Yes	
Ambient conditions		
Ambient temperature during operation		
• min.	0 °C	
• max.	60 °C	
Ambient temperature during storage/ transportation		
• min.	0 °C	
• max.	70 °C	
Mechanics/material		
rack profile material		aluminum
Dimensions		
Width	257.5 mm	
Height	290 mm	
Depth	27.5 mm	
Weights		
Weight, approx.	2 200 g	1 250 g

Power supply modules

3

3.1 Common characteristics of the power supply modules

Purpose of the power supply modules

The power supply modules of the S7-400 supply the other modules in the rack with their operating voltages via the backplane bus. They do not provide load voltages for the signal modules.

Common properties of all power supply modules

In addition to their module-specific technical specifications, power supply modules share the following properties:

- Encapsulated design for use in racks of the S7-400 system.
- Heat dissipation through natural convection
- Plug-in connection of the supply voltage with AC - DC coding
- Protection class I (with protective conductor) according to IEC 61140 (VDE 0140, part 1)
- Limiting of inrush current according to NAMUR recommendation NE 21
- Short-circuit-proof outputs
- Monitoring of the two output voltages. If one of these voltages fails, the power supply module signals an error to the CPU.
- The two output voltages (5 V DC and 24 V DC) have a common ground.
- Primary clocked
- Battery backup is possible. The set parameters and the memory contents (RAM) are buffered in CPUs and configurable modules over the backplane bus. The backup battery thus enables a hot restart of the CPU. Both the power supply module and the battery-backed modules monitor the battery voltage.
- Operation and error display via LEDs on the front plate

Note

A disconnect switch must be provided when installing AC power supply modules.

Switching the line voltage off/on

The power supply modules have inrush current limiting in accordance with NAMUR.

Power supply module in improper slot

If you plug the power supply module of a rack into a slot not intended for it, it will not go into operation. In this case, proceed as follows to correctly put the power supply module into operation:

1. Disconnect the power supply from the supply system (not just standby switch).
2. Remove the power supply module.
3. Install the power supply module in slot 1.
4. Wait at least 1 minute and then switch the supply voltage back on.

CAUTION

Property damage may occur.

If you plug a power supply module in a slot that is not intended for power supply modules, the module may be damaged. Slots 1 to 4 are permitted, whereby the power supply modules must be plugged in starting from slot 1 without leaving gaps.

Make sure that power supply modules are only plugged into permitted slots.

3.2 Redundant power supply modules

Order numbers and function

Table 3-1 Power supply modules with redundant capability

Type	Order number	Input voltage	Output voltage	See section
PS 407 10A R	6ES7 407-0KR02-0AA0	85 V to 264 V AC or 88 V to 300 V DC	5 V DC/10 A and 24 V DC/1 A	3.9 (Page 61)
PS 405 10A R	6ES7 405-0KR02-0AA0	19.2 V to 72 V DC	5 V DC/10 A and 24 V DC/1 A	3.15 (Page 70)

Redundant operation

With two power supply modules of the type PS 407 10A R or PS 405 10A R, you can set up a redundant power supply for a rack. This is recommended if you want to increase the availability of your controller, especially if you must operate it on an unreliable power system.

Setting up a redundant power supply

Redundant operation is possible with the S7 CPUs and racks described in this documentation package. STEP 7 V4.02 or higher is also required.

To set up a redundant power supply, plug one power supply module each into slots 1 and 3 of the rack. You can then equip the rack with as many modules as can be supplied by a single power supply, i.e. for redundant operation, all the modules used may draw a total of 10 A.

Properties

The redundant power supply of an S7-400 has the following properties:

- The power supply module has inrush current limiting in accordance with NAMUR.
- Each of the two power supply modules can take over supplying power to the entire rack if the other one fails. There is no interruption of operation.
- Each of the two power supply modules can be replaced while the system is in operation. Neither voltage dips nor voltage peaks in the useful voltages occur when modules are unplugged and plugged.
- Each of the two power supply modules monitors its function and reports its failure.
- Neither power supply module can generate a fault that affects the output voltage of the other power supply module.
- A redundant battery concept (backup concept) only exists if two backup batteries are used in each of the two power supply modules. If only one battery is used in each module, only non-redundant battery backup is possible, since both batteries are under load simultaneously.

- The failure of a power supply module is signaled by a pull/plug interrupt (default STOP). The CPU in the 2nd segment of the CR2 does not report the failure of a power supply module.
- If two power supply modules are plugged in but only one is switched on, there is an ON delay of up to one minute when the line voltage is switched on.

Note

In the Properties dialog box of the CPU, "Startup when expected/actual config. differ" should be enabled.

3.3 Backup battery (option)

Introduction

The power supply modules of the S7-400 have a battery compartment for one or two backup batteries. The installation of these backup batteries is optional.

Function of the backup battery(ies)

If backup batteries have been installed, the set parameters and the memory contents (RAM) are buffered via the backplane bus if the power supply module is switched off or the supply voltage in CPUs and configurable modules fails, as long as the battery voltage is within tolerance.

Furthermore, the backup battery enables a hot restart of the CPU after power ON.

Both the power supply module and the battery-backed modules monitor the battery voltage.

Inserting the backup battery

Activate battery monitoring after inserting one or two backup batteries. Then make sure that neither the corresponding BATT1F or BATT2F LED nor the BAF LED are lit when the power supply is ON. Only then is the backup battery working properly and the buffering guaranteed, as described above.

Note

Plug the power supply module into the rack and switch it on before inserting a backup battery for the first time. By doing so, you will extend the service life of the backup battery.

Power supply modules with two backup batteries

Some power supply modules have a battery compartment for two batteries. If you insert two batteries and set the switch to 2BATT, the power supply module defines one of the two batteries as the backup battery. This assignment remains in force until the battery is empty. When the backup battery is completely empty, the system switches to the reserve battery, which in turn is used as the backup battery for the duration of its life. The "Backup battery" status is also stored across a power failure.

Battery type

Only batteries approved by Siemens may be used (see Appendix C: Spare parts (Page 365))

The batteries can form a passivation layer. Depassivation takes place after insertion into the power supply module.

Technical specifications of the backup battery

Article number	6ES7971-0BA00
General information	
Product type designation	3.6 V backup battery
Accessories	
belongs to product	S7-400
Weights	
Weight, approx.	25 g

Buffer times

The maximum buffer time results from the capacity of the backup battery(ies) used and the backup current in the rack. The latter is the sum of the individual currents of the plugged-in battery-backed modules plus the power supply module's own current draw when the power is OFF.

Example for calculation of buffer times

The capacity of the batteries is listed in the technical specifications of the respective power supply, and the typical and maximum backup current of the battery-backed module in the technical specifications of the module.

The typical backup current of a CPU is an empirically determined value, and the maximum backup current is a worst-case value determined by summing the corresponding manufacturer specifications of the memory blocks.

Thus, for a central rack with a PS 407 10A (6ES7407-0KA02-0AA0) and a CPU 410-5H (6ES7410-5HX08-0AB0) as the only battery-backed module, buffer times result from the following technical specifications:

- Capacity of the backup battery: 2.3 Ah
- Maximum backup current (own draw when power is OFF) of the power supply: 120 µA
- Typical backup current of the CPU 410-5H: 370 µA to 40 °C

Since a load is placed on the backup battery by the periodic depassivation at power ON, 100% of the nominal capacity should not be assumed when calculating the buffer time.

A battery capacity of 63% of the nominal capacity results in the following calculation:

Buffer time = 2.3 Ah * 0.63 / (120 + 370)µA = (1.449 / 490) * 1 000 000 = 2957 h

This results in a maximum buffer time of 123 days.

3.4 Operator controls and indicators

Introduction

The power supply modules of the S7-400 have essentially the same controls and indicators. The main differences are:

- Power supply modules with a backup battery have an LED (BATTF) that indicates an empty, defective, or missing backup battery.
- Power supply modules with two redundant backup batteries have two LEDs (BATT1F and BATT2F) to indicate empty, defective or missing backup battery.

Operator controls and indicators

The figure shows you an example of a power supply module (PS 407 20A) with two (redundant) backup batteries. The LEDs are at the top left of the module front plate.

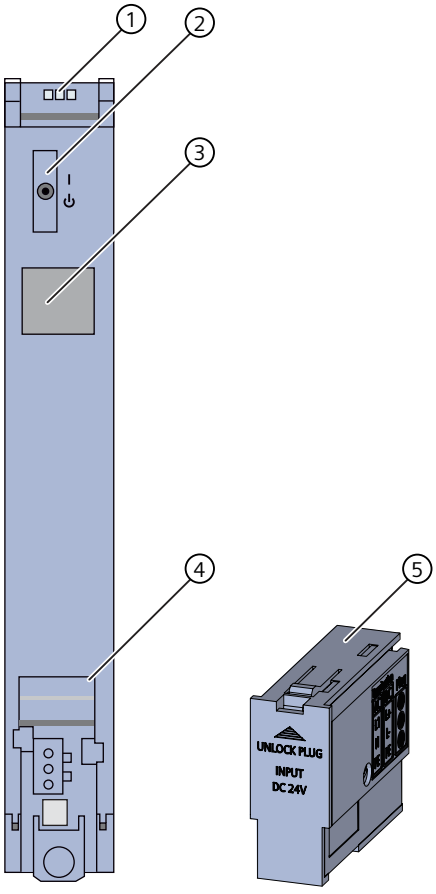


Figure 3-1 Operator controls and indicators on the PS 407 20A power supply module

Meaning of the LEDs

The meaning of the LEDs on the power supply modules is described in the tables below. The following section contains a list of the faults indicated by these LEDs and notes on how to acknowledge the faults.

LEDs INTF, 5 VDC, 24 VDC

Table 3-2 LEDs INTF, 5 VDC, 24 VDC

LED	Color	Meaning
INTF	Red	Lights up in the event of an internal fault
5 VDC	green	Lights up as long as the 5 V voltage is within the tolerance limits
24 VDC	green	Lights up as long as the 24 V voltage is within the tolerance limits

LEDs BAF, BATTF

Power supply modules with a backup battery have the following indicators:

Table 3-3 LEDs BAF, BATTF

LED	Color	Meaning
BAF	Red	Lights up if the battery voltage on the backplane bus is too low and the BATT.INDIC switch is at the BATT position
BATTF	Yellow	Lights up if the battery is empty, if the polarity is reversed, or if the battery is missing, and the BATT.INDIC switch is at the BATT position

LEDs BAF, BATT1F, BATT2F

Power supply modules with two backup batteries have the following indicators:

Table 3-4 LEDs BAF, BATT1F, BATT2F

LED	Color	Meaning
BAF	Red	Lights up if the battery voltage on the backplane bus is too low and the BATT.INDIC switch is at the 1 BATT or 2 BATT position
BATT1F	Yellow	Lights up if battery 1 is empty or if the polarity is reversed or if the battery is missing, and the BATT.INDIC switch is at the 1 BATT or 2 BATT position
BATT2F	Yellow	Lights up if the battery 2 is empty, if the polarity is reversed, or if the battery is missing, and the BATT.INDIC switch is at the 2 BATT position

Backup voltage to the backplane bus

The backup voltage is either supplied by the backup battery or fed externally into the CPU or receiver IM. In its normal state, the level of the backup voltage is between 2.7 V and 3.6 V.

The backup voltage is monitored at the lower limit. Violation of the lower limit is indicated by the BAF LED and reported to the CPU.

BAF lights up if the backup voltage on the backplane bus is too low. Possible causes of this include:

- Battery (batteries) empty or battery polarity has been reversed.
- External supply via CPU or receive IM is defective or supply from secondary power supply module is defective or missing.
- Short-circuit or overload on the battery voltage.

Note

Due to internal capacities, if you remove the battery or switch off the external supply, some time may elapse before BAF, BATT1F, or BATT2F lights up.

Function of the operator controls of the power supply modules

Table 3-5 Function of the operator controls of the power supply modules

Control	Function	
FMR button	For acknowledging and resetting a fault indicator after correcting the fault	
Standby switch	Switches the output voltages (5 V VDC24 VDC) to 0 V by intervening in the control loop (no mains disconnection).	
	• |	Output voltages at nominal value
	• ⏻	Output voltage 0 V
Switches BATT.INDIC	Used for setting LEDs and battery monitoring Where one battery can be used (PS 407 4A, PS 405 4A): • OFF: LEDs and monitor signals inactive • BATT: BAF/BATTF LEDs and monitor signals active Where two batteries can be used (PS 407 10A, PS 407 20A, PS 405 10A, PS 405 20A): • OFF: LEDs and monitor signals inactive • 1 BATT: Only BAF/BATT1F LEDs (for battery 1) active. • 2 BATT: BAF/BATT1F/BATT2F LEDs (for batteries 1 and 2) active.	
Battery compartment	For backup battery (batteries)	
Power connection	3-pin connector for the power main (do not pull and plug under power)	

Cover

The battery compartment, battery selector switch, voltage selector switch and power connection are housed under one cover. The cover must remain closed during operation in order to protect these operator controls and to prevent static electricity from affecting the battery connections.

Discharge your body before you start taking any measurements on a module. Do so by touching grounded metallic parts. Always use grounded measuring instruments.

3.5 Fault/Error messages via LEDs

Introduction

The power supply modules of the S7-400 report module faults and backup battery failures via LEDs on the front plate.

Overview of the error messages of the power supply modules

Table 3-6 Error messages of the power supply modules

Type of error	LED display
Module fault	INTF DC5V DC24V
Backup battery failure	Power supply with 1 backup battery: BAF BATTF
	Power supply with 2 backup batteries: BAF BATT1F BATT2F

LED displays INTF, DC5V, DC24V

The following table lists the errors indicated by the LED displays INTF, DC5V and DC24V and provides information on troubleshooting. The status of the LED displays BAF, BATTF, BATT1F and BATT2F is not relevant here.

Table 3-7 LED displays INTF, DC5V, DC24V

INTF LED	DC5V LED	DC24V LED	Cause of error	Remedy
Off	Off	Off	Standby switch in ⏻ position	Put standby switch in | position
			No line voltage	Check line voltage
			Internal error, power supply module defective	Replace power supply module
			Shutdown after overvoltage at 5 V or impermissible external power supply	Disconnect from supply system and reconnect after approx. 3 minutes, remove external power supply if necessary.
			Operation of the power supply module at the wrong slot	Install the power supply module in the correct slot (slot 1).
			Short-circuit or overload at 5 V	Switch off the power supply module, eliminate the cause of the short-circuit, after approx. 3 s the power supply module can be switched on again with the standby switch or via the supply system.

INTF LED	DC5V LED	DC24V LED	Cause of error	Remedy
Off	On	Off	Overvoltage at 24 V	Check whether external power supply is present; if not, replace power supply module.
On	Off*	Off	Short-circuit or overload at 5 V and 24 V and overtemperature	Check the load on the power supply module. Remove the module if necessary. Wait 5 minutes before switching the power supply module back on.
On	On	Off	If standby switch is in ⏻ position, impermissible external power supply at 5 V.	Remove all modules; identify faulty modules.
			Standby switch in | position, short-circuit or overload at 24 V.	Check the load on the power supply module. Remove the module if necessary.
Off	Flash	On	Voltage recovery after short-circuit or overload at 5 V, if error occurred during operation.	Press the FMR button: flashing turns to steady light.
			Dynamic overload at 5 V.	Check the load on the power supply module. Remove module if necessary.
Off	Flash	Flash	Voltage recovery after short-circuit or overload at 5 V and 24 V, if error occurred during operation.	Press the FMR button: flashing turns to steady light.
Off	Flash	Flash	Dynamic overload at 5 V and 24 V.	Check the load on the power supply module. Remove module if necessary.
Off = LED is dark; On = LED is lit; Flash = LED is flashing;				

* If the power supply module does not restart after a few seconds after elimination of the overload, disconnect the module from the supply system for 5 minutes and then switch it on again. If the module still does not start up, you must replace it. This applies to the following power supply modules:

- 6ES7405-0DA02-0AA0, 6ES7407-0DA02-0AA0
- 6ES7405-0KA02-0AA0, 6ES7407-0KA02-0AA0
- 6ES7405-0KR02-0AA0, 6ES7407-0KR02-0AA0
- 6ES7405-0RA02-0AA0, 6ES7407-0RA02-0AA0

The response of the built-in overtemperature protection is the same.

If either the DC5V or DC24V LED remains dark after switch-on, the system does not power up.

If either the DC5V or DC24V LED of the PS 407 10AR remains dark for longer than approx. 1 to 2 seconds after switch-on, the power supply module does not start up.

In the event of short-circuit or overload, the power supply modules listed below switch off after 1 s to 3 s. After 3 s at the latest, the module attempts a hot restart. If the error has been eliminated by then, the module starts up. This applies to the modules:

Modules	
PS 405 4A (6ES7405-0DA02-0AA0)	PS 407 4A (6ES7407-0DA02-0AA0)
PS 405 10A (6ES7405-0KA02-0AA0)	PS 407 10A (6ES7407-0KA02-0AA0)
PS 405 10A R (6ES7405-0KR02-0AA0)	PS 407 10A R (6ES7407-0KR02-0AA0)
PS 405 20A (6ES7405-0RA02-0AA0)	PS 407 20A (6ES7407-0RA02-0AA0)

Overload at 24 V

In the event of overload at 24 V, the output current is electronically limited to a value between 100 and 150% of the nominal value. If this causes the voltage to fall below the undervoltage threshold of 19.2 V (-0/+5% corresponds to 19.2 to 20.16 V), the modules behave as follows:

- In the case of the power supply modules, the 24 V voltage is switched off and then switched on again every 0.5 to 1 s until an output voltage above the undervoltage threshold is established.
- In the case of the 6ES740x-0KR00-0AA0 and 6ES740x-0KR01-0AA0 power supply modules, the voltage adjusts itself according to the load resistance; the module operates according to its characteristic curve.

After the overload has been eliminated, the voltage returns to the nominal range and the green 24 V LED flashes. The CPU sets the EXTF LED (external fault) and saves the fault in the diagnostic buffer. Further reactions such as CPU STOP or message to a control room may be triggered in OB 81 "Power supply error". If no OB 81 is configured, the CPU continues to run normally.

Overload at 5 V

In the event of an overload at 5 V, the power supply modules with 10 A or 20 A output current can maintain an output current of 16 A or 26 A for 300 ms. The power supply modules with 4 A output current can maintain an output current of 6 A for 300 ms. After that the CPU changes to DEFECTIVE state. If the DC 5 V LED at the power supply flashes and can be reset with the FMR button, you can execute a hot restart. Afterwards, the CPU remains in STOP and requests a memory reset.

BAF, BATTF

The following table is valid for power supply modules with a battery when the BATT.INDIC. switch is in the BATT position. It lists the signaled faults and provides information for troubleshooting.

Table 3-8 LED displays BAF, BATTF, BATT.INDIC. on BATT

BAF LED	BATF LED	Cause of error	Remedy
On	On	Battery is empty or missing. No external backup voltage available.	Insert new battery. Press the FMR button.
Off	On	Battery is empty or missing. Battery stored too long. External backup voltage available.	Insert new battery. Press the FMR button. Depassivate battery (see *Installation manual*).
On	Off	Battery OK. No backup voltage available (short-circuit).	• Error after plugging in a module: plugged module defective. • Error after switching on: remove all modules and plug them in individually.
Off	Off	Battery OK. External backup voltage available.	-
Off = LED is dark; ON = LED is lit;			

BAF, BATT1F, BATT2F

The following table applies to power supply modules with two batteries when the BATT.INDIC. switch is in the 1BATT position. It lists the signaled faults and provides information for troubleshooting.

Nothing is indicated about the status of a second battery that may be in use.

Table 3-9 LED displays BAF, BATT1F, BATT2F, BATT.INDIC. on 1BATT

BAF LED	BATT1F LED	BATT2F LED	Cause of error	Remedy
On	On	Off	Battery 1 is empty or missing. No external backup voltage available.	Insert new battery in compartment 1. Press the FMR button.
Off	On	Off	Battery 1 is empty or missing. External backup voltage available.	Insert new battery in compartment 1. Press the FMR button.
			Battery 1 stored too long. External backup voltage available.	Depassivate battery (see *Installation manual*)
On	Off	Off	Battery 1 OK. No external backup voltage available (short-circuit).	• Error after plugging in a module: plugged module defective. • Error after switching on: remove all modules and plug them in individually.

BAF LED	BATT1F LED	BATT2F LED	Cause of error	Remedy
Off	Off	Off	Battery 1 OK. External backup voltage available.	-
Off = LED is dark; ON = LED is lit;				

BAF, BATT1F, BATT2F

The following table applies to power supply modules with two batteries when the BATT.INDIC. switch is in the 2BATT position. It lists the signaled faults and provides information for troubleshooting.

Table 3-10 LED displays BAF, BATT1F, BATT2F; BATT.INDIC. on 2BATT

BAF LED	BATT1F LED	BATT2F LED	Cause of error	Remedy
On	On	On	Both batteries are empty or missing. No external backup voltage available.	Insert new battery in compartments 1 and 2. Press the FMR button.
Off	On	On	Both batteries are empty or missing. External backup voltage available.	Insert new battery in compartments 1 and 2. Press the FMR button.
On	On	Off	Battery 1 is empty or missing. No external backup voltage available (short-circuit or overload).	Insert new battery in compartment 1. Press the FMR button. • Error after plugging in a module: plugged module defective. • Error after switching on: remove all modules and plug them in individually.
Off	On	Off	Battery 1 is empty or missing.	Insert new battery in compartments 1 and 2. Press the FMR button.
			Battery stored too long. External backup voltage available.	Depassivate battery (see *Installation manual*).
On	Off	On	Battery 2 is empty or missing. No external backup voltage available (short-circuit or overload).	Insert new battery in compartment 2. Press the FMR button. • Error after plugging in a module: plugged module defective. • Error after switching on: remove all modules and plug them in individually.
Off	Off	On	Battery 2 is empty or missing.	Insert new battery in compartments 1 and 2. Press the FMR button.
			Battery stored too long. External backup voltage available.	Depassivate battery (see *Installation manual*).

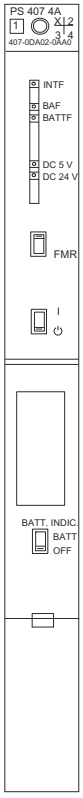
BAF LED	BATT1F LED	BATT2F LED	Cause of error	Remedy
On	Off	Off	Both batteries OK. No external backup voltage available (short-circuit).	• Error after plugging in a module: plugged module defective. • Error after switching on: remove all modules and plug them in individually.
Off	Off	Off	Both batteries OK. External backup voltage available.	-
Off = LED is dark; ON = LED is lit;				

3.6 Power supply module PS 407 4A (6ES7407-0DA02-0AA0)

Function

The power module PS 407 4A is designed for connection to an 85 to 264 V AC network or an 88 to 300 V DC network, and supplies DC 5 V/4 A and DC 24 V/0.5 A at the secondary side.

PS 407 4A operator control and monitoring elements



Mounting screw

LEDs INTF, BAF,
BATTF,
5 V DC, 24 V DC

FMR button (Failure Message Reset)

Standby switch (does not cut off mains)

Under cover

Battery compartment

Switch BATT. INDIC, BATT,
OFF

3-pin power connector

Mounting screw

Figure 3-2 PS 407 4A operator control and monitoring elements

Mains connection

An AC power plug is used with PS 407 4A for connection to an AC network and for connection to a DC network.

Reverse polarity of L+ and L-

Reverse polarity of L+ and L with a supply voltage of 88 V DC to 300 V DC does not affect the function of the power supply. The connection should comply with the instructions in the installation manual.

PS 407 4A technical specifications

Article number	6ES7407-0DA02-0AA0
Supply voltage	
Rated value (DC)	
• 120 V DC	Yes
• 230 V DC	Yes
Rated value (AC)	
• 120 V AC	Yes
• 230 V AC	Yes
Line frequency	
• Rated value 50 Hz	Yes
• Rated value 60 Hz	Yes
• permissible range, lower limit	47 Hz
• permissible range, upper limit	63 Hz
Mains buffering	
• Mains/voltage failure stored energy time	20 ms
• Mains buffering according to NAMUR recommendation	Yes
Input current	
Rated value at 120 V DC	350 mA
Rated value at 230 V DC	190 mA
Rated value at 120 V AC	0.42 A
Rated value at 230 V AC	0.22 A
Inrush current, max.	8.5 A; Full width at half maximum 5 ms
Leakage current, max.	3.5 mA
output voltage / header	
Type of output voltage	DC
Rated value (DC)	
• 5 V DC	Yes
• 24 V DC	Yes
Output current	
for backplane bus (5 V DC), max.	4 A; no base load required
for backplane bus (24 V DC), max.	0.5 A; idling-proof
Short-circuit protection	Yes
Power	
Active power input, typ.	52 W
Power loss	
Power loss, typ.	20 W
Battery	
Backup battery	
• Backup battery (optional)	Yes; 1x lithium AA; 3.6 V / 2.2 Ah
• Backup voltage	3.6 V
• Backup current, max.	100 µA; When power off

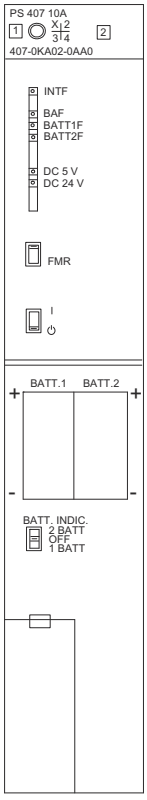
Article number	**6ES7407-0DA02-0AA0**
Hardware configuration	
Slots	
• required slots	1
Potential separation	
primary/secondary	Yes
Isolation	
Overvoltage category	II
EMC	
Compliance with line harmonic distortion limits	
• Compliance with line harmonic distortion acc. to IEC 61000-3-2, IEC 61000-3-3	Yes
Degree and class of protection	
Equipment protection class	I, with protective conductor
Standards, approvals, certificates	
FM approval	Yes; Ta: 0 °C to 70 °C T4
BIS	Yes
Ambient conditions	
Ambient temperature during operation	
• min.	0 °C
• max.	60 °C
connection method / header	
Design of electrical connection	3x 1.5 mm², solid or stranded wire with end sleeve, external diameter 3 mm to 9 mm
Dimensions	
Width	25 mm
Height	290 mm
Depth	217 mm
Weights	
Weight, approx.	760 g

3.7 Power supply modules PS 407 10A (6ES7407-0KA02-0AA0) and PS 10A R (6ES7407-0KR02-0AA0)

Function

The power modules PS 407 10A (standard) and PS 407 10A R (for redundant operation, see Redundant power supply modules (Page 45)) are designed for connection to an 85-264 V AC network or an 88-300 V DC network, and supply 5 V/10 A DC and 24 V/1 A DC at the secondary side.

PS 407 10A and PS 407 10A R operator control and monitoring elements



Mounting screw

LEDs INTF, BAF, BATT1F, BATT2F, 5 V DC, 24 V DC

FMR button (Failure Message Reset)

Standby switch (does not cut off mains)

Under cover

Battery compartment

Switch BATT. INDIC, 2 BATT, OFF, 1 BATT

3-pin power connector

Mounting screw

Figure 3-3 PS 407 10A and PS 407 10A R operator control and monitoring elements

Mains connection

An AC power plug is used with PS 407 10A and PS 407 10A R both for connection to an AC network and connection to a DC network.

Reverse polarity of L+ and L-

Reverse polarity of L+ and L with a supply voltage of 88 V DC to 300 V DC does not affect the function of the power supply. The connection must comply with the instructions in the installation manual.

PS 407 10A and PS 407 10A R technical specifications

Article number	6ES7407-0KA02-0AA0	6ES7407-0KR02-0AA0
Supply voltage		
Rated value (DC)		
• 120 V DC	Yes	
• 230 V DC	Yes	
Rated value (AC)		
• 120 V AC	Yes	
• 230 V AC	Yes	
Line frequency		
• Rated value 50 Hz	Yes	
• Rated value 60 Hz	Yes	
• permissible range, lower limit	47 Hz	
• permissible range, upper limit	63 Hz	
Mains buffering		
• Mains/voltage failure stored energy time	20 ms	
• Mains buffering according to NAMUR recommendation	Yes	
Input current		
Rated value at 120 V DC	1 A	
Rated value at 230 V DC	0.5 A	
Rated value at 120 V AC	0.9 A	
Rated value at 230 V AC	0.5 A	
Inrush current, max.	63 A; Full width at half maximum 1 ms	
Leakage current, max.	3.5 mA	
output voltage / header		
Type of output voltage	DC	
Rated value (DC)		
• 5 V DC	Yes	
• 24 V DC	Yes	
Output current		
for backplane bus (5 V DC), max.	10 A; no base load required	
for backplane bus (24 V DC), max.	1 A; idling-proof	
Short-circuit protection	Yes	
Power		
Active power input, typ.	95 W	
Power loss		
Power loss, typ.	20 W	
Battery		
Backup battery		
• Backup battery (optional)	Yes; 1x lithium AA; 3.6 V / 2.2 Ah	
• Backup voltage	3.6 V	

Article number	6ES7407-0KA02-0AA0	6ES7407-0KR02-0AA0
• Backup current, max.	100 µA; When power off	
Hardware configuration		
Slots		
• required slots	2	
Potential separation		
primary/secondary	Yes	
Isolation		
Overvoltage category	II	
EMC		
Compliance with line harmonic distortion limits		
• Compliance with line harmonic distortion acc. to IEC 61000-3-2, IEC 61000-3-3	Yes	
Degree and class of protection		
Equipment protection class	I, with protective conductor	
Standards, approvals, certificates		
FM approval	Yes; Ta: 0 °C to 70 °C T4	
Ambient conditions		
Ambient temperature during operation		
• min.	0 °C	
• max.	60 °C	
connection method / header		
Design of electrical connection	3x 1.5 mm², solid or stranded wire with end sleeve, external diameter 3 mm to 9 mm	
Dimensions		
Width	50 mm	
Height	290 mm	
Depth	217 mm	
Weights		
Weight, approx.	1 200 g	

3.8 Power supply module PS 407 20A (6ES7407-0RA02-0AA0)

Function

The power module PS 407 20A is designed for connection to an 85-264 V AC network or an 88-300 V DC network, and supply 5 V/20 A DC and 24 V/1 A DC at the secondary side.

PS 407 20A operator control and monitoring elements

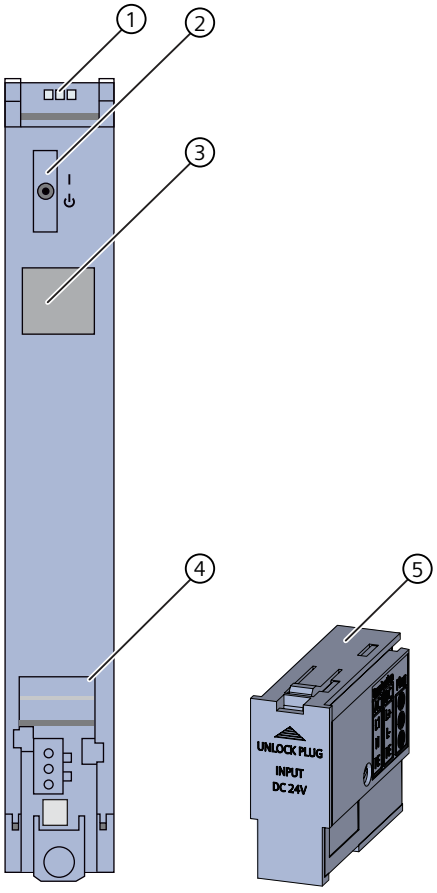


Figure 3-4 PS 407 20A power module operator control and monitoring elements

Mains connection

An AC power plug is used with PS 407 20A both for connection to an AC network and for connection to a DC network.

Reverse polarity of L+ and L-

Reverse polarity of L+ and L with a supply voltage of 88 V DC to 300 V DC does not affect the function of the power supply. The connection must comply with the instructions in the *installation manual*.

PS 407 20A technical specifications

Article number	6ES7407-0RA02-0AA0
Supply voltage	
Rated value (DC)	
• 120 V DC	Yes
• 230 V DC	Yes
Rated value (AC)	
• 120 V AC	Yes
• 230 V AC	Yes
Line frequency	
• Rated value 50 Hz	Yes
• Rated value 60 Hz	Yes
• permissible range, lower limit	47 Hz
• permissible range, upper limit	63 Hz
Mains buffering	
• Mains/voltage failure stored energy time	20 ms
• Mains buffering according to NAMUR recommendation	Yes
Input current	
Rated value at 120 V DC	1.4 A
Rated value at 230 V DC	0.7 A
Rated value at 120 V AC	1.4 A
Rated value at 230 V AC	0.7 A
Inrush current, max.	88 A; Full width at half maximum 1.1 ms
Leakage current, max.	3.5 mA
output voltage / header	
Type of output voltage	DC
Rated value (DC)	
• 5 V DC	Yes
• 24 V DC	Yes
Output current	
for backplane bus (5 V DC), max.	20 A; no base load required
for backplane bus (24 V DC), max.	1 A; idling-proof
Short-circuit protection	Yes
Power	
Active power input, typ.	158 W
Power loss	
Power loss, typ.	35 W
Battery	
Backup battery	
• Backup battery (optional)	Yes; 1x lithium AA; 3.6 V / 2.2 Ah
• Backup voltage	3.6 V
• Backup current, max.	100 µA; When power off

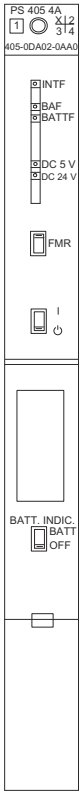
Article number	6ES7407-0RA02-0AA0
Hardware configuration	
Slots	
• required slots	2
Potential separation	
primary/secondary	Yes
Isolation	
Overvoltage category	II
EMC	
Compliance with line harmonic distortion limits	
• Compliance with line harmonic distortion acc. to IEC 61000-3-2, IEC 61000-3-3	Yes
Degree and class of protection	
Equipment protection class	I, with protective conductor
Standards, approvals, certificates	
FM approval	Yes; Ta: 0 °C to 70 °C T4
Ambient conditions	
Ambient temperature during operation	
• min.	0 °C
• max.	60 °C
connection method / header	
Design of electrical connection	3x 1.5 mm², solid or stranded wire with end sleeve, external diameter 3 mm to 9 mm
Dimensions	
Width	50 mm
Height	290 mm
Depth	217 mm
Weights	
Weight, approx.	1 300 g

3.9 Power supply module PS 405 4A (6ES7405-0DA02-0AA0)

Function

The power module PS 405 4A is designed for connection to a 19.2 to 72 V DC network, and supplies 5 V/4 A DC and 24 V/0.5 A DC at the secondary side.

PS 405 4A operator control and monitoring elements



Mounting screw

LEDs INTF, BAF,
BATTF,
5 V DC, 24 V DC

FMR button (Failure Message Reset)

Standby switch (does not cut off mains)

Under cover

Battery compartment

Switch BATT. INDIC,
BATT, OFF

3-pin power connector

Mounting screw

Figure 3-5 PS 405 4A operator control and monitoring elements

PS 405 4A technical specifications

Article number	6ES7405-0DA02-0AA0
Supply voltage	
Rated value (DC)	
• 24 V DC	Yes
• 48 V DC	Yes
• 60 V DC	Yes
Mains buffering	
• Mains/voltage failure stored energy time	20 ms
• Mains buffering according to NAMUR recommendation	Yes
Input current	
Rated value at 24 V DC	2 A
Rated value at 48 V DC	1 000 mA
Rated value at 60 V DC	800 mA
Inrush current, max.	18 A; Full width at half maximum 20 ms
output voltage / header	
Type of output voltage	DC
Rated value (DC)	
• 5 V DC	Yes
• 24 V DC	Yes
Output current	
for backplane bus (5 V DC), max.	4 A; no base load required
for backplane bus (24 V DC), max.	0.5 A; idling-proof
Short-circuit protection	Yes
Power	
Active power input, typ.	48 W
Power loss	
Power loss, typ.	16 W
Battery	
Backup battery	
• Backup battery (optional)	Yes; 2x lithium AA; 3.6 V / 2.2 Ah
• Backup voltage	3.6 V
• Backup current, max.	100 µA; When power off
Hardware configuration	
Slots	
• required slots	1
Potential separation	
primary/secondary	Yes
Isolation	
Overvoltage category	II
Degree and class of protection	
Equipment protection class	I, with protective conductor

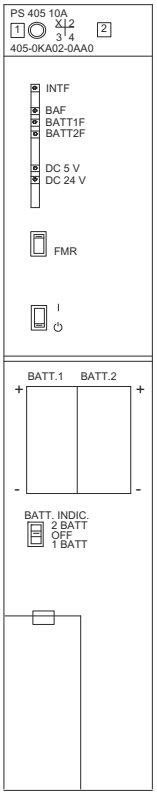
Article number	**6ES7405-0DA02-0AA0**
Standards, approvals, certificates	
FM approval	Yes; Ta: 0 °C to 60 °C T4
CCC	Yes
BIS	Yes
Ambient conditions	
Ambient temperature during operation	
• min.	0 °C
• max.	60 °C
connection method / header	
Design of electrical connection	3x 1.5 mm^2, solid or stranded wire with end sleeve, external diameter 3 mm to 9 mm
Dimensions	
Width	25 mm
Height	290 mm
Depth	217 mm
Weights	
Weight, approx.	760 g

3.10 Power supply modules PS 405 10A (6ES7405-0KA02-0AA0) and PS 405 10A R (405-0KR02-0AA0)

Function

The power modules PS 405 10A (standard) and PS 405 10A R (for redundant operation) are designed for connection to a 19.2-72 V DC network, and supply 5 V/10 A DC and 24 V/1 A DC at the secondary side.

PS 405 10A and PS 405 10A R operator control and monitoring elements



Mounting screw

LEDs INTF, BAF, BATT1F, BATT2F, 5 V DC, 24 V DC

FMR button (Failure Message Reset)

Standby switch (does not cut off mains)

Under cover

Battery compartment

Switch BATT. INDIC, 2 BATT, OFF, 1 BATT

3-pin power connector

Mounting screw

Figure 3-6 PS 405 10A and PS 405 10A R operator control and monitoring elements

PS 405 10A and PS 405 10A R technical specifications

Article number	6ES7405-0KA02-0AA0	6ES7405-0KR02-0AA0
Supply voltage		
Rated value (DC)		
• 24 V DC	Yes	
• 48 V DC	Yes	
• 60 V DC	Yes	
Mains buffering		
• Mains/voltage failure stored energy time	20 ms	
• Mains buffering according to NAMUR recommendation	Yes	
Input current		
Rated value at 24 V DC	4 A	
Rated value at 48 V DC	2 A	
Rated value at 60 V DC	1.6 A	
Inrush current, max.	18 A; Full width at half maximum 20 ms	
output voltage / header		
Type of output voltage	DC	
Rated value (DC)		
• 5 V DC	Yes	
• 24 V DC	Yes	
Output current		
for backplane bus (5 V DC), max.	10 A; no base load required	
for backplane bus (24 V DC), max.	1 A; idling-proof	
Short-circuit protection	Yes	
Power		
Active power input, typ.	95 W	
Power loss		
Power loss, typ.	20 W	
Battery		
Backup battery		
• Backup battery (optional)	Yes; 2x lithium AA; 3.6 V / 2.2 Ah	
• Backup voltage	3.6 V	
• Backup current, max.	100 µA; When power off	
Hardware configuration		
Slots		
• required slots	2	
Potential separation		
primary/secondary	Yes	
Isolation		
Overvoltage category	II	
Degree and class of protection		
Equipment protection class	I, with protective conductor	

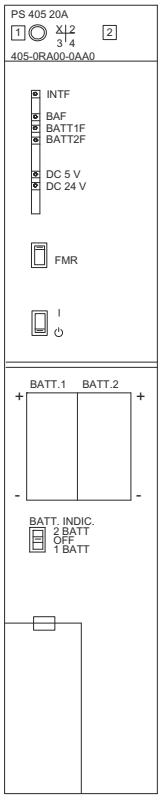
Article number	6ES7405-0KA02-0AA0	6ES7405-0KR02-0AA0
Standards, approvals, certificates		
FM approval	Yes; Ta: 0 °C to 60 °C T4	
CCC	Yes	
BIS	Yes	
Ambient conditions		
Ambient temperature during operation		
• min.	0 °C	
• max.	60 °C	
connection method / header		
Design of electrical connection	3x 1.5 mm², solid or stranded wire with end sleeve, external diameter 3 mm to 9 mm	
Dimensions		
Width	50 mm	
Height	290 mm	
Depth	217 mm	
Weights		
Weight, approx.	1 200 g	

3.11 Power supply module PS 405 20A (6ES7405-0RA02-0AA0)

Function

The power module PS 405 20A is designed for connection to a 19.2-72 V DC network, and supplies 5 V/20 A DC and 24 V/1 A DC at the secondary side.

PS 405 20A operator control and monitoring elements



Mounting screw

LEDs INTF, BAF,
BATT1F, BATT2F, 5 V
DC, 24 V DC

FMR button (Failure Message Reset)

Standby switch (does not cut off mains)

Under cover

Battery compartment

Switch BATT. INDIC,
2 BATT, OFF, 1 BATT

3-pin power connector

Mounting screw

Figure 3-7 PS 405 20A operator control and monitoring elements

PS 405 20A technical specifications

Article number	6ES7405-0RA02-0AA0
Supply voltage	
Rated value (DC)	
• 24 V DC	Yes
• 48 V DC	Yes
• 60 V DC	Yes
Mains buffering	
• Mains/voltage failure stored energy time	20 ms
• Mains buffering according to NAMUR recommendation	Yes
Input current	
Rated value at 24 V DC	7 A
Rated value at 48 V DC	3.2 A
Rated value at 60 V DC	2.5 A
Inrush current, max.	56 A; Full width at half maximum 1.5 ms
output voltage / header	
Type of output voltage	DC
Rated value (DC)	
• 5 V DC	Yes
• 24 V DC	Yes
Output current	
for backplane bus (5 V DC), max.	20 A; no base load required
for backplane bus (24 V DC), max.	1 A; idling-proof
Short-circuit protection	Yes
Power	
Active power input, typ.	168 W
Power loss	
Power loss, typ.	44 W
Battery	
Backup battery	
• Backup battery (optional)	Yes; 2x lithium AA; 3.6 V / 2.2 Ah
• Backup voltage	3.6 V
• Backup current, max.	120 µA; When power off
Hardware configuration	
Slots	
• required slots	2
Potential separation	
primary/secondary	Yes
Isolation	
Overvoltage category	II
Degree and class of protection	
Equipment protection class	I, with protective conductor

Article number	**6ES7405-0RA02-0AA0**
Standards, approvals, certificates	
FM approval	Yes; Ta: 0 °C to 60 °C T4
CCC	Yes
BIS	Yes
Ambient conditions	
Ambient temperature during operation	
• min.	0 °C
• max.	60 °C
connection method / header	
Design of electrical connection	3x 1.5 mm^2, solid or stranded wire with end sleeve, external diameter 3 mm to 9 mm
Dimensions	
Width	50 mm
Height	290 mm
Depth	217 mm
Weights	
Weight, approx.	1 300 g

Digital modules

4

4.1 Module overview

Properties of the digital modules

The following tables summarize the main properties of the digital modules. The purpose of this overview is to help you select the right module for your requirements.

Table 4-1 Digital input modules: Properties at a glance

Properties	SM 421; DI 32xDC 24 V (-1BL0x-)	SM 421; DI 16xDC 24 V (-7BH0x-)	SM 421; DI 16xUC 24/60 V (-7DH00-)	SM 421; DI 16xUC 120/230 V (-1FH00-)	SM 421; DI 16xUC 120/230 V (-1FH20-)	SM 421; DI 32xUC 120 V (-1EL00-)
Number of inputs	32 DI, isolated in groups of 32	16 DI, isolated in groups of 8	16 DI, isolated in groups of 1	16 DI, isolated in groups of 4	16 DI, isolated in groups of 4	32 DI, isolated in groups of 8
Nominal input voltage	24 V DC	24 V DC	24 V to 60 V UC	120 V AC/ 230 V DC	120 V UC/ 230 V UC	120 V AC/DC
Suitable for ...	Switches; 2-wire proximity switches (BEROs)					
Configurable diagnostics	No	Yes	Yes	No	No	No
Diagnostic interrupt	No	Yes	Yes	No	No	No
Hardware interrupt at edge transition	No	Yes	Yes	No	No	No
Adjustable input delays	No	Yes	Yes	No	No	No
Substitute value output	-	Yes	-	-	-	-
Special features	High packing density	Fast and interruptible	Interruptible for low, variable voltages	For high, variable voltages	For high, variable voltages Input characteristic curve according to IEC 61131-2	High packing density

Table 4-2 Digital output modules: Properties at a glance

Properties	SM 422; DO 16xDC 24 V/2 A (-1BH1x)	SM 422; DO 32xDC 24 V/0.5 A (-1BL00)	SM 422; DO 32xDC 24 V/0.5 A (-7BL00)	SM 422; DO 8xAC 120/230 V/ 5 A (-1FF00)	SM 422; DO 16xAC 120/230 V/ 2 A (-1FH00)
Number of outputs	16 DO, isolated in groups of 8	32 DO, isolated in groups of 32	32 DO, isolated in groups of 8	8 DO, isolated in groups of 1	16 DO, isolated in groups of 4
Output current	2 A	0.5 A	0.5 A	5 A	2 A
Nominal load voltage	24 V DC	24 V DC	24 V DC	120/ 230 V AC	120/ 230 V AC
Configurable diagnostics	No	No	Yes	No	No
Diagnostic interrupt	No	No	Yes	No	No
Substitute value output	No	No	Yes	No	No
Special features	For high currents	High packing density	Especially fast and interruptible	For high currents with channel-granular isolation	-

Table 4-3 Relay output module: Properties at a glance

Properties	SM 422; DO 16 x UC 30/230 V/Rel. 5 A (-1HH00)
Number of outputs	16 outputs, isolated in groups of 8
Load voltage	125 V DC 230 V AC
Special features	-

4.2 Steps in selecting and commissioning the digital module

Introduction

The following table contains the tasks that you have to perform one after the other to commission digital modules successfully.

The sequence of steps is a suggestion, but you can perform individual steps either earlier or later (for example, assign parameters to the module) or install, commission etc. other modules in between times.

Overview of steps in selecting and commissioning the digital module

Step	Procedure	
1	Select the module.	Section 4.1 (Page 77) and special sections for modules beginning with Section 4.7 (Page 91)
2	Mount the module in the rack.	"Installing" section in the *Automation System S7-400, Hardware and Installation* manual
3	Assigning module parameters	Section 4.3 (Page 79) and special sections for modules beginning with Section 4.7
4	Commissioning the configuration	"Commissioning" section in the *Automation System S7-400, Hardware and Installation* manual
5	Analyzing the configuration if commissioning is not successful	Section 4.4 (Page 82)

4.3 Assigning parameters to digital modules

4.3.1 Parameters

Introduction

Digital modules may have different features. You can configure the features of some modules.

Tools for parameter assignment

You assign parameters to digital modules in *STEP 7*.

After you have defined all parameters, download these from your programming device to the CPU. On a transition from STOP > RUN mode, the CPU then transfers the parameters to the individual digital modules.

Static and dynamic parameters

The parameters are divided into static and dynamic parameters.

Static parameters are passed to digital modules after a STOP > RUN transition of the CPU, as described above.

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. You will find a description of the parameter assignment of modules in the user program in the Appendix.

Configuration in RUN (CiR)

CiR (Configuration in RUN) is a method you can use to modify your system or edit the parameters of individual modules. These changes are made while your system is in operation, that is, your CPU will stay in RUN over a maximum of 2.5 seconds while these changes are applied.

For detailed information on this topic, refer to the "Configuration in RUN by means of CiR" manual. This manual is found, for example, as a file in PDF format on the STEP 7 CD supplied.

4.3.2 Parameters of digital input modules

Overview

The configurable digital input modules use a subset of the parameters and ranges of values listed in the table below, depending on functionality. For information on subsets "supported" by specific digital modules, refer to the chapter dealing with the relevant module. Do not forget that some digital modules have different input delays after parameter assignment.

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

Table 4-4 Parameters of digital input modules

Parameters	Value range	Default[2]	Parameter type	Scope
Enable				
• Diagnostic interrupt[1]	Yes/no	No	Dynamic	Module
• Hardware interrupt[1]	Yes/no	No		
• Destination CPU for interrupt	1 to 4	-	Static	Module
Diagnostics				
• Wire break	Yes/no	No	Static	Channel
• No load voltage L+/sensor supply	Yes/no	No		
Hardware interrupt trigger				
• Positive edge	Yes/no	No	Dynamic	Channel
• Negative edge	Yes/no	No		
Input delay	0.1 ms (DC) 0.5 ms (DC) 3 ms (DC) 20 ms (DC/AC)	3 (DC)	Static	Channel
Reaction to error	Set substitution value (SSV) Keep last value (KLV)	SV	Dynamic	Module
Set substitution value "1"	Yes/no	No	Dynamic	Channel [3]

[1] If you use the module in ER-1/ER-2, you must set this parameter to "No" because the interrupt lines are not available in ER-1/ER-2.

[2] Only in the CR (central rack) is it possible to start up the digital modules with the default settings and without support from HWCONFIG.

[3] Channels not selected for substitute value "1" are assigned substitute value "0".

4.3.3 Parameters of digital output modules

Overview

The configurable digital output modules use a subset of the parameters and ranges of values listed in the table below, depending on the functionality. For information on subsets "supported" by specific digital modules, refer to the section dealing with the relevant module beginning with section 4.7.

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

Table 4-5 Parameters of digital output modules

Parameters	Value range	Default[2]	Parameter type	Scope
Enable				
• Diagnostic interrupt[1]	Yes/no	No	Dynamic	Module
• Destination CPU for interrupt	1 to 4	-	Static	Module
Reaction to CPU STOP	Substitute a value (SV) Keep last value (KLV)	SV	Dynamic	Module
Diagnostics				
• Wire break	Yes/no	No	Static	Channel
• Load voltage L+ missing	Yes/no	No		
• Short-circuit to M	Yes/no	No		
• Short-circuit to L+	Yes/no	No		
• Fuse blown	Yes/no	No		
Set substitution value "1"	Yes/no	No	Dynamic	Channel [3]

[1] If you use the module in ER-1/ER-2, you must set this parameter to "No" because the interrupt lines are not available in ER-1/ER-2.

[2] Only in the CR (central rack) is it possible to start up the digital modules with the default settings and without support from HWCONFIG.

[3] Channels not selected for substitute value "1" are assigned substitute value "0".

4.4 Diagnostics for digital modules

4.4.1 General information about diagnostic messages

Programmable and non-programmable diagnostic messages

Using the diagnostics function, we make a distinction between programmable and non-programmable diagnostic messages.

You only obtain programmable diagnostic messages if you have enabled the diagnostics using the relevant parameters. You perform parameter assignment in the "Diagnostics" tab in *STEP 7*, see section 6.7.

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

Reactions to diagnostic messages in STEP 7

Actions initiated by diagnostic messages:

- The diagnostic message is entered in the diagnostics of the digital module, forwarded to the CPU and can be read out by the user program.
- The fault LED on the digital module lights up.
- If you have set "Enable diagnostic interrupt" in *STEP 7*, a diagnostic interrupt is triggered and OB 82 is called, see section 5.5.

Reading diagnostic messages

You can read detailed diagnostic messages using SFCs in the user program (refer to the appendix "Diagnostic data of signal modules").

You can view the cause of the error in *STEP 7* in the module diagnostics (refer to the *online help for STEP 7*).

Diagnostics using the INTF and EXTF LEDs

Some digital modules indicate faults by means of their two fault LEDs INTF (internal fault) and EXTF (external fault). The LEDs go out when all the internal and external faults have been eliminated.

Refer to the specifications of the modules beginning with section 5.7 to find out which digital modules have these fault LEDs.

See also

General information about parameter assignment (Page 178)

Interrupts of the digital modules (Page 87)

4.4.2 Diagnostic messages of the digital modules

Overview

The table below gives an overview of the diagnostic messages for the digital modules with diagnostics capability.

You can find out which diagnostic message each module is capable of in the Appendix entitled "Diagnostic data of the signal modules".

Table 4-6 Diagnostic messages of the digital modules

Diagnostic message	LED	Scope of diagnostics	Programmable
Module error	INTF/EXTF	Module	No
Internal error	INTF	Module	No
External error	EXTF	Module	No
Channel error	INTF/EXTF	Module	No
External auxiliary voltage missing	EXTF	Module	No
Front connector missing	EXTF	Module	No
No module parameters	INTF	Module	No
Incorrect parameters	INTF	Module	No
Channel information available	INTF/EXTF	Module	No
STOP mode	-	Module	No
Internal voltage failure	INTF	Module	No
EPROM error	INTF	Module	No
Hardware interrupt lost	INTF	Module	No
Parameter assignment error	INTF	Channel	No
Short-circuit to M	EXTF	Channel	Yes
Short-circuit to L+	EXTF	Channel	Yes
Wire break	EXTF	Channel	Yes
Fuse blown	INTF	Channel	Yes
Sensor supply missing	EXTF	Channel/channel group	Yes
Load voltage L+ missing	EXTF	Channel/channel group	Yes

Note

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

4.4.3 Causes of errors and remedies for digital modules

Overview

Table 4-7 Diagnostic messages of the digital modules, causes of errors and remedies

Diagnostic message	Possible cause of error	Remedy
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 certain channels are faulty.	-
External auxiliary voltage missing	Voltage required to operate the module is missing (load voltage, sensor supply).	Supply missing voltage
Front connector missing	Jumper between connections 1 and 2 in the front connector is missing.	Install jumper
No module parameters	Module requires information whether it should operate with default system parameters or with your parameters.	Message queued after power-on until parameter transmission by the CPU has been completed; configure the module, as required.
Incorrect parameters	One parameter, or the combination of parameters, is not plausible.	Reassign parameters to the module
Channel information available	Channel error; module can provide additional channel information.	-
STOP mode	No parameters have been assigned to the module and the first module cycle has not been completed.	If after rebooting the CPU all the input values are in the intermediate memory, this message is reset.
Internal voltage failure	Module is defective	Replace the module
EPROM error	Module is defective	Replace the module
Hardware interrupt lost	The module cannot send an interrupt, since the previous interrupt was not acknowledged; possible configuration error.	Change the interrupt handling in the CPU (change priority for interrupt OB; shorten interrupt program).
Parameter assignment error	Incorrect parameters transferred to the module (for example, impossible input delay); the corresponding channel is deactivated.	Reassign parameters to the module
Short-circuit to M	Overload at output	Eliminate overload
	Short-circuit of output to M	Check the wiring of the outputs.
Short-circuit to L+	Short-circuit of output to L+	Check the wiring of the outputs.

Diagnostic message	Possible cause of error	Remedy
Wire break	Lines interrupted	Connect the cable
	No external sensor supply	Wire sensors with10 to 18 kΩ.
	Channel not connected (open)	Disable the "Diagnostics – Wire break" parameter for the channel in STEP 7.
		Wire the channel
Fuse blown	One or more fuses on the module has blown and caused this fault.	Remove the overload and replace the fuse.
Sensor supply missing	Overload at sensor supply	Eliminate overload
	Short-circuit of sensor supply to M	Eliminate the short-circuit.
Load voltage L+ missing	Power supply L+ to module missing	Feed in supply voltage L+.
	Fuse in module is defective	Replace the module

4.5 Interrupts of the digital modules

Introduction

This section describes the interrupt behavior of the digital modules. There are two types of interrupt:

- Diagnostic interrupt
- Hardware interrupt

Note that not all digital modules have interrupt capability or they are only capable of a subset of the interrupts described here. For information on the digital modules that support interrupts, refer to their specifications.

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

Enabling interrupts

The interrupts are not preset - in other words, they are inhibited without appropriate parameter assignment. Interrupts are enabled in *STEP 7*.

Special feature: The module is inserted in ER-1/ER-2

Note

If you use the digital module in ER-1/ER-2, you must set the parameters for enabling all the interrupts to "No" because the interrupt lines are not available in ER-1/ER-2.

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, and executes diagnostic interrupt OB82.

In the user program, you can call SFC 51 or SFC 59 in OB 82 to obtain more detailed diagnostic information from the module.

The diagnostic information is consistent until such time as OB 82 is exited. When OB 82 is exited, the diagnostic interrupt is acknowledged on the module.

Hardware interrupt

A digital input module can trigger a hardware interrupt for each channel at a rising or falling edge, or both, of a signal status change.

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

Pending hardware interrupts trigger hardware interrupt processing in the CPU (OB 40 to OB 47). The CPU interrupts the execution of the user program or the priority classes with low priority.

In the user program of the hardware interrupt OB (OB 40 to OB 47) you can specify how the programmable controller is to respond to an edge change. The module acknowledges the hardware interrupt when the program exits the hardware interrupt OB.

For each channel the digital input module can buffer an interrupt that has not been triggered. If no run levels of a higher priority class 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" diagnostics interrupt is generated, if a successive interrupt occurs at the same channel before the CPU has processed the previously buffered interrupt.

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

Interrupt-triggering channels

The interrupt-triggering channels are stored in the local data of the hardware interrupt OBs (in the start information of the corresponding OB). The start information is two words long (bits 0 to 31). The bit number is the channel number. Bits 16 to 31 are not assigned.

See also

General information about parameter assignment (Page 178)

4.6 Input characteristic curve for digital inputs

IEC 61131, type 1 and type 2

The IEC 61131 standard requires the following for the input current:

- In the case of type 2, an input current of ≥ 2 mA already at + 5 V
- In the case of type 1, an input current of ≥ 0.5 mA already at + 5 V

EN 60947-5-2, 2-wire BEROs

The standard for BEROs (EN 60947-5-2) specifies that there can be a current of ≤ 1.5 mA for BEROs in the "0" signal state.

The input current of the module in the "0" signal state is decisive for the operation of 2-wire BEROs. This must be in accordance with BERO requirements.

Input characteristic curve for digital inputs

As long as the current flowing into the module remains ≤ 1.5 mA, the module recognizes this as a "0" signal.

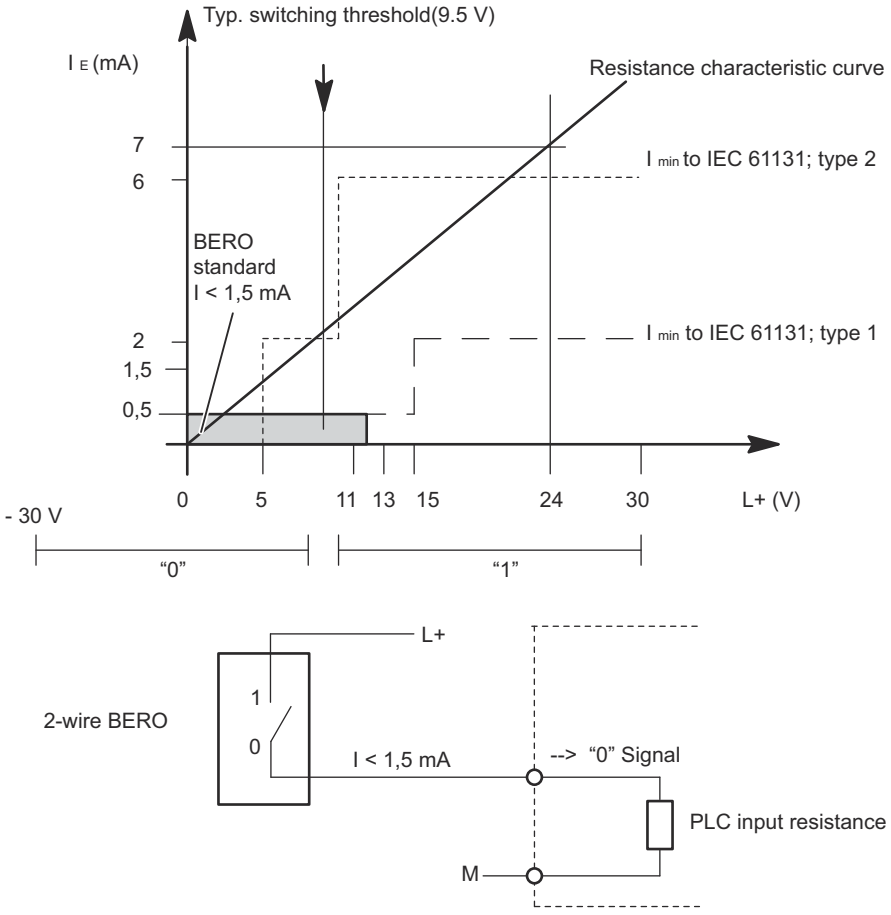


Figure 4-1 Input characteristic curve for digital inputs

4.7 Digital input module SM 421; DI 32 x DC 24 V (6ES7421-1BL01-0AA0)

Properties

Key properties of the SM 421; DI 32 x 24 V DC:

- 32 inputs, isolated in a group of 32
- Rated input voltage 24 V DC
- Suitable for switches and 2-/3-/4-wire proximity switches (BEROs, IEC 61131; type 1)

The status LEDs indicate the process status.

Connection and circuit diagram for SM 421; DI 32 x 24 V DC

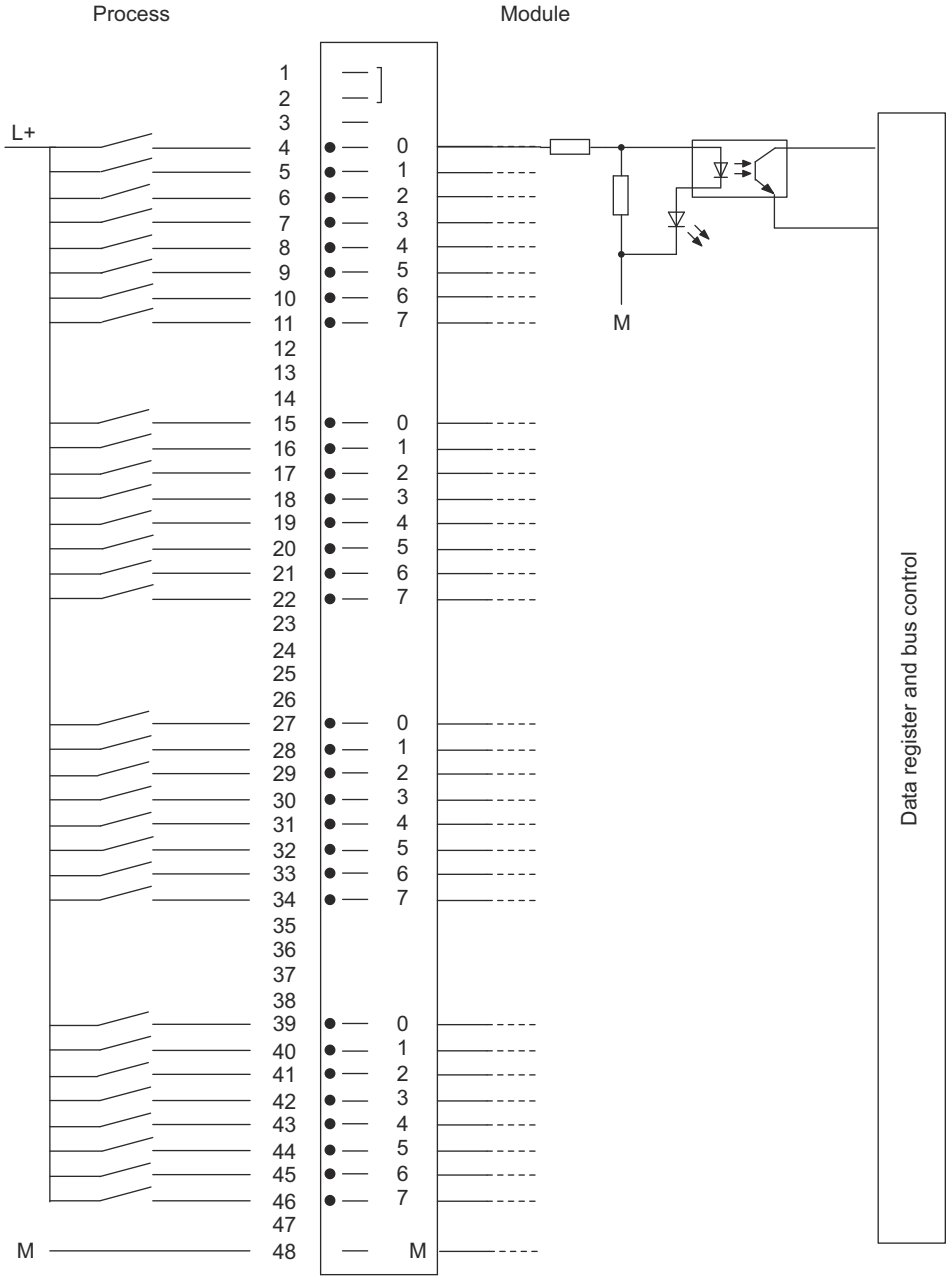


Figure 4-2 Connection and circuit diagram for SM 421; DI 32 x 24 V DC

Technical specifications for SM 421; DI 32 x DC 24 V

Article number	6ES7421-1BL01-0AA0
Input current	
from backplane bus 5 V DC, max.	20 mA
Power loss	
Power loss, typ.	6 W
Digital inputs	
Number of digital inputs	32
Input characteristic according to IEC 61131	Type 1
Number of simultaneously controllable inputs	
• Number of simultaneously controllable inputs	32
Input voltage	
• Type of input voltage	DC
• Rated value (DC)	24 V
• for signal "0"	-30 V DC to +5 V DC
• for signal "1"	13 V DC to 30 V DC
Input current	
• for signal "0", max. (permissible quiescent current)	1.3 mA
• for signal "1", typ.	7 mA
Input delay (for rated value of input voltage) for standard inputs	
– at "0" to "1", min.	1.2 ms
– at "0" to "1", max.	4.8 ms
– at "1" to "0", min.	1.2 ms
– at "1" to "0", max.	4.8 ms
Cable length	
• shielded, max.	1 000 m
• unshielded, max.	600 m
Encoder	
Connectable encoders	
• 2-wire sensor	Yes
– permissible quiescent current (2-wire sensor), max.	1.5 mA
Interrupts/diagnostics/status information	
Diagnostics function	No
Substitute values connectable	No
Diagnostics indication LED	
• Status indicator digital input (green)	Yes
Potential separation	
Potential separation digital inputs	
• between the channels	No

Article number	6ES7421-1BL01-0AA0
• between the channels, in groups of	32
• between the channels and backplane bus	Yes
Permissible potential difference	
between different circuits	60 V DC/30 V AC
Isolation	
Isolation tested with	500 V AC/707 V DC, type test
tested with	
• Channels against backplane bus and load voltage L+	500 V AC/707 V DC, type test
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	500 g

4.8 Digital input module SM 421; DI 16 x DC 24 V (6ES7421-7BH01-0AB0)

4.8.1 Features

Overview

SM 421; DI 16 x 24 V DC has the following properties:

- 16 inputs, isolated in 2 groups of 8
- Rapid signal processing Input filter from 50 µs
- Rated input voltage 24 V DC
- Suitable for switches and 2-/3-/4-wire proximity switches (BEROs, IEC 61131-2; type 2)
- 2 short-circuit proof sensor supplies for 8 channels each
- External redundant supply for sensor supply possible
- Status display "Sensor voltage (Vs) O.K."
- Group fault display for internal faults (INTF) and external faults (EXTF)
- Configurable diagnostics
- Configurable diagnostic interrupt
- Configurable hardware interrupts

- Configurable input delays
- Configurable substitute values in the input range

The status LEDs indicate the process status.

Note

The module spare parts are compatible with SM 421 module; DI 16 x 24 V DC; (6ES7 421-7BH00-0AB0)

To use the new function "Input delay 50 µs", you require STEP7 from V 5.2.

Connection and circuit diagram for SM 421; DI 16 x 24 V DC

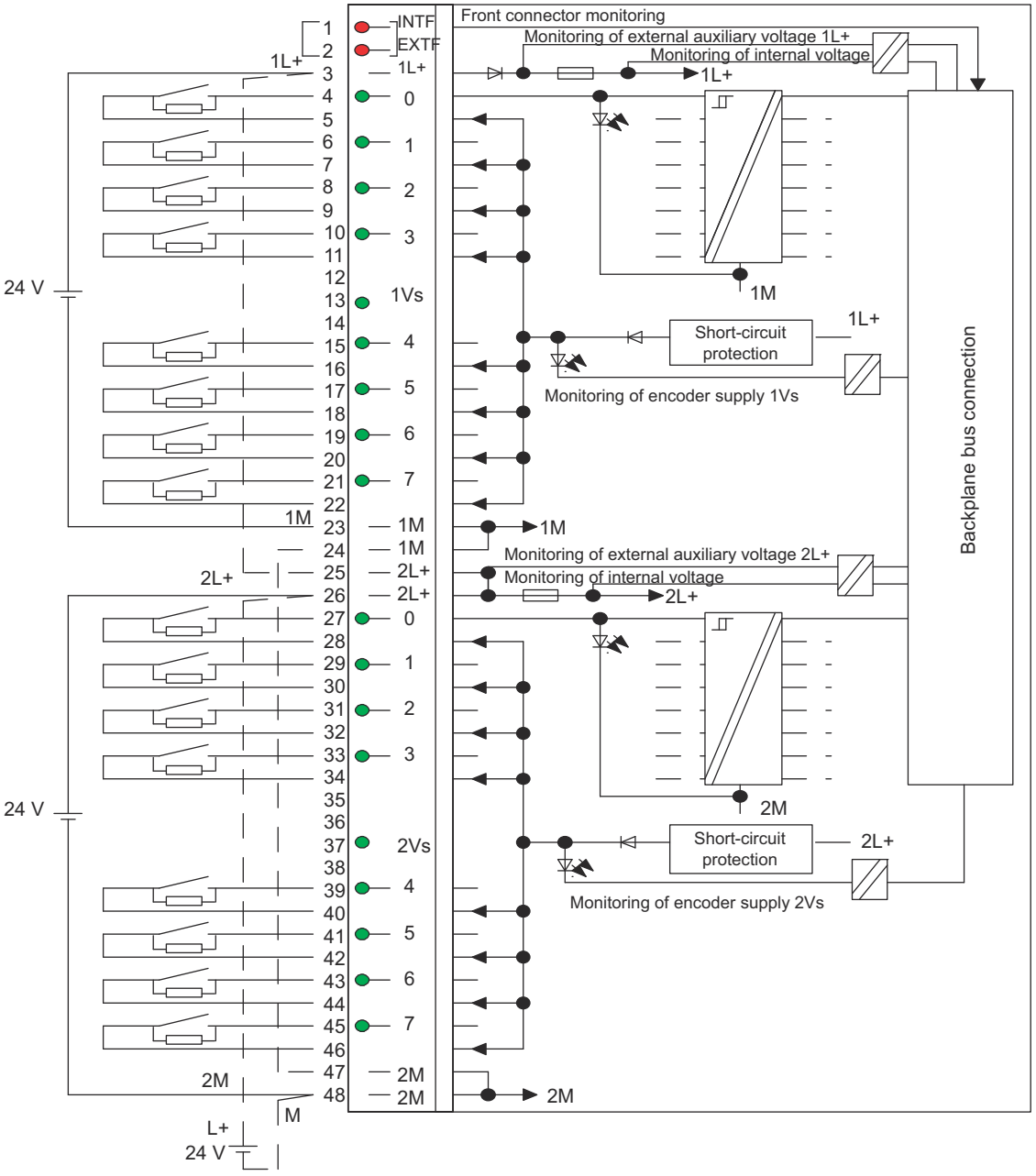


Figure 4-3 Connection and circuit diagram for SM 421; DI 16 x 24 V DC

Connection diagram for redundant sensor supply

The image below shows how sensors can be supplied with a redundant voltage source over Vs (e.g. through another module).

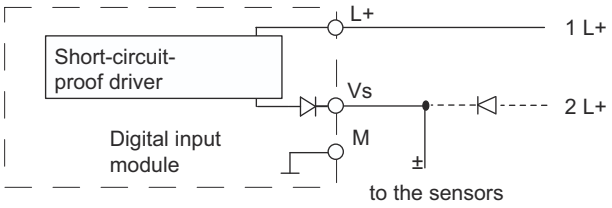


Figure 4-4 Connection diagram for redundant sensor supply for SM 421; DI 16 x 24 V DC

Technical specifications for SM 421; DI 16 x 24 V DC

Article number	6ES7421-7BH01-0AB0
Supply voltage	
Load voltage L+	
• Rated value (DC)	24 V
• permissible range, lower limit (DC)	20.4 V
• permissible range, upper limit (DC)	28.8 V
• Reverse polarity protection	Yes
Input current	
from supply voltage L+, max.	120 mA
from backplane bus 5 V DC, max.	130 mA
Encoder supply	
Number of outputs	2
Type of output voltage	L+ (-2.5 V)
Short-circuit protection	Yes; Electronic
additional (redundant) feed	Yes; possible
Output current	
• Rated value	120 mA
• permissible range, lower limit	0 mA
• permissible range, upper limit	150 mA
Power loss	
Power loss, typ.	5 W
Digital inputs	
Number of digital inputs	16
Input characteristic according to IEC 61131	Type 2
Number of simultaneously controllable inputs	
• Number of simultaneously controllable inputs	16
Input voltage	
• Type of input voltage	DC
• Rated value (DC)	24 V
• for signal "0"	-30 V DC to +5 V DC
• for signal "1"	11 V DC to 30 V DC
Input current	
• for signal "0", min.	6 mA; < 6 mA
• for signal "1", typ.	6 mA; 6 to 8 mA
Internal preparation time	
• for enable process interrupt, max.	60 µs
Input delay (for rated value of input voltage)	
• Input frequency (with a time delay of 0.1 ms), max.	2 kHz
for standard inputs	
– parameterizable	Yes

Article number	**6ES7421-7BH01-0AB0**
– at "0" to "1", min.	3 µs; 0.05 / 0.1 / 0.5 / 3 ms
Encoder connection	
• Fixed current limitation for wire-break monitoring, min.	10 kΩ
• Fixed current limitation for wire-break monitoring, max.	18 kΩ
Cable length	
• shielded, max.	1 000 m; 1 000 m: 3 ms, 70 m: 0.5 ms, 30 m: 0.1 ms, 30 m: 0.05 ms
• unshielded, max.	600 m; 600 m: 3 ms; 50 m: 0,5 ms; 20 m: 0,1 ms; 20 m: 0,05 ms
Encoder	
Connectable encoders	
• 2-wire sensor	Yes
– permissible quiescent current (2-wire sensor), max.	3 mA
Interrupts/diagnostics/status information	
Diagnostics function	Yes; Parameterizable
Substitute values connectable	Yes
Alarms	
• Diagnostic alarm	Yes; Parameterizable
• Hardware interrupt	Yes; Parameterizable
Diagnoses	
• Diagnostic information readable	Yes
• Monitoring the supply voltage	Yes
• Wire-break	Yes; I < 1 mA
Diagnostics indication LED	
• Rated load voltage PWR (green)	Yes; Per group
• internal fault INTF (red)	Yes
• external fault EXTF (red)	Yes
• Status indicator digital input (green)	Yes
• Channel fault indicator F (red)	No
Potential separation	
Potential separation digital inputs	
• between the channels	Yes
• between the channels, in groups of	8
• between the channels and backplane bus	Yes
Permissible potential difference	
between different circuits	75 V DC/60 V AC
Isolation	
Isolation tested with	500 V DC
tested with	

Article number	**6ES7421-7BH01-0AB0**
• Channels against backplane bus and load voltage L+	500 V DC
• Between channels	500 V DC
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	600 g

4.8.2 Assigning parameters to the SM 421; DI 16 x DC 24 V

Parameter assignment

You will find a description of the general configuration of digital modules in section 5.3.

Parameters of SM 421; DI 16 x DC 24 V

The table below shows an overview of configurable parameters and their default settings for SM 421; DI 16 x DC 24 V.

Table 4-8 Parameters of SM 421; DI 16 x DC 24 V

Parameters	Value range	Default[2]	Parameter type	Scope
Enable				
• Diagnostic interrupt[1]	Yes/no	No	Dynamic	Module
• Hardware interrupt[1]	Yes/no	No		
• Destination CPU for interrupt	1 to 4	-	Static	Module
Diagnostics				
• Wire break	Yes/no	No	Static	Channel Channel group
• No load voltage L+/sensor supply	Yes/no	No		
Hardware interrupt trigger				
• Positive edge	Yes/no	-	Dynamic	Channel
• Negative edge	Yes/no			
Input delay	0.05 ms 0.1 ms 0.5 ms 3 ms	3 ms	Static	Channel group
Reaction to error	Set substitution value (SSV) Hold last value (HLV)	SV	Dynamic	Module
Set substitution value "1"	Yes/no	No	Dynamic	Channel

[1] If you use the module in ER-1/ER-2, you must set this parameter to "No" because the interrupt lines are not available in ER-1/ER-2.

[2] Only in the CR (central rack) is it possible to start up the digital modules with the default settings.

Allocating the sensor supplies to channel groups

The two sensor supplies of the module are used to supply two channel groups: Inputs 0 to 7 and inputs 8 to 15. You also configure diagnostics for the sensor supply at those two channel groups.

Ensuring a wire break check is carried out

To ensure that a wire break check is carried out, you require an external sensor circuit using a resistor of 10 to 18 kΩ. The resistor should be connected parallel to the contact and should be arranged as closely as possible to the sensor.

This additional resistor is not required in the following cases:

- If 2-wire BEROs are used
- If you do no configure the "Wire break" diagnostics

Setting the input delay for channel groups

You can only set the input delay for each group of channels. In other words, the setting for channel 0 applies to inputs 0 to 7 and the setting for channel 8 applies to inputs 8 to 15.

Note

The parameters that are entered for the remaining channels (1 to 7 and 9 to 15) must be equal to the value 0 or 8, otherwise those channels will be reported as being incorrectly configured.

Any hardware interrupts that have occurred in the meantime will be reported after acknowledgement.

Optimum signal propagation delays

You can achieve the fastest signal propagation delay with the following settings:

- Both channel groups are configured with an input delay of 50 µs
- All the diagnoses (load voltage error, wire break) are deactivated
- Diagnostic interrupt is not enabled

See also

Parameters (Page 79)

4.8.3 Behavior of the SM 421; DI 16 x DC 24 V

Effect of operating mode and supply voltage on the input values

The input values of the SM 421; DI 16 x 24 DC depend on the operating mode of the CPU and on the supply voltage of the module.

Table 4-9 Relationships of the analog input values on the CPU's operating state and on the L+ supply voltage

CPU operating state		Power supply L+ at digital module	Input value of 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	-
* Depends on the parameter assignment			

Reaction to failure of the supply voltage

Failure of the supply voltage of the SM 421; DI 16 x 24 DC is always indicated by the EXTF LED on the module. This information is also available on the module (entry in diagnostic data.)

Diagnostics interrupt triggering is based on parameter settings.

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.

Effect of errors and parameter assignment on the input values

The input values of the SM 421; DI 16 x 24 DC are affected by certain errors and the parameter assignment of the module. The following table lists the effects on the input values.

You can find more diagnostic messages in the Appendix "Diagnostic Data of the Signal Modules".

Table 4-10 Relationships between the input values of errors and the configuration

Diagnostic message	"Diagnostics" parameter	"Reaction to Error" parameter	Input value of digital module
No module parameters	Cannot be disabled	Not relevant	0 signal (all channels)
Front connector missing		Substitute a value (SV)	Configured substitute value
		KLV	Last read, valid value

Diagnostic message	"Diagnostics" parameter	"Reaction to Error" parameter	Input value of digital module
Incorrect parameters (module/channel)	Cannot be disabled	Not relevant	0 signal (module/all incorrectly configured channels)
Internal voltage failure	Cannot be disabled	Substitute a value (SV)	Configured substitute value
		KLV	Last read, valid value
Hardware interrupt lost	Cannot be disabled	Not relevant	Current process value
Wire break (for each channel)	Disabled	-	0 signal
	Activated	Substitute a value (SV)	Configured substitute value
		KLV	Last read, valid value
Sensor supply missing (also activated via "No Load Voltage L+")	Disabled	-	0 signal
	Activated	Substitute a value (SV)	Configured substitute value
		KLV	Last read, valid value
No load voltage L+ (for each channel group)	Disabled	-	0 signal, if the contact is connected via the sensor supply; process value for the external sensor supply
	Activated	Substitute a value (SV)	Configured substitute value
		KLV	Last read, valid value

Behavior when the input delay equals 0.1 ms or 0.05 ms and an error occurs

If you have set the following parameters:

- Input delay: 0.1 ms or 0.05 ms
- Reaction to error: "Keep Last Value" (KLV) or "Substitute Value" (SV)
- Set substitution value "1"

In the event of a fault on a channel that has a 1 signal, the following could occur:

- A 0 signal may be briefly output
- If configured, a hardware interrupt may be generated.

This occurs before the last valid value or substitute value "1" is output.

4.9 Digital input module SM 421; DI 16 x UC 24/60 V (6ES7421-7DH00-0AB0)

4.9.1 Features

Overview

SM 421; DI 16 x UC 24/60 V has the following features:

- 16 inputs, individually isolated
- Rated input voltage UC 24 V to UC 60 V
- Suitable for switches and 2-wire proximity switches (BEROs)
- Suitable as P-reading and M-reading input
- Group fault display for internal faults (INTF) and external faults (EXTF)
- Configurable diagnostics
- Configurable diagnostic interrupt
- Configurable hardware interrupts
- Configurable input delays

The status LEDs indicate the process status.

Connection and circuit diagram for SM 421; DI 16 x UC 24/60 V

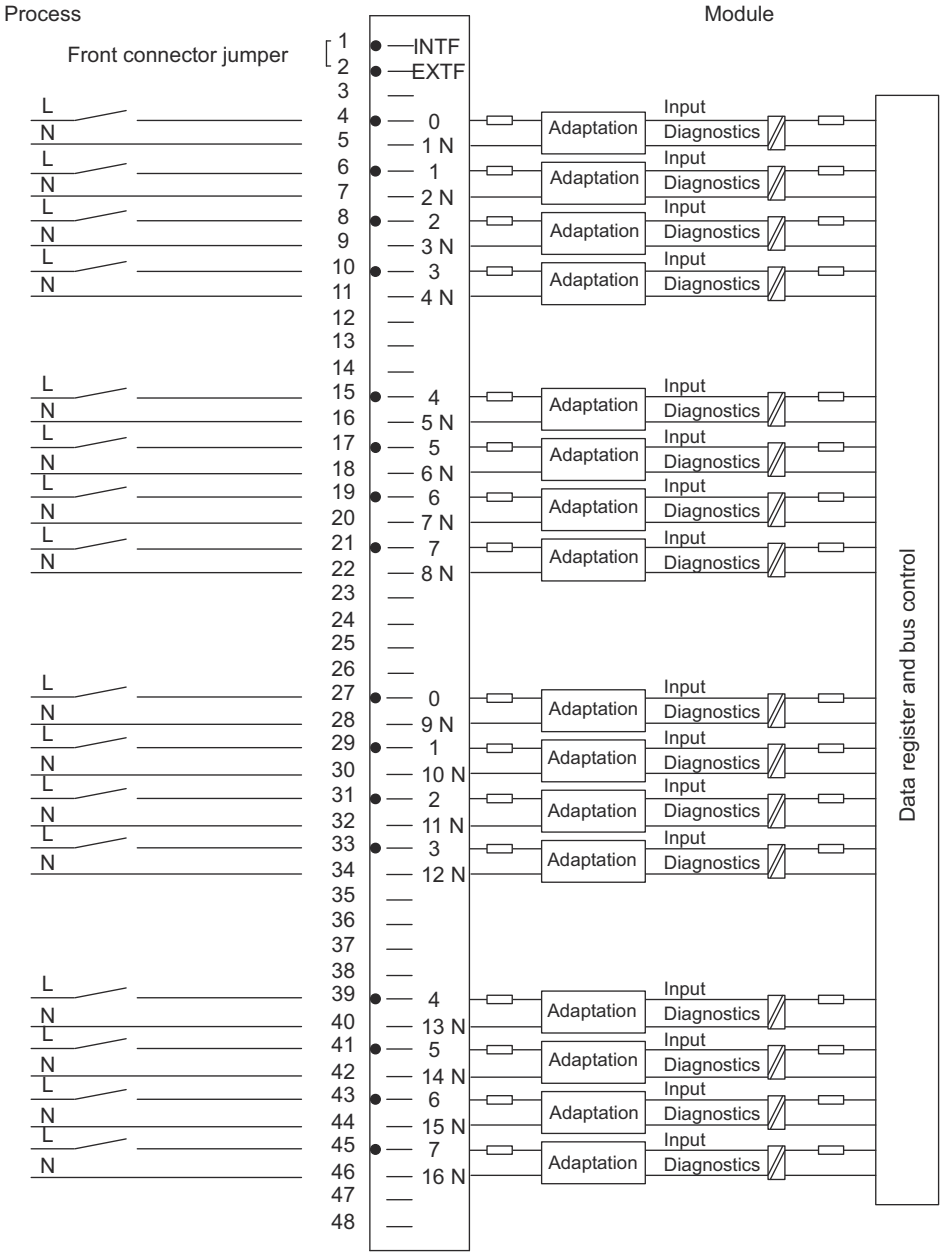


Figure 4-5 Connection and circuit diagram for SM 421; DI 16 x UC 24/60 V

Technical specifications for SM 421; DI 16 x UC 24/60 V

Article number	6ES7421-7DH00-0AB0
Input current	
from backplane bus 5 V DC, max.	150 mA
Power loss	
Power loss, typ.	8 W; 3.5 W (24 V DC); 6.5 W (48 V DC); 8.0 W (60 V DC)
Digital inputs	
Number of digital inputs	16
Number of simultaneously controllable inputs	
• Number of simultaneously controllable inputs	16
Input voltage	
• Type of input voltage	AC/DC
• Rated value (UC)	24 V; 24 V UC to 60 V UC (47 ... 63 Hz)
• for signal "0"	-6 to +6 V DC/ 0 to 5 V AC
• for signal "1"	15 to 72 V DC; -15 to -72 V DC; 15 to 60 V AC
Input current	
• for signal "1", typ.	4 mA; 4 to 10 mA
Internal preparation time	
• for enable process interrupt, max.	450 µs
• for enable process and diagnostics interrupt , max.	2 ms
Input delay (for rated value of input voltage)	
for standard inputs	
– parameterizable	Yes
– Rated value	0.5 ms; 0.5 / 3 / 10 / 20 ms
Encoder connection	
• Fixed current limitation for wire-break monitoring, min.	18 kΩ; 18 kohms: Rated voltage 24 V (15 to 35 V); 39 kohms: Rated voltage 48 V (30 to 60 V)
• Fixed current limitation for wire-break monitoring, max.	56 kΩ; Rated voltage 60 V (50 to 72 V)
Cable length	
• shielded, max.	1 000 m
• unshielded, max.	600 m; 600 m: 3, 10, 20 ms; 100 m: 0,5 ms
Encoder	
Connectable encoders	
• 2-wire sensor	Yes
– permissible quiescent current (2-wire sensor), max.	0.5 mA; 0.5 to 2 mA
Interrupts/diagnostics/status information	
Diagnostics function	Yes; Parameterizable
Substitute values connectable	No
Alarms	

Article number	**6ES7421-7DH00-0AB0**
• Diagnostic alarm	Yes; Parameterizable
• Hardware interrupt	Yes; Parameterizable
Diagnoses	
• Diagnostic information readable	Yes; possible
• Wire-break	Yes; I> 0.7 mA
Diagnostics indication LED	
• Status indicator digital input (green)	Yes
• Channel fault indicator F (red)	No
Potential separation	
Potential separation digital inputs	
• between the channels	Yes
• between the channels, in groups of	1
• between the channels and backplane bus	Yes
Permissible potential difference	
between different circuits	75 V DC/60 V AC
Isolation	
Isolation tested with	1 500 V AC
tested with	
• Channels against backplane bus and load voltage L+	1 500 V AC
• Between channels	1 500 V AC
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	600 g

4.9.2 Assigning parameters to the SM 421; DI 16 x UC 24/60 V

Parameter assignment

You will find a description of the general configuration of digital modules in section 5.3.

Parameters of the SM 421; DI 16 x UC 24/60 V

The following table contains an overview of the parameters you can set and their default settings for the SM 421; DI 16 x UC 24/60 V.

Table 4-11 Parameters of the SM 421; DI 16 x UC 24/60 V

Parameters	Value range	Default[2]	Parameter type	Scope
Enable				
• Diagnostic interrupt[1]	Yes/no	No	Dynamic	Module
• Hardware interrupt[1]	Yes/no	No		
• Destination CPU for interrupt	1 to 4	-	Static	Module
Diagnostics				
• Wire break	Yes/no	No	Static	Channel
Hardware interrupt trigger				
• Positive edge • Negative edge	yes/no yes/no	-	Dynamic	Channel
Input delay[3]	0.5 ms (DC) 3 ms (DC) 20 ms (DC/AC)	3 ms (DC)	Static	Channel group

[1] If you use the module in ER-1/ER-2, you must set this parameter to "No" because the interrupt lines are not available in ER-1/ER-2.

[2] Only in the CR (central rack) is it possible to start up the digital modules with the default settings.

[3] If you assign 0.5 ms , then you should not configure diagnostics because the internal processing time for diagnostic functions can be > 0.5 ms.

Ensuring a wire break check is carried out

To ensure that a wire break check is carried out, you require an external sensor circuit using a resistor of 18 to 56 kΩ. The resistor should be connected parallel to the contact and should be arranged as closely as possible to the sensor.

This additional resistor is not required in the following cases:

- If 2-wire BEROs are used
- If you do no configure the "Wire Break" diagnostics

Setting the input delay for channel groups

You can only set the input delay for each group of channels. In other words, the setting for channel 0 applies to inputs 0 to 7 and the setting for channel 8 applies to inputs 8 to 15.

Note

The parameters that are entered for the remaining channels (1 to 7 and 9 to 15) must be equal to the value 0 or 8, otherwise those channels will be reported as being incorrectly configured.

Any hardware interrupts that have occurred in the meantime will be reported after acknowledgement.

Optimum signal propagation delays

You can achieve the fastest signal propagation delay with the following settings:

- Both channel groups are configured with an input delay of 0.5 ms
- The diagnostics parameter is disabled
- The diagnostic interrupt parameter is disabled

Circuit as for active high or active low input

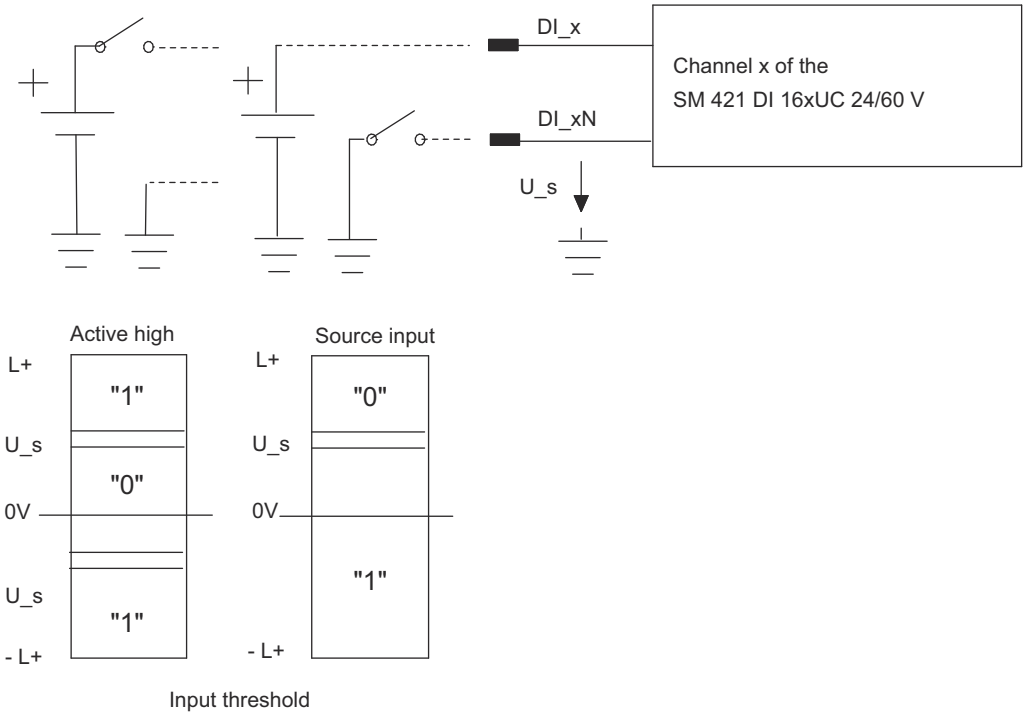


Figure 4-6 Circuit as for active high or active low input

See also

Parameters (Page 79)

4.10 Digital input module SM 421; DI 16 x UC 120/230 V (6ES7421-1FH20-0AA0)

Properties

SM 421; DI 16 x UC 120/230 V has the following features:

- 16 inputs, isolated in groups of 4
- Rated input voltage UC 120/230 V
- Input characteristic in accordance with IEC 61131-2; type 2
- Suitable for switches and 2-wire proximity switches (BEROs)

The status LEDs indicate the process status.

Connection and circuit diagram for SM 421; DI 16 x UC 120/230 V

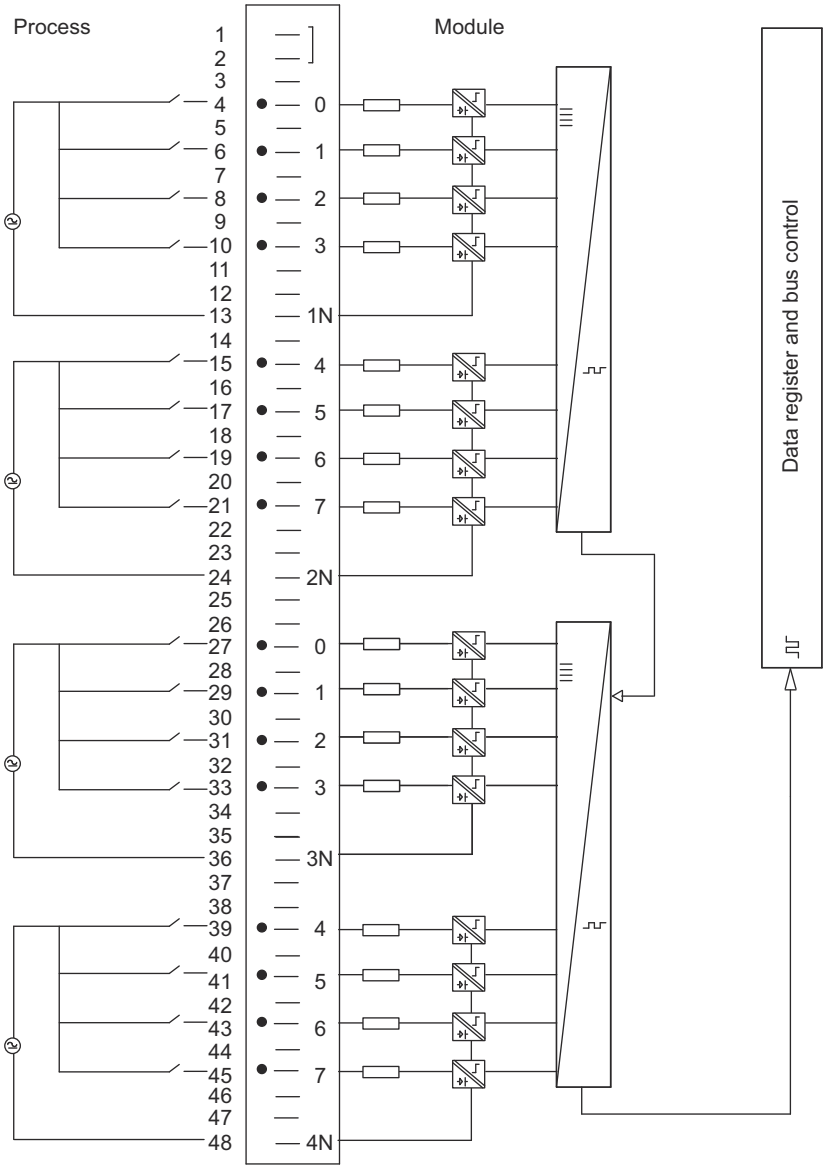


Figure 4-7 Connection and circuit diagram for SM 421; DI 16 x UC 120/230 V

Technical specifications for SM 421; DI 16 x UC 120/230 V

Article number	**6ES7421-1FH20-0AA0**
Input current	
from backplane bus 5 V DC, max.	80 mA
Power loss	
Power loss, typ.	12 W
Digital inputs	
Number of digital inputs	16
Input characteristic according to IEC 61131	Type 2
Number of simultaneously controllable inputs	
• Number of simultaneously controllable inputs	16
Input voltage	
• Type of input voltage	AC/DC
• Rated value (UC)	230 V; 120/230 V UC (47 ... 63 Hz)
• for signal "0"	0 to 40 V AC/ -40 to +40 V DC
• for signal "1"	74 to 264 V AC; 80 to 264 V DC, -80 to -264 V
Input current	
• for signal "0", min.	0 mA; AC: 0 mA; DC: 0 mA
• for signal "0", max. (permissible quiescent current)	6 mA; AC: 6 mA; DC: 2 mA
• for signal "1", typ.	10 mA; at 120 V: 10 mA AC, 1.8 mA DC; at 230 V: 14 mA AC, 2 mA DC
Input delay (for rated value of input voltage) for standard inputs	
– at "0" to "1", max.	20 ms; AC: 20 ms; DC: 15 ms
– at "1" to "0", max.	30 ms; AC: 30 ms; DC: 25 ms
Cable length	
• shielded, max.	1 000 m
• unshielded, max.	600 m
Encoder	
Connectable encoders	
• 2-wire sensor	Yes
– permissible quiescent current (2-wire sensor), max.	5 mA; AC: 5 mA
Interrupts/diagnostics/status information	
Diagnostics function	No
Substitute values connectable	No
Diagnostics indication LED	
• Status indicator digital input (green)	Yes
Potential separation	
Potential separation digital inputs	
• between the channels	Yes
• between the channels, in groups of	4

Article number	6ES7421-1FH20-0AA0
• between the channels and backplane bus	Yes
Permissible potential difference	
between M internally and the inputs	250 V AC
Isolation	
Isolation tested with	1 500 V AC
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	650 g

4.11 Digital input module SM 421; DI 32xUC 120 V (6ES7421-1EL00-0AA0)

Properties

SM 421; DI 32 x UC 120 V has the following features:

- 32 inputs, isolated
- Rated input voltage UC 120 V
- Suitable for switches and 2-wire proximity switches

Connection and circuit diagram for SM 421; DI 32 x UC 120 V

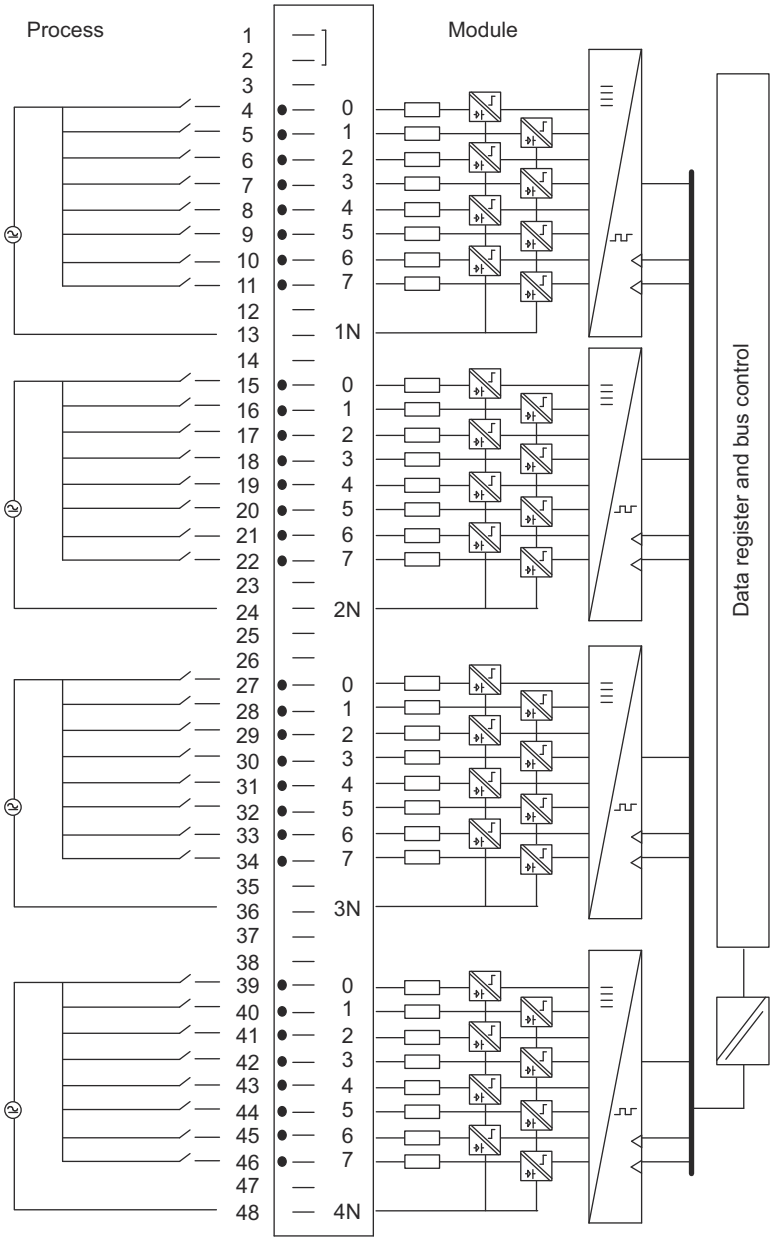


Figure 4-8 Connection and circuit diagram for SM 421; DI 32 x UC 120 V

Technical specifications for SM 421; DI 32 x UC 120 V

Article number	6ES7421-1EL00-0AA0
Input current	
from backplane bus 5 V DC, max.	200 mA
Power loss	
Power loss, typ.	6.5 W
Digital inputs	
Number of digital inputs	32
Input characteristic according to IEC 61131	Type 1
Number of simultaneously controllable inputs	
• Number of simultaneously controllable inputs	32
Input voltage	
• Type of input voltage	AC/DC
• Rated value (UC)	120 V; 47 ... 63 Hz
• for signal "0"	0 to 20 V UC
• for signal "1"	79 to 132 V AC; 80 to 132 V DC
Input current	
• for signal "0", min.	0 mA
• for signal "0", max. (permissible quiescent current)	1 mA
• for signal "1", typ.	2 mA; 2 to 5 mA
Input delay (for rated value of input voltage)	
for standard inputs	
– at "0" to "1", min.	5 ms
– at "0" to "1", max.	25 ms; 10 / 20 ms
– at "1" to "0", min.	5 ms
– at "1" to "0", max.	25 µs
Cable length	
• shielded, max.	1 000 m
• unshielded, max.	600 m
Encoder	
Connectable encoders	
• 2-wire sensor	Yes
– permissible quiescent current (2-wire sensor), max.	1 mA
Interrupts/diagnostics/status information	
Diagnostics indication LED	
• Status indicator digital input (green)	Yes
Potential separation	
Potential separation digital inputs	
• between the channels	Yes
• between the channels, in groups of	8

Article number	6ES7421-1EL00-0AA0
• between the channels and backplane bus	Yes
Permissible potential difference	
between M internally and the inputs	120 V AC
Isolation	
Isolation tested with	1 500 V AC
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	600 g

4.12 Digital output module SM 422; DO 16 x DC 24 V/2 A; (6ES7422-1BH11-0AA0)

Properties

SM 422; DO 16 x DC 24 V/2 A has the following features:

- 16 outputs, isolated in two groups of 8
- Output current 2 A
- Rated load voltage 24 V DC

The status LEDs indicate the system state even if the front connector is not connected.

Special points to note when commissioning

Digital output module SM 422; DO 16 x DC 24 V/2 A, order number 6ES7422-1BH**11**-0AA0, differs from digital output module SM 422; DO 16 x DC 24 V/2 A, order number 6ES7422-1BH**10**-0AA0, in the following feature:

To commission the module, it is **not** necessary to supply each group of 8 outputs with load voltage (e.g. connection of 1L+ and 3L+). The module is fully functional even if only one group is supplied with L+.

Note

Any switch-off of all outputs by switching off a single L+ supply implemented with the previous module 6ES7422-1BH**10**-0AA0 is no longer possible.

Connection and circuit diagram for SM 422; DO 16 x DC 24 V/2 A

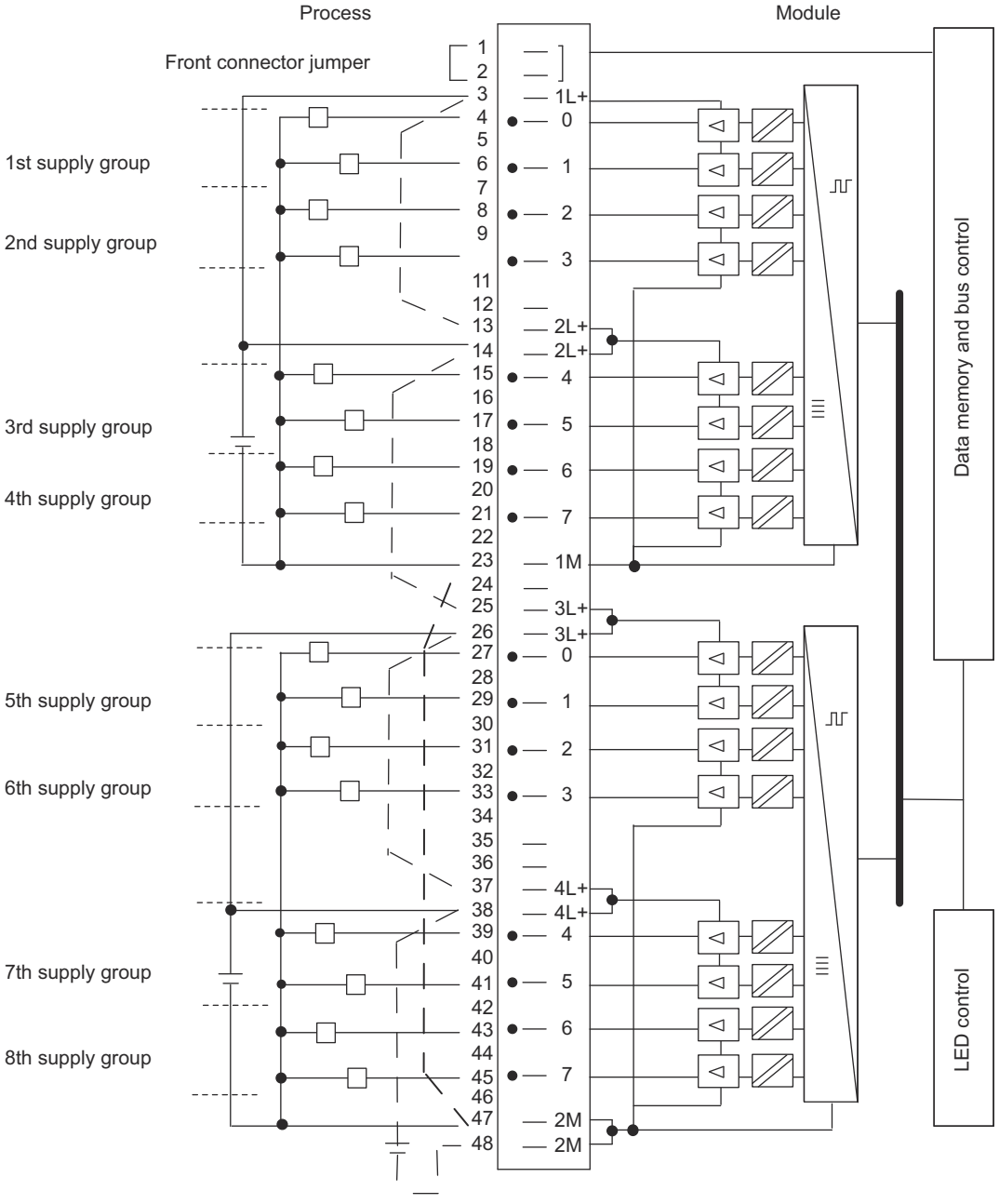


Figure 4-9 Connection and circuit diagram for SM 422; DO 16 x DC 24 V/2 A

Technical specifications for SM 422, DO 16 x DC 24 V/2 A

Article number	6ES7422-1BH11-0AA0
Supply voltage	
Load voltage L+	
• Rated value (DC)	24 V
• permissible range, lower limit (DC)	20.4 V
• permissible range, upper limit (DC)	28.8 V
Input current	
from load voltage L+ (without load), max.	30 mA
from backplane bus 5 V DC, max.	160 mA
Power loss	
Power loss, typ.	5 W
Digital outputs	
Number of digital outputs	16
Short-circuit protection	Yes; Clocked electronically
• Response threshold, typ.	2.8 to 6 A
Limitation of inductive shutdown voltage to	-30 V
Controlling a digital input	Yes; possible
Switching capacity of the outputs	
• on lamp load, max.	10 W
Load resistance range	
• lower limit	24 Ω
• upper limit	4 kΩ
Output voltage	
• for signal "1", min.	L+ (-0.5 V)
Output current	
• for signal "1" rated value	2 A
• for signal "1" permissible range, min.	5 mA
• for signal "1" permissible range, max.	2.4 A
• for signal "0" residual current, max.	0.5 mA
Output delay with resistive load	
• "0" to "1", max.	1 ms
• "1" to "0", max.	1 ms
Parallel switching of two outputs	
• for uprating	No; Not possible
• for redundant control of a load	Yes; possible (only outputs of the same group)
Switching frequency	
• with resistive load, max.	100 Hz
• with inductive load, max.	0.1 Hz
• with inductive load (acc. to IEC 60947-5-1, DC13), max.	0.2 Hz; 0.2 Hz at 1 A; 0.1 Hz at 2 A
• on lamp load, max.	10 Hz
Total current of the outputs (per group)	

Article number	6ES7422-1BH11-0AA0
all mounting positions	
– up to 40 °C, max.	3 A
– up to 60 °C, max.	2 A; 2 adjacent outputs each
Cable length	
• shielded, max.	1 000 m
• unshielded, max.	600 m
Interrupts/diagnostics/status information	
Alarms	No
Diagnostics function	No
Potential separation	
Potential separation digital outputs	
• between the channels	Yes
• between the channels, in groups of	8
• between the channels and backplane bus	Yes
Permissible potential difference	
between different circuits	75 V DC/60 V AC
Isolation	
Isolation tested with	500 V DC
tested with	
• Channels against backplane bus and load voltage L+	500 V DC
• between the outputs of different groups	500 V DC
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	600 g

4.13 Digital output module SM 422; DO 32 x DC 24 V/0.5 A (6ES7422-1BL00-0AA0)

Properties

SM 422; DO 32 x DC 24 V/0.5 A has the following features:

- 32 outputs, isolated in a group of 32
- Power supply in groups of 8 channels.
- A supply group always consists of 8 neighboring channels, starting from channel 0. Channels 0 to 7, 8 to 15, ... 16 to 23 and 24 to 31 each form a supply group.
- Each of these supply groups can be switched off separately by disconnecting L+; however, you must remember the common ground connection.
- Output current 0.5 A
- Rated load voltage 24 V DC

The status LEDs indicate the system state even if the front connector is not connected.

Connection and circuit diagram for SM 422\; DO 32 x DC 24 V/0.5 A

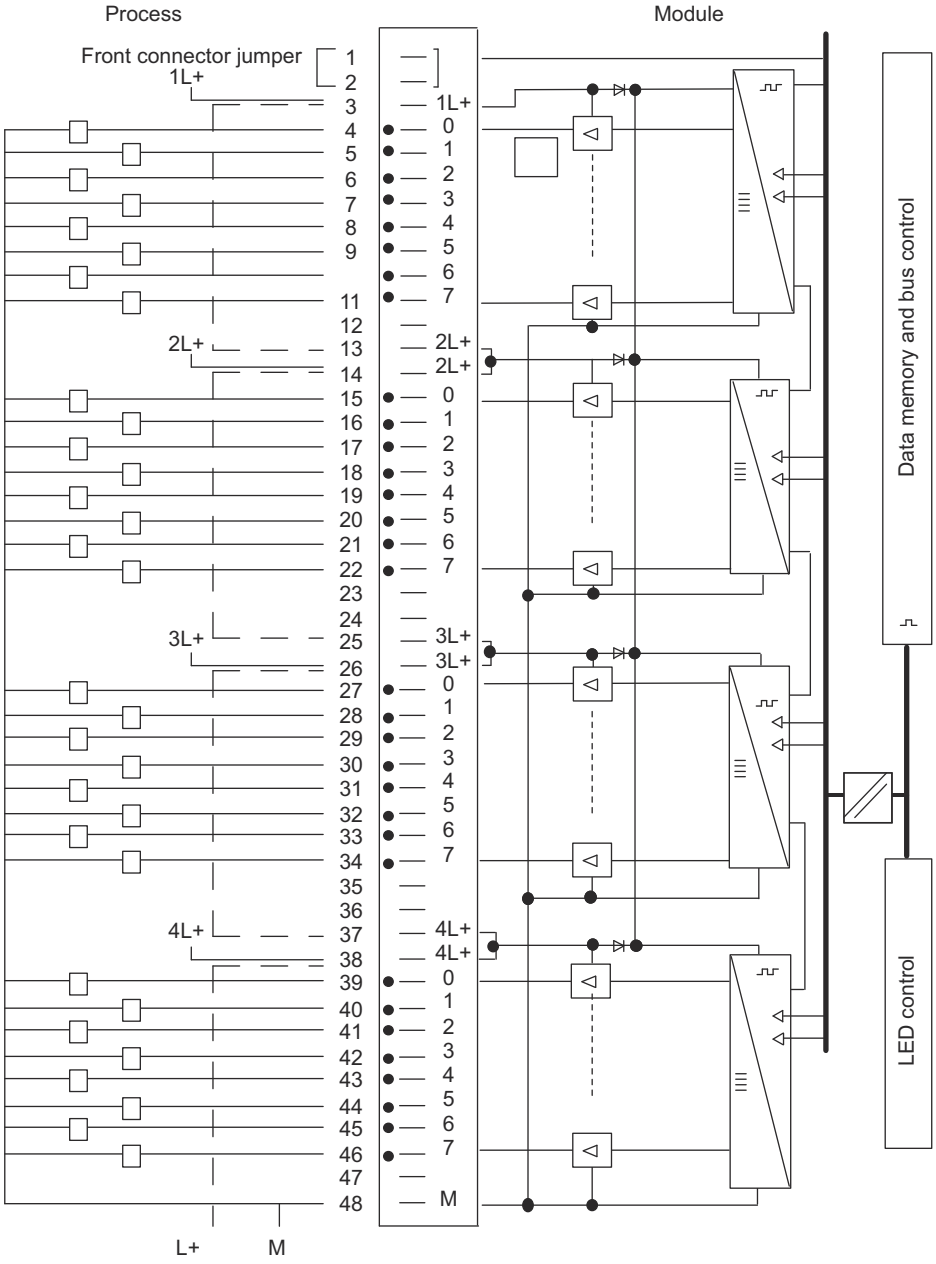


Figure 4-10 Connection and circuit diagram for SM 422; DO 32 x DC 24 V/0.5 A

Technical specifications for SM 422; DO 32 x DC 24 V/0.5 A

Article number	6ES7422-1BL00-0AA0
Supply voltage	
Load voltage L+	
• Rated value (DC)	24 V
• permissible range, lower limit (DC)	20.4 V
• permissible range, upper limit (DC)	28.8 V
Input current	
from load voltage L+ (without load), max.	30 mA
from backplane bus 5 V DC, max.	200 mA
Power loss	
Power loss, typ.	4 W
Digital outputs	
Number of digital outputs	32
Short-circuit protection	Yes; Clocked electronically
• Response threshold, typ.	0.7 to 1.5 A
Limitation of inductive shutdown voltage to	-27 V
Controlling a digital input	Yes; possible
Switching capacity of the outputs	
• on lamp load, max.	5 W
Load resistance range	
• lower limit	48 Ω
• upper limit	4 kΩ
Output voltage	
• for signal "1", min.	L+ (-0.3 V)
Output current	
• for signal "1" rated value	0.5 A
• for signal "1" permissible range, min.	5 mA
• for signal "1" permissible range, max.	0.6 A
• for signal "0" residual current, max.	0.3 mA
Output delay with resistive load	
• "0" to "1", max.	1 ms
• "1" to "0", max.	1 ms
Parallel switching of two outputs	
• for uprating	Yes; possible (only outputs of the same group)
• for redundant control of a load	Yes; possible (only outputs of the same group)
Switching frequency	
• with resistive load, max.	100 Hz
• with inductive load, max.	0.5 Hz
• with inductive load (acc. to IEC 60947-5-1, DC13), max.	2 Hz; 2 Hz at 0.3 A; 0.5 Hz at 0.5 A
• on lamp load, max.	10 Hz
Total current of the outputs (per group)	

Article number	6ES7422-1BL00-0AA0
all mounting positions	
– up to 40 °C, max.	4 A
– up to 60 °C, max.	2 A; 8 adjacent outputs each
Cable length	
• shielded, max.	1 000 m
• unshielded, max.	600 m
Interrupts/diagnostics/status information	
Alarms	No
Diagnostics function	No
Potential separation	
Potential separation digital outputs	
• between the channels	No
• between the channels, in groups of	32
• between the channels and backplane bus	Yes
Permissible potential difference	
between different circuits	75 V DC/60 V AC
Isolation	
Isolation tested with	500 V AC/707 V DC, type test
tested with	
• Channels against backplane bus and load voltage L+	500 V DC
• Load voltage L+ against backplane bus	500 V DC
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	600 g

4.14 Digital output module SM 422; DO 32 x DC 24 V/0.5 A (6ES7422-7BL00-0AB0)

4.14.1 Features

Overview

SM 422; DO 32 x DC 24 V/0.5 A has the following features:

- 32 outputs, fused and isolated in groups of 8
- Output current 0.5 A

- Rated load voltage 24 V DC
- Group fault display for internal faults (INTF) and external faults (EXTF)
- Configurable diagnostics
- Configurable diagnostic interrupt
- Configurable substitute value output

The status LEDs indicate the system state even if the front connector is not connected.

Connection and circuit diagram for SM 422; DO 32 x DC 24 V/0.5 A

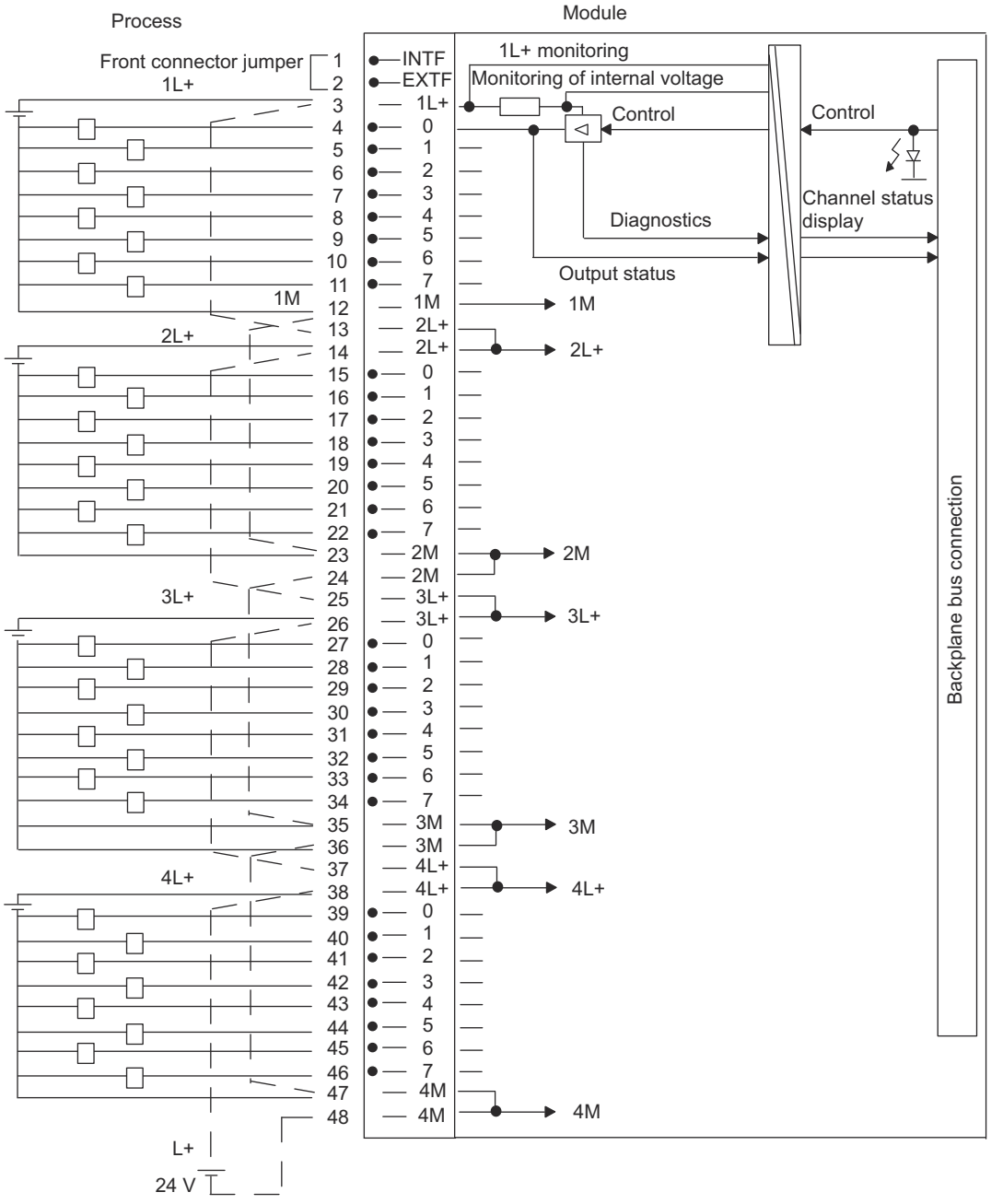


Figure 4-11 Connection and circuit diagram for SM 422; DO 32 x DC 24 V/0.5 A

Technical specifications for SM 422; DO 32 x DC 24 V/0.5 A

Article number	6ES7422-7BL00-0AB0
Supply voltage	
Load voltage L+	
• Rated value (DC)	24 V
• permissible range, lower limit (DC)	20.4 V
• permissible range, upper limit (DC)	28.8 V
Input current	
from load voltage L+ (without load), max.	120 mA
from backplane bus 5 V DC, max.	200 mA
Power loss	
Power loss, typ.	8 W
Digital outputs	
Number of digital outputs	32
Short-circuit protection	Yes; Clocked electronically
• Response threshold, typ.	0.75 to 1.5 A
Limitation of inductive shutdown voltage to	L+ (-45 V)
Controlling a digital input	Yes; possible
Switching capacity of the outputs	
• on lamp load, max.	5 W
Load resistance range	
• lower limit	48 Ω
• upper limit	4 kΩ
Output voltage	
• for signal "1", min.	L+ (-0.8 V)
Output current	
• for signal "1" rated value	0.5 A
• for signal "1" permissible range, min.	5 mA
• for signal "1" permissible range, max.	600 A
• for signal "0" residual current, max.	0.5 mA
Parallel switching of two outputs	
• for uprating	Yes; possible (only outputs of the same group)
• for redundant control of a load	Yes; possible (only outputs of the same group)
Switching frequency	
• with resistive load, max.	100 Hz
• with inductive load, max.	2 Hz
• with inductive load (acc. to IEC 60947-5-1, DC13), max.	2 Hz
• on lamp load, max.	2 Hz
Total current of the outputs (per group)	
all mounting positions	
– up to 40 °C, max.	4 A
– up to 60 °C, max.	2 A

Article number	6ES7422-7BL00-0AB0
Cable length	
• shielded, max.	1 000 m
• unshielded, max.	600 m
Interrupts/diagnostics/status information	
Diagnostics function	Yes; Parameterizable
Substitute values connectable	Yes
Alarms	
• Diagnostic alarm	Yes; Parameterizable
• Hardware interrupt	Yes; Parameterizable
Diagnoses	
• Diagnostic information readable	Yes
• Wire-break	Yes; <0.15 mA
• Short-circuit	Yes; > 1 A (typ.)
Diagnostics indication LED	
• internal fault INTF (red)	Yes
• external fault EXTF (red)	Yes
• Status indicator digital output (green)	Yes
Potential separation	
Potential separation digital outputs	
• between the channels	Yes
• between the channels, in groups of	8
• between the channels and backplane bus	Yes
Permissible potential difference	
between different circuits	75 V DC/60 V AC
Isolation	
Isolation tested with	500 V DC
tested with	
• Channels against backplane bus and load voltage L+	500 V DC
• between the outputs of different groups	500 V DC
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	600 g

4.14.2 Assigning parameters to the SM 422; DO 32 x DC 24 V/0.5 A

Parameter assignment

You will find a description of the general procedure for assigning parameters to digital modules in the respective sections.

Parameters of SM 422; DO 32 x DC 24 V/0.5 A

You will find an overview of the parameters that you can set and their default settings for the SM 422; DO 32 x DC 24 V/0.5 A in the table below.

Table 4-12 Parameters of SM 422; DO 32 x DC 24 V/0.5 A

Parameters	Value range	Default[2]	Parameter type	Scope
Enable				
• Diagnostic interrupt[1]	Yes/no	No	Dynamic	Module
• Destination CPU for interrupt	1 to 4	-	Static	Module
Reaction to CPU STOP	Set substitution value (SSV) Keep last value (KLV)	SV	Dynamic	Module
Diagnostics				
• Wire break	Yes/no	No	Static	Channel
• No load voltage L+/sensor supply	Yes/no	No		Channel group
• Short-circuit to M	Yes/no	No		Channel
• Short-circuit to L+	Yes/no	No		Channel
Set substitution value "1"	Yes/no	No	Dynamic	Channel

[1] If you use the module in ER-1/ER-2, you must set this parameter to "No" because the interrupt lines are not available in ER-1/ER-2.

[2] Only in the CR (central rack) is it possible to start up the digital modules with the default settings.

See also

Parameters (Page 79)

4.14.3 Behavior of the SM 422; DO 32 x DC 24 V/0.5 A

Influence of the operating state and supply voltage on output values

The output values of the SM 422; DO 32 x DC 24 V/0.5 A depend on the operating mode of the CPU and on the supply voltage of the module.

Table 4-13 Relationships of the analog output values on the CPU's operating state and on the L+ supply voltage

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

Reaction to failure of the supply voltage

The failure of the supply voltage of the SM 422; DO 32 x DC 24 V/0.5 A is always indicated by the EXTF LED on the module. This information is also available on the module (entry in diagnostic data.)

Diagnostics interrupt triggering is based on parameter settings.

See also

Assigning parameters to the SM 422; DO 32 x DC 24 V/0.5 A (Page 132)

4.15 Digital output module SM 422; DO 16 x AC 120/230 V/2 A (6ES7422-1FF00-0AA0)

Properties

SM 422; DO 16 x AC 120/230 V/2 A has the following features:

- 16 outputs, isolated in groups of 4
- Output current 2 A
- Rated load voltage 120/230 V AC

The status LEDs indicate the system state even if the front connector is not connected.

Connection and circuit diagram for SM 422; DO 16 x AC 120/230 V/2 A

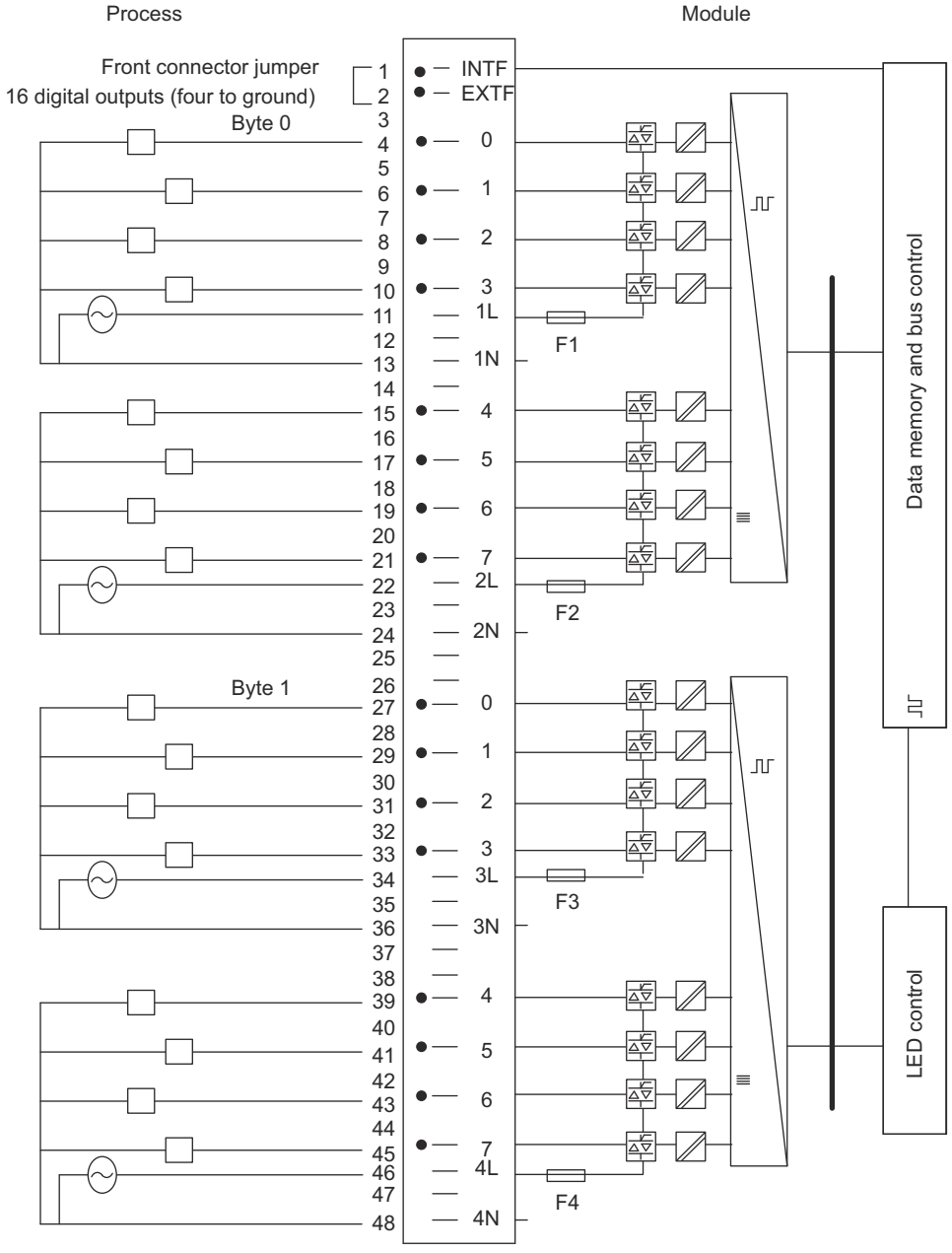


Figure 4-12 Connection and circuit diagram for SM 422; DO 16 x AC 120/230 V/2 A

Technical specifications for SM 422; DO 16 x AC 120/230 V/2 A

Article number	6ES7422-1FH00-0AA0
Supply voltage	
Load voltage L1	
• Rated value (AC)	230 V; 120/230 V AC
• permissible range, lower limit (AC)	79 V
• permissible range, upper limit (AC)	264 V
• permissible frequency range, lower limit	47 Hz
• permissible frequency range, upper limit	63 Hz
Input current	
from load voltage L+ (without load), max.	1.5 mA
from backplane bus 5 V DC, max.	400 mA
Power loss	
Power loss, typ.	16 W
Digital outputs	
Number of digital outputs	16
Short-circuit protection	Yes; Fuse 8 A, 250 V; per group
• required current for fuse shutdown, min.	100 A
• Response time, max.	100 ms
Controlling a digital input	Yes; possible
Size of motor starters according to NEMA, max.	Size 5 according to NEMA
Spare fuses	Fuse 8 A, 250 V, quick response
Zero-crossing switch	No
Switching capacity of the outputs	
• on lamp load, max.	50 W
Output voltage	
• for signal "1", min.	L1 (-18.1 V)
• for signal "1" (at max. current), min.	L1 (-1.3 Vrms)
• for signal "1" (at min. current), min.	L1 (-18.1 Vrms)
Output current	
• for signal "1" rated value	2 A
• for signal "1" permissible range, min.	10 mA
• for signal "1" permissible range, max.	2 A
• for signal "1" permissible surge current, max.	50 A; per cycle
• for signal "0" residual current, max.	2.6 mA
Output delay with resistive load	
• "0" to "1", max.	1 ms
• "1" to "0", max.	1 AC cycle
Parallel switching of two outputs	
• for redundant control of a load	Yes; Possible (only outputs with the same load voltage)
Switching frequency	
• with resistive load, max.	10 Hz

Article number	6ES7422-1FH00-0AA0
• with inductive load, max.	0.5 Hz
• with inductive load (acc. to IEC 60947-5-1, AC15), max.	0.5 Hz
• on lamp load, max.	1 Hz
Total current of the outputs (per group)	
all mounting positions	
– up to 40 °C, max.	4 A; 6 A with fan assembly
– up to 60 °C, max.	2 A; 5 A with fan subassembly; per 4 adjacent outputs
Cable length	
• shielded, max.	1 000 m
• unshielded, max.	600 m
Interrupts/diagnostics/status information	
Alarms	No
Diagnostics function	Not parameterizable
Diagnostics indication LED	
• internal fault INTF (red)	Yes; Fuse blown
• external fault EXTF (red)	Yes; Missing load voltage
Potential separation	
Potential separation digital outputs	
• between the channels	Yes
• between the channels, in groups of	4
• between the channels and backplane bus	Yes
Permissible potential difference	
between the outputs of different groups	500 V AC
Isolation	
Isolation tested with	1 500 V AC
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	800 g

Changing the fuse

Note

Injury is possible.

If you change a fuse without first unplugging the front connector of the module, you may receive an electric shock.

Always remove the front connector before changing a fuse.

4.16 Relay output module SM 422; DO 16 x UC 30/230 V/Rel. 5 A (6ES7422-1HH00-0AA0)

Properties

SM 422; DO 16 x UC 30/230 V/Rel. 5 A has the following features:

- 16 outputs, isolated in 8 groups of 2
- Output current 5 A
- Rated load voltage 230 V AC/125 V DC

The status LEDs indicate the system state even if the front connector is not connected.

Connection and circuit diagram for SM 422, DO 16 x UC 30/230 V/Rel. 5 A

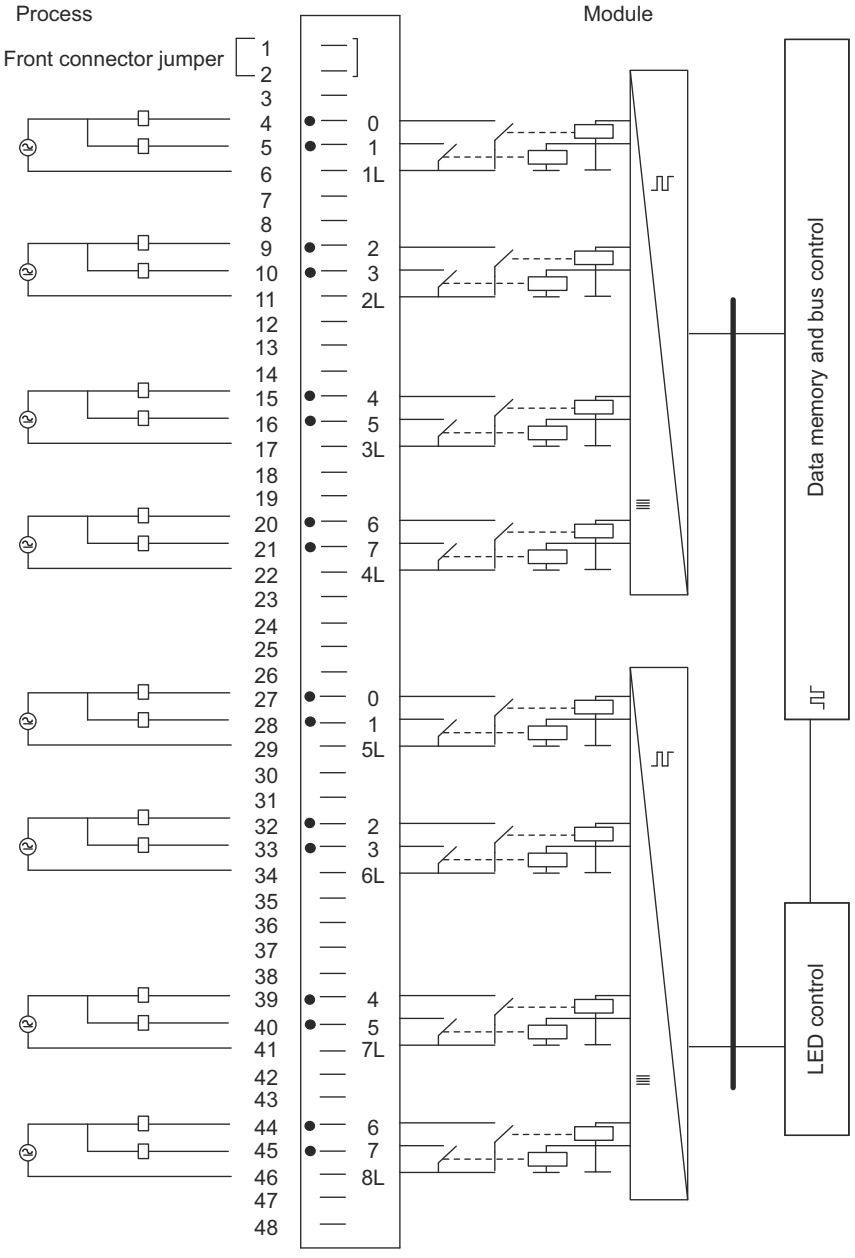


Figure 4-13 Connection and circuit diagram for SM 422, DO 16 x UC 30/230 V/Rel. 5 A

Technical specifications for SM 422, DO 16 x UC 30/230 V/Rel. 5 A

Article number	6ES7422-1HH00-0AA0
Supply voltage	
Load voltage L+	
• Rated value (DC)	60 V
• permissible range, lower limit (DC)	1 V
• permissible range, upper limit (DC)	60 V
Load voltage L1	
• Rated value (AC)	230 V
• permissible range, lower limit (AC)	2 V
• permissible range, upper limit (AC)	264 V
Input current	
from backplane bus 5 V DC, max.	1 A
Power loss	
Power loss, typ.	4.5 W
Digital outputs	
Number of digital outputs	16; Relays
Short-circuit protection	No
Controlling a digital input	Yes; possible
Size of motor starters according to NEMA, max.	Size 5 according to NEMA
Switching capacity of the outputs	
• on lamp load, max.	60 W
Output current	
• for signal "1" rated value	5 A
• for signal "1" minimum load current	11 mA
Parallel switching of two outputs	
• for uprating	No; Not possible
• for redundant control of a load	Yes; Possible (only outputs with the same load voltage)
Switching frequency	
• with resistive load, max.	10 Hz
• With inductive load (to IEC 60947-5-1, DC13/ AC15), max.	1 Hz
• on lamp load, max.	1 Hz
• mechanical, max.	20 Hz
Total current of the outputs (per group)	
all mounting positions	
– up to 40 °C, max.	10 A; 10 A with fan subassembly
– up to 60 °C, max.	5 A; 10 A with fan subassembly
Relay outputs	
• external protection for relay outputs	Fusible link, 6 A, quick response
• Contact connection (internal)	No

Article number	**6ES7422-1HH00-0AA0**
• Number of operating cycles, max.	100 000; 100 000 (AC-15 / DC-13); 3 000 000 mechanical
Switching capacity of contacts	
– with inductive load, max.	5 A; 5 A (30 V DC), 5 A (230 V AC)
– with resistive load, max.	5 A; 5 A (30 V DC), 5 A (230 V AC), 1.2 A (60 V DC), 0.2 A (125 V DC)
– Thermal continuous current, max.	5 A
Cable length	
• shielded, max.	1 000 m
• unshielded, max.	600 m
Interrupts/diagnostics/status information	
Alarms	No
Diagnostics function	No
Diagnostics indication LED	
• Status indicator digital output (green)	Yes; per channel
Potential separation	
Potential separation digital outputs	
• between the channels	Yes
• between the channels, in groups of	2
• between the channels and backplane bus	Yes
Permissible potential difference	
between the outputs of different groups	500 V AC
Isolation	
Isolation tested with	1 500 V AC
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	700 g

Note

Use a suppressor circuit in environments with high humidity and where sparks might occur at the relay contacts. This will increase the service life of the relay contacts.

To install the suppressor circuit, connect an RC element or a varistor in parallel with the relay contacts or load. The dimensions depend on the size of the load.

Analog modules

5

5.1 General information

Structure

This section contains the following topics:

1. Overview of the analog modules available
2. General information concerning all analog modules (such as parameter assignment and diagnostics)
3. Information that refers to specific modules (for example, features, wiring diagram and block diagrams, specifications and special characteristics of the module):
   a) for analog input modules
   b) for analog output modules

STEP 7 blocks for analog functions

You can use blocks FC 105 and FC 106 to read and output analog values in *STEP 7*. You will find the FCs in the standard library of *STEP 7* in the subdirectory called "S5-S7 Converting Blocks" (for a description refer to the *STEP 7 Online Help* for the FCs).

Further information

The appendix describes the structure of the parameter records (data records 0 and 1) and diagnostic information (data records 0 and 1) in the system data. You must be familiar with this configuration if you want to modify the parameters of the modules in the *STEP 7* user program.

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

5.2 Module overview

Features of the analog modules

The tables below set out the main features of the analog modules. This summary is designed to help you select the right module for your requirements.

Table 5-1 Analog input modules: Summary of features

Properties	SM 431; AI 8 x 13 bit (-1KF00-)	SM 431; AI 8 x 14 bit (-1KF10-)	SM 431; AI 8 x 14 bit (-1KF20-)	SM 431; AI 16 x 13 bit (-0HH0-)	SM 431; AI 16 x 16 bit (-7QH00-)	SM 431; AI 8 x RTD 16 bit (-7KF10-)	SM 431; AI 8 x 16 bit (-7KF00-)
Number of inputs	8 AI for U/I measurement 4 AI for resistance measurement	8 AI for U/I measurement 4 AI for resist. / temp. measurement	8 AI for U/I measurement 4 AI for resistance measurement	16 inputs	16 AI for U/I / temp. measurement 8 AI for resistance measurement	8 inputs	8 inputs
Resolution	13 bits	14 bits	14 bits	13 bits	16 bits	16 bits	16 bits
Type of measurement	Voltage Current Resistance	Voltage Current Resistance Temperature	Voltage Current Resistance	Voltage Current	Voltage Current Resistance Temperature	Resistance	Voltage Current Temperature
Measuring principle	Integrating	Integrating	Instantaneous value encoding	Integrating	Integrating	Integrating	Integrating
Configurable diagnostics	No	No	No	No	Yes	Yes	Yes
Diagnostic interrupt	No	No	No	No	Can be set	Yes	Yes
Threshold value monitoring	No	No	No	No	Can be set	Can be set	Can be set
Hardware interrupt upon limit violation	No	No	No	No	Can be set	Can be set	Can be set
Hardware interrupt at end of cycle	No	No	No	No	Can be set	No	No
Voltage relationships	Analog section isolated from the CPU			Non-isolated	Analog section isolated from the CPU		
Maximum permitted common mode voltage	between channels or between reference potential of connected sensors and $M_{ANA:}$ 30 V AC	between channels or between channel and central grounding point: 60 V DC / 30 V AC (SELV)	between channels or between reference potential of connected sensors and $M_{ANA:}$ 8 V AC	between channels or between reference potential of connected sensors and central grounding point: 2 V DC/AC	between channels or between channel and central grounding point: 60 V DC / 30 V AC (SELV)	between channel and central grounding point: 60 V DC / 30 V AC (SELV)	between channels or between channel and central grounding point: 60 V DC / 30 V AC (SELV)

Properties	SM 431; AI 8 x 13 bit (-1KF00-)	SM 431; AI 8 x 14 bit (-1KF10-)	SM 431; AI 8 x 14 bit (-1KF20-)	SM 431; AI 16 x 13 bit (-0HH0-)	SM 431; AI 16 x 16 bit (-7QH00-)	SM 431; AI 8 x RTD 16 bit (-7KF10-)	SM 431; AI 8 x 16 bit (-7KF00-)
External power supply required	No	24 V DC (only with current, 2 DMU) [1]	24 V DC (only with current, 2 DMU) [1]	24 V DC (only with current, 2 DMU) [1]	24 V DC (only with current, 2 DMU) [1]	No	No
Special features	-	Suitable for temp. measurement Temperature sensor types configurable Linearization of sensor characteristic curves Measured value smoothing can be set	Rapid A/D change, suitable for highly dynamic processes Measured value smoothing can be set	-	Suitable for temp. measurement Temperature sensor types configurable Linearization of sensor characteristic curves Measured value smoothing can be set	Resistance thermometer configurable Linearization of sensor characteristic curves Measured value smoothing can be set	Internal measurement resistance Field connection with internal reference temperature (included in module scope of delivery) Measured value smoothing can be set

[1] 2-DMU 2-wire transducer

Table 5-2 Analog output modules: Summary of features

Properties	Module SM 432; AO 8 x 13 bit (-1HF00-)
Number of outputs	8 outputs
Resolution	13 bits
Type of output	Channel by channel: • Voltage • Current
Configurable diagnostics	No
Diagnostic interrupt	No
Substitute value output	No
Voltage relationships	Analog section isolated from: • the CPU • the load voltage
Maximum permitted common mode voltage	Between channels or between channels and M_{ANA} 3 V DC
Special features	-

5.3 Steps for commissioning analog modules

Introduction

The following table contains the tasks that you have to perform one after the other to commission analog modules successfully.

The sequence of steps is a suggestion, but you can perform individual steps either earlier or later (for example, assign parameters to the module) or install, commission etc. other modules in between times.

Steps

Table 5-3 Steps from the selection of analog modules to commissioning

Step	Procedure
1	Select the module.
2	For certain analog input modules: Set the measuring type and range using the measuring range module.
3	Mount the module in the rack.
4	Assign parameters to module.
5	Connect the measuring sensors or loads to the module.
6	Commission the configuration.
7	Analyze the configuration if commissioning failed.

5.4 Representation of analog values

5.4.1 General information

Introduction

This chapter describes the analog values for all measuring or output ranges supported by the analog modules.

Analog to digital conversion

Analog input modules convert the analog process signal into digital form.

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 nominal range. Analog values are output as real numbers in two's complement. The resulting 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}

Bit 15 can be interpreted as a sign

The sign of the analog value is always set at bit 15:

- "0" → +
- "1" → -

Resolution less than 16 bits

On analog modules with a resolution of less than 16 bits, the analog value is stored left-justified. The unused least significant bit positions are padded with "0".

Example

The example below demonstrates the "0" padding of unused bit positions for low resolution values.

Table 5-4 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

5.4.2 Representation of analog values of analog input channels

Introduction

The tables in this section contain the measured value representations for the various measuring ranges of the analog input modules. The values in the tables apply to all modules with the corresponding measuring ranges.

Notes for readers of the tables

The tables "Bipolar input ranges", "Unipolar input ranges", "Life-zero input ranges" contain the binary representation of the measured values.

The binary representation of the measured values is always the same, so the analog representation tables only compare the measuring ranges and the units.

Measured value resolution

The resolution of the analog values may differ, based on the analog module and module parameters. At resolutions < 16 bits, all bits identified by "x" are set to "0".

Note

This resolution does not apply to temperature values. The converted temperature values are the result of a conversion in the analog module (see tables for analog representation of resistance thermometer and for thermometer elements).

Table 5-5 Supported analog value resolutions

Resolution in bits	Unit decimal	Unit hexadecimal	Analog value High byte	Analog value Low byte
9	128	80_H	0 0 0 0 0 0 0 0	1 x x x x x x x
10	64	40_H	0 0 0 0 0 0 0 0	0 1 x x x x x x
11	32	20_H	0 0 0 0 0 0 0 0	0 0 1 x x x x x
12	16	10_H	0 0 0 0 0 0 0 0	0 0 0 1 x x x x
13	8	8_H	0 0 0 0 0 0 0 0	0 0 0 0 1 x x x
14	4	4_H	0 0 0 0 0 0 0 0	0 0 0 0 0 1 x x
15	2	2_H	0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 x
16	1	1_H	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1

5.4.3 Binary representation of input ranges

Input ranges

The input ranges shown in tables "Bipolar input ranges", "Unipolar input ranges", "Life-zero input ranges" are defined in complementary 2-by-2 representation:

Table 5-6 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	
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	Nominal range
- 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

Table 5-7 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 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	
1	0,003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Nominal 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 range
- 4864	- 17,593	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	
-32768	≤- 17,596	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Underflow

Table 5-8 Life-zero 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}	
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	Nominal 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	Undershoot range
- 4864	- 17,593	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	
In the event of a wire break, the module reports $7FFF_H$																		

5.4.4 Representation of analog values in voltage measuring ranges

Table 5-9 Representation of analog values in the ±1 V to ±10 V voltage measuring ranges

System			Voltage measuring range				
	Dec.	**Hex.**	**± 10 V**	**± 5 V**	**± 2.5 V**	**± 1 V**	
118,515 %	32767	7FFF	11.851 V	5.926 V	2.963 V	1.185 V	Overflow
117,593 %	32512	7F00					
117,589 %	32511	7EFF	11.759 V	5.879 V	2.940 V	1.176 V	Overshoot range
	27649	6C01					
100,000 %	27648	6C00	10 V	5 V	2.5 V	1 V	Nominal range
75,000 %	20736	5100	7.5 V	3.75 V	1.875 V	0.75 V	
0,003617 %	1	1	361.7 µV	180.8 µV	90.4 µV	36.17 µV	
0 %	0	0	0 V	0 V	0 V	0 V	
	- 1	FFFF					
- 75,00 %	- 20736	AF00	- 7.5 V	- 3.75 V	- 1.875 V	- 0.75 V	
- 100,000 %	- 27648	9400	- 10 V	- 5 V	- 2.5 V	- 1 V	
	- 27649	93FF					Undershoot range
- 117,593 %	- 32512	8100	- 11.759 V	- 5.879 V	- 2.940 V	- 1.176 V	
- 117,596 %	- 32513	80FF					Underflow
- 118,519 %	- 32768	8000	- 11.851 V	- 5.926 V	- 2.963 V	- 1.185 V	

Table 5-10 Representation of analog values in the ±25 to ±500 mV voltage measuring ranges

System			Voltage measuring range					
	Dec.	**Hex.**	**± 500 mV**	**± 250 mV**	**± 80 mV**	**± 50 mV**	**± 25 mV**	
118,515 %	32767	7FFF	592.6 mV	296.3 mV	94.8 mV	59.3 mV	29.6 mV	Overflow
117,593 %	32512	7F00						
117,589 %	32511	7EFF	587.9 mV	294.0 mV	94.1 mV	58.8 mV	29.4 mV	Overshoot range
	27649	6C01						
100,000 %	27648	6C00	500 mV	250 mV	80 mV	50 mV	25 mV	Nominal range
75 %	20736	5100	375 mV	187.54 mV	60 mV	37.5 mV	18.75 mV	
0,003617%	1	1	18.08 µV	9.04 µV	2.89 µV	1.81 µV	904.2 nV	
0 %	0	0	0 mV	0 mV	0 mV	0 mV	0 mV	
	- 1	FFFF						
- 75,00 %	- 20736	AF00	- 375 mV	-187.54 mV	- 60 mV	- 37.5 mV	- 18.75 mV	
- 100,000%	- 27648	9400	- 500 mV	- 250 mV	- 80 mV	- 50 mV	- 25 mV	
	- 27649	93FF						Undershoot range
- 117,593%	- 32512	8100	- 587.9 mV	- 294.0 mV	- 94.1 mV	- 58.8 mV	- 29.4 mV	
- 117,596%	- 32513	80FF						Underflow
- 118,519%	- 32768	8000	- 592.6mV	- 296.3 mV	- 94.8mV	- 59.3 mV	- 29.6 mV	

Table 5-11 Representation of analog values in the voltage measuring ranges 1 to 5 V and 0 to 10 V

System			Voltage measuring range		
	Dec.	**Hex.**	**1 to 5 V**	**0 to 10 V**	
118,515 %	32767	7FFF	5.741 V	11.852 V	Overflow
117,593 %	32512	7F00			
117,589 %	32511	7EFF	5.704 V	11.759 V	Overshoot range
	27649	6C01			
100,000 %	27648	6C00	5 V	10 V	Nominal range
75 %	20736	5100	3.75 V	7.5 V	
0,003617 %	1	1	1 V + 144.7 µV	0 V + 361.7 µV	
0 %	0	0	1 V	0 V	
	- 1	FFFF			Undershoot range
- 17,593 %	- 4864	ED00	0.296 V	Negative values are not supported	
					Wire break
≤-17,596 %	32767	7FFF			

5.4.5 Representation of analog values in the current measuring ranges

Table 5-12 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**	**± 5 mA**	**± 3.2 mA**	
118,515 %	32767	7FFF	23.70 mA	11.85 mA	5.93 mA	3.79 mA	Overflow
117,593 %	32512	7F00					
117,589 %	32511	7EFF	23.52 mA	11.76 mA	5.88 mA	3.76 mA	Overshoot range
	27649	6C01					
100,000 %	27648	6C00	20 mA	10 mA	5 mA	3.2 mA	Nominal range
75 %	20736	5100	15 mA	7.5 mA	3.75 mA	2.4 mA	
0,003617 %	1	1	723.4 nA	361.7 nA	180.8 nA	115.7 nA	
0 %	0	0	0 mA	0 mA	0 mA	0 mA	
	- 1	FFFF					
- 75 %	- 20736	AF00	- 15 mA	- 7.5 mA	- 3.75 mA	- 2.4 mA	
- 100,000 %	- 27648	9400	- 20 mA	- 10 mA	- 5 mA	- 3.2 mA	
	- 27649	93FF					Undershoot range
- 117,593 %	- 32512	8100	- 23.52 mA	- 11.76 mA	- 5.88 mA	- 3.76 mA	
- 117,596 %	- 32513	80FF					Underflow
- 118,519 %	- 32768	8000	- 23.70 mA	- 11.85 mA	- 5.93 mA	- 3.79 mA	

Table 5-13 Representation of analog values in current measuring ranges 0 to 20 mA

System			Current measuring range	
	Dec.	**Hex.**	**0 to 20 mA**	
118,515 %	32767	7FFF	23.70 mA	Overflow
117,593 %	32512	7F00		
117,589 %	32511	7EFF	23.52 mA	Overshoot range
	27649	6C01		Nominal range
100,000 %	27648	6C00	20 mA	
75 %	20736	5100	15 mA	
0,003617 %	1	1	723.4 nA	
0 %	0	0	0 mA	
	- 1	FFFF		Undershoot range
- 17,593 %	- 4864	ED00	- 3.52 mA	
	- 4865	ECFF		Underflow
≤ - 17,596 %	- 32768	8000		

Table 5-14 Representation of analog values in current measuring ranges 4 to 20 mA

System			Current measuring range	
	Dec.	**Hex.**	**4 to 20 mA**	
118,515 %	32767	7FFF	22.96 mA	Overflow
117,593 %	32512	7F00		
117,589 %	32511	7EFF	22.81 mA	Overshoot range
	27649	6C01		Nominal range
100,000 %	27648	6C00	20 mA	
75 %	20736	5100	16 mA	
0,003617 %	1	1	4 mA + 578.7 nA	
0 %	0	0	4 mA	
	- 1	FFFF		Undershoot range
- 17,593 %	- 4864	ED00	1.185 mA	
				Wire break
≤ - 17,596 %	32767	7FFF		

5.4.6 Representation of analog values for resistance-type sensors

Table 5-15 Analog value representation for resistance-type sensors from 48 Ω to 6 kΩ

System			Resistive transducer range					
	Dec.	**Hex.**	**48 Ω**	**150 Ω**	**300 Ω**	**600 Ω**	**6 kΩ**	
118,515 %	32767	7FFF	56.89 Ω	177.77 Ω	355.54 Ω	711.09 Ω	7.11 kΩ	Overflow
117,593 %	32512	7F00						
117,589 %	32511	7EFF	56.44 Ω	176.38 Ω	352.77 Ω	705.53 Ω	7.06 kΩ	Overshoot range
	27649	6C01						
100,000 %	27648	6C00	48 Ω	150 Ω	300 Ω	600 Ω	6 kΩ	Nominal range
75 %	20736	5100	36 Ω	112.5 Ω	225 Ω	450 Ω	4.5 kΩ	
0,003617 %	1	1	1.74 mΩ	5.43 mΩ	10.85 mΩ	21.70 mΩ	217.0 mΩ	
0 %	0	0	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω	
			(negative values are physically impossible)					Undershoot range

5.4.7 Representation of analog values for resistance thermometer

Representation of the analog values of Pt x00 standard resistance thermometers

Table 5-16 Representation of analog values for Pt 100/200/500/1000 resistance thermometers

Pt x00 Standard in °C (1 digit = 0.1° C)	Unit decimal	Unit hexadecimal	Pt x00 Standard in °F (1 digit = 0.1 ° F)	Unit decimal	Unit hexadecimal	Pt x00 Standard in K (1 digit = 0.1 K)	Unit decimal	Unit hexadecimal	Range
> 1000,0	32767	$7FFF_H$	> 1832,0	32767	$7FFF_H$	> 1273,2	32767	$7FFF_H$	Overflow
1000,0 : 850,1	10000 : 8501	2710_H : 2135_H	1832,0 : 1562,1	18320 : 15621	4790_H : $3D05_H$	1273,2 : 1123,3	12732 : 11233	$31BC_H$: $2BE1_H$	Overshoot range
850,0 : -200,0	8500 : -2000	2134_H : $F830_H$	1562,0 : -328,0	15620 : -3280	$3D04_H$: $F330_H$	1123,2 : 73,2	11232 : 732	$2BE0_H$: $2DC_H$	Nominal range
-200,1 : -243,0	-2001 : -2430	$F82F_H$: $F682_H$	-328,1 : -405,4	-3281 : -4054	$F32F_H$: $F02A_H$	73,1 : 30,2	731 : 302	$2DB_H$: $12E_H$	Undershoot range
< -243,0	-32768	8000_H	< -405,4	-32768	8000_H	< 30,2	32768	8000_H	Underflow

Representation of analog values for Pt x00 climatic resistance thermometers

Table 5-17 Representation of analog values for Pt 100/200/500/1000 resistance thermometers

Pt x00 Climatic in °C (1 digit = 0.01° C)	Unit decimal	Unit hexadecimal	Pt x00 Climatic in °F (1 digit = 0.01 °F)	Unit decimal	Unit hexadecimal	Range
> 155,00	32767	$7FFF_H$	> 311,00	32767	$7FFF_H$	Overflow
155,00 : 130,01	15500 : 13001	$3C8C_H$: $32C9_H$	311,00 : 266,01	31100 : 26601	$797C_H$: $67E9_H$	Overshoot range
130,00 : -120,00	13000 : -12000	$32C8_H$: $D120_H$	266,00 : -184,00	26600 : -18400	$67E8_H$: $B820_H$	Nominal range
-120,01 : -145,00	-12001 : -14500	$D11F_H$: $C75C_H$	-184,01 : -229,00	-18401 : -22900	$B81F_H$: $A68C_H$	Undershoot range
< - 145,00	-32768	8000_H	< -229,00	-32768	8000_H	Underflow

Representation of analog values for Ni x00 standard resistance thermometers

Table 5-18 Analog value representation for resistance thermometers Ni100, 120, 200, 500, 1000

Ni x00 Standard in °C (1 digit = 0.1° C)	Unit decimal	Unit hexa-decimal	Ni x00 Standard in °F (1 digit = 0.1 °F)	Unit decimal	Unit hexa-decimal	Ni x00 standard in K (1 digit = 0.1 K)	Unit decimal	Unit hexa-decimal	Range
> 295,0	32767	$7FFF_H$	> 563,0	32767	$7FFF_H$	> 568,2	32767	$7FFF_H$	Overflow
295,0	2950	$B86_H$	563,0	5630	$15FE_H$	568,2	5682	1632_H	Overshoot range
:	:	:	:	:	:	:	:	:	
250,1	2501	$9C5_H$	482,1	4821	$12D5_H$	523,3	5233	1471_H	
250,0	2500	$9C4_H$	482,0	4820	$12D4_H$	523,2	5232	1470_H	Nominal range
:	:	:	:	:	:	:	:	:	
-60,0	-600	$FDA8_H$	-76,0	-760	$FD08_H$	213,2	2132	854_H	
-60,1	-601	$FDA7_H$	-76,1	-761	$FD07_H$	213,1	2131	853_H	Undershoot range
:	:	:	:	:	:	:	:	:	
-105,0	-1050	$FBE6_H$	-157,0	-1570	$F9DE_H$	168,2	1682	692_H	
< -105,0	-32768	8000_H	< -157,0	-32768	8000_H	< 168,2	32768	8000_H	Underflow

Representation of analog values for Ni x00 climatic resistance thermometers

Table 5-19 Analog value representation for resistance thermometers Ni 100, 120, 200, 500, 1000

Ni x00 Climatic in °C (1 digit = 0.01° C)	Unit decimal	Unit hexa-decimal	Ni x00 Climatic in °F (1 digit = 0.01 °F)	Unit decimal	Unit hexa-decimal	Range
> 295,00	32767	$7FFF_H$	> 325,11	32767	$7FFF_H$	Overflow
295,00 : 250,01	29500 : 25001	$733C_H$: $61A9_H$	327,66 : 280,01	32766 : 28001	$7FFE_H$: $6D61_H$	Overshoot range
250,00 : -60,00	25000 : -6000	$61A8_H$: $E890_H$	280,00 : -76,00	28000 : -7600	$6D60_H$: $E250_H$	Nominal range
-60,01 : -105,00	-6001 : -10500	$E88F_H$: $D6FC_H$	-76,01 : -157,00	-7601 : -15700	$E24F_H$: $C2AC_H$	Undershoot range
< -105,00	-32768	8000_H	< -157,00	-32768	8000_H	Underflow

Representation of analog values for Cu 10 standard resistance thermometers

Table 5-20 Representation of analog values for Cu 10 standard resistance thermometers

Cu 10 Standard in °C (1 digit = 0.01° C)	Unit decimal	Unit hexa-decimal	Cu 10 Standard in °F (1 digit = 0.01° F)	Unit decimal	Unit hexa-decimal	Cu 10 Standard in K (1 digit = 0.01 K)	Unit decimal	Unit hexa-decimal	Range
> 312,0	32767	$7FFF_H$	> 593,6	32767	$7FFF_H$	> 585,2	32767	$7FFF_H$	Overflow
312,0 : 260,1	3120 : 2601	$C30_H$: $A29_H$	593,6 : 500,1	5936 : 5001	1730_H : $12D5_H$	585,2 : 533,3	5852 : 5333	$16DC_H$: $14D5_H$	Overshoot range
260,0 : -200,0	2600 : -2000	$A28_H$: $F830_H$	500,0 : -328,0	5000 : -3280	1389_H : $F330_H$	533,2 : 73,2	5332 : 732	$14D4_H$: $2DC_H$	Nominal range
-200,1 : -240,0	-2001 : -2400	$F82F_H$: $F6A0_H$	-328,1 : -400,0	-3281 : -4000	$F32F_H$: $F060_H$	73,1 : 33,2	731 : 332	$2DB_H$: $14C_H$	Undershoot range
< -240,0	-32768	8000_H	< -400,0	-32768	8000_H	< 33,2	32768	8000_H	Underflow

Representation of analog values for Cu 10 climatic resistance thermometers

Table 5-21 Representation of analog values for Cu 10 climatic resistance thermometers

Cu 10 Climatic in °C (1 digit = 0.01° C)	Unit decimal	Unit hexadecimal	Cu 10 Climatic in °F (1 digit = 0.01° F)	Unit decimal	Unit hexadecimal	Range
> 180,00	32767	$7FFF_H$	>325,11	32767	$7FFF_H$	Overflow
180,00 : 150,01	18000 : 15001	4650_H : $3A99_H$	327,66 : 280,01	32766 : 28001	$7FFE_H$: $6D61_H$	Overshoot range
150,00 : -50,00	15000 : -5000	$3A98_H$: $EC78_H$	280,00 : -58,00	28000 : -5800	$6D60_H$: $E958_H$	Nominal range
-50,01 : -60,00	-5001 : -6000	$EC77_H$: $E890_H$	-58,01 : -76,00	-5801 : -7600	$E957_H$: $E250_H$	Undershoot range
< -60,00	-32768	8000_H	< -76,00	-32768	8000_H	Underflow

5.4.8 Representation of analog values for thermocouples

Representation of analog values for thermocouples type B

Table 5-22 Representation of analog values for thermocouples type B

Type B in °C	Unit decimal	Unit decimal	Type B in °F	Unit decimal	Unit hexa-decimal	Type B in K	Unit decimal	Unit hexa-decimal	Range
> 2070,0	32767	$7FFF_H$	>3276,6	3276,6	$7FFF_H$	> 2343,2	32767	$7FFF_H$	Overflow
2070,0 : 1821,0	20700 : 18210	$50DC_H$: 4722_H	3276,6 : 2786,6	32766 : 27866	$7FFE_H$: $6CDA_H$	2343,2 : 2094,2	23432 : 20942	$5B88_H$: $51CE_H$	Overshoot range
1820,0 : 0,0	18200 : 0	4718_H : 0000_H	2786,5 : -32,0	27865 : -320	$6CD9_H$: $FEC0_H$	2093,2 : 273,2	20932 : 2732	$51C4_H$: $0AAC_H$	Nominal range
: -120,0	: -1200	: $FB50_H$	: -184,0	: -1840	: $F8D0_H$	: 153,2	: 1532	: $05FC_H$	Undershoot range
< -120,0	-32768	8000_H	< -184,0	-32768	8000_H	< 153,2	32768	8000_H	Underflow

Representation of analog values for thermocouples type E

Table 5-23 Representation of analog values for thermocouples type E

Type E in °C	Unit dec-imal	Unit hexa-decimal	Type E in °F	Unit decimal	Unit hexa-decimal	Type E in K	Unit decimal	Unit hexa-decimal	Range
> 1200,0	32767	$7FFF_H$	> 2192,0	32767	$7FFF_H$	> 1473,2	32767	$7FFF_H$	Overflow
1200,0 : 1000,1	12000 : 10001	$2EE0_H$: 2711_H	2192,0 : 1833,8	21920 : 18338	$55A0_H$: $47A2_H$	1473,2 : 1274,2	14732 : 12742	$398C_H$: $31C6_H$	Overshoot range
1000,0 : -270,0	10000 : -2700	2710_H : $F574_H$	1832,0 : -454,0	18320 : -4540	4790_H : $EE44_H$	1273,2 : 0	12732 : 0	$31BC_H$: 0000_H	Nominal 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 ...									
... $F0C4_H$, and to output 8000_H.			... $FB70_H$, and to output 8000_H.			... $E5D4_H$, and to output 8000_H.			

Representation of analog values for thermocouples type J

Table 5-24 Representation of analog values for thermocouples type J

Type J in °C	Unit decimal	Unit hexadecimal	Type J in °F	Unit decimal	Unit hexadecimal	Type J in K	Unit decimal	Unit hexadecimal	Range
> 1450,0	32767	$7FFF_H$	> 2642,0	32767	$7FFF_H$	> 1723,2	32767	$7FFF_H$	Overflow
1450,0 : 1201,0	14500 : 12010	$38A4_H$: $2EEA_H$	2642,0 : 2193,8	26420 : 21938	6734_H : $55B2_H$	1723,2 : 1474,2	17232 : 14742	4350_H : 3996_H	Overshoot range
1200,0 : -210,0	12000 : -2100	$2EE0_H$: $F7CC_H$	2192,0 : -346,0	21920 : -3460	$55A0_H$: $F27C_H$	1473,2 : 63,2	14732 : 632	$398C_H$: 0278_H	Nominal 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 ...									
... $F31C_H$, and to output 8000_H.			... $EA0C_H$, and to output 8000_H.			... $FDC8_H$, and to output 8000_H.			

Representation of analog values for thermocouples type K

Table 5-25 Representation of analog values for thermocouples type K

Type K in °C	Unit decimal	Unit hexadecimal	Type K in °F	Unit decimal	Unit hexadecimal	Type K in K	Unit decimal	Unit hexadecimal	Range
> 1622,0	32767	$7FFF_H$	> 2951,6	32767	$7FFF_H$	> 1895,2	32767	$7FFF_H$	Overflow
1622,0 : 1373,0	16220 : 13730	$3F5C_H$: $35A2_H$	2951,6 : 2503,4	29516 : 25034	$734C_H$: $61CA_H$	1895,2 : 1646,2	18952 : 16462	$4A08_H$: $404E_H$	Overshoot range
1372,0 : -270,0	13720 : -2700	3598_H : $F574_H$	2501,6 : -454,0	25016 : -4540	$61B8_H$: $EE44_H$	1645,2 : 0	16452 : 0	4044_H : 0000_H	Nominal 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 ...									
... $F0C4_H$, and to output 8000_H.			... $E5D4_H$, and to output 8000_H.			... $FB70_H$, and to output 8000_H.			

Representation of analog values for thermocouples type L

Table 5-26 Representation of analog values for thermocouples type L

Type L in °C	Unit decimal	Unit hexadecimal	Type L in °F	Unit decimal	Unit hexadecimal	Type L in K	Unit decimal	Unit hexadecimal	Range
> 1150,0	32767	$7FFF_H$	> 2102,0	32767	$7FFF_H$	> 1423,2	32767	$7FFF_H$	Overflow
1150,0 : 901,0	11500 : 9010	$2CEC_H$: 2332_H	2102,0 : 1653,8	21020 : 16538	$521C_H$: $409A_H$	1423,2 : 1174,2	14232 : 11742	3798_H : $2DDE_H$	Overshoot range
900,0 : -200,0	9000 : -2000	2328_H : $F830_H$	1652,0 : -328,0	16520 : -3280	4088_H : $F330_H$	1173,2 : 73,2	11732 : 732	$2DD4_H$: $02DC_H$	Nominal 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 ...									
... $F380_H$, and to output 8000_H.			... $EAC0_H$, and to output 8000_H.			... $FE2C_H$, and to output 8000_H.			

Representation of analog values for thermocouples type N

Table 5-27 Representation of analog values for thermocouples type N

Type N in °C	Unit decimal	Unit hexadecimal	Type N in °F	Unit decimal	Unit hexadecimal	Type N in K	Unit decimal	Unit hexadecimal	Range
> 1550,0	32767	$7FFF_H$	> 2822,0	32767	$7FFF_H$	> 1823,2	32767	$7FFF_H$	Overflow
1550,0 : 1300,1	15500 : 13001	$3C8C_H$: $32C9_H$	2822,0 : 2373,8	28220 : 23738	$6E3C_H$: $5CBA_H$	1823,2 : 1574,2	18232 : 15742	4738_H : $3D7E_H$	Overshoot range
1300,0 : -270,0	13000 : -2700	$32C8_H$: $F574_H$	2372,0 : -454,0	23720 : -4540	$5CA8_H$: $EE44_H$	1573,2 : 0	15732 : 0	$3D74_H$: 0000_H	Nominal 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 ...									
... $F0C4_H$, and to output 8000_H.			... $E5D4_H$, and to output 8000_H.			... $FB70_H$, and to output 8000_H.			

Representation of analog values for thermocouple types R, S

Table 5-28 Representation of analog values for thermocouple types R, S

Type R, S in °C	Unit decimal	Unit hexa-decimal	Type R, S in °F	Unit decimal	Unit hexa-decimal	Types R, S in K	Unit decimal	Unit hexa-decimal	Range
> 2019,0	32767	$7FFF_H$	> 3276,6	32767	$7FFF_H$	> 2292,2	32767	$7FFF_H$	Overflow
2019,0 : 1770,0	20190 : 17770	$4EDE_H$: 4524_H	3276,6 : 3218,0	32766 : 32180	$7FFE_H$: $7DB4_H$	2292,2 : 2043,2	22922 : 20432	$598A_H$: $4FD0_H$	Overshoot range
1769,0 : -50,0	17690 : -500	$451A_H$: $FE0C_H$	3216,2 : -58,0	32162 : -580	$7DA2_H$: $FDBC_H$	2042,2 : 223,2	20422 : 2232	$4FC6_H$: $08B8_H$	Nominal range
-51,0 : -170,0	-510 : -1700	$FE02_H$: $F95C_H$	-59,8 : -274,0	-598 : -2740	$FDAA_H$: $F54C_H$	222,2 : 103,2	2222 : 1032	$08AE_H$: 0408_H	Undershoot range
< -170,0	-32768	8000_H	< -274,0	-32768	8000_H	< 103-2	< 1032	8000_H	Underflow

Representation of analog values for thermocouples type T

Table 5-29 Representation of analog values for thermocouples type T

Type T in °C	Unit decimal	Unit hexa-decimal	Type T in °F	Unit decimal	Unit hexa-decimal	Type T in K	Unit decimal	Unit hexa-decimal	Range
> 540,0	32767	$7FFF_H$	> 1004,0	32767	$7FFF_H$	> 813,2	32767	$7FFF_H$	Overflow
540,0 : 401,0	5400 : 4010	1518_H : $0FAA_H$	1004,0	10040	2738_H	813,2	8132	$1FC4_H$	Overshoot range
400,0 : -270,0	4000 : -2700	$0FA0_H$: $F574_H$	752,0 : -454,0	7520 : -4540	$1D60_H$: $EE44_H$	673,2 : 3,2	6732 : 32	$1AAC_H$: 0020_H	Nominal 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 ...									
... $F0C4_H$, and to output 8000_H.			... $E5D4_H$, and to output 8000_H.			... $FB70_H$, and to output 8000_H.			

Representation of analog values for thermocouples type U

Table 5-30 Representation of analog values for thermocouples type U

Type U in °C	Unit decimal	Unit hexa-decimal	Type U in °F	Unit decimal	Unit hexa-decimal	Type U in K	Unit decimal	Unit hexa-decimal	Range
> 850,0	32767	$7FFF_H$	> 1562,0	32767	$7FFF_H$	> 1123,2	32767	$7FFF_H$	Overflow
850,0 : 601,0	8500 : 6010	2134_H : $177A_H$	1562,0 : 1113,8	15620 : 11138	$2738,0_H$: $2B82_H$	1123,2 : 874,2	11232 : 8742	$2BE0_H$: 2226_H	Overshoot range
600,0 : -200,0	6000 : -2000	1770_H : $F830_H$	1112,0 : -328,0	11120 : -3280	$2B70_H$: $F330_H$	873,2 : 73,2	8732 : 732	$221C_H$: $02DC_H$	Nominal 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 ...									
... $F380_H$, and to output 8000_H.			... $EAC0_H$, and to output 8000_H.			... $FE2C_H$, and to output 8000_H.			

5.4.9 Representation of analog values for analog output channels

Introduction

The tables in this section contain the analog value representation for output channels of the analog output modules. The values in the tables apply to all modules with the corresponding output ranges.

Notes for readers of the tables

The tables "Bipolar output ranges", "Unipolar output ranges", "Life-zero output ranges" contain the binary representation of the measured values.

Since the binary representation of the output values is always the same, starting with the table at "Representation of Analog Values in the Voltage Output Range ± 10 V" these tables only contain the output ranges and the units.

Binary representation of output ranges

The input ranges shown in tables "Bipolar output ranges", "Unipolar output ranges", "Life-zero output ranges" are defined in complementary 2-by-2 representation:

Table 5-31 Bipolar 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	Nominal 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 5-32 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	Nominal 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 nominal 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

Table 5-33 Life-zero input 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	Nominal 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	Undershoot range
- 6912	-25,000	1	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	
- 6913	-25,000	1	1	1	0	0	1	0	0	1	1	1	1	1	1	1	1	Limited to overshoot range lower limit 0 V and 0 mA
- 32512		1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
≤-32513	- 25 %	1	0	0	0	0	0	0	0	x	x	x	x	x	x	x	x	Underflow

Representation of analog values in the voltage output ranges

Table 5-34 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	
75 %	20736	5100	7.5 V	Nominal range
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, idle state
- 118,519 %	- 32768	8000	0.00 V	

Table 5-35 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 to 10 V**	**1 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	Nominal range
75 %	20736	5100	7.5 V	3.75 V	
0,003617 %	1	1	361.7 µV	1V+144.7µV	
0 %	0	0	0 V	1 V	
	- 1	FFFF			Undershoot range
- 25 %	- 6912	E500		0 V	
	- 6913	E4FF			Not possible. The output value is limited to 0 V.
- 117,593 %	- 32512	8100			
	- 32513	80FF			Underflow, idle state
- 118,519 %	- 32768	8000	0.00 V	0.00 V	

Representation of analog values in the current output ranges

Table 5-36 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	Nominal range
0,003617 %	1	1	723.4 mA	
0 %	0	0	0 mA	
	- 1	FFFF	- 723.4 mA	
- 75 %	- 20736	AF00	- 15 mA	
- 100 %	- 27648	9400	- 20 mA	
	- 27649	93FF		Undershoot range
- 117,593 %	- 32512	8100	- 23.52 mA	
	- 32513	80FF		Underflow, idle state
- 118,519 %	- 32768	8000	0.00 mA	

Table 5-37 Representation of analog values in the 0 to 20 mA and 4 to 20 mA output ranges

System			Current output range		
	Dec.	**Hex.**	**0 to 20 mA**	**4 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	Nominal range
75 %	20736	5100	15 mA	15 mA	
0,003617 %	1	1	723.4 mA	4mA+578.7 nA	
0 %	0	0	0 mA	4 mA	
	- 1	FFFF			Undershoot range
- 25 %	- 6912	E500		0 mA	
	- 6913	E4FF			Not possible. Output value limited to 0 mA.
- 117,593 %	- 32512	8100			
	- 32513	80FF			Underflow, idle state
- 118,519 %	- 32768	8000	0.00 mA	0.00 mA	

5.5 Setting the measuring method and ranges of analog input channels

Two procedures

There are two procedures for setting the measuring method and ranges of analog input channels of analog modules:

- With a measuring range module and STEP 7
- By hardwiring the analog input channel, and programming in STEP 7

The method to use for the various analog modules is module-specific, and described in detail in the relevant module sections.

The procedure for setting the measuring method and measuring range of the module in STEP 7 is described in the respective sections.

This section describes how to set the measuring method and range using measuring range modules.

Setting the measuring method and range using measuring range modules

Analog modules are supplied with measuring range modules as required.

Reposition the measuring range modules to suit the measuring method and range.

Note

Make sure that the measuring range modules are on the side of the analog input module.

Before you install the analog input module, check the measuring method and range of the measuring range modules, and adapt these as required.

Optional settings of the measuring range modules

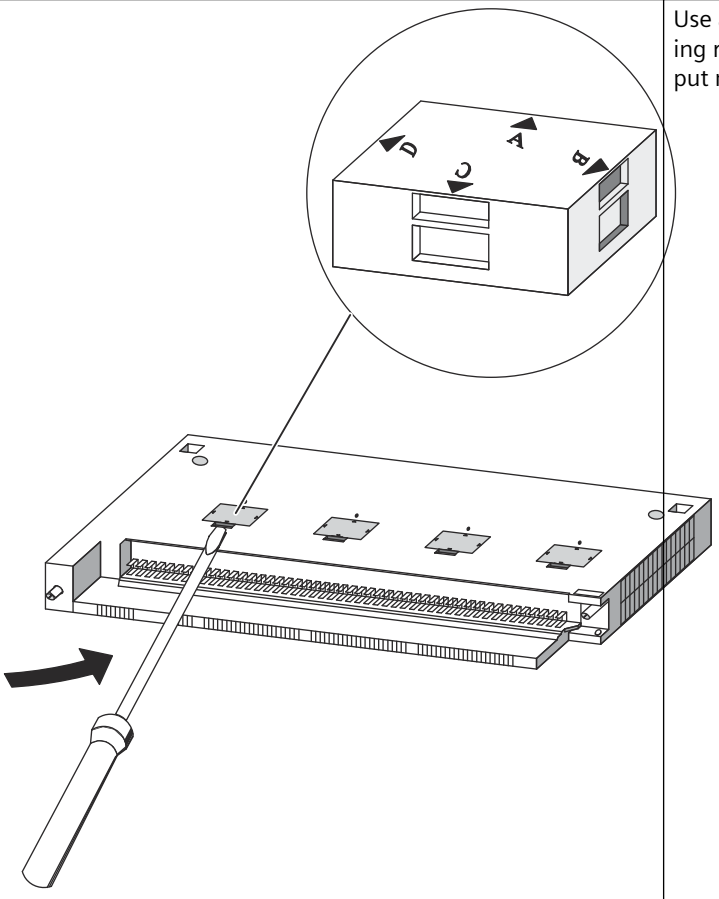
Optional settings of the measuring range modules are: "A", "B", "C" and "D".

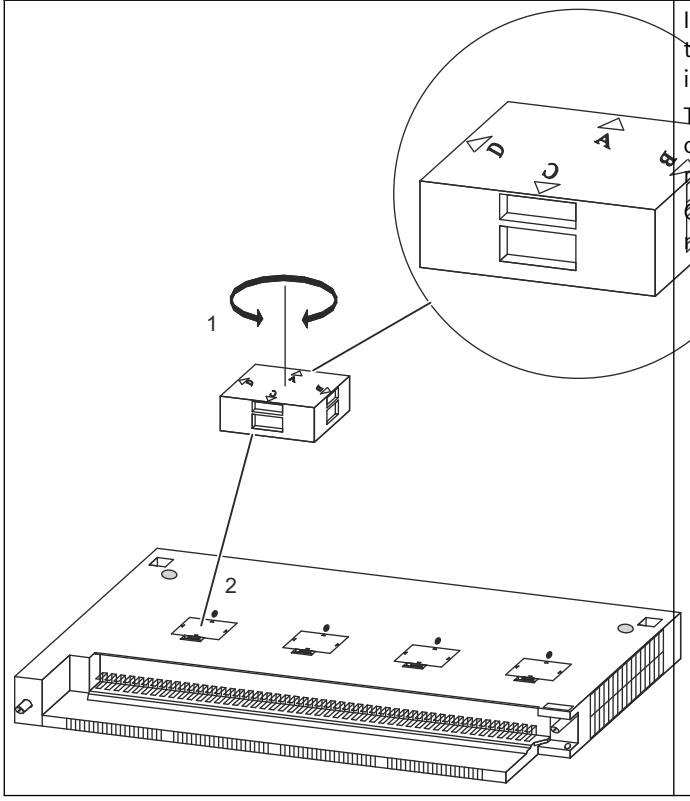
For detailed information on specific measuring method and range settings, refer to the relevant module section.

The settings for the various measuring methods and ranges are also shown on the printed label of the analog module.

Replugging measuring range modules

To reconnect a measuring range module:

Graphic	Description
	Use a screwdriver to lever the measuring range module out of the analog input module.

Graphic	Description
	Insert the measuring range module into the required slot (1) of the analog input module. The measuring range selected is the one that points to the marker point on module (2). Continue with the insertion of all other measuring range modules.

Then mount the module.

CAUTION

Danger of damage to equipment.

Faulty measuring range module settings may lead to the destruction of the module.

Always make sure the measuring range module is in the correct position before you connect any sensors to the module.

5.6 Behavior of the analog modules

5.6.1 Introduction

Overview

This section describes:

- How the analog input and output values depend on the operating states of the CPU and the supply voltage of the analog module
- The reaction of analog modules, based on the actual analog value within the relevant value range
- The effect of errors on analog modules with diagnostics capability
- The effect of the operational limit of the analog module on the analog input and output value, as illustrated by an example

5.6.2 Effect of supply voltage and operating mode

Overview

The IO values of analog modules are determined by the CPU operating state and the module's supply voltage.

Table 5-38 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	Output value of the analog output module	Input value of the analog input module*
POWER ON	RUN	L+ present	CPU values	Measured value
			Until the first conversion... • after power-up has been completed, a signal of 0 mA or 0 V is output. • after programming is successfully completed, it outputs the previous value.	$7FFF_H$, until the first conversion after POWER ON is completed, or when the module has been programmed.
		L+ missing	0 mA / 0 V	
POWER ON	STOP	L+ present	Substitution value / last value (default: 0 mA / 0 V)	Measured value
		L+ missing	0 mA / 0 V	$7FFF_H$, until the first conversion after POWER ON is completed, or when the module has been programmed.
POWER OFF	-	L+ present	0 mA / 0 V	-
		L+ missing	0 mA / 0 V	-
* L+ only required with 2-wire sensors				

Behavior on failure of the supply voltage

Failure of the load power supply L+ of the diagnostics-capable analog module is indicated in the case of configured 2-wire sensors by the EXTF LED on the module. This information is also available on the module (in the diagnostic buffer data.)

Diagnostics interrupt triggering is based on parameter settings.

See also

General information about parameter assignment (Page 178)

5.6.3 Effect of the value range for analog values

Effect of errors on analog modules with diagnostics capability

Errors may lead to an entry in the diagnostics buffer and trigger a diagnostic interrupt at analog modules with diagnostics function and corresponding parameter settings. You will find the errors that might be involved in the section "Diagnostics of the analog modules".

Effect of value range on the analog input module

The reaction of analog modules is determined by the actual input values within the value range.

Table 5-39 Reaction of analog input modules as a function of the actual analog value within the value range

Measured value within	Input value	LED (EXTF)	Diagnostics	Interrupt
Nominal range	Measured value	-	-	-
Overshoot/undershoot range	Measured value	-	-	-
Overflow	7FFFH	lit[1]	Entry is made[1]	Diagnostic interrupt[1]
Underflow	8000H	lit[1]	Entry is made[1]	Diagnostic interrupt[1]
Outside of the programmed limit	Measured value	-	-	Hardware interrupt[1]
[1] Only for modules with diagnostics function and depending on parameter settings				

Effect of value range on the analog output module

The reaction of analog modules is determined by the actual output values within the value range.

Table 5-40 Behavior of the analog output modules as a function of the position of the analog value within the value range

Output value within	Output value	LED (EXTF)	Diagnostics	Interrupt
Nominal range	CPU value	-	-	-
Overshoot/undershoot range	CPU value	-	-	-
Overflow	0 signal	-	-	-
Underflow	0 signal	-	-	-

5.6.4 Effect of operational limit and basic error limit

Operational limit

The operational limit represents the measuring error, or output error, of an analog module across the entire permissible temperature range of the module, based on the module's nominal range.

Basic error limit

The basic error limit represents the operational limit at 25° C, based on the module's nominal range.

Note

The percentage details of operational and basic error limits in the specifications of the modules always refer to the highest possible input and output value in the nominal range of the module. In the ± 10 V measurement range this would be the 10 V.

Example of determination of the output error of a module

An analog output module SM 432; AO 8 x 13 Bit is being used for voltage output. An output range of "±10 V" is set. The module is operating at an ambient temperature of 30° C, i.e. the operational limit applies. The specifications 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.

This means that with an actual voltage of, say, 1 V, a value in the range from 0.95 V to 1.05 V is output by the module. 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 10V range.

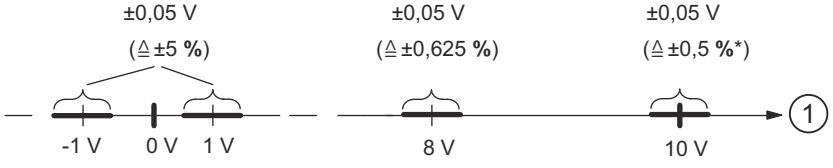


Figure 5-1 Example of the relative error of an analog output module

* Operational limit

(1) Output value

5.7 Conversion, cycle, settling and response time 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
- Wire break 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 specifications of the relevant module.

Cycle time of analog input channels

The analog/digital conversion and the transfer of the digitized measured values to memory or to the backplane bus take place sequentially. In other words, the analog input channels are converted one after the other. The scan time - in other words, the time elapsing until an analog input value is again converted - is the sum of the conversion times 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.

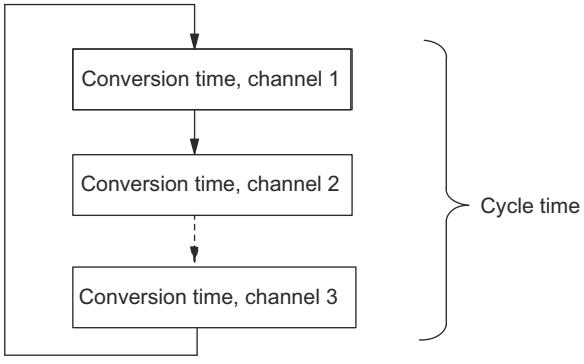


Figure 5-2 Scan time of an analog input or output module

Basic execution time of the analog input channels

The basic execution time corresponds to the cycle time for all the enabled channels.

Setting of the smoothing of analog values

You can set the smoothing of the analog values in STEP 7 for some analog input modules.

Use of smoothing

Smoothing of analog values ensures a stable analog signal for further processing.

It makes sense to smooth the analog values with slow variations of measured values, for example, with temperature measurements.

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 assigns parameters to smoothing with a maximum of four levels (none, weak, medium, strong). 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.)

Example

The figure below shows the number of cycles a module requires to apply an almost 100% analog value after a step response, based on the smoothing function settings. The figure applies to all signal changes at the analog input.

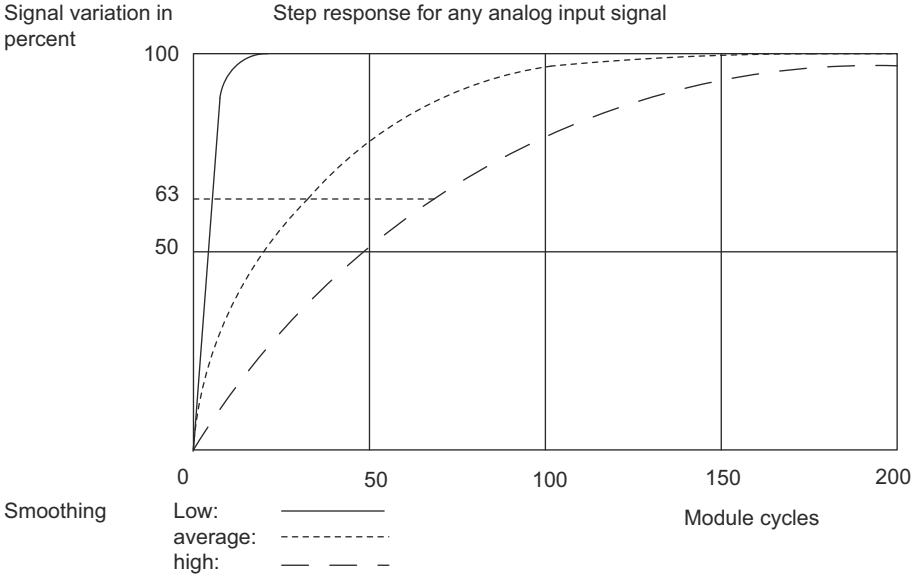


Figure 5-3 Example of the effect of smoothing on step responses

Further information on smoothing

For information showing whether a specific module supports smoothing functions, and special features to observe, refer to the section 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

The analog output channels are converted sequentially - that is the analog output channels are converted one after the other.

The cycle time - that is 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 Input/Output Channel".

Basic execution time of the analog output channels

The basic execution time corresponds to the cycle time for all the enabled channels.

Note

You should disable any analog channels that are not being used to reduce the scan time in STEP 7.

Overview of the settling time and response time of the analog output modules

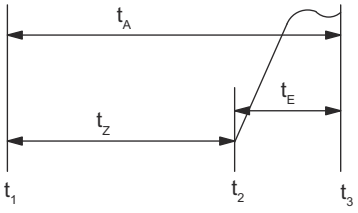


Figure 5-4 Settling and response times of the analog output channels

t_A = Response time

t_S = Setting time

t_3 = Specified output value reached

t_2 = Output value transferred and converted

t_C = Cycle time, corresponds to n x conversion time (n = activated channels)

t_1 = New output value is present

Settling time

The settling time (t_2 to t_3) - that is the time from the application of the converted value until the specified value is obtained at the analog output - depends on the load. 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 specifications of the relevant module.

Response time

The response time (t_1 to t_3) - that is the time from the application of the digital output values in internal memory until the specified value is obtained at the analog output - is, in the most unfavorable case, the sum of the cycle time and the 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.)

See also

Commissioning the SM 431; AI 8 x 13 Bit (Page 213)

5.8 Assigning parameters to analog modules

5.8.1 General information about parameter assignment

Introduction

The characteristics of analog modules may differ. The characteristics of the modules can be defined by assigning parameters.

Tools for parameter assignment

You program analog modules in *STEP 7*.

After you have defined all parameters, download these from your programming device to the CPU. The CPU transfers the parameters to the relevant analog modules at the STOP > RUN transition.

Static and dynamic parameters

The parameters are divided into static and dynamic parameters.

Set the static parameters in STOP mode of the CPU, as described above.

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. You will find a description of the parameter assignment of modules in the user program in the Appendix.

Configuration in RUN (CiR)

CiR (Configuration in RUN) is a method you can use to modify your system or edit the parameters of individual modules. These changes are made while your system is in operation, that is, your CPU will stay in RUN over a maximum of 2.5 seconds while these changes are applied.

For detailed information on this topic, refer to the "Configuration in RUN by means of CiR" manual. This manual is found, for example, as a file in PDF format on the STEP 7 CD supplied.

5.8.2 Parameters of analog input modules

Overview

Analog input modules use a subset of the parameters and value range listed in the table below, based on their functionality. For information on subsets "supported" by specific analog modules, refer to the section dealing with the relevant module.

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

Table 5-41 Parameters of analog input modules

Parameters	Value range		Default[2]	Parameter type	Scope
Enable					
• Diagnostic interrupt[1]	Yes/no		No	Dynamic	Module
• Hardware interrupt[1]	Yes/no		No		
• Destination CPU for interrupt	1 to 4		-	Static	Module
Hardware interrupt trigger					
• End of scan cycle reached at input	Yes/no		No	Static	Channel
	May be restricted by the measuring range				
• High limit	32511 to - 32512		-	Dynamic	Channel
• Low limit	-32512 to 32511				
Diagnostics					
• Wire break	Yes/no		No	Static	Channel
• Reference channel error	Yes/no		No		
• Underflow	Yes/no		No		
• Overflow	Yes/no		No		
• Short-circuit to M	Yes/no		No		
Measurement					
• Measuring method	Disabled		U	Static	Channel
	U	Voltage			
	4DMU	Current (4-wire sensor)			
	2DMU	Current (2-wire sensor)			
	R-4L	Resistance (4-conductor connection)			
	R-3L	Resistance (3-conductor connection)			
	RTD-4L	Thermal resistance (linear, 4-conductor connection)			
	RTD-3L	Thermal resistance (linear, 3-conductor connection)			
	TC-L	Thermocouple (linear)			

Parameters	Value range	Default[2]	Parameter type	Scope
• Measuring range	For information on configurable measuring ranges of the input channels, refer to the relevant module description.	± 10 V		
• Reference temperature	- 273.15 to 327.67° C	0° C	Dynamic	Module
• Temperature unit	Degrees Celsius; degrees Fahrenheit; Kelvin	Degrees Celsius	Static	Module
• Temperature coefficient for temperature measurement with thermal resistance (RTD)	Platinum (Pt) 0.00385 Ω/Ω/° C 0.003916 Ω/Ω/° C 0.003902 Ω/Ω/° C 0.003920 Ω/Ω/° C Nickel (Ni) 0.00618 Ω/Ω/° C 0.00672 Ω/Ω/° C	0,00385	Static	Channel
• Interference frequency suppression	400 Hz; 60 Hz; 50 Hz; 10 Hz; none	50 or 60 Hz		
• Smoothing	None Weak Medium Strong	None		
• Reference junction	None internal RTD on channel 0 dynamic reference temperature value	None		

[1] If you use the module in ER-1/ER-2, you must set this parameter to "No" because the interrupt lines are not available in ER-1/ER-2.

[2] Only in the CR (central rack) is it possible to start up the analog modules with the default settings.

See also

Commissioning the SM 431; AI 8 x 14 Bit (Page 224)

5.8.3 Parameters of analog output modules

Overview

Analog output modules use a subset of the parameters and value range listed in the table below, based on their functionality. For information on subsets "supported" by specific analog modules, refer to the section dealing with the relevant module.

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

Table 5-42 Parameters of analog output modules

Parameters	Value range	Default setting[1]	Parameter type	Scope
Output				
• Output type	Deactivated voltage current	U	Static	Channel
• Output range	For information on configurable measuring ranges of output channels, refer to the relevant module description.	± 10 V		

[1] Only in the CR (central rack) is it possible to start up the analog modules with the default settings.

See also

Commissioning the SM 431; AI 8 x 14 Bit (Page 224)

5.9 Connecting sensors to analog inputs

Introduction

The analog input modules support various sensors, such as voltage/current sensors, and resistors, depending on the set measuring method.

This section contains general information that is generally applicable to all the connection options for sensors described in the sections that follow.

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.

If there are potential differences between the cable ends, an equipotential bonding current, which can flow over the shield, can cause interference of the analog signals. To avoid this situation, you should ground the shield only at one end of the cable.

Non-isolated analog input modules

In the case of the non-isolated analog input modules there is an electrical connection between the reference point of the measuring circuit M_{ANA} and chassis ground.

You use non-isolated analog modules if there are few or no potential differences between the measuring sensors and chassis ground.

Isolated analog input modules

With the isolated analog input modules there is no electrical connection between the reference point of the measuring circuit M_{ANA} and chassis ground.

You use isolated analog input modules if a potential difference U_{ISO} can occur between the reference point of the measuring circuit M_{ANA} and chassis ground. By means of an equipotential bonding conductor between the M_{ANA} terminal and chassis ground, make sure that U_{ISO} does not exceed the permitted value.

Limited potential difference U_{CM}

Only a limited potential difference U_{CM} (common mode voltage) may occur amongst the M-measuring lines of the input channels and between the leads and the reference point of the measuring circuit M_{ANA}. In order to prevent the permissible value from being exceeded, you must take different actions, described below, depending on the potential connection of the sensors.

Connecting electrically isolated sensors

The isolated sensors are not connected with the local ground potential (chassis ground). They can be floating.

With isolated sensors, potential differences might arise between the different sensors. These potential differences can arise as a result of interference or the local distribution of the sensors.

To ensure that the permissible value for U_{CM} is not exceeded during use in heavily EMC-affected environments, connect M- to MANA in modules with an M_{ANA} connection.

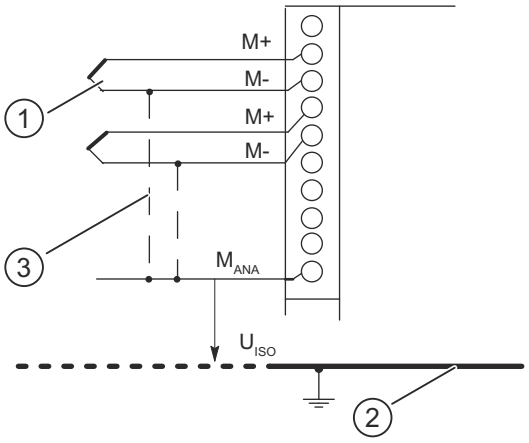


Figure 5-5 Connecting isolated sensors to an electrically isolated AI

(1) Electrically isolated sensors

(2) Chassis ground

(3) Connection required for modules with M_{ANA}

M +: Measuring line (positive)

M -: Measuring line (negative)

M_{ANA}: Reference potential of the analog measuring circuit

U_{ISO}: Potential difference between M_{ANA} and chassis ground

Note

Do not connect M- to MANA when connecting 2-wire transducers for current measurement and when connecting resistance-type sensors. This also applies to inputs which are programmed accordingly, but remain unused.

Non-isolated sensors

The isolated sensors are not connected with the local ground potential (chassis ground). When using non-isolated sensors, you must connect M_{ANA} to chassis ground.

Connecting non-isolated sensors

Depending on local conditions or interference, potential differences U_{CM} (static or dynamic) can occur between the locally distributed measuring points. If the permitted value for U_{CM} is exceeded, there must be equipotential bonding conductors between the measuring points.

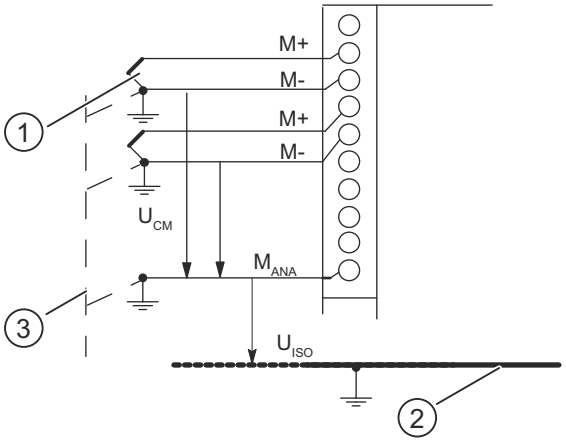


Figure 5-6 Connecting non-isolated sensors to an isolated AI

(1) Non-isolated sensors

(2) Chassis ground

(3) Equipotential bonding conductor

M +: Measuring line (positive)

M -: Measuring line (negative)

M_{ANA}: Reference potential of the analog measuring circuit

U_{ISO}: Potential difference between M_{ANA} and chassis ground

Note

Do not use non-isolated 2-wire transducers and non-isolated resistance-type sensors!

5.10 Connecting voltage sensors

Connecting voltage sensors

Note

The cables required to connect the analog input module and the sensors are not drawn in the figures shown below.

In other words, you must continue to read and follow the instructions in the section "Connecting sensors to analog inputs", which contains general information on connecting sensors.

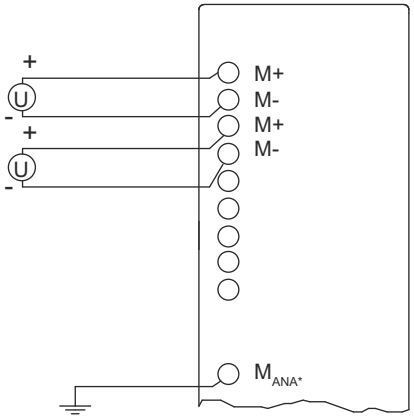


Figure 5-7 Connecting voltage sensors to an AI

M +: Measuring line (positive)

M -: Measuring line (negative)

M_{ANA}: Reference potential of the analog measuring circuit

(1) Connection required for modules with M_{ana}

5.11 Connecting current sensors

Sensor supply voltage

Note

The cables required to connect the analog input module and the sensors are not drawn in the figures shown below.

In other words, you must continue to read and follow the instructions in the section "Connecting sensors to analog inputs", which contains general information on connecting sensors.

The 2-wire sensor is wired to a short-circuit-proof supply voltage at the terminals of the analog input module. This 2-wire transducer then converts the measured variable into a current.

Because the 2-wire transducer is supplied by the module, you must **not** ground the M- cables.

4-wire transducers require a separate supply voltage U_H (auxiliary supply).

Connecting 2-wire transducers

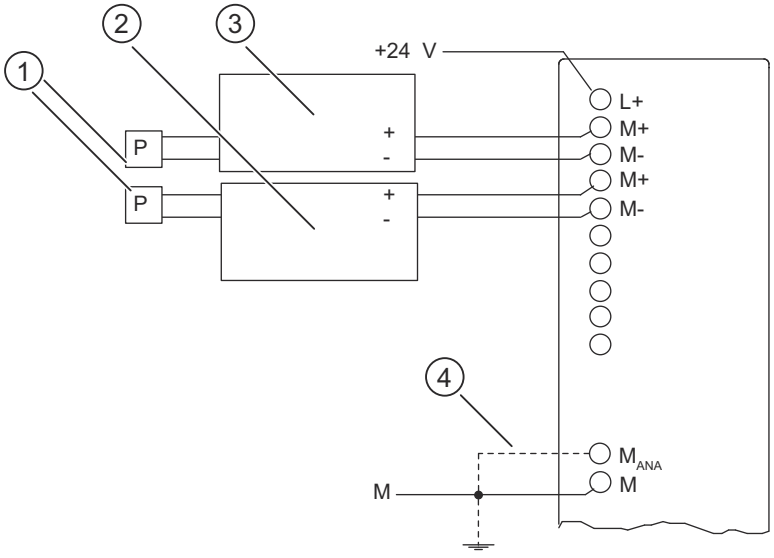


Figure 5-8 Connecting 2-wire transducers to an isolated AI

M +:	Measuring line (positive)
M -:	Measuring line (negative)
L +:	Power supply connection 24 VDC
M_{ANA}:	Reference potential of the analog measuring circuit
(1)	Sensor, for example, pressure gauge
(2) + (3)	2-wire transducer
(4)	Connection required for modules with M_{ana}

SM 431; 8 x 13 Bit: Connecting 2-wire transducers

Because the supply voltage for the 2-wire transducers is not fed by the SM 431; 8 x 13 Bit, you must supply the sensors separately with 24 V.

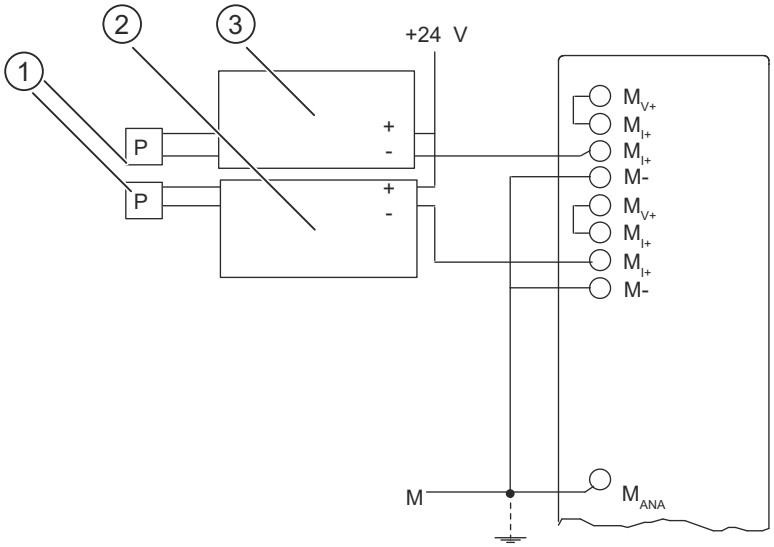


Figure 5-9 Connecting 2-wire transducers to an SM 431; 8 x 13 Bit

M_{I+}:	Measuring current (positive)
M_{V+}:	Measuring voltage (positive)
M +:	Measuring line (positive)
M_{ANA}:	Reference potential of the analog measuring circuit
M -:	Measuring line (negative)
(1)	Sensor, for example, pressure gauge
(2)+(3)	2-wire transducer

Connecting 4-wire transducers

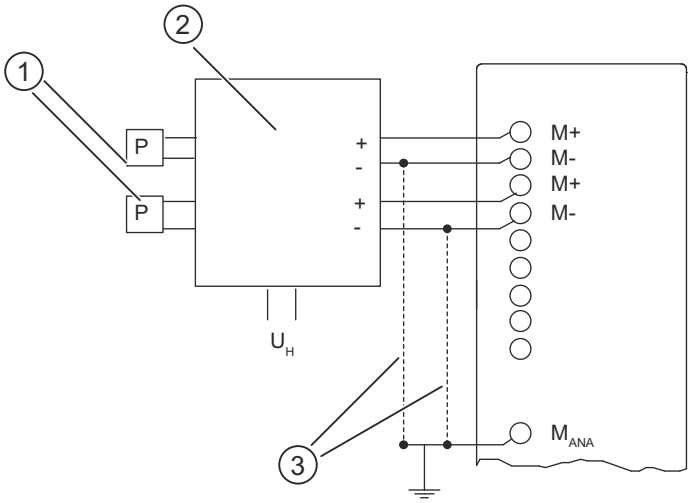


Figure 5-10 Connecting 4-wire transducers to an AI

M +: Measuring line (positive)
M -: Measuring line (negative)
M_{ANA}: Reference potential of the analog measuring circuit
U_H: Auxiliary voltage
(1) Sensor, for example, pressure gauge
(2) 4-wire transducer
(3) Connection required for modules with M_{ana}

SM 431; 8 x 13 Bit: Connecting 4-wire transducers

To ensure that the permissible value for U_{CM} is not exceeded, you must connect the M-cables to M_{ANA}.

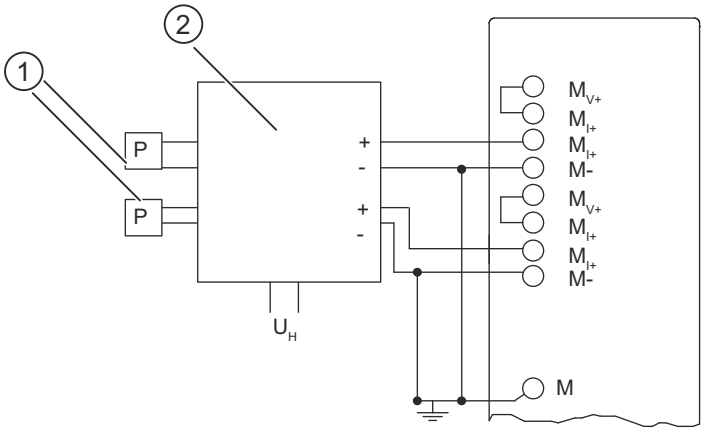


Figure 5-11 Connecting 4-wire transducers to an SM 431; 8 x 13 Bit

M_{I+}: Measuring current (positive)
M_{V+}: Measuring voltage (positive)
M +: Measuring line (positive)
M -: Measuring line (negative)
U_H: Auxiliary voltage
(1) Sensor, for example, pressure gauge
(2) 4-wire transducer

5.12 Connecting resistance thermometers and resistors

Connecting resistance thermometers and resistors

Note

The cables required to connect the analog input module and the sensors are not drawn in the figures shown below.

In other words, you must continue to read and follow the instructions in the section "Connecting sensors to analog inputs", which contains general information on connecting sensors.

Resistance thermometers/resistors are wired in 2-, 3- or 4-wire technique.

With 4-conductor and 3-conductor connections, the module supplies a constant current via terminals I_{C+} and I_{C-} so that the potential drop occurring on the measuring cables is compensated. It is imperative to wire the constant current cables directly to the resistance thermometer/resistor.

Compensated measurements with 3- or 4-wire elements return a more precise result compared to 2-wire measurements.

4-conductor connection of a resistance thermometer

The voltage generated at the resistance thermometer is measured via the M_+ and M_- terminals. When you connect, watch out for the polarity of the connected cable (connect I_{C+} and M+ as well as I_{C-} and M- to the resistance thermometer).

Make sure that the connected cables **I_C+ and M+** and**SO and SE+** and cables **I_C- and M-** and **AGND and SE-** are connected directly on the resistance thermometer.

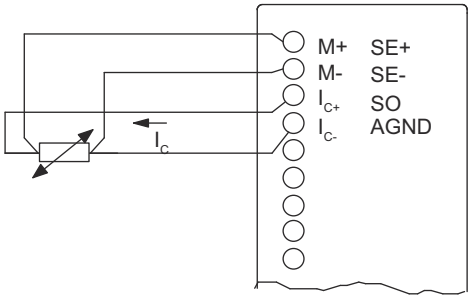


Figure 5-12 4-conductor connection of a resistance thermometer to an AI

I_{C+}	Constant current line (positive)
I_{C-}	Constant current line (negative)
M_+	Measuring line (positive)
M_-	Measuring line (negative)

3-conductor connection of a resistance thermometer

With a 3-conductor connection to modules with 4 terminals per resistance thermometer, you must set up a **jumper between M- and I_C-** and **SE- and AGND** (see Figure).

The module compensates in this circuit for the effect of the line resistance between the module and the resistance thermometer/resistor.

Make sure that the connected cables **I_C+ and M+** and **SO and SE+** are directly connected to the resistance thermometer.

To get an accurate measurement, make sure that the connected cables **M+, I_C+ and I_C-** and **SE+, SO and AGND** are the same length and have the same cross-section.

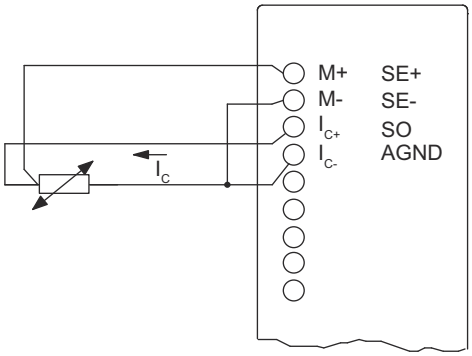


Figure 5-13 3-conductor connection of a resistance thermometer to an electrically isolated analog input

I_{C+}	Constant current line (positive)
I_{C-}	Constant current line (negative)
M_+	Measuring line (positive)
M_-	Measuring line (negative)

2-conductor connection of a resistance thermometer

For 2-conductor connections, bridge the M_+ and I_{C+}, and the M_- and I_{C-} terminals of the module.

Note: Cable resistance is also measured.

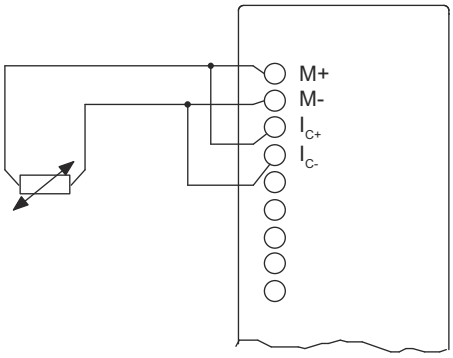


Figure 5-14 2-conductor connection of a resistance thermometer to an electrically isolated analog input

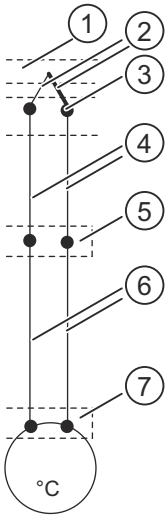
I_{C+}	Constant current line (positive)
I_{C-}	Constant current line (negative)
M_+	Measuring line (positive)
M_-	Measuring line (negative)

5.13 Connecting thermocouples

Thermocouple design

Thermocouples consist of a pair of thermal probes, and all necessary installation and connecting parts. The thermocouple consists of two wires of dissimilar metals or metal alloys soldered or welded together at the ends.

There are different types of thermocouple, depending on the composition of the material used, for example, K, J, N thermocouples. The measuring principle of all thermocouples is the same, irrespective of their type.



(1) Measuring junction
(2) Thermocouple with positive or negative limbs
(3) Connecting point
(4) Compensating leads
(5) Reference junction
(6) Leads
(7) Measurement input

Figure 5-15 Thermocouple design

Operating principle of thermocouples

If the measuring point is subjected to a temperature different from that of the free ends of the thermocouple (point of connection), a voltage, the thermo e.m.f., occurs at the free ends. The magnitude of the thermo-e.m.f. generated depends on the difference between the temperature at the measuring junction and the temperature at the free ends, as well as on the material combination used for the thermocouple.

Since a thermocouple always measures a temperature difference, the free ends must be kept at a known temperature at a reference junction in order to determine the temperature of the measuring junction.

The thermocouples can be extended from their point of connection to the reference junction by means of compensating wires. These compensating wires are made of the same materials as the thermocouple wires. The supply lines are made of copper.

Note

Make sure that the polarity is correct, otherwise significant measuring errors will occur.

Compensation of the reference junction temperature

There are several options for you to choose from for acquiring the reference junction temperature in order to obtain an absolute temperature value from the difference in temperature between the reference junction and measuring point.

You can use internal or external compensation, depending on where you want the reference junction to be.

The last column of the following table lists the feature you must set for the "Reference Junction" parameter in STEP 7. The reference temperature value is a separate parameter in STEP 7.

Options for compensation of the reference junction temperature

Option	Explanations	Reference junction
No compensation	When you want to acquire only the difference in temperature between the measuring point and the reference junction	None
Internal compensation	If you employ internal compensation, the internal temperature of the module is used for comparison purposes.	Internal
External compensation with a compensating box in leads of an individual thermocouple	You have already acquired and compensated the reference junction temperature using a compensating box, which you have looped into an individual thermocouple. Further processing at the module is not required.	None
External compensation with a resistance thermometer to obtain the reference junction temperature **(recommended method)**	You can acquire the reference temperature by means of a resistance thermometer (pt 100) and have it calculated by the module for any thermocouple.	RTD on Channel 0
External compensation with a resistance thermometer when thermocouples with the same reference junction are divided amongst several modules	Use a resistance thermometer on a module that measures the reference junction temperature. Read in the climatic temperature value to the CPU and transfer the value to the other modules using SFC55.	RTD on Channel 0
Constant reference junction temperature (thermometer, ice bath)	If the reference junction temperature is constant and known, you can specify this value in parameter assignment in STEP 7.	Reference temperature value

Principle of operation 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: internal compensation is not as accurate as external compensation.

Principle of operation of external compensation with compensating box

If you employ external compensation, the temperature of the reference junction of the thermocouples is taken into account via a compensating box, for example.

The compensating box contains a bridge circuit calibrated for a definite reference junction temperature. The reference junction is formed by the connecting ends of the thermocouple's compensating lines.

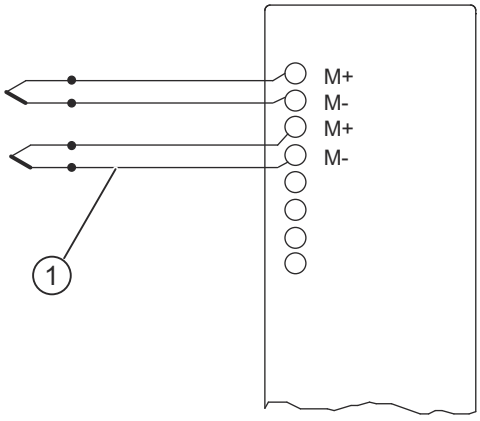
The resistance of the temperature-sensitive bridge changes as a function of the difference between the actual reference temperature and calibrating temperature. This difference induces a positive or negative compensating voltage, which is added to the thermal voltage.

Note

The diagrams below do not show the connecting lines required for connecting the electrical potentials of the analog input module and the sensors. This means that you must still read and follow the instructions in the generally applicable information on connecting sensors.

Connection of thermocouples without compensation or using the reference temperature value

Wire the thermocouples either directly to the inputs of the module, or indirectly via compensating lines. Each channel can use a thermocouple type supported by the analog module independently of the other channels.



M_+: Measuring line (positive)

M_-: Measuring line (negative)

(1) Compensating leads (same material as thermocouple)

Figure 5-16 Connection of thermocouples without compensation or using the reference temperature value to an isolated AI

Connecting the compensating box

The compensating box is looped in through the leads of each thermocouple. The compensating box must be supplied on an isolated basis. The power supply module must provide adequate noise filtering, for example, by means of grounded cable shielding.

Each channel can use a thermocouple type supported by the analog module independently of the other channels. Each channel requires its own compensating box.

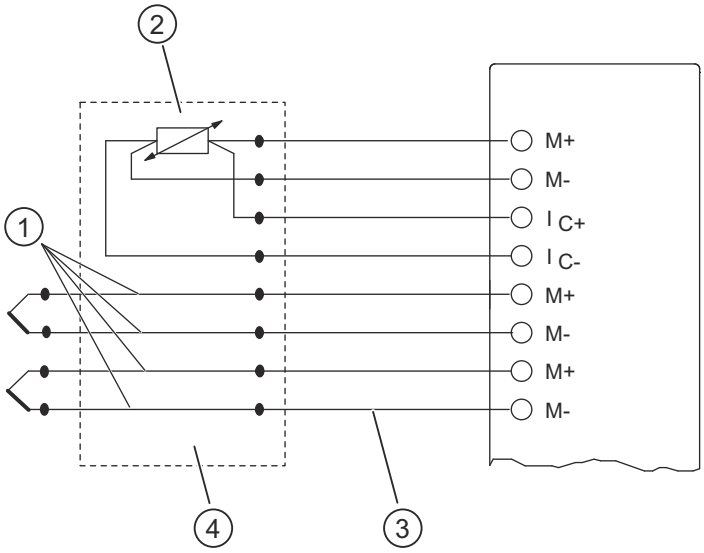
Note

Use compensating boxes with a reference junction temperature of 0° C for analog input modules.

Connecting thermocouples using resistance thermometers

Connect the resistance thermometer to channel 0 of the module. Make sure that you configure the "RTD on Channel 0" reference junction in STEP 7 for each channel that has a thermocouple connected to it.

If all thermocouples connected to the module's inputs share a common reference junction, compensate the circuit as follows:



M $_+$: Measuring line (positive)

M $_-$: Measuring line (negative)

I_{C+}: Constant current line (negative)

I_{C+}: Constant current line (negative)

(1) Compensating leads (same material as thermocouple)

(2) RTD on Channel 0

(3) Incoming line (Cu)

(4) Reference junction

Figure 5-17 Connection of thermocouples of the same type with external compensation by means of a resistance thermometer, connected to channel 0

5.14 Connecting loads/actuators to analog outputs

Introduction

The analog output modules can be used to supply power to loads and actuators.

This section contains general information that is generally applicable to all the connection options for loads and actuators described in the sections that follow.

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. This reduces interference. Connect both ends of the analog cable shield to ground.

If there are potential differences between the cable ends, an equipotential bonding current, which can flow over the shield, can cause interference of the analog signals. To avoid this situation, you should ground the shield only at one end of the cable.

Isolated analog output modules

With the isolated analog output modules there is no electrical connection between the reference point of the measuring circuit M_{ANA} and chassis ground.

You must use isolated analog output modules if a potential difference U_{ISO} can occur between the reference point of the measuring circuit M_{ANA} and chassis ground. By means of an equipotential bonding conductor between the M_{ANA} terminal and chassis ground, make sure that U_{ISO} does not exceed the permitted value.

5.15 Connecting loads/actuators to voltage outputs

Connecting loads to a voltage output

Connecting loads to a voltage output is possible both in a 4-conductor and a 2-conductor connection.

Note

The cables required to connect the analog output module are not drawn in the figures shown below.

In other words, you must continue to read and follow the instructions in the section "Connecting loads/actuators to analog outputs", which contains general information on connecting sensors.

4-conductor connection of loads to a voltage output

You can use the 4-wire technique to achieve a high accuracy at the load by wiring the S- and S+ sensor lines directly to the load. This results in direct measurement and correction of the voltage at the load.

Faults or a voltage drop can result in a potential difference between the sensor lead S- and the reference circuit of the analog circuit M_{ANA}. This potential difference (U_{CM}) must not exceed the permissible value. A negative influence on the accuracy of the analog signal is otherwise inevitable.

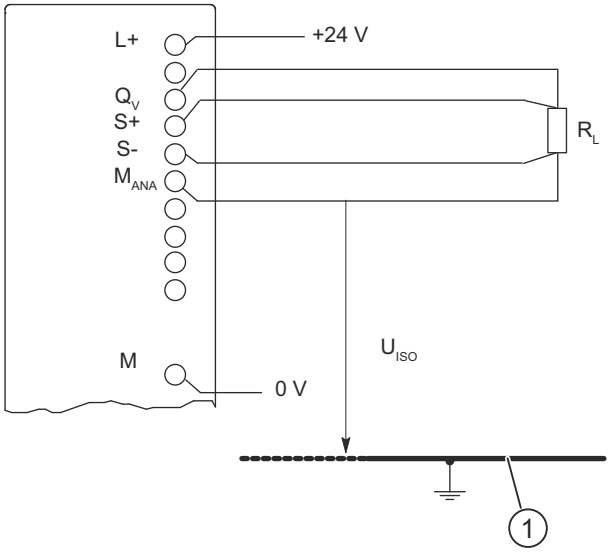


Figure 5-18 4-conductor connection of loads to a voltage output of an electrically isolated analog output module

L +: Terminal for 24 VDC supply voltage

Q_V: Analog output voltage

S +: Sensing line (positive)

S -: Sensing line (negative)

M_{ANA}: Reference potential of the analog circuit

M : Ground
U_{ISO}: Potential difference between M_{ANA} and chassis ground
(1) Chassis ground

2-conductor connection of loads to a voltage output

In the case of a 2-conductor connection, connect Q_V with S+ and M_{ANA} with S on the front connector. However, this will not provide the accuracy of a 4-conductor connection.

Wire the loads to the Q_V terminals and to the reference point of measuring circuit M_{ANA}.

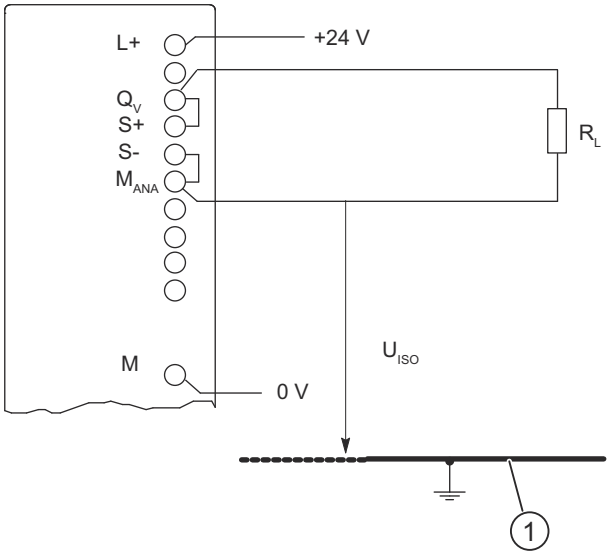


Figure 5-19 2-conductor connection of loads to a voltage output of an electrically isolated analog output module

L +: Terminal for 24 VDC supply voltage
Q_V: Analog output voltage
S +: Sensing line (positive)
S -: Sensing line (negative)
M_{ANA}: Reference potential of the analog circuit
M : Ground
U_{ISO}: Potential difference between M_{ANA} and chassis ground
(1) Chassis ground

See also

Connecting loads/actuators to analog outputs (Page 197)

5.16 Connecting loads/actuators to current outputs

Connecting loads to current outputs

Always connect loads to Q_I and to the reference point of analog circuit M_{ANA} of a current output.

Note

The cables required to connect the analog output module are not drawn in the figure shown below.

In other words, you must continue to read and follow the instructions in the section "Connecting loads/actuators to analog outputs", which contains general information on connecting sensors.

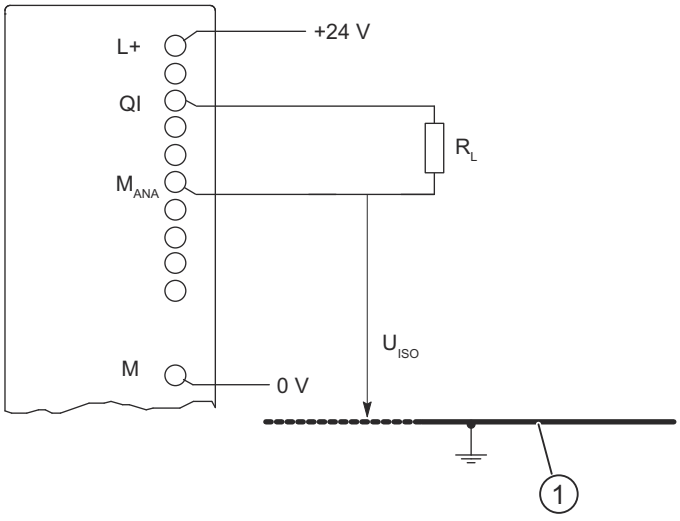


Figure 5-20 Connecting loads to a current output of an isolated AO

L +:	Terminal for 24 VDC supply voltage
Q_I:	Analog output current
M_{ANA}:	Reference potential of the analog circuit
M :	Ground
U_{ISO}:	Potential difference between M_{ANA} and chassis ground
(1)	Chassis ground

See also

Connecting loads/actuators to analog outputs (Page 197)

5.17 Diagnostics functions 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 the diagnostics using the relevant parameters. You perform parameter assignment in the "Diagnostics" tab in *STEP 7*.

The analog module always provides non-programmable diagnostic messages, irrespective of the enable state of diagnostics functions.

Reactions to diagnostic messages in STEP 7

Actions initiated by diagnostic messages:

- The diagnostic message is entered in the diagnostics of the analog module, forwarded to the CPU and can be read out by the user program.
- The error LED on the analog module is lit.
- If you have set "Enable Diagnostic Interrupt" in *STEP 7*, a diagnostic interrupt is triggered and OB 82 is called.

Reading diagnostic messages

You can read detailed diagnostic messages using SFCs in the user program (refer to the appendix "Diagnostic data of signal modules").

You can view the cause of the error in *STEP 7* in the module diagnostics (refer to the *online help for STEP 7*).

Diagnostic message 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.

Diagnostics using the INTF and EXTF LEDs

Some analog input modules indicate faults by means of their two fault LEDs INTF (internal fault) and EXTF (external fault). The LEDs go out when all the internal and external faults have been eliminated.

Refer to the specifications of the modules to find out which analog input modules have these fault LEDs.

Diagnostic messages of the analog input modules

The table below gives an overview of the diagnostic messages for the analog input modules with diagnostics capability.

You can find out which diagnostic messages are possible with which modules in the Appendix entitled "Diagnostic Data of the Signal Modules".

Table 5-43 Diagnostic messages of the analog input modules

Diagnostic message	LED	Scope of diagnostics	Programmable
Module error	INTF/EXTF	Module	No
Internal error	INTF	Module	No
External error	EXTF	Module	No
Channel error	INTF/EXTF	Module	No
External auxiliary voltage missing	EXTF	Module	No
Front connector missing	EXTF	Module	No
No module parameters	INTF	Module	No
Incorrect parameters	INTF	Module	No
Channel information available	INTF/EXTF	Module	No
Measuring range module incorrect/missing	INTF	Module	No
Thermocouple connection error	EXTF	Module	No
STOP mode	-	Module	No
EPROM error	INTF	Module	No
RAM error	INTF	Module	No
ADC/DAC error	INTF	Module	No
Hardware interrupt lost	INTF	Module	No
Configuration / programming error	INTF	Channel	No
Short-circuit to M	EXTF	Channel	Yes
Wire break	EXTF	Channel	Yes
Reference channel error	EXTF	Channel	Yes
Underflow	EXTF	Channel	Yes
Overflow	EXTF	Channel	Yes
User connection not wired	EXTF	Channel	No
Open conductor in + direction	EXTF	Channel	No
Open conductor in - direction	EXTF	Channel	No
Run time calibration error	EXTF	Channel	No
Underrange or overrange	EXTF	Channel	No
Open conductor in the current source	EXTF	Channel	No
User calibration does not correspond to the parameter assignment	EXTF	Channel	No

Note

A prerequisite for detecting the errors indicated by programmable diagnostic messages is that you must have assigned parameters to the analog module accordingly in STEP 7.

Causes of errors and remedies for analog input modules

Table 5-44 Diagnostic messages of the analog input modules, causes of errors and remedies

Diagnostic message	Possible cause of error	Remedy
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 certain channels are faulty	-
External auxiliary voltage missing	Load voltage to supply the 2-wire transducer is missing on terminals L+ and M.	Connect supply L+
Front connector missing	Jumper between connections 1 and 2 in the front connector is missing.	Install jumper
No module parameters	Module requires information whether it should operate with default system parameters or with your parameters.	Message present after power on, until the CPU has completed the transfer of parameters; configure the module as required.
Incorrect parameters	A parameter or combination of parameters is incorrect; impermissible measurement range, for example.	Reassign parameters to the module
Channel information available	Channel error; module can provide additional channel information.	-
Measuring range module incorrect/missing	One or more measuring range modules is missing or incorrectly inserted	Insert the measuring range modules on the module according to the parameter assignment of the type of measurement and the measurement range
STOP mode	No parameters have been assigned to the module and the first module cycle has not been completed.	If a reboot of the CPU all the digitized analog values are in the intermediate memory, this message is reset
EPROM error	Module is defective	Replace the module
RAM error		
ADC/DAC error		
Hardware interrupt lost	The module cannot send an interrupt, since the previous interrupt was not acknowledged; possible configuration error.	Change the interrupt handling in the CPU (change priority for interrupt OB; shorten interrupt program).
Configuration / programming error	Illegal parameters transferred to module	Check the measuring range module
		Reassign parameters to the module
Short-circuit to M	A short-circuit to the M potential has occurred on the sensor supply of 2-wire transducers.	Eliminate the short-circuit.
Wire break	Resistance of transducer circuit too high	Use a different type of transducer, 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 channel ("Measuring type" parameter)
		Wire the channel

Diagnostic message	Possible cause of error	Remedy
Reference channel error	The reference junction connected at channel 0 is faulty due to a wire break, for example.	Check the connections
	The reference temperature value transferred is not within the value range.	Reassign the parameters for the reference temperature
Underflow	Input value below undershoot range; possible cause of error: wrong measuring range selected	Set another measuring range
	With the measuring ranges 4 to 20 mA and 1 to 5 V, if necessary by polarity reversal of sensor connection	Check the connections
Overflow	Input value exceeds overshoot range	Set another measuring range
Run time calibration error	A wiring fault has occurred on a channel during the calibration cycle	Eliminate the wiring fault (fault remains until the next calibration; in other words, a maximum 6 minutes or until there is a STOP-RUN transition of the CPU).

5.18 Interrupts of analog modules

Introduction

This section describes the interrupt reaction of analog modules. There are two types of interrupt:

- Diagnostic interrupt
- Hardware interrupt

Note: certain analog modules do not support interrupts, or can only partially "handle" the interrupts described below. For information on modules supporting interrupt functions, refer to their specifications.

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

Enabling interrupts

The interrupts are not preset - in other words, they are inhibited without appropriate parameter assignment. Interrupts are enabled in STEP 7.

Special feature: The module is inserted in ER-1/ER-2

Note

If you use the analog module in ER-1/ER-2, you must set the parameters for the input of all the interrupts to "No" because the interrupt lines are not available in ER-1/ER-2.

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, and executes diagnostic interrupt OB82.

In the user program, you can call SFC 51 or SFC 59 in OB 82 to obtain more detailed diagnostic information from the module.

The diagnostic information is consistent until such time as OB 82 is exited. When OB 82 is exited, the diagnostic interrupt is acknowledged on the module.

Hardware interrupt with trigger "high and low limit exceeded"

Define a working range by setting a high and low limit. If the process signal (for example, the temperature) leaves this working range, the module triggers a hardware interrupt, provided the interrupt is enabled.

As a result, the CPU interrupts execution of the user program and executes hardware interrupt OB 40.

In the user program of OB 40, you can set how the programmable controller is required to react to a limit value being surpassed or not being reached.

When OB 40 is exited, the hardware interrupt is acknowledged on the module.

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 tag OB40_POINT_ADDR of OB 40

The limit values exceeded by the different channels are entered in the start information of OB 40 in the tag OB40_POINT_ADDR. The figure below shows the assignment of bits in DWORD 8 of local data.

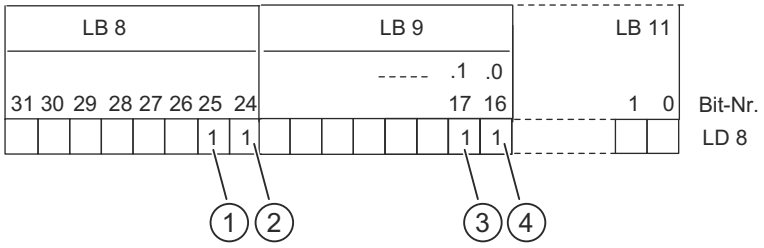


Figure 5-21 Start Information of OB 40: Which event has violated limits and triggered a hardware interrupt

(1) Value exceeds high limit in channel 1

(2) Value exceeds high limit in channel 0

(3) Value exceeds low limit in channel 1

(4) Value exceeds low limit in channel 0

(5) Bit No.

Hardware interrupt triggered by "Reached end of scan cycle"

A hardware interrupt programmed to be triggered at the end of scan cycles allows you to synchronize a process with the scan cycle of the analog input module.

A scan cycle includes the conversion of the measured values of all active channels of the analog input module. The module processes the channels in succession. When all measured values are successfully converted, the module reports the existence of new measurement data at its channels to the CPU by means of an interrupt.

You can always use this interrupt to load the actual, converted analog values.

See also

Features (Page 207)

General information about parameter assignment (Page 178)

5.19 Analog input module SM 431; AI 8 x 13 Bit (6ES7431-1KF00-0AB0)

5.19.1 Features

Overview

The analog input module SM 431; AI 8 x 13 bit has the following features:

- 8 inputs for voltage/current measurement
- 4 inputs for resistance measurement
- Various measuring ranges, adjustable in parallel
- Resolution 13 bits
- Analog section isolated from the CPU
- Maximum permitted common mode voltage between the channels or between the reference potentials of the connected sensors and M_{ANA} 30 V AC

Circuit diagram for SM 431; AI 8 x 13 bit

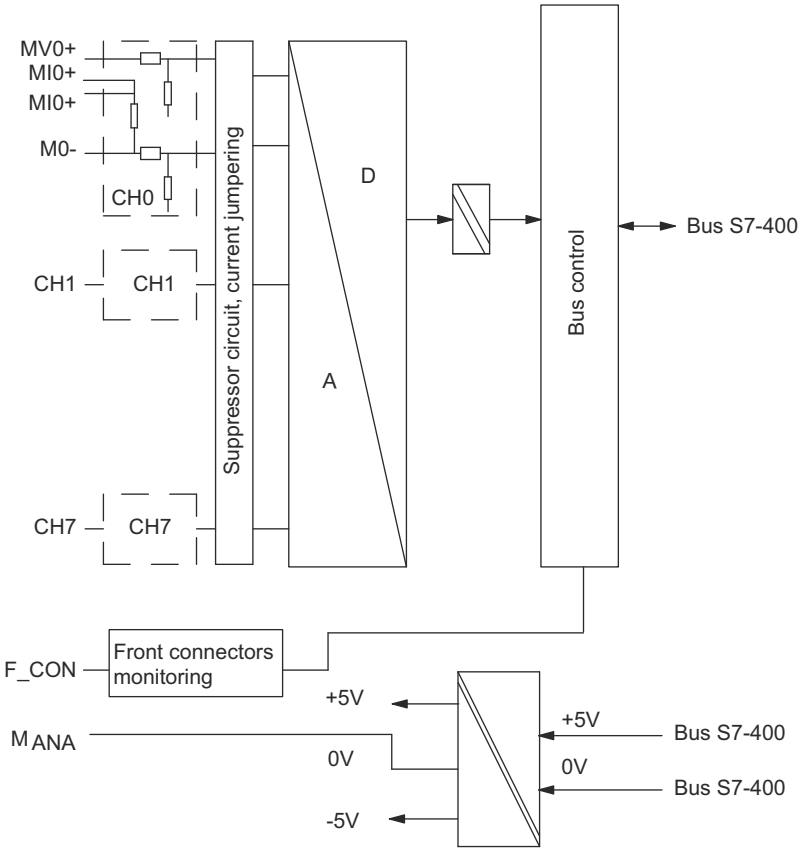


Figure 5-22 Circuit diagram for SM 431; AI 8 x 13 bit

WARNING

The module can get damaged.

The shunt of an input channel can be destroyed if you inadvertently connect a voltage sensor to the M- /MI+ terminals of a channel.

Make sure that the front connector is wired in accordance with the following connection diagram.

Connection diagram for SM 431; AI 8 x 13 bit

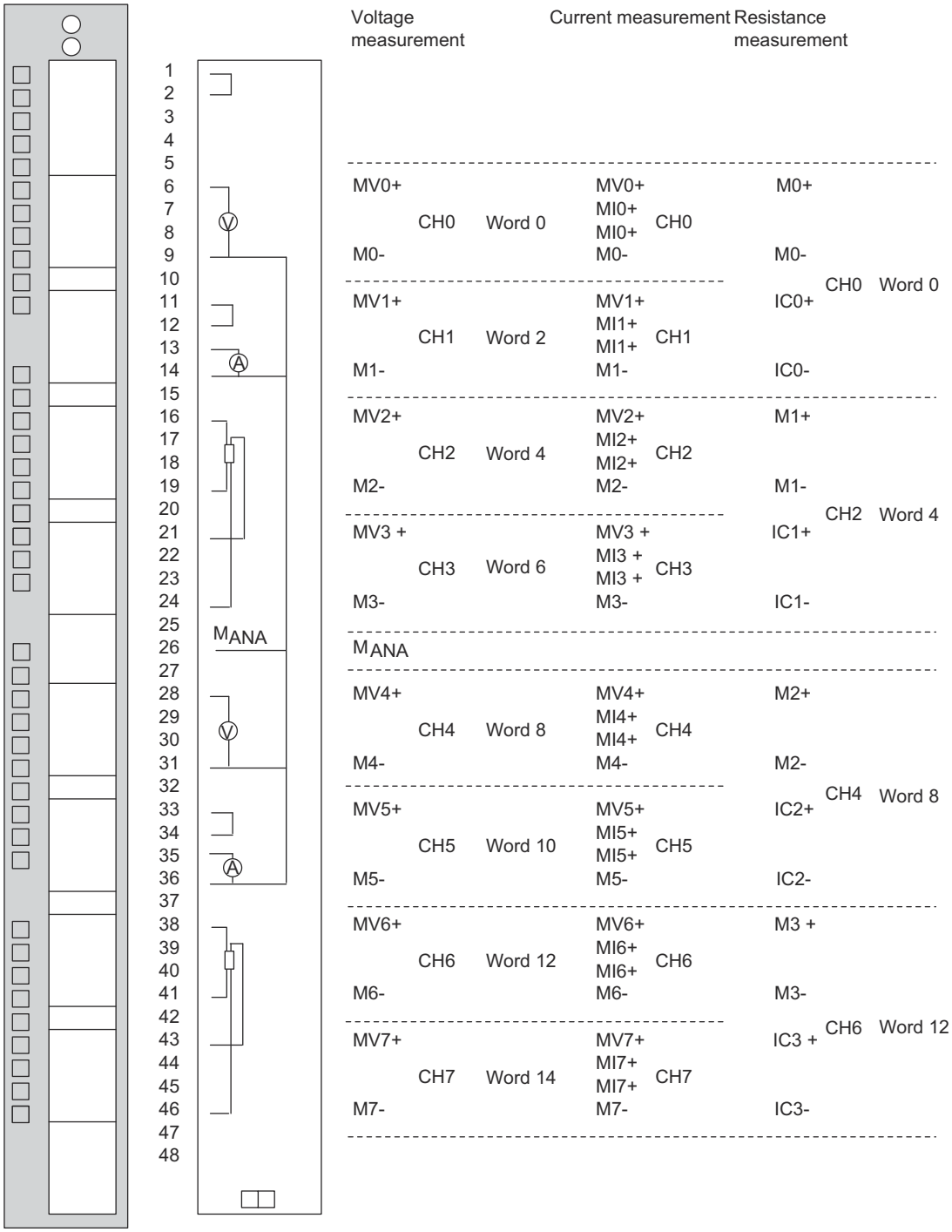


Figure 5-23 Connection diagram for SM 431; AI 8 x 13 bit

Technical specifications for SM 431; AI 8 x 13 bit

Article number	6ES7431-1KF00-0AB0
Supply voltage	
Load voltage L+	
• Rated value (DC)	not necessary
Input current	
from backplane bus 5 V DC, max.	350 mA
Power loss	
Power loss, typ.	1.8 W
Analog inputs	
Number of analog inputs	8
• For voltage/current measurement	8
• For resistance measurement	4
permissible input voltage for voltage input (destruction limit), max.	50 V
permissible input current for current input (destruction limit), max.	50 mA; 40 mA continuous
Constant measurement current for resistance-type transmitter, typ.	1.67 mA
Input ranges	
• Voltage	Yes
• Current	Yes
• Thermocouple	No
• Resistance thermometer	No
• Resistance	Yes
Input ranges (rated values), voltages	
• 1 V to 5 V	Yes
– Input resistance (1 V to 5 V)	200 kΩ
• -1 V to +1 V	Yes
– Input resistance (-1 V to +1 V)	200 kΩ
• -10 V to +10 V	Yes
– Input resistance (-10 V to +10 V)	200 kΩ
Input ranges (rated values), currents	
• -20 mA to +20 mA	Yes
– Input resistance (-20 mA to +20 mA)	80 Ω
• 4 mA to 20 mA	Yes
– Input resistance (4 mA to 20 mA)	80 Ω
Input ranges (rated values), resistors	
• 0 to 600 ohms	Yes
– Input resistance (0 to 600 ohms)	usable up to 500 ohms
Cable length	
• shielded, max.	200 m
Analog value generation for the inputs	

Article number	6ES7431-1KF00-0AB0
Measurement principle	integrating
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	13 bit
• Integration time, parameterizable	Yes
• Basic conversion time (ms)	23 / 25 ms
• Integration time (ms)	16,7 / 20 ms
• Interference voltage suppression for interference frequency f1 in Hz	50 / 60 Hz
• Basic execution time of the module (all channels released)	200 ms; 184 / 200 ms
Smoothing of measured values	
• parameterizable	No
Encoder	
Connection of signal encoders	
• for voltage measurement	Yes; possible
• for current measurement as 2-wire transducer	Yes; with external transmitter supply
• for current measurement as 4-wire transducer	Yes
• for resistance measurement with two-wire connection	Yes; Line resistances are also measured
• for resistance measurement with three-wire connection	Yes; Line resistances are also measured
• for resistance measurement with four-wire connection	Yes
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.05 %
Temperature error (relative to input range), (+/-)	0.02 %/K; ±0.02 %/K in impedance measuring range; ±0.007 % in all other measuring ranges
Crosstalk between the inputs, min.	50 dB
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	0.1 %
Operational error limit in overall temperature range	
• Voltage, relative to input range, (+/-)	1 %; ±1.0 % at ±1 V; ±0.6 % at ±10 V; ±0.7 % at 1 to 5 V
• Current, relative to input range, (+/-)	1 %; at ±20 mA, 4 to 20 mA
• Resistance, relative to input range, (+/-)	1.25 %; 0 to 500 ohms (4-conductor measurement, in range of 600 ohms)
Basic error limit (operational limit at 25 °C)	
• Voltage, relative to input range, (+/-)	0.7 %; 0.7% at ±1 V; 0.4% at ±10 V; 0.5% at 1 to 5 V
• Current, relative to input range, (+/-)	0.7 %; at ±20 mA, 4 to 20 mA

Article number	**6ES7431-1KF00-0AB0**
• Resistance, relative to input range, (+/-)	0.8 %; 0 to 500 ohms (4-conductor measurement, in range of 600 ohms)
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
• Series mode interference (peak value of interference < rated value of input range), min.	40 dB
• Common mode interference, min.	100 dB; UCM > 30 V
Interrupts/diagnostics/status information	
Alarms	No
Diagnostics function	No
Substitute values connectable	No
Potential separation	
Potential separation analog inputs	
• Potential separation analog inputs	Yes; internal/external
• between the channels	No
• between the channels and backplane bus	Yes
Permissible potential difference	
between the inputs (UCM)	30 V AC
Between the inputs and MANA (UCM)	30 V AC
between MANA and M internally (UISO)	60 V DC/30 V AC
Isolation	
Isolation tested with	2 120 V DC between bus and analog part; 500 V DC between bus and local ground; 2 120 V DC between analog part and local ground
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	500 g

5.19.2 Commissioning the SM 431; AI 8 x 13 Bit

Setting the operating mode

You set the mode of operation of the SM 431; AI 8 x13 Bit in STEP 7.

Parameters

You will find a description of the general procedure for assigning parameters to analog modules in the respective sections.

The table below provides an overview of configurable parameters, including defaults.

Table 5-45 Parameters of the SM 431; AI 8 x 13 Bit

Parameters	Value range		Default[1]	Parameter type	Scope
Measurement					
• Measuring method	Disabled		U		
	U 4DMU 2DMU R-4L	Voltage Current (4-wire sensor) Current (2-wire sensor) Resistance (4-conductor connection)		Static	Channel
• Measuring range	Refer to respective section for the measuring ranges of the input channels that you can set.		± 10 V		
• Interference frequency suppression	60 Hz; 50 Hz		50 Hz		
[1] Only in the CR (central rack) is it possible to start up the analog modules with the default settings.					

See also

General information about parameter assignment (Page 178)

5.19.3 Measuring methods and measuring ranges of SM 431; AI 8 x 13 Bit

Measuring methods

You can set the measuring method at the input channels:

- Voltage measurement
- Current measurement
- Resistance measurement

You perform the setting with the "measuring method" parameter in STEP 7.

Circuit for resistance measurement

The following conditions apply when measuring the resistance with the SM 431; AI 8 x 13 Bit:

Table 5-46 Channels for resistance measurement of the SM 431; AI 8 x 13 Bit

Measuring type parameter	Permissible for channel n	Condition
Resistance (4-conductor connection)	0, 2, 4 or 6	You must disable the "Measuring type" parameter for channels n+1 (1, 3, 5, 7). Reason: The connections of channel n+1 are used to supply the resistance that is connected to channel n.

Unused channels

Unused channels can be left open. You can improve the noise immunity of the module in a measuring environment with serious interference by short-circuiting the channels and connecting to M_{ANA}. For unused channels, set the "measuring method" parameter to "deactivated". This reduces the module's cycle time.

Measuring ranges

Set the measuring ranges at the "measuring range" parameter in *STEP 7*.

Table 5-47 Measuring ranges of the SM 431; AI 8 x 13 Bit

Selected measuring method	Measuring range	Description
V: Voltage	±1 V 1 V to 5 V ±10 V	The digitized analog values are listed in the section "Representation of analog values for output channels" in the voltage measuring range.
2DMU: Current (2-wire transducer)	4 to 20 mA	The digitized analog values are listed in the section "Representation of analog values for output channels in the current measuring range".

Selected measuring method	Measuring range	Description
4DMU: Current (4-wire transducer)	4 to 20 mA ± 20 mA	The digitized analog values are listed in the section "Representation of analog values for output channels in the current measuring range".
R-4L: Resistance (4-conductor connection)	600 Ω	The digitized analog values are listed in the section "Representation of analog values for output channels in the resistance-type sensor range".

Default

The "voltage" measuring method and "± 10 V" measuring range are set by default at the module. You can use this combination of measuring method and measuring range without configuring the SM 431; AI 8 x 13 Bit in *STEP 7*.

5.20 Analog input module SM 431; AI 8 x 14 Bit (6ES7431-1KF10-0AB0)

5.20.1 Features

Overview

The analog input module SM 431; AI 8 x 14 bit has the following features:

- 8 inputs for current and voltage measurement
- 4 inputs for resistance and temperature measurement
- Various measuring ranges, adjustable in parallel
- Resolution 14 bits
- Particularly suited to temperature measurement
- Temperature sensor types configurable
- Linearization of sensor characteristic curves
- Supply voltage: 24 V DC only required for connection of 2-wire transducers
- Analog section isolated from the CPU
- Maximum permitted common mode voltage between channels or between channel and central grounding point 120 V AC

Note

"Wire break" diagnostics

The diagnosis "wire break" can be configured for "voltage" measurement for this module, but is not evaluated by the module in that measurement type.

Circuit diagram for SM 431; AI 8 x 14 bit

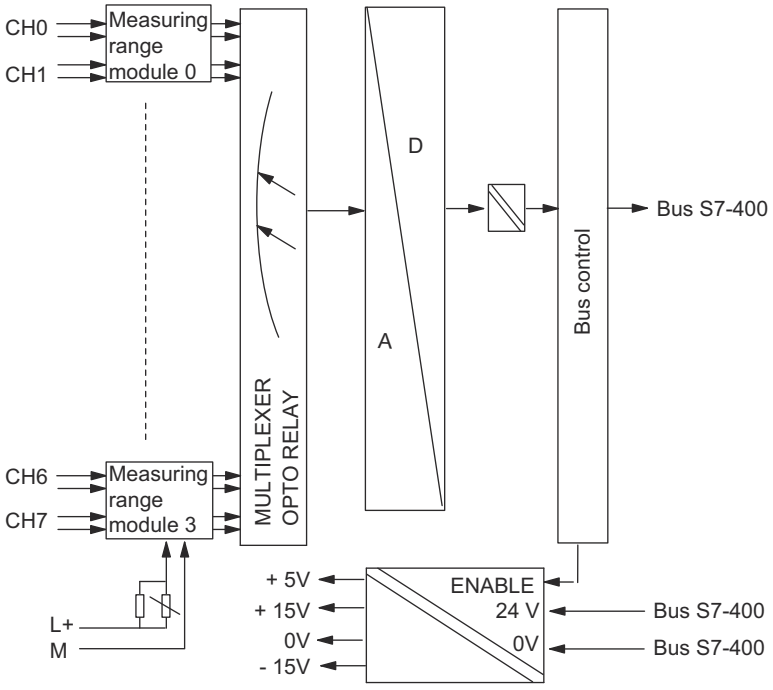


Figure 5-24 Circuit diagram for SM 431; AI 8 x 14 bit

Connection diagram for SM 431; AI 8 x 14 bit

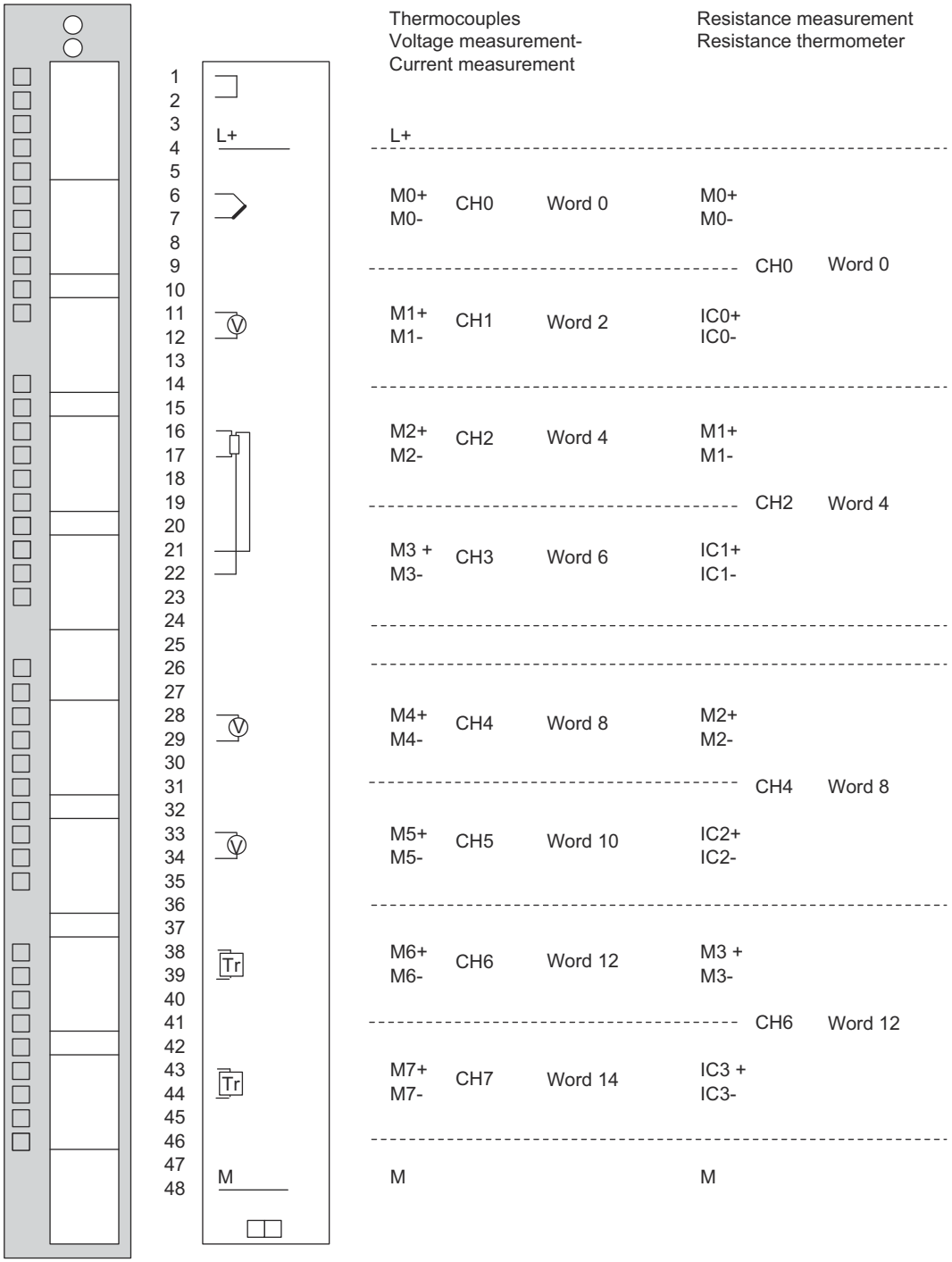


Figure 5-25 Connection diagram for SM 431; AI 8 x 14 bit

Technical specifications for SM 431; AI 8 x 14 bit

Article number	6ES7431-1KF10-0AB0
Supply voltage	
Load voltage L+	
• Rated value (DC)	24 V; Only required for supplying 2-wire transmitters
• Reverse polarity protection	Yes
Input current	
from load voltage L+ (without load), max.	200 mA; for 8 connected, fully controlled 2-wire transmitters
from backplane bus 5 V DC, max.	600 mA
output voltage / header	
supply voltage of the transmitters / header	
• short-circuit proof	Yes
• Supply current, max.	50 mA
Power loss	
Power loss, typ.	3.5 W
Analog inputs	
Number of analog inputs	8
• For voltage/current measurement	8
• For resistance measurement	4
permissible input voltage for voltage input (destruction limit), max.	18 V; 18 V continuous, 75 V for 1 ms (mark to space ratio 1:20)
permissible input current for current input (destruction limit), max.	40 mA; Permanent
Constant measurement current for resistance-type transmitter, typ.	1.67 mA
Input ranges	
• Voltage	Yes
• Current	Yes
• Thermocouple	Yes
• Resistance thermometer	Yes
• Resistance	Yes
Input ranges (rated values), voltages	
• 1 V to 5 V	Yes
– Input resistance (1 V to 5 V)	1 MΩ
• -1 V to +1 V	Yes
– Input resistance (-1 V to +1 V)	1 MΩ
• -10 V to +10 V	Yes
– Input resistance (-10 V to +10 V)	1 MΩ
• -2.5 V to +2.5 V	Yes
– Input resistance (-2.5 V to +2.5 V)	1 MΩ
• -250 mV to +250 mV	Yes
– Input resistance (-250 mV to +250 mV)	1 MΩ

Article number	6ES7431-1KF10-0AB0
• -5 V to +5 V	Yes
– Input resistance (-5 V to +5 V)	1 MΩ
• -500 mV to +500 mV	Yes
– Input resistance (-500 mV to +500 mV)	1 MΩ
• -80 mV to +80 mV	Yes
– Input resistance (-80 mV to +80 mV)	1 MΩ
Input ranges (rated values), currents	
• 0 to 20 mA	Yes
– Input resistance (0 to 20 mA)	50 Ω
• 4 mA to 20 mA	Yes
– Input resistance (4 mA to 20 mA)	50 Ω
Input ranges (rated values), thermocouples	
• Type B	Yes
– Input resistance (Type B)	1 MΩ
• Type E	Yes
– Input resistance (Type E)	1 MΩ
• Type J	Yes
– Input resistance (type J)	1 MΩ
• Type K	Yes
– Input resistance (Type K)	1 MΩ
• Type L	Yes
– Input resistance (Type L)	1 MΩ
• Type N	Yes
– Input resistance (Type N)	1 MΩ
• Type R	Yes
– Input resistance (Type R)	1 MΩ
• Type S	Yes
– Input resistance (Type S)	1 MΩ
• Type T	Yes
– Input resistance (Type T)	1 MΩ
• Type U	Yes
– Input resistance (Type U)	1 MΩ
Input ranges (rated values), resistance thermometer	
• Ni 100	Yes
– Input resistance (Ni 100)	1 MΩ
• Ni 1000	Yes
– Input resistance (Ni 1000)	1 MΩ
• Pt 100	Yes
– Input resistance (Pt 100)	1 MΩ
• Pt 1000	Yes
• Pt 10000	Yes

Article number	6ES7431-1KF10-0AB0
• Pt 200	Yes
– Input resistance (Pt 200)	1 MΩ
• Pt 500	Yes
– Input resistance (Pt 500)	1 MΩ
Input ranges (rated values), resistors	
• 0 to 48 ohms	Yes
– Input resistance (0 to 48 ohms)	1 MΩ
• 0 to 150 ohms	Yes
– Input resistance (0 to 150 ohms)	1 MΩ
• 0 to 300 ohms	Yes
– Input resistance (0 to 300 ohms)	1 MΩ
• 0 to 600 ohms	Yes
– Input resistance (0 to 600 ohms)	1 MΩ
• 0 to 6000 ohms	Yes; Usable up to 5000 Ohm
– Input resistance (0 to 6000 ohms)	1 MΩ
Thermocouple (TC)	
Temperature compensation	
– parameterizable	Yes
– internal temperature compensation	No
– external temperature compensation with Pt100	Yes
– external temperature compensation with compensations socket	Yes
– dynamic reference temperature value	Yes
Characteristic linearization	
• parameterizable	Yes
– for thermocouples	Type B, E, J, K, L, N, R, S, T, U
– for resistance thermometer	Pt100, Pt200, Pt500, Pt1000, Ni100, Ni1000
Cable length	
• shielded, max.	200 m; 50 m with thermocouples and input ranges ≤ 80 mV
Analog value generation for the inputs	
Measurement principle	integrating
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	14 bit; with activated filtering: 16 bit
• Integration time, parameterizable	Yes
• Basic conversion time (ms)	20.1 / 23.5 ms
• Integration time (ms)	16,7 / 20 ms
• Basic conversion time, including integration time (ms)	

Article number	6ES7431-1KF10-0AB0
– additional conversion time for wire-break monitoring	4,3 ms
– additional conversion time for resistance measurement	40.2 / 47 ms
– additional conversion time for wire-break monitoring and resistance measurement	5,5 ms
• Interference voltage suppression for interference frequency f1 in Hz	50 / 60 Hz
• Basic execution time of the module (all channels released)	161 ms; 161 / 188 ms
Smoothing of measured values	
• parameterizable	Yes; in 4 stages
Encoder	
Connection of signal encoders	
• for voltage measurement	Yes; possible
• for current measurement as 2-wire transducer	Yes
– Burden of 2-wire transmitter, max.	750 Ω
• for current measurement as 4-wire transducer	Yes
• for resistance measurement with two-wire connection	Yes; Line resistances are also measured
• for resistance measurement with three-wire connection	Yes
• for resistance measurement with four-wire connection	Yes
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.01 %
Temperature error (relative to input range), (+/-)	0.004 %/K
Crosstalk between the inputs, min.	70 dB
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	0.1 %
Operational error limit in overall temperature range	
• Voltage, relative to input range, (+/-)	0.38 %; ±0.38 % at ±80 mV; ±0.35 % at ±250 mV, ±500 mV, ±1 V, ±2,5 V, ±5 V, 1 to 5 V, ±10 V
• Current, relative to input range, (+/-)	0.35 %; ±20 mA, 0 to 20 mA, 4 to 20 mA
• Resistance, relative to input range, (+/-)	0.5 %
• Resistance thermometer, relative to input range, (+/-)	0.5 %
• Thermocouple, relative to input range, (+/-)	TC Type B (±14.8 K), TC Type R (±9.4 K), TC Type S (±10.6 K), TC Type T (±2.2 K), TC Type E (±4.0 K), TC Type J (±5.2 K), TC Type K (±7.6 K), TC Type U (±3.5 K), TC Type L (±5.1 K), TC Type N (±5.5 K)
Basic error limit (operational limit at 25 °C)	

Article number	**6ES7431-1KF10-0AB0**
• Voltage, relative to input range, (+/-)	0.15 %; ±0.15 % (±250 mV, ±500 mV, ±1 V, ±2.5 V, ±5 V, 1 to 5 V, ±10 V); ±0.17% (±80 mV)
• Current, relative to input range, (+/-)	0.15 %; ±20 mA, 0 to 20 mA, 4 to 20 mA
• Resistance, relative to input range, (+/-)	0.15 %; ±0.15 % at 0 to 48 ohms (4-conductor measurement), 0 to 150 ohms (4-conductor measurement), 0 to 300 ohms (4-conductor measurement), 0 to 600 ohms (4-conductor measurement), 0 to 5000 ohms (4-conductor measurement, in range of 6000 ohms); ±0.3 % at 0 to 300 ohms (3-conductor measurement), 0 to 600 ohms (3-conductor measurement), 0 to 5000 ohms (3-conductor measurement, in range of 6000 ohms)
• Resistance thermometer, relative to input range, (+/-)	0.3 %
• Thermocouple, relative to input range, (+/-)	TC Type B (±8.2 K), TC Type R (±5.2 K), TC Type S (±5.9 K), TC Type T (±1.2 K), TC Type E (±1.8 K), TC Type J (±2.3 K), TC Type K (±3.4 K), TC Type U (±1.8 K), TC Type L (±2.3 K), TC Type N (±2.9 K)
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
• Series mode interference (peak value of interference < rated value of input range), min.	40 dB
• Common mode interference, min.	100 dB; UCM < 120 VSS
Interrupts/diagnostics/status information	
Alarms	No
Diagnostics function	No
Substitute values connectable	No
Potential separation	
Potential separation analog inputs	
• Potential separation analog inputs	Yes; internal/external
• between the channels	No
• between the channels and backplane bus	Yes
• Between the channels and load voltage L+	Yes
Permissible potential difference	
between the inputs (UCM)	60 V DC/30 V AC
Between the inputs and MANA (UCM)	60 V DC/30 V AC
between MANA and M internally (UISO)	60 V DC/30 V AC
Isolation	
Isolation tested with	2 120 V DC between bus and L+/M; 2 120 V DC between bus and analog section; 500 V DC between bus and local ground; 500 V DC between analog section and L+/M; 2 120 V DC between analog section and local ground; 2 120 V DC between L+/M and local ground
Dimensions	
Width	25 mm
Height	290 mm

Article number	**6ES7431-1KF10-0AB0**
Depth	210 mm
Weights	
Weight, approx.	500 g

5.20.2 Commissioning the SM 431; AI 8 x 14 Bit

Setting the operating mode

You set the mode of operation of the SM 431; AI 8 x 14 Bit by means of measuring range modules on the module and in *STEP 7*.

Measuring range modules

A measuring range module of the module matches two channels and one resistance channel to each type of sensor. Reposition the measuring range modules to suit the measuring method and range. The steps you have to perform to do this are described in detail in the respective section.

For an overview of the settings of specific measuring methods and ranges, refer to the corresponding table in the section "Measuring methods and measuring ranges of SM 431; AI 8 x 14 Bit". The necessary settings are also shown on the label attached to the module.

Parameters

You will find a description of the general procedure for assigning parameters to analog modules in the respective sections.

The table below provides an overview of configurable parameters, including defaults.

Table 5-48 Parameters of the SM 431; AI 8 x 14 Bit

Parameters	Value range	Default setting[1]	Parameter type	Scope
Diagnostics				
• Wire break	Yes/no	No	Static	Channel
Measurement				

Parameters	Value range		Default setting[1]	Parameter type	Scope
• Measuring method	Deactivated U	Voltage	U	Static	Channel
	4DMU	Current (4-wire sensor)			
	2DMU	Current (2-wire sensor)			
	R-4L	Resistance (4-conductor connection)			
	R-3L	Resistance (3-conductor connection)			
	RTD-4L	Thermal resistor (linear, 4-conductor connection)			
	RTD-3L	Thermal resistor (linear, 3-conductor connection)			
	TC-L	Thermocouple (linear)			
• Measuring range	For information on configurable measuring ranges of input channels, refer to the chapter "Measuring methods and measuring ranges of SM 431; AI 8 x 14 Bit".		± 10 V		
• Reference temperature	- 273.15 to 327.67 °C		0,00 °C	Dynamic	Module
• Interference frequency suppression	60 Hz; 50 Hz		50 Hz	Static	Channel
• Smoothing	None Weak Medium Strong		None	Static	Channel
• Reference junction	None RTD on Channel 0 Reference temperature value dynamic		None		

[1] Only in the CR (central rack) is it possible to start up the analog modules with the default settings.

Measured value smoothing

You will find information that is generally applicable to the smoothing of analog values in the respective section.

The following figure shows for the module the number of module cycles, in the case of a step response, after which the smoothed analog value is applied to almost 100%, depending on the smoothing setting. The figure applies to every change of signal at an analog input.

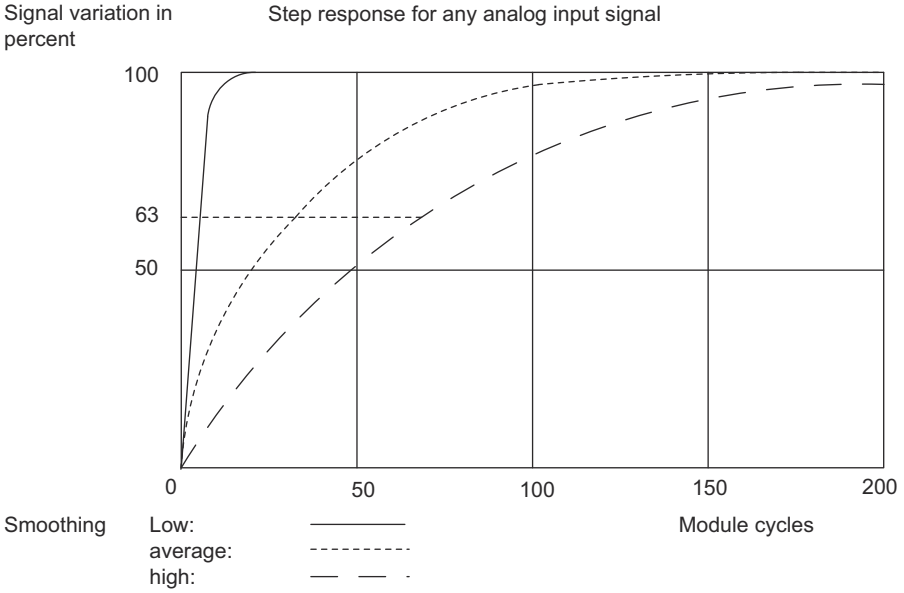


Figure 5-26 Step response of the SM 431; AI 8 x 14 Bit

See also

General information about parameter assignment (Page 178)

Conversion, cycle, settling and response time of analog modules (Page 175)

5.20.3 Measuring methods and measuring ranges of SM 431; AI 8 x 14 Bit

Measuring methods

You can set the measuring method at the input channels:

- Voltage measurement
- Current measurement
- Resistance measurement
- Temperature measurement

You specify the setting by means of the measuring range modules on the module and the "Measuring type" parameter in STEP 7.

Circuit variants for the channels

Two channels are set in each case with the measuring range module. There are therefore restrictions as regards the measuring method for the adjacent channels 0/1, 2/3, 4/5 and 6/7, as shown in the following table:

Table 5-49 Selection of the measuring method for channel n and channel n+1 of the SM 431; AI 8 x 14 Bit (6ES7431-1KF10-0AB0)

Measuring method, channel n	**Measuring method, channel n + 1**								
	Deacti-vated	Voltage	Current 4-DMU	Current 2-DMU	R-4L	R-3L	RTD-4L	RTD-3L	TC-L
Disabled	x	x	x	x					x
Voltage	x	x							x
Current 4-wire transducer	x		x						
Current 2-wire transducer	x			x					
4-wire resistor	x								
3-wire resistor	x								
Four-wire thermal resistor	x								
3-wire thermal resistor	x								
Thermocouples	x	x							x

Example

If you select "current (2-wire transducer)" for channel 6, you can only disable the measuring method or set "current (2-wire transducer)" for channel 7.

Circuit for resistance measurement

The following conditions apply when measuring the resistance and temperature with the SM 431; AI 8 x 14 Bit:

Table 5-50 Channels for resistance and temperature measurement of the SM 431; AI 8 x 14 Bit

Measuring type parameter	Permissible for channel n	Condition
Resistance (4-conductor connection)	0, 2, 4 or 6	You must disable the "Measuring type" parameter for channels n+1 (1, 3, 5, 7). Reason: The connections of channel n+1 are used to supply the resistance that is connected to channel n.
Resistance (3-conductor connection)	0, 2, 4 or 6	
Thermal resistance (linear, 4-wire connection)	0, 2, 4 or 6	
Thermal resistance (linear, 3-wire connection)	0, 2, 4 or 6	

Circuit for reference junction compensation for thermocouples

If you select "RTD on Channel 0" as a reference junction for reference junction compensation for thermocouples, the following applies:

Table 5-51 Thermocouple with reference junction compensation via RTD on channel 0

Measuring type parameter	Permissible for channel n	Condition
RTD on Channel 0	2 to 7	You must connect and configure on channel 0 a resistance thermometer with linearization, a 3 or 4-conductor connection in climatic range. This means that channels 0 and 1 are assigned. Reason: If channel 0 is to be used as the reference junction, a resistance-type sensor must be connected there to record absolute temperatures in the climatic range.

Unused channels

Unused channels can usually be left open. Set the measuring range modules to position "A". In measuring environments with strong interference, you can improve the module's immunity to interference by short-circuiting the channels.

For unused channels, set the "measuring method" parameter to "deactivated". This reduces the module's cycle time.

Measuring ranges

Set the measuring ranges using the measuring range modules, and at the "measuring method" parameter in *STEP 7*.

Table 5-52 Measuring ranges of the SM 431; AI 8 x 14 Bit (6ES7431-1KF10-0AB0)

Selected measuring method	Measuring range (type of sensor)	Measuring range module settings	Description
V: Voltage	± 80 mV ± 250 mV ± 500 mV ± 1 V ± 2.5 V ± 5 V 1 to 5 V ± 10 V	A	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the voltage measuring range.
2DMU: Current (2-wire transducer)	4 to 20 mA	D	To supply these transducers with current you must connect 24 V to the L+ and M front connector terminals. The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the current measuring range.
4DMU: Current (4-wire transducer)	0 mA to 20 mA 4 mA to 20 mA ± 20 mA	C	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the current measuring range.
R-4L: Resistance (4-conductor connection)	48 Ω 150 Ω 300 Ω 600 Ω 6000 Ω	A	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the resistance measuring range.
R-3L: Resistance (3-conductor connection)	300 Ω 600 Ω 6000 Ω		

Selected measuring method	Measuring range (type of sensor)	Measuring range module settings	Description
TCL: Thermocouple (linear) (temperature measurement)	Type B Type N Type E Type R Type S Type J Type L Type T Type K Type U	A	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the temperature range.
RTD-4L: Thermal resistance (linear, 4-wire connection) (temperature measurement)	Pt 100 Climatic Pt 200 Climatic Pt 500 Climatic Pt 1000 Climatic Ni 100 Climatic Ni 1000 Climatic Pt 100 Standard Pt 200 Standard Pt 500 Standard Pt 1000 Standard Ni 100 Standard Ni 1000 Standard	A	
RTD-3L: Thermal resistance (linear, 3-wire connection) (temperature measurement)			

Defaults

The module has the following default settings in *STEP 7*:

- Channels 0 to 7: "Voltage" measuring method ; "± 10 V" measuring range

You can use these measuring methods and measuring ranges without configuring the SM 431; AI 8 x 14 Bit in STEP 7.

5.21 Analog input module SM 431; AI 8 x 14 Bit (6ES7431-1KF20-0AB0)

5.21.1 Features

Overview

SM 431; AI 8 x 14 bit has the following features:

- Rapid A/D change, therefore highly suited to highly dynamic processes
- 8 inputs for voltage/current measurement
- 4 inputs for resistance measurement

- Various measuring ranges, adjustable in parallel
- Resolution 14 bits
- Supply voltage: 24 V DC only required for connection of 2-wire transducers
- Analog section isolated from the CPU
- Maximum permitted common mode voltage between the channels or between the reference potentials of the connected sensors and M_{ANA} 8 V AC

Circuit diagram for SM 431; AI 8 x 14 bit

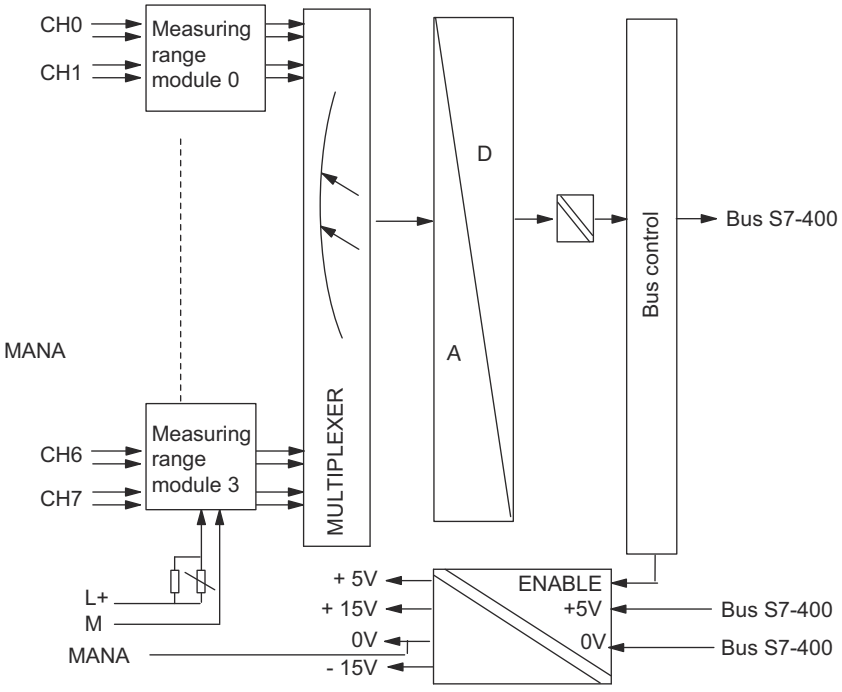


Figure 5-27 Circuit diagram for SM 431; AI 8 x 14 bit

Connection diagram for SM 431; AI 8 x 14 bit

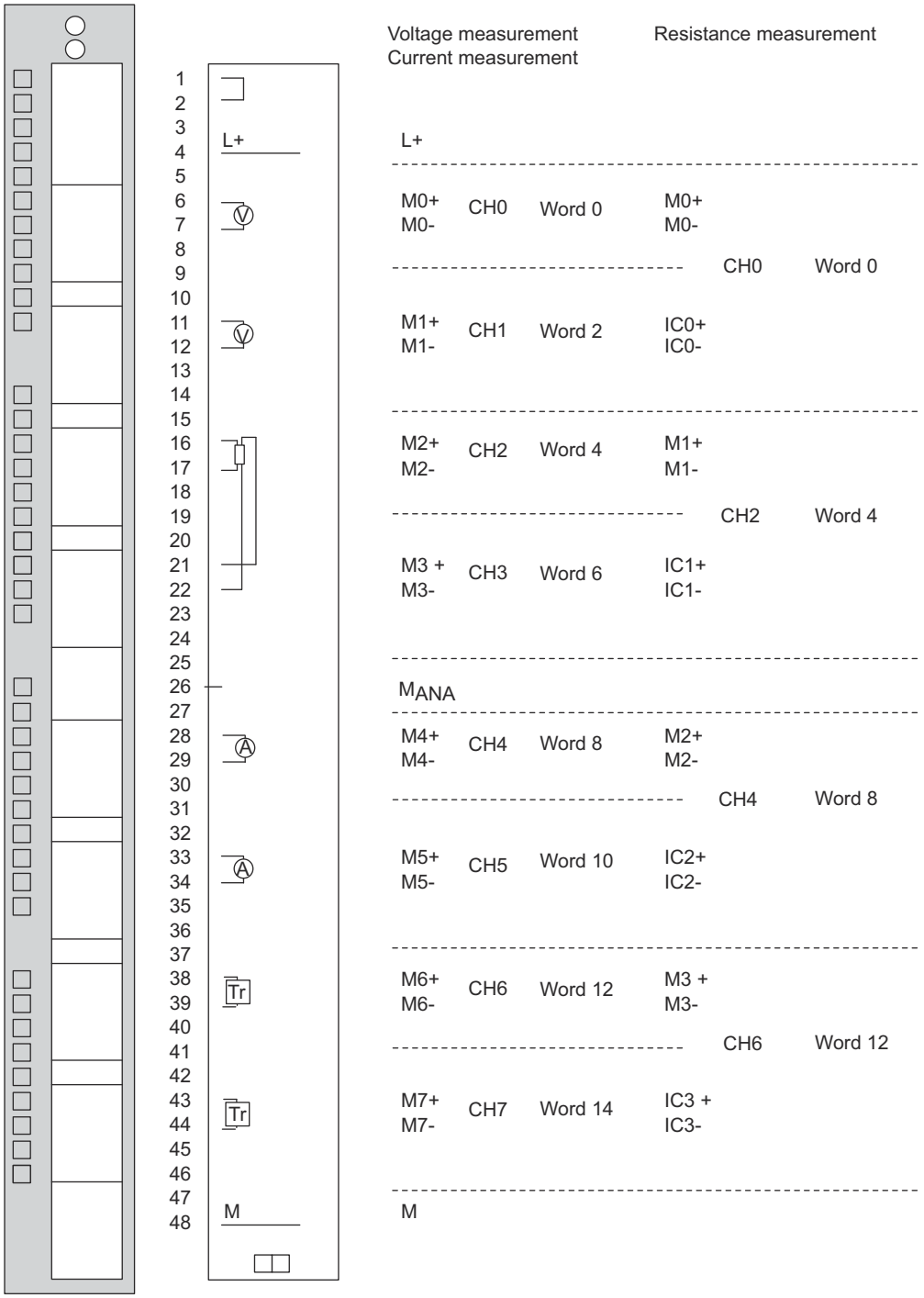


Figure 5-28 Connection diagram for SM 431; AI 8 x 14 bit

Technical specifications for SM 431; AI 8 x 14 bit

Article number	6ES7431-1KF20-0AB0
Supply voltage	
Load voltage L+	
• Rated value (DC)	24 V; Only required for supplying 2-wire transmitters
• Reverse polarity protection	Yes
Input current	
from load voltage L+ (without load), max.	200 mA; for 8 connected, fully controlled 2-wire transmitters
from backplane bus 5 V DC, max.	1 000 mA
output voltage / header	
supply voltage of the transmitters / header	
• short-circuit proof	Yes
• Supply current, max.	50 mA
Power loss	
Power loss, typ.	4.9 W
Analog inputs	
Number of analog inputs	8
• For voltage/current measurement	8
• For resistance measurement	4
permissible input voltage for voltage input (destruction limit), max.	18 V; 18 V continuous, 75 V for 1 ms (mark to space ratio 1:20)
permissible input current for current input (destruction limit), max.	40 mA; Permanent
Constant measurement current for resistance-type transmitter, typ.	1.67 mA
Input ranges	
• Voltage	Yes
• Current	Yes
• Thermocouple	No
• Resistance thermometer	No
• Resistance	Yes
Input ranges (rated values), voltages	
• 1 V to 5 V	Yes
– Input resistance (1 V to 5 V)	10 MΩ
• -1 V to +1 V	Yes
– Input resistance (-1 V to +1 V)	10 MΩ
• -10 V to +10 V	Yes
– Input resistance (-10 V to +10 V)	100 kΩ
Input ranges (rated values), currents	
• -20 mA to +20 mA	Yes
– Input resistance (-20 mA to +20 mA)	50 Ω
• 4 mA to 20 mA	Yes

Article number	**6ES7431-1KF20-0AB0**
– Input resistance (4 mA to 20 mA)	50 kΩ
Input ranges (rated values), resistors	
• 0 to 600 ohms	Yes
Cable length	
• shielded, max.	200 m
Analog value generation for the inputs	
Measurement principle	Actual value encryption
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	14 bit; 14 / 14 / 14
• Integration time, parameterizable	Yes
• Basic conversion time (ms)	52 µs
• Interference voltage suppression for interference frequency f1 in Hz	none / 400 / 60 / 50 Hz
• Time constant of the input filter	15 µs
• Basic execution time of the module (all channels released)	0.42 s
Smoothing of measured values	
• parameterizable	Yes; None, strong
Encoder	
Connection of signal encoders	
• for voltage measurement	Yes; possible
• for current measurement as 2-wire transducer	Yes
– Burden of 2-wire transmitter, max.	750 Ω
• for current measurement as 4-wire transducer	Yes
• for resistance measurement with two-wire connection	Yes; Line resistances are also measured
• for resistance measurement with three-wire connection	Yes; Line resistances are also measured
• for resistance measurement with four-wire connection	Yes
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.05 %
Temperature error (relative to input range), (+/-)	0.03 %/K
Crosstalk between the inputs, min.	70 dB
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	0.2 %
Operational error limit in overall temperature range	
• Voltage, relative to input range, (+/-)	0.7 %; ±0.7 % at ±1 V; ±0.9 % at ±10 V, 1 to 5 V
• Current, relative to input range, (+/-)	0.8 %; at ±20 mA, 4 to 20 mA

Article number	6ES7431-1KF20-0AB0
• Resistance, relative to input range, (+/-)	1 %
Basic error limit (operational limit at 25 °C)	
• Voltage, relative to input range, (+/-)	0.6 %; 0.6 % at ±1 V; 0.75 % at ±10 V, 1 to 5 V
• Current, relative to input range, (+/-)	0.7 %; at ±20 mA, 4 to 20 mA
• Resistance, relative to input range, (+/-)	0.7 %; 0 to 600 ohms
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
• Series mode interference (peak value of interference < rated value of input range), min.	40 dB
• Common mode interference, min.	80 dB
Interrupts/diagnostics/status information	
Alarms	No
Diagnostics function	No
Substitute values connectable	No
Potential separation	
Potential separation analog inputs	
• Potential separation analog inputs	Yes; internal/external
• between the channels	No
• between the channels and backplane bus	Yes
• Between the channels and load voltage L+	Yes
Permissible potential difference	
between the inputs (UCM)	8 V AC
Between the inputs and MANA (UCM)	8 V AC
between MANA and M internally (UISO)	60 V DC/30 V AC
Isolation	
Isolation tested with	2 120 V DC between bus and analog section; 500 V DC between bus and local ground; 500 V DC between analog part and L+/M; 2 120 V DC between analog part and local ground; 2 120 V DC between L+/M and local ground
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	500 g

5.21.2 Commissioning the SM 431; AI 8 x 14 Bit

Introduction

You set the mode of operation of the SM 431; AI 8 x 14 Bit by means of measuring range modules on the module and in *STEP 7*.

Measuring range modules

A measuring range module of the module matches two channels and one resistance channel to each type of sensor. Reposition the measuring range modules to suit the measuring method and range. The steps you have to perform to do this are described in detail in the respective section.

For an overview of the settings of specific measuring methods and ranges, refer to the corresponding table in the section "Measuring methods and measuring ranges of SM 431, AI 8 x 14 Bit". The necessary settings are also shown on the label attached to the module.

Parameters

You will find a description of the general procedure for assigning parameters to analog modules in the respective sections.

The table below provides an overview of configurable parameters, including defaults.

Table 5-53 Parameters of the SM 431; AI 8 x 14 Bit (6ES7431-1KF20-0AB0)

Parameters	Value range		Default[1]	Parameter type	Scope
Measurement					
• Measuring method	Disabled		U	Static	Channel
	U	Voltage			
	4DMU	Current (4-wire sensor)			
	2DMU	Current (2-wire sensor)			
	R-4L	Resistance (4-conductor connection)			
• Measuring range	Refer to the respective section for the measuring ranges of the input channels that you can set.		± 10 V		
• Noise suppression	400 Hz; 60 Hz; 50 Hz; none		50 Hz		
• Smoothing	None Strong		None		

[1] Only in the CR (central rack) is it possible to start up the analog modules with the default settings.

Measured value smoothing

You will find information that is generally applicable to the smoothing of analog values in the respective section. You can only set strong smoothing for the SM 431; AI 8 x 14 Bit.

The module cycle time is a constant, irrespective of how many channels are enabled. It therefore has no effect on the filter settling time, which is defined by the parameter assignment of interference frequency suppression and smoothing.

Filter settling time with strong smoothing

Table 5-54 Interference frequency suppression and filter settling time with smoothing

Noise suppression	Smoothing	Filter settling time in ms
None	Strong	-
50 Hz	Strong	100
60 Hz	Strong	83,333
400 Hz	Strong	12,5

Step response with strong smoothing

The following figure illustrates the contents of the table above. It shows the filter settling time after which, in the case of a step response, the smoothed analog value is applied to almost 100%, depending on the interference frequency suppression that has been set. The figure applies to every change of signal at an analog input.

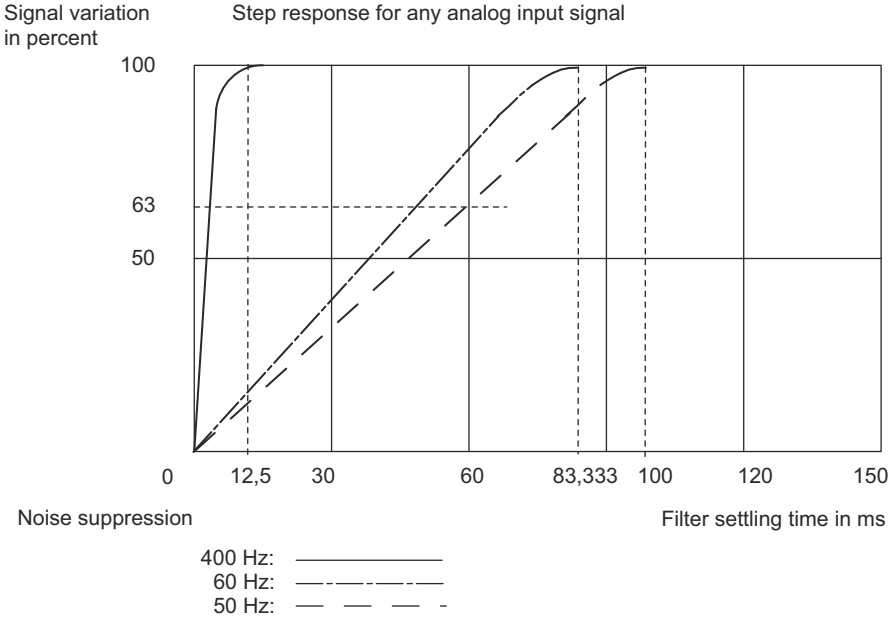


Figure 5-29 Step response of the SM 431; AI 8 x 14 Bit (6ES7 431-1KF20-0AB0)

See also

General information about parameter assignment (Page 178)
Measuring methods and measuring ranges of SM 431; AI 8 x 14 Bit (Page 239)

5.21.3 Measuring methods and measuring ranges of SM 431; AI 8 x 14 Bit

Measuring methods

You can set the measuring method at the input channels:

- Voltage measurement
- Current measurement
- Resistance measurement
- Temperature measurement

You specify the setting by means of the measuring range modules on the module and the "Measuring type" parameter in STEP 7.

Circuit variants for the channels

Two channels are set in each case with the measuring range module. There are therefore restrictions as regards the measuring method for the adjacent channels 0/1, 2/3, 4/5 and 6/7, as shown in the following table:

Table 5-55 Selection of the measuring method for channel n and channel n+1 of the SM 431; AI 8 x 14 Bit (6ES7431-1KF10-0AB0)

Measuring method, channel n	**Measuring method, channel n + 1**								
	Deacti-vated	Voltage	Current 4-DMU	Current 2-DMU	R-4L	R-3L	RTD-4L	RTD-3L	TC-L
Disabled	x	x	x	x					x
Voltage	x	x							x
Current 4-wire trans-ducer	x		x						
Current 2-wire trans-ducer	x			x					
4-conductor resistor	x								
3-conductor resistor	x								
4-conductor thermal resistor	x								
3-conductor thermal resistor	x								
Thermocouples	x	x							x

Example

If you select "current (2-wire transducer)" for channel 6, you can only disable the measuring method or set "current (2-wire transducer)" for channel 7.

Circuit for resistance measurement

The following conditions apply when measuring the resistance and temperature with the SM 431; AI 8 x 14 Bit:

Table 5-56 Channels for resistance measurement of the SM 431; AI 8 x 14 Bit (6ES7431-1KF10-0AB0)

Measuring type parameter	Permissible for channel n	Condition
Resistance (4-conductor connection)	0, 2, 4 or 6	You must disable the "Measuring type" parameter for channels n+1 (1, 3, 5, 7). Reason: The connections of channel n+1 are used to supply the resistance that is connected to channel n.

Unused channels

Unused channels can be left open. Set the measuring range modules to position "B". You can improve the noise immunity of the module in a measuring environment with serious interference by interconnecting M- and M_{ANA}.

Measuring ranges

Set the measuring ranges using the measuring range modules, and at the "measuring method" parameter in *STEP 7*.

Table 5-57 Measuring ranges of the SM 431; AI 8 x 14 Bit (6ES7431-1KF10-0AB0)

Selected measuring method	Measuring range (type of sensor)	Measuring range module settings	Description
V: Voltage	± 1 V	A	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the voltage measuring range.
	1 to 5 V ± 10 V	B	
2DMU: Current (2-wire transducer)	4 to 20 mA	D	To supply these transducers with current you must connect 24 V to the L+ and M front connector terminals. The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the current measuring range.
4DMU: Current (4-wire transducer)	4 to 20 mA ± 20 mA	C	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the current measuring range.
R-4L: Resistance (4-conductor connection)	600 Ω	A	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the resistance measuring range.

Defaults

The module has the following default settings in *STEP 7*:

- Channels 0 to 7: "Voltage" measuring method ; "± 10 V" measuring range

You can use these measuring methods and measuring ranges without configuring the SM 431; AI 8 x 14 Bit in STEP 7.

5.22 Analog input module SM 431; AI 16 x 13 Bit (6ES7431-0HH00-0AB0)

5.22.1 Features

Overview

The analog input module SM 431; AI 16 x 13 bit has the following features:

- 16 inputs for current/voltage measurement
- Various measuring ranges, adjustable in parallel
- Resolution 13 bits
- Non-isolated between analog section and bus
- Maximum permitted common mode voltage between the channels or between the reference potentials of the connected sensors and central grounding point 2 V DC/AC

Circuit diagram for SM 431; AI 16 x 13 bit

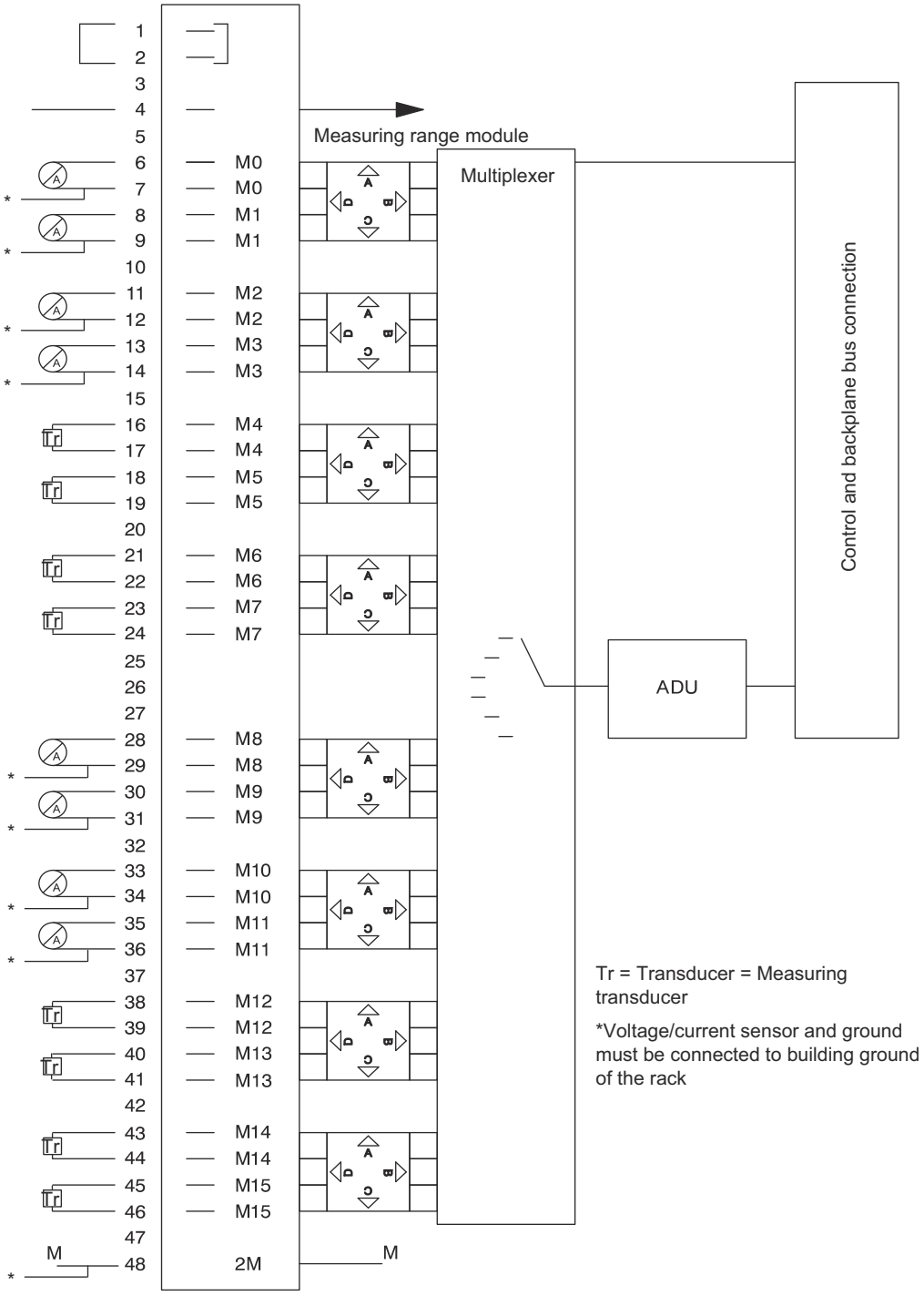


Figure 5-30 Circuit diagram for SM 431; AI 16 x 13 bit

Connection diagram for SM 431; AI 16 x 13 bit

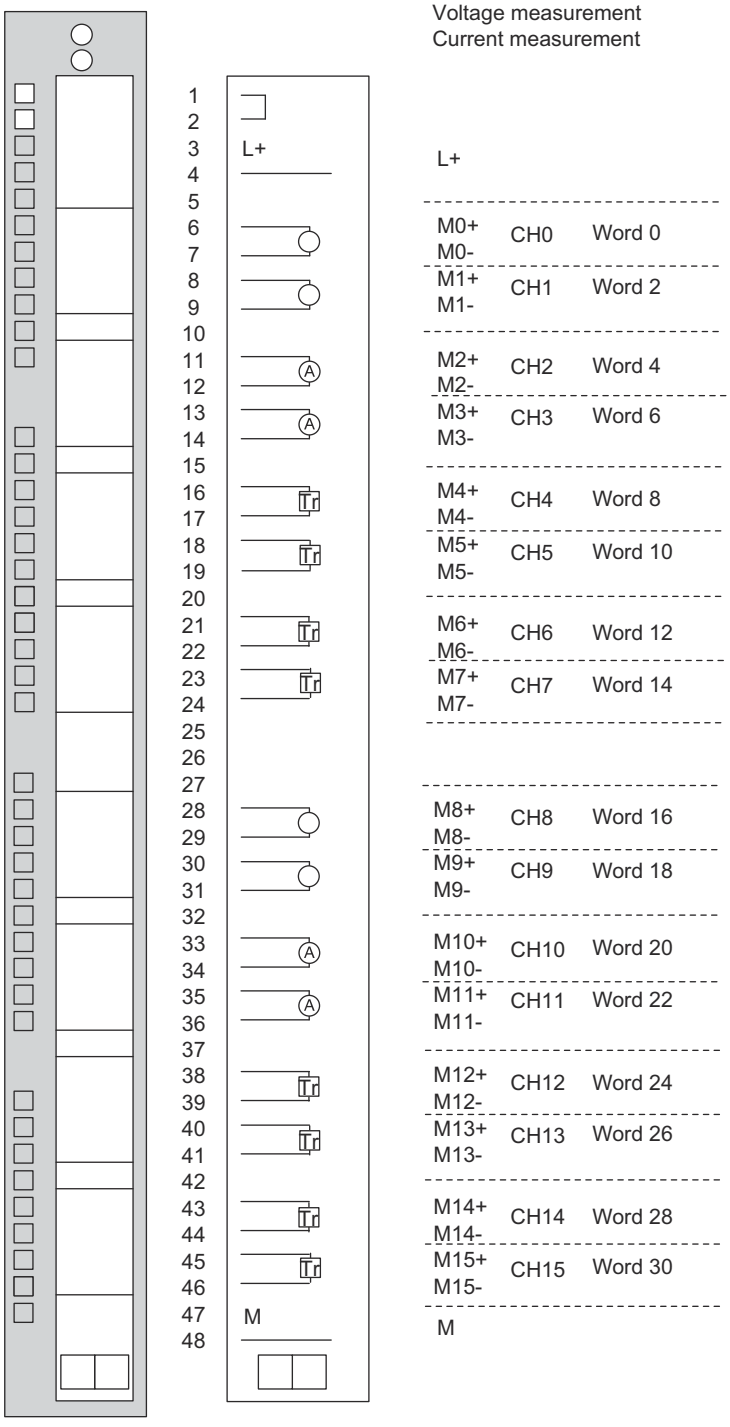


Figure 5-31 Connection diagram for SM 431; AI 16 x 13 bit

Technical specifications for SM 431; AI 16 x 13 bit

Article number	6ES7431-0HH00-0AB0
Supply voltage	
Load voltage L+	
• Rated value (DC)	24 V; Only required for supplying 2-wire transmitters
• Reverse polarity protection	Yes
Input current	
from load voltage L+ (without load), max.	400 mA; for 16 connected, fully controlled 2-wire transmitters
from backplane bus 5 V DC, max.	100 mA
output voltage / header	
supply voltage of the transmitters / header	
• short-circuit proof	Yes
• Supply current, max.	50 mA
Power loss	
Power loss, typ.	2 W
Analog inputs	
Number of analog inputs	16
• For voltage/current measurement	16
permissible input voltage for voltage input (destruction limit), max.	20 V; 20 V DC permanent, 75 V DC for max. 1 s (duty factor 1:20)
permissible input current for current input (destruction limit), max.	40 mA
Constant measurement current for resistance-type transmitter, typ.	1.67 mA
Input ranges	
• Voltage	Yes
• Current	Yes
• Thermocouple	No
• Resistance thermometer	No
• Resistance	No
Input ranges (rated values), voltages	
• 1 V to 5 V	Yes
– Input resistance (1 V to 5 V)	100 kΩ
• -1 V to +1 V	Yes
– Input resistance (-1 V to +1 V)	10 MΩ
• -10 V to +10 V	Yes
– Input resistance (-10 V to +10 V)	100 kΩ
Input ranges (rated values), currents	
• -20 mA to +20 mA	Yes
– Input resistance (-20 mA to +20 mA)	50 Ω
• 4 mA to 20 mA	Yes
– Input resistance (4 mA to 20 mA)	50 Ω

Article number	6ES7431-0HH00-0AB0
Cable length	
• shielded, max.	200 m
Analog value generation for the inputs	
Measurement principle	integrating
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	13 bit
• Integration time, parameterizable	Yes
• Basic conversion time (ms)	55 / 65 ms
• Integration time (ms)	50 / 60 ms
• Interference voltage suppression for interference frequency f1 in Hz	50 / 60 Hz
• Basic execution time of the module (all channels released)	1 040 ms; 880 / 1 040 ms
Smoothing of measured values	
• parameterizable	No
Encoder	
Connection of signal encoders	
• for voltage measurement	Yes; possible
• for current measurement as 2-wire transducer	
– Burden of 2-wire transmitter, max.	750 Ω
• for current measurement as 4-wire transducer	Yes
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.05 %
Temperature error (relative to input range), (+/-)	0.01 %/K
Crosstalk between the inputs, min.	50 dB
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	0.01 %
Operational error limit in overall temperature range	
• Voltage, relative to input range, (+/-)	0.65 %; 1.0 % at 1 to 5 V; 0.65 % at ±1 V, ±10 V
• Current, relative to input range, (+/-)	0.65 %
Basic error limit (operational limit at 25 °C)	
• Voltage, relative to input range, (+/-)	0.25 %; 0.5% at 1 to 5 V; 0.25% at ±1 V, ±10 V
• Current, relative to input range, (+/-)	0.25 %; at ±20 mA, 4 to 20 mA
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
• Series mode interference (peak value of interference < rated value of input range), min.	50 dB
• Common mode interference, min.	86 dB; UCM < 2 V
Interrupts/diagnostics/status information	

Article number	**6ES7431-0HH00-0AB0**
Alarms	No
Diagnostics function	No
Substitute values connectable	No
Potential separation	
Potential separation analog inputs	
• Potential separation analog inputs	No
• between the channels	No
• between the channels and backplane bus	No
• Between the channels and load voltage L+	No
Permissible potential difference	
between the inputs (UCM)	2 V DC / 2 Vpp AC
Between the inputs and MANA (UCM)	2 V DC / 2 Vpp AC
Isolation	
Isolation tested with	500 V AC/707 V DC, type test
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	500 g

5.22.2 Commissioning the SM 431; AI 16 x 13 Bit

Introduction

You set the mode of operation of the SM 431; AI 16 x 13 Bit by means of measuring range modules on the module and in STEP 7.

Measuring range modules

A measuring range module of the module matches two consecutive channels to each type of sensor. Reposition the measuring range modules to suit the measuring method and range. The steps you have to perform to do this are described in detail in the respective section.

For an overview of the settings of specific measuring methods and ranges, refer to the corresponding table in the section "Measuring methods and measuring ranges of SM 431; AI 16 x 13 Bit". The necessary settings are also shown on the label attached to the module.

Parameters

You will find a description of the general procedure for assigning parameters to analog modules in the respective sections.

The table below provides an overview of configurable parameters, including defaults.

Table 5-58 Parameters of the SM 431; AI 16 x 13 Bit

Parameters	Value range		Default[1]	Parameter type	Scope
Measurement					
• Measuring method	Disabled		U	Static	Channel
	U	Voltage			
	4DMU	Current (4-wire sensor)			
	2DMU	Current (2-wire sensor)			
• Measuring range	For information on configurable measuring ranges of input channels, refer to the chapter "Measuring methods and measuring ranges of SM 431; AI 16 x 13 Bit".		±10 V		
• Noise suppression	60 Hz; 50 Hz		50 Hz		

[1] Only in the CR (central rack) is it possible to start up the analog modules with the default settings.

See also

General information about parameter assignment (Page 178)

Measuring methods and measuring ranges of SM 431; AI 16 x 16 Bit (Page 263)

General information about diagnostic messages (Page 82)

5.22.3 Measuring methods and measuring ranges of SM 431; AI 16 x 13 Bit

Measuring methods

You can set the measuring method at the input channels:

- Voltage measurement
- Current measurement

You specify the setting by means of the measuring range modules on the module and the "Measuring type" parameter in STEP 7.

Circuit variants for the channels

Two channels are set in each case with the measuring range module. There are therefore restrictions as regards the measuring method for the adjacent channels 0/1, 2/3, 4/5, 6/7, 8/9, 10/11, 12/13 and 14/15, as shown in the following table:

Table 5-59 Selection of the measuring method for channel n and channel n+1 of the SM 431; AI 16 x 13 Bit

Measuring method, channel n	Measuring method, channel n + 1					
	Disabled	Voltage ±1 V	Voltage 1 to 5 V	Voltage ±10 V	Current 4-DMU	Current 2-DMU
Disabled	x	x	x	x	x	x
Voltage ±1 V	x	x				
Voltage 1 to 5 V	x		x	x		
Voltage ±10 V	x		x	x		
Current 4-wire transducer	x				x	
Current 2-wire transducer	x					x

Example

If you select "current (2-wire transducer)" for channel 6, you can only disable the measuring method or set "current (2-wire transducer)" for channel 7.

Unused channels

Unused channels can be left open. Set the measuring range modules to position "B". You can improve the noise immunity of the module in a measuring environment with serious interference by interconnecting M- and M_{ANA}.

For unused channels, set the "measuring method" parameter to "deactivated". This reduces the module's cycle time.

Measuring ranges

You set the measuring ranges by means of the measuring range modules on the module and the "Measuring type" parameter in STEP 7.

Table 5-60 Measuring ranges of the SM 431; AI 16 x 13 Bit

Selected measuring method	Measuring range (type of sensor)	Measuring range module settings	Description
V: Voltage	±1 V	A	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the voltage measuring range.
	1 to 5 V ± 10 V	B	
2DMU: Current (2-wire sensor)	4 to 20 mA	D	To supply these transducers with current you must connect 24 V to the L+ and M front connector terminals. The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the current measuring range.
4DMU: Current (4-wire sensor)	4 to 20 mA ± 20 mA	C	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the current measuring range.

Default

The module has the following default settings in *STEP 7*:

- Measuring method "voltage"
- Measuring range "± 10 V".

You can use this combination of measuring method and measuring range without configuring the SM 431; AI 16 x 13 Bit in *STEP 7*.

See also

Representation of analog values of analog input channels (Page 148)

5.23 Analog input module SM 431; AI 16 x 16 Bit (6ES7431-7QH00-0AB0)

5.23.1 Features

Overview

The analog input module SM 431; AI 16 x 16 bit has the following features:

- 16 inputs for voltage measurement, current measurement and temperature measurement with thermocouples (TC)
- 8 inputs for resistance and temperature measurement with resistance thermometers (RTD)
- Various measuring ranges, adjustable in parallel
- Resolution 16 bits
- Configurable diagnostics
- Configurable diagnostic interrupt
- Configurable limit alarm
- Configurable end-of-cycle interrupt
- Analog section isolated from the CPU
- Maximum permitted common mode voltage between channels or between channel and central grounding point 120 V AC

Circuit diagram for SM 431; AI 16 x 16 bit

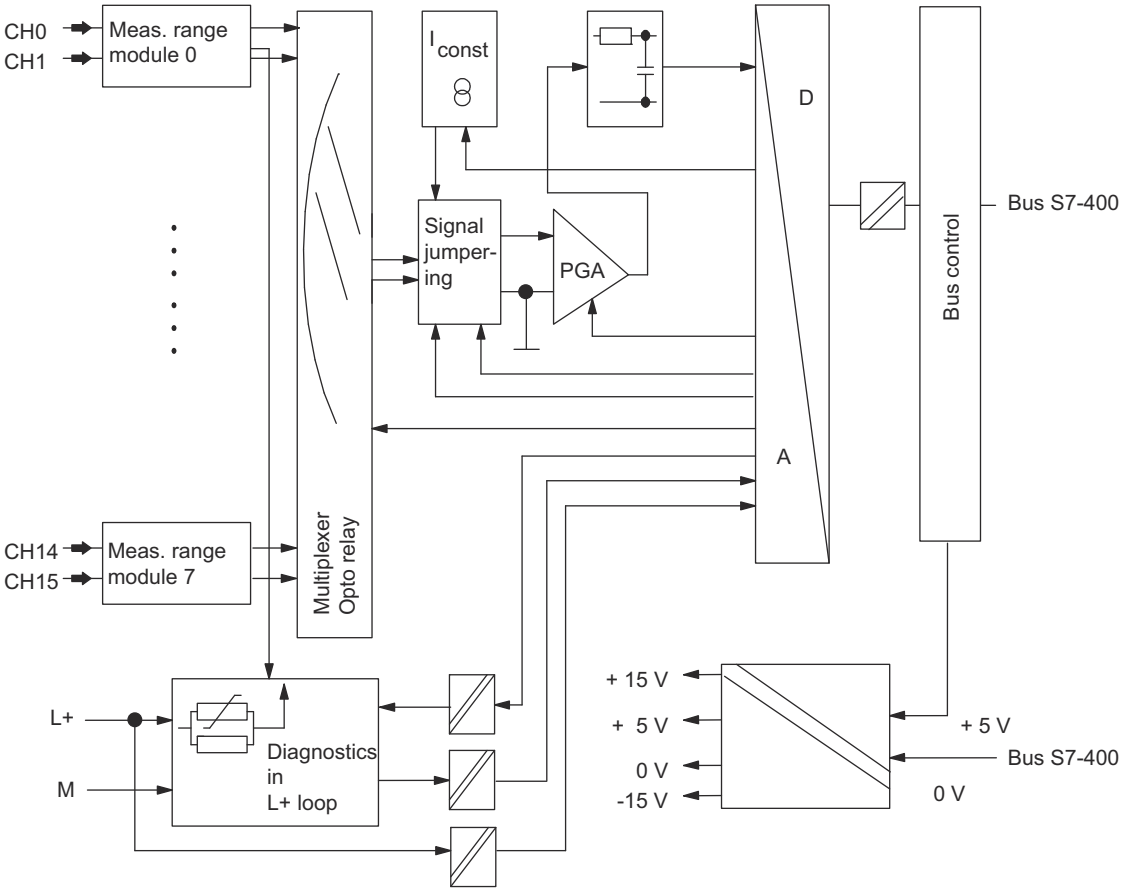


Figure 5-32 Circuit diagram for SM 431; AI 16 x 16 bit

Connection diagram for SM 431; AI 16 x 16 bit

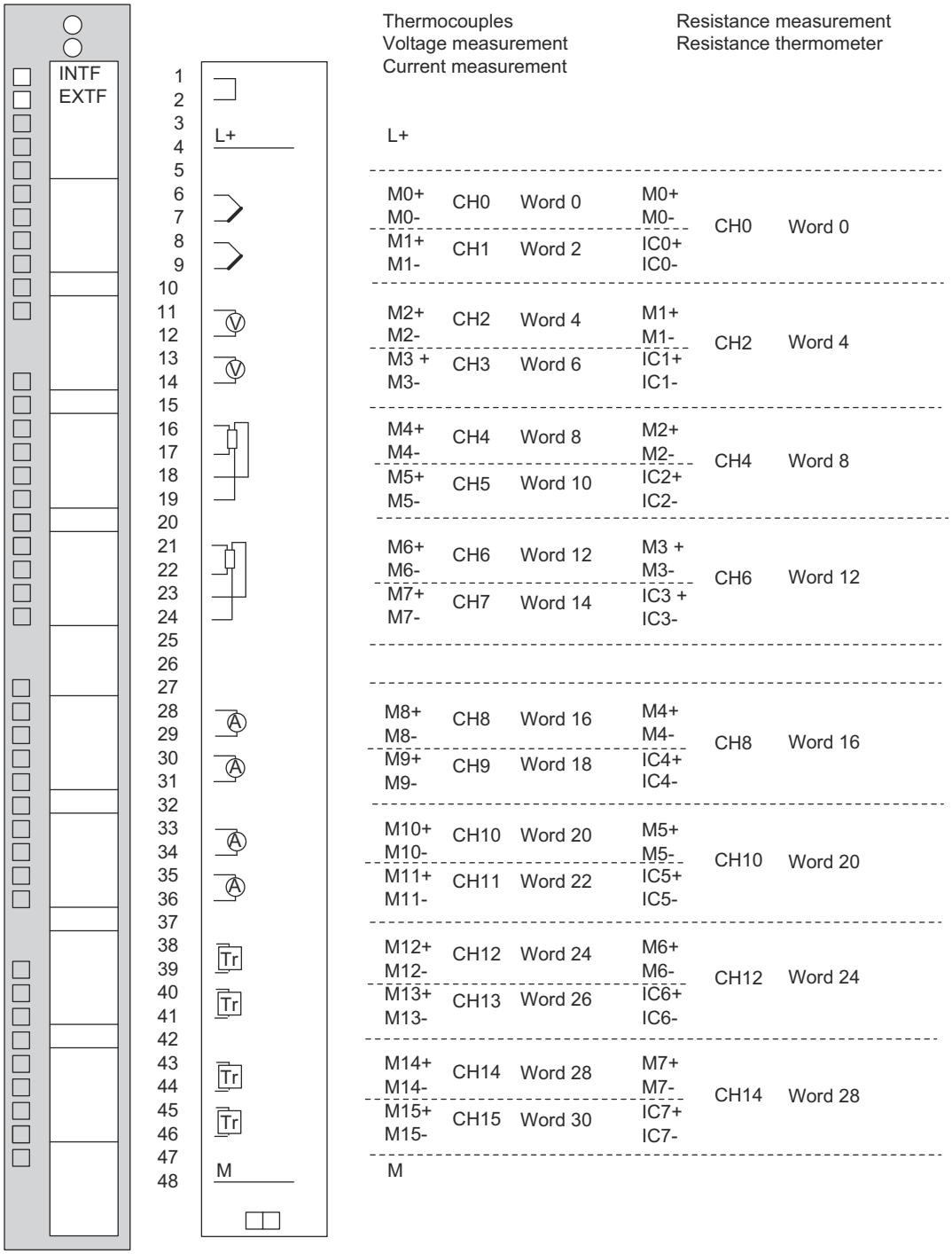


Figure 5-33 Connection diagram for SM 431; AI 16 x 16 bit

Technical specifications for SM 431; AI 16 x 16 bit

Article number	6ES7431-7QH00-0AB0
Supply voltage	
Load voltage L+	
• Rated value (DC)	24 V; Only required for supplying 2-wire transmitters
• Reverse polarity protection	Yes
Input current	
from load voltage L+ (without load), max.	400 mA; for 16 connected, fully controlled 2-wire transmitters
from backplane bus 5 V DC, max.	700 mA
output voltage / header	
supply voltage of the transmitters / header	
• short-circuit proof	Yes
• Supply current, max.	50 mA
Power loss	
Power loss, typ.	4.5 W
Analog inputs	
Number of analog inputs	16
• For voltage/current measurement	16
• For resistance measurement	8
permissible input voltage for voltage input (destruction limit), max.	18 V; 18 V continuous, 75 V for 1 ms (mark to space ratio 1:20)
permissible input current for current input (destruction limit), max.	40 mA
Constant measurement current for resistance-type transmitter, typ.	1.67 mA
Input ranges	
• Voltage	Yes
• Current	Yes
• Thermocouple	Yes
• Resistance thermometer	Yes
• Resistance	Yes
Input ranges (rated values), voltages	
• 1 V to 5 V	Yes
– Input resistance (1 V to 5 V)	1 MΩ
• -1 V to +1 V	Yes
– Input resistance (-1 V to +1 V)	1 MΩ
• -10 V to +10 V	Yes
– Input resistance (-10 V to +10 V)	1 MΩ
• -2.5 V to +2.5 V	Yes
– Input resistance (-2.5 V to +2.5 V)	1 MΩ
• -25 mV to +25 mV	Yes
– Input resistance (-25 mV to +25 mV)	1 MΩ

Article number	6ES7431-7QH00-0AB0
• -250 mV to +250 mV	Yes
– Input resistance (-250 mV to +250 mV)	1 MΩ
• -5 V to +5 V	Yes
– Input resistance (-5 V to +5 V)	1 MΩ
• -50 mV to +50 mV	Yes
– Input resistance (-50 mV to +50 mV)	1 MΩ
• -500 mV to +500 mV	Yes
– Input resistance (-500 mV to +500 mV)	1 MΩ
• -80 mV to +80 mV	Yes
– Input resistance (-80 mV to +80 mV)	1 MΩ
Input ranges (rated values), currents	
• 0 to 20 mA	Yes
– Input resistance (0 to 20 mA)	50 Ω
• -10 mA to +10 mA	Yes
– Input resistance (-10 mA to +10 mA)	50 Ω
• -20 mA to +20 mA	Yes
– Input resistance (-20 mA to +20 mA)	50 Ω
• 4 mA to 20 mA	Yes
– Input resistance (4 mA to 20 mA)	50 Ω
• -5 mA to +5 mA	Yes
– Input resistance (-5 mA to +5 mA)	50 Ω
Input ranges (rated values), thermocouples	
• Type B	Yes
– Input resistance (Type B)	1 MΩ
• Type E	Yes
– Input resistance (Type E)	1 MΩ
• Type J	Yes
– Input resistance (type J)	1 MΩ
• Type K	Yes
– Input resistance (Type K)	1 MΩ
• Type L	Yes
– Input resistance (Type L)	1 MΩ
• Type N	Yes
– Input resistance (Type N)	1 MΩ
• Type R	Yes
– Input resistance (Type R)	1 MΩ
• Type S	Yes
– Input resistance (Type S)	1 MΩ
• Type T	Yes
– Input resistance (Type T)	1 MΩ
• Type U	Yes

Article number	6ES7431-7QH00-0AB0
– Input resistance (Type U)	1 MΩ
Input ranges (rated values), resistance thermometer	
• Ni 100	Yes
– Input resistance (Ni 100)	1 MΩ
• Ni 1000	Yes
– Input resistance (Ni 1000)	1 MΩ
• Pt 100	Yes
– Input resistance (Pt 100)	1 MΩ
• Pt 1000	Yes
– Input resistance (Pt 1000)	1 MΩ
• Pt 200	Yes
– Input resistance (Pt 200)	1 MΩ
• Pt 500	Yes
– Input resistance (Pt 500)	1 MΩ
Input ranges (rated values), resistors	
• 0 to 48 ohms	Yes
– Input resistance (0 to 48 ohms)	1 MΩ
• 0 to 150 ohms	Yes
– Input resistance (0 to 150 ohms)	1 MΩ
• 0 to 300 ohms	Yes
– Input resistance (0 to 300 ohms)	1 MΩ
• 0 to 600 ohms	Yes
– Input resistance (0 to 600 ohms)	1 MΩ
• 0 to 6000 ohms	Yes; Usable up to 5000 Ohm
– Input resistance (0 to 6000 ohms)	1 MΩ
Thermocouple (TC)	
Temperature compensation	
– parameterizable	Yes
– external temperature compensation with Pt100	Yes
– external temperature compensation with compensations socket	Yes
– dynamic reference temperature value	Yes
Characteristic linearization	
• parameterizable	Yes
– for thermocouples	Type B, E, J, K, L, N, R, S, T, U
– for resistance thermometer	Pt100, Pt200, Pt500, Pt1000, Ni100, Ni1000
Cable length	
• shielded, max.	200 m; 50 m with thermocouples and input ranges ≤ 80 mV
Analog value generation for the inputs	

Article number	**6ES7431-7QH00-0AB0**
Measurement principle	integrating
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	16 bit; 16 / 16 / 16
• Integration time, parameterizable	Yes
• Basic conversion time (ms)	6 / 20,1 / 23,5 ms
• Integration time (ms)	2,5 / 16,7 / 20 ms
• Basic conversion time, including integration time (ms)	
– additional conversion time for wire-break monitoring	4.3 / 4.3 / 4.3 ms
– additional conversion time for resistance measurement	12 / 40,2 / 47 ms
– additional conversion time for wire-break monitoring and resistance measurement	5,5 ms
• Interference voltage suppression for interference frequency f1 in Hz	400 / 60 / 50 Hz
Smoothing of measured values	
• parameterizable	Yes; in 4 stages
Encoder	
Connection of signal encoders	
• for voltage measurement	Yes; possible
• for current measurement as 2-wire transducer	Yes
– Burden of 2-wire transmitter, max.	750 Ω
• for current measurement as 4-wire transducer	Yes
• for resistance measurement with two-wire connection	Yes; Line resistances are also measured
• for resistance measurement with three-wire connection	Yes
• for resistance measurement with four-wire connection	Yes
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.01 %
Temperature error (relative to input range), (+/-)	0.004 %/K
Crosstalk between the inputs, min.	70 dB; > 70 dB
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	0.1 %
Operational error limit in overall temperature range	
• Voltage, relative to input range, (+/-)	0.3 %; ±0.3 % at ±250 mV, ±500 mV, ±1 V, ±2.5 V, ±5 V, 1 to 5 V, ±10 V; ±0.31 % at ±80 mV; ±0.32 % at ±50 mV; ±0.35 % at ±25 mV

Article number	6ES7431-7QH00-0AB0
• Current, relative to input range, (+/-)	0.3 %; at 0 to 20 mA, ±5 mA, ±10 mA, ±20 mA, 4 to 20 mA
• Resistance, relative to input range, (+/-)	0.3 %; ±0.3% at 0 to 48 Ohm (4-conductor measurement), 0 to 150 Ohm (4-conductor measurement), 0 to 300 Ohm (4-conductor measurement), 0 to 600 Ohm (4-conductor measurement), 0 to 5000 Ohm (4-conductor measurement, in range of 6000 Ohm); ±0.4% at 0 to 300 Ohm (3-conductor measurement), 0 to 600 Ohm (3-conductor measurement), 0 to 5000 Ohm (3-conductor measurement, in range of 6000 Ohm);
• Resistance thermometer, relative to input range, (+/-)	0.4 %
• Thermocouple, relative to input range, (+/-)	TC Type B (±11.5 K), TC Type R (±7.3 K), TC Type S (±8.3 K), TC Type T (±1.7 K), TC Type E (±3.2 K), TC Type J (±4.3 K), TC Type K (±6.2 K), TC Type U (±2.8 K), TC Type L (±4.2 K), TC Type N (±4.4 K)
Basic error limit (operational limit at 25 °C)	
• Voltage, relative to input range, (+/-)	0.15 %; ±0.15% at ±250 mV, ±500 mV, ±1 V, ±2.5 V, ±5 V, 1 V to 5 V, ±10 V; ±0.17% at ±80 mV; ±0.19% at ±50 mV; ±0.23% at ±25 mV
• Current, relative to input range, (+/-)	0.15 %; at 0 to 20 mA, ±5 mA, ±10 mA, ±20 mA, 4 to 20 mA
• Resistance, relative to input range, (+/-)	0.15 %; ±0.15 % at 0 to 48 ohms (4-conductor measurement), 0 to 150 ohms (4-conductor measurement), 0 to 300 ohms (4-conductor measurement), 0 to 5000 ohms (4-conductor measurement, in range of 6000 ohms); ±0.3 % at 0 to 300 ohms (3-conductor measurement), 0 to 600 ohms (3-conductor measurement), 0 to 5000 ohms (3-conductor measurement, in range of 6000 ohms)
• Resistance thermometer, relative to input range, (+/-)	0.3 %
• Thermocouple, relative to input range, (+/-)	TC Type B (±7.6 K), TC Type R (±4.8 K) TC Type S (±5.4 K), TC Type T (±1.1 K), TC Type E (±1.8 K), TC Type J (±2.3 K), TC Type K (±3.4 K), TC Type U (±1.7 K), TC Type L (±2.3 K), TC Type N (±2.6 K)
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
• Series mode interference (peak value of interference < rated value of input range), min.	40 dB
• Common mode interference, min.	100 dB
Interrupts/diagnostics/status information	
Diagnostics function	Yes; Parameterizable
Substitute values connectable	No
Alarms	
• Diagnostic alarm	Yes; Parameterizable
• Limit value alarm	Yes; Parameterizable
• Hardware interrupt	Yes; Parameterizable

Article number	6ES7431-7QH00-0AB0
Diagnoses	
• Diagnostic information readable	Yes
Diagnostics indication LED	
• internal fault INTF (red)	Yes
• external fault EXTF (red)	Yes
Potential separation	
Potential separation analog inputs	
• Potential separation analog inputs	Yes; internal/external
• between the channels	No
• between the channels and backplane bus	Yes
• Between the channels and load voltage L+	Yes
Permissible potential difference	
between the inputs (UCM)	60 V DC/30 V AC
Between the inputs and MANA (UCM)	60 V DC/30 V AC
between MANA and M internally (UISO)	60 V DC/30 V AC
Isolation	
Isolation tested with	2 120 V DC between bus and L+/M; 2 120 V DC between bus and analog section; 500 V DC between bus and local ground; 500 V DC between analog section and L+/M; 2 120 V DC between analog section and local ground; 2 120 V DC between L+/M and local ground
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	500 g

5.23.2 Commissioning the SM 431; AI 16 x 16 Bit

Setting the operating mode

You set the mode of operation of the SM 431; AI 16 x 16 Bit by means of measuring range modules on the module and in STEP 7.

Measuring range modules

A measuring range module of the module matches two channels and one resistance channel to each type of sensor. Reposition the measuring range modules to suit the measuring method and range. The steps you have to perform to do this are described in detail in the respective section.

For an overview of the settings of specific measuring methods and ranges, refer to the corresponding table in the section "Measuring methods and measuring ranges of SM 431; AI 16 x 16 Bit". The necessary settings are also shown on the label attached to the module.

Parameters

You will find a description of the general procedure for assigning parameters to analog modules in the respective sections.

The table below provides an overview of configurable parameters, including defaults.

Table 5-61 Parameters of the SM 431; AI 16 x 16 Bit

Parameters	Value range	Default[2]	Parameter type	Scope
Enable				
• Diagnostic interrupt[1] • Hardware interrupt[1]	Yes/no Yes/no	No No	Dynamic	Module
• Destination CPU for interrupt	1 to 4	-	Static	Module
Hardware interrupt trigger				
• End of scan cycle reached at input	Yes/no	No	Static	Channel
• High limit • Low limit	32511 to - 32512 -32512 to 32511	-	Dynamic	Channel
Diagnostics				
• Wire break • Reference channel error • Underflow • Overflow • Short-circuit to M	Yes/no Yes/no Yes/no Yes/no Yes/no	No No No No No	Static	Channel
Measurement				

Parameters	Value range		Default[2]	Parameter type	Scope
• Measuring method	Disabled		U	Static	Channel
	U	Voltage			
	4DMU	Current (4-wire transducer)			
	2DMU	Current (2-wire transducer)			
	R-4L	Resistance (4-conductor connection)			
	R-3L	Resistance (3-conductor connection)			
	RTD-4L	Thermal resistance (linear, 4-wire connection)			
	RTD-3L	Thermal resistance (linear, 3-conductor connection)			
	TC-L	Thermocouple (linear)			
• Measuring range	For information on configurable measuring ranges of input channels, refer to the section "Measuring methods and measuring ranges of SM 431; Ai 16x16 Bit".		±10 V		
• Reference temperature	- 273.15 to 327.67 °C		0,00 °C	Dynamic	Module
• Noise suppression	400 Hz; 60 Hz; 50 Hz		50 Hz		
• Smoothing	None Weak Medium Strong		None		
• Reference junction	None RTD on Channel 0 Reference temperature value		None		

[1] If you use the module in ER-1/ER-2, you must set this parameter to "No" because the interrupt lines are not available in ER-1/ER-2.

[2] Only in the CR (central rack) is it possible to start up the analog modules with the default settings.

A point to note about channels for hardware interrupts with the end of scan cycle trigger

You can configure hardware interrupts for the end of scan cycle **for one** of the 16 channels because the module can only trigger these interrupts on one channel.

Measured value smoothing

You will find information that is generally applicable to the smoothing of analog values in the respective section.

The following figure shows for the module the number of module cycles, in the case of a step response, after which the smoothed analog value is applied to almost 100%, depending on the smoothing setting. The figure applies to every change of signal at an analog input.

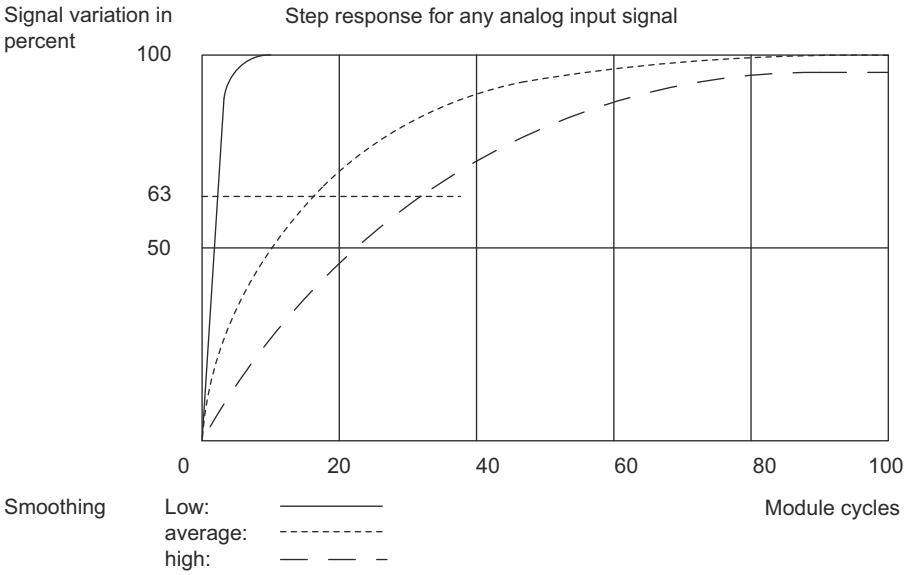


Figure 5-34 Step response of the SM 431; AI 16 x 16 Bit (6ES7431-7QH00-0AB0)

Displaying parameter assignment errors

The SM 431; AI 16 x 16 Bit has diagnostics capability. Below you will find an overview of the displays that are possible for modules with parameter assignment errors.

Table 5-62 Diagnostic information of the SM 431; AI 16 x 16 Bit

Incorrect parameter assignment	Possible display	Explanation
Of the module	• Module error • Internal error • Incorrect parameters	You will find explanations of the diagnostics information in the respective tables.
Affecting certain channels	• Module error • Internal error • Channel error • Incorrect parameters • Channel information available • Channel error vector • Channel parameter assignment error	

See also

Parameters of analog input modules (Page 180)
General information about diagnostic messages (Page 82)

5.23.3 Measuring methods and measuring ranges of SM 431; AI 16 x 16 Bit

Measuring methods

You can set the measuring method at the input channels:

- Voltage measurement
- Current measurement
- Resistance measurement
- Temperature measurement

You specify the setting by means of the measuring range modules on the module and the "Measuring type" parameter in STEP 7.

Circuit variants for the channels

Two channels are set in each case with the measuring range module. There are therefore restrictions as regards to the measuring method for the adjacent channels 0/1, 2/3, 4/5, 6/7, 8/9, 10/11, 12/13 and 14/15, as shown in the following table:

Table 5-63 Selection of the measuring method for channel n and channel n+1 of the SM 431; AI 16 x 16 Bit

Measuring method, channel n	Measuring method channel n+1								
	deactivated	Voltage	Current 4-DMU	Current 2-DMU	R-4L	R-3L	RTD-4L	RTD-3L	TC-L
Disabled	x	x	x	x					x
Voltage	x	x							x
Current 4-wire transducer	x		x						
Current 2-wire transducer	x			x					
4-conductor resistor	x								
3-conductor resistor	x								
Four-wire thermal resistor	x								
3-wire thermal resistor	x								
Thermocouples	x	x							x

Example

If you select "current (2-wire transducer)" for channel 6, you can only disable the measuring method or set "current (2-wire transducer)" for channel 7.

Circuit for resistance and temperature measurement

The following conditions apply when measuring the resistance and temperature with the SM 431; AI 16 x 16 Bit:

Table 5-64 Channels for resistance and temperature measurement of the SM 431; AI 16 x 16 Bit

Measuring type parameter	Permissible for channel n	Condition
Resistance (4-conductor connection)	0, 2, 4, 6, 8, 10, 12 or 14	You must disable the "Measuring type" parameter for channels n+1 (1, 3, 5, 7, 9, 11, 13, 15). Reason: The connections of channel n+1 are used to supply the resistance that is connected to channel n.
Resistance (3-conductor connection)	0, 2, 4, 6, 8, 10, 12 or 14	
Thermal resistance (linear, 4-wire connection)	0, 2, 4, 6, 8, 10, 12 or 14	
Thermal resistance (linear, 3-wire connection)	0, 2, 4, 6, 8, 10, 12 or 14	
Thermocouple (linear)	0 to 15	You can select the reference junction. It is only advisable to specify a reference junction with thermocouples.

Circuit for reference junction compensation for thermocouples

If you select "RTD on Channel 0" as a reference junction for reference junction compensation for thermocouples, the following applies:

Table 5-65 Reference junction compensation via RTD on channel 0 of the SM 431; AI 16 x 16 Bit

Reference junction parameters	Permissible for channel n	Condition
RTD on Channel 0	2 to 15	You must connect and configure on channel 0 a resistance thermometer with linearization, a 3- or 4-conductor connection in **climatic range**. This means that channels 0 and 1 are assigned. Reason: If channel 0 is to be used as the reference junction, a resistance-type sensor must be connected there to record absolute temperatures in the climatic range.

Unused channels

Unused channels can be left open. Set the measuring range modules to position "A". You can improve the noise immunity of the module in a measuring environment with serious interference by short-circuiting the channels.

For unused channels, set the "measuring method" parameter to "deactivated". This reduces the module's cycle time.

Measuring ranges

You set the measuring ranges by means of the measuring range modules on the module and the "Measuring type" parameter in STEP 7.

Table 5-66 Measuring ranges of the SM 431; AI 16 x 16 Bit

Selected measuring method	Measuring range (type of sensor)	Measuring range module settings	Description
V: Voltage	± 25 mV ± 50 mV ± 80 mV ± 250 mV ± 500 mV ± 1 V ± 2.5 V ± 5 V 1 to 5 V ± 10 V	A	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the voltage measuring range.
2DMU: Current (2-wire sensor)	4 to 20 mA	D	To supply these transducers with current you must connect 24 V to the L+ and M front connector terminals. The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the current measuring range.
4DMU: Current (4-wire sensor)	± 5 mA ± 10 mA 0 to 20 mA 4 to 20 mA ± 20 mA	C	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the current measuring range.
R-3L: Resistance (3-conductor connection)	300 Ω 600 Ω 6000 Ω (maximum 5000 Ω)	A	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the resistance measuring range.
R-4L: Resistance (4-conductor connection)	48 Ω 150 Ω 300 Ω 600 Ω 6000 Ω (maximum 5000 Ω)		
TC-L: Thermocouple (linear) (Temperature measurement)	Type B Type N Type E Type R Type S Type J Type L Type T Type K Type U	A	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the temperature range.

Selected measuring method	Measuring range (type of sensor)	Measuring range module settings	Description
RTD-3L: Thermal resistance (linear, 3-conductor connection) (temperature measurement)	Pt 100 Climatic Pt 200 Climatic Pt 500 Climatic Pt 1000 Climatic Ni 100 Climatic Ni 1000 Climatic Pt 100 Standard Pt 200 Standard Pt 500 Standard Pt 1000 Standard Ni 100 Standard Ni 1000 Standard	A	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the temperature range.
RTD-4L: Thermal resistance (linear, 4-conductor connection) (temperature measurement)			

Default

The "voltage" measuring method and "± 10 V" measuring range are set by default in STEP 7. You can use this combination of measuring method and measuring range without configuring the SM 431; AI 16 x 16 Bit in STEP 7.

Wire break monitoring

The wire break check is intended primarily for temperature measurements (TC, RTD) or resistance measurements. Always configure the wire break check in these cases as this ensures that in the event of a wire break the measured value provided by the module accepts the data for overrun 7FFFH.

Special characteristics of the wire break check for the voltage measurement methods

In some transducers, incorrect measured values may occur due to the fact that the wire break check is enabled. If so, disable the wire break check.

Reason: Some transducers try to correct the test current and in doing so corrupt the setpoint value they provide.

Points to note about the wire break check when current sensors are connected

A wire break check of current sensors is not possible for the SM 431; AI 16 x 16 Bit except in life-zero areas. You can therefore only configure the wire break check for the "Current (4-wire transducer)" measuring method and the "4 to 20 mA" measuring range.

Checking for reference channel errors when connecting thermocouples

If you have connected a thermocouple, you can then enable the "Reference channel error" diagnostics if you have configured an "RTD on Channel 0" or "Reference Temperature Value" reference junction.

Points to note about checking for "Underflow" with some measuring methods and measuring ranges

There is now underflow in life-zero areas. A value that is too low or is negative is interpreted as a wire break. You can therefore **not** configure the underflow check for the SM 431; AI 16 x 16 Bit for the following measuring methods and ranges:

Table 5-67 Points to note when checking for "Underflow"

Measuring method	Measuring range
Voltage	1 to 5 V
Current (4-wire sensor)	4 to 20 mA
Current (2-wire sensor)	4 to 20 mA

Points to note about the "Short-circuit to M" diagnostics

You can only configure the check for "Short-circuit to M" for the SM 431; AI 16 x 16 Bit for the "Current (2-wire transducer)" measuring method.

5.24 Analog input module SM 431; AI 8 x RTD x 16 Bit (6ES7431-7KF10-0AB0)

5.24.1 Features

Overview

The analog input module SM 431; AI 8 x RTD x 16 bit has the following features:

- 8 differential inputs for resistance thermometer
- Resistance thermometer configurable
- Linearization of characteristic curves of the resistance thermometer
- Resolution 16 bits
- Update rate 25 ms for 8 channels
- Configurable diagnostics
- Configurable diagnostic interrupt
- Configurable limit alarm
- Analog section isolated from CPU
- The maximum permissible common-mode voltage between the channel and the central grounding point is 60 V DC / 30 V AC (SELV)

Calibration software

The calibration software is only available over the Internet. You will find the latest version of the calibration software under entry ID 12443337.

Following the installation of this software, you can specify user-specific calibration values for each channel and each input range. Further information can be found under ID 12436891 on the Customer Support FAQ page.

Circuit diagram for SM 431; AI 8 x RTD x 16 bit

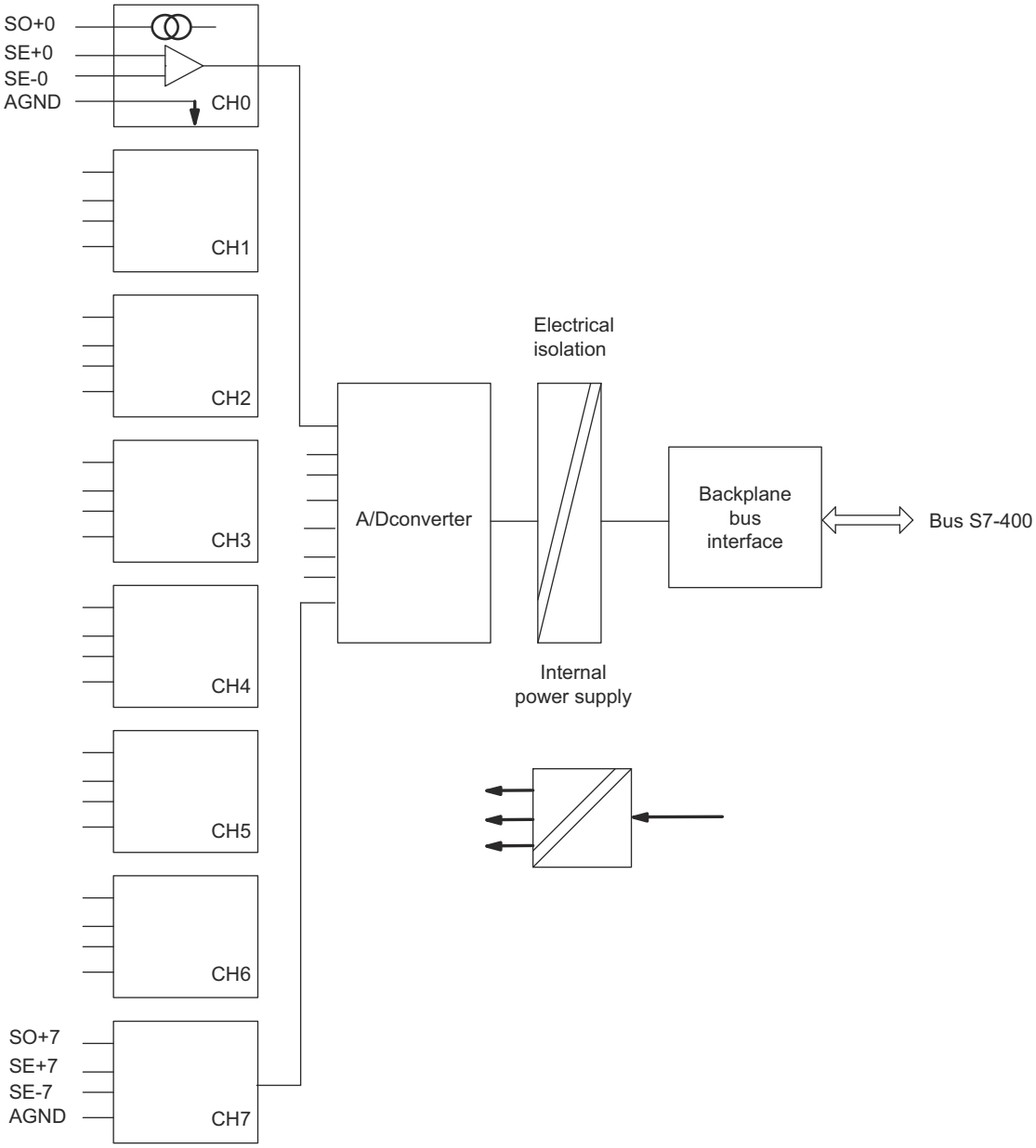


Figure 5-35 Circuit diagram for SM 431; AI 8 x RTD x 16 bit

Note

An external protective network is required for the signal lines in accordance with IEC 61000-4-5 (12 V Blitzductor, model CT919-506, connected in series with all inputs as recommended by the manufacturer).

Connection diagram for SM 431; AI 8 x RTD x 16 bit

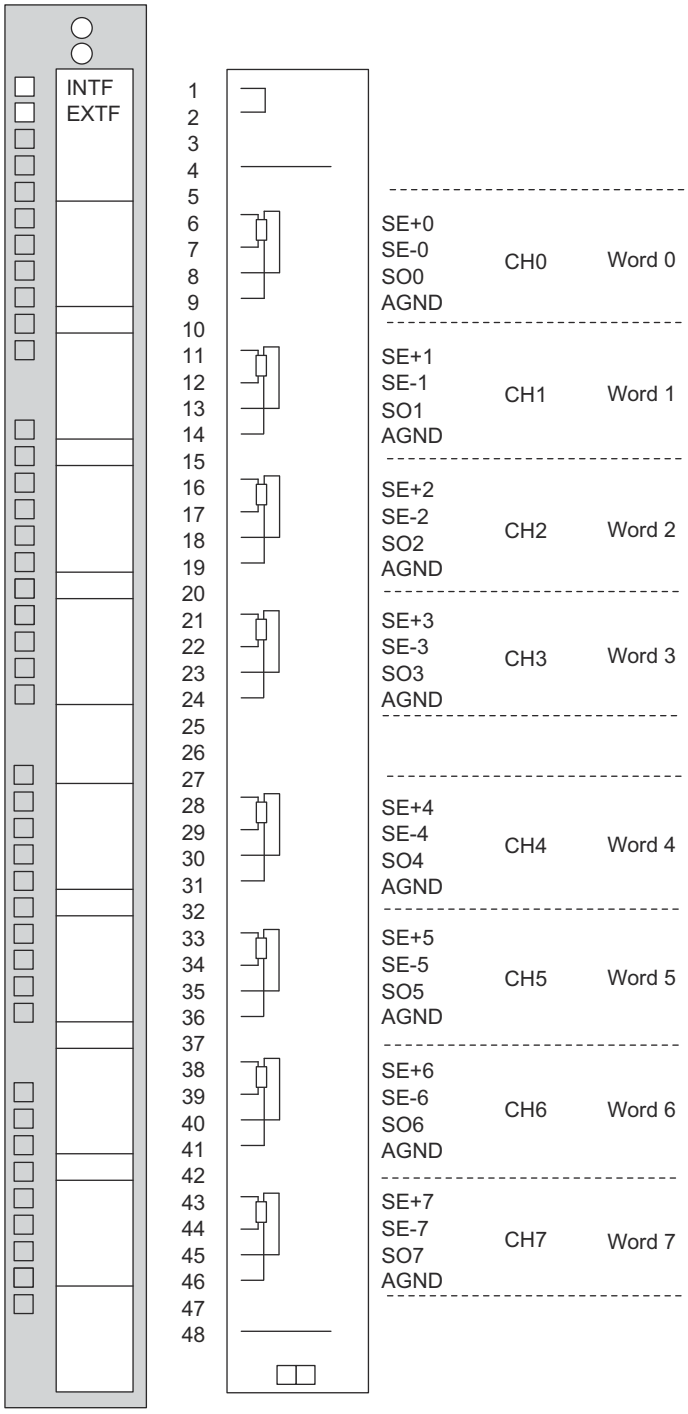


Figure 5-36 Connection diagram for SM 431; AI 8 x RTD x 16 bit

Technical specifications for SM 431; AI 8 x RTD x 16 bit

Article number	6ES7431-7KF10-0AB0
Input current	
from backplane bus 5 V DC, max.	650 mA
Power loss	
Power loss, typ.	3.3 W
Analog inputs	
Number of analog inputs	8
• For resistance measurement	8
permissible input voltage for voltage input (destruction limit), max.	35 V; 35 V continuous, 75 V for max. 1 s (mark to space ratio 1:20)
Constant measurement current for resistance-type transmitter, typ.	1 mA
Input ranges	
• Voltage	No
• Current	No
• Thermocouple	No
• Resistance thermometer	Yes
• Resistance	Yes
Input ranges (rated values), resistance thermometer	
• Ni 100	Yes
– Input resistance (Ni 100)	> 10 000 ohms
• Ni 1000	Yes; Different characteristics selectable: Europe/U.S.
– Input resistance (Ni 1000)	> 10 000 ohms
• Pt 100	Yes
– Input resistance (Pt 100)	> 10 000 ohms
• Pt 1000	Yes
– Input resistance (Pt 1000)	> 10 000 ohms
• Pt 200	Yes
– Input resistance (Pt 200)	> 10 000 ohms
• Pt 500	Yes
– Input resistance (Pt 500)	> 10 000 ohms
Characteristic linearization	
• parameterizable	Yes
– for resistance thermometer	Pt100, Pt200, Pt500, Pt1000, Ni100, Ni1000; different characteristics selectable (Europe/U.S.)
Cable length	
• shielded, max.	200 m; 50 m with thermocouples and input ranges ±80 mV
Analog value generation for the inputs	
Measurement principle	integrating

Article number	6ES7431-7KF10-0AB0
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	16 bit
• Integration time, parameterizable	Yes
• Basic conversion time (ms)	8 / 23 / 25 ms
• Integration time (ms)	20 ms at 50 Hz (entire module incl. wire break)
• Basic conversion time, including integration time (ms)	
– additional conversion time for wire-break monitoring	110 ms / 4 ms
– additional conversion time for wire-break monitoring and resistance measurement	none
• Interference voltage suppression for interference frequency f1 in Hz	none/ 60 / 50 Hz
• Basic execution time of the module (all channels released)	8 ms; 8 / 23 / 25 ms
Smoothing of measured values	
• parameterizable	Parameters can be assigned in the 4 levels
Encoder	
Connection of signal encoders	
• for resistance measurement with three-wire connection	Yes
• for resistance measurement with four-wire connection	Yes
Errors/accuracies	
Linearity error (relative to input range), (+/-)	With Pt100: ±0.2 °C (RTD-4L), ±0.3 °C (RTD-3L); with Pt200: ±0.2 °C (RTD-4L), ±0.2 °C (RTD-3L); with Pt500: ±0.1 °C (RTD-4L), ±0.1 °C (RTD-3L); with Pt1000: ±0.1 °C (RTD-4L), ±0.1 °C (RTD-3L); with Ni100: ±0.1 °C (RTD-4L), ±0.2 °C (RTD-3L); with Ni1000: ±0.1 °C (RTD-4L), ±0.1 °C (RTD-3L);
Crosstalk between the inputs, min.	70 dB
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	With Pt100: ±0.2 °C (RTD-4L), ±0.3 °C (RTD-3L); with Pt200: ±0.2 °C (RTD-4L), ±0.2 °C (RTD-3L); with Pt500: ±0.1 °C (RTD-4L), ±0.1 °C (RTD-3L); with Pt1000: ±0.1 °C (RTD-4L), ±0.1 °C (RTD-3L); with Ni100: ±0.1 °C (RTD-4L), ±0.2 °C (RTD-3L); with Ni1000: ±0.1 °C (RTD-4L), ±0.1 °C (RTD-3L);
Operational error limit in overall temperature range	
• Resistance thermometer, relative to input range, (+/-)	±1 °C
Basic error limit (operational limit at 25 °C)	
• Resistance thermometer, relative to input range, (+/-)	±0,2 °C

Article number	6ES7431-7KF10-0AB0
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
• Series mode interference (peak value of interference < rated value of input range), min.	50 dB
• Common mode interference, min.	100 dB
Interrupts/diagnostics/status information	
Diagnostics function	Yes; Parameterizable
Alarms	
• Diagnostic alarm	Yes; Parameterizable
• Limit value alarm	Yes
• Hardware interrupt	Yes; Parameterizable
Diagnoses	
• Diagnostic information readable	Yes; possible
Potential separation	
Potential separation analog inputs	
• Potential separation analog inputs	Yes; internal/external
• between the channels	No
• between the channels and backplane bus	Yes
Permissible potential difference	
between the inputs (UCM)	none
between MANA and M internally (UISO)	60 V DC/30 V AC
Isolation	
Isolation tested with	500 V DC
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	650 g

5.24.2 Commissioning the SM 431; AI 8 x RTD x 16 Bit

Setting the operating mode

You set the operating mode of the SM 431; AI 8 x RTD x 16 Bit in STEP 7.

Parameters

You will find a description of the general procedure for assigning parameters to analog modules in the respective sections.

The table below provides an overview of configurable parameters, including defaults.

Table 5-68 Parameters of the SM 431; AI 8 x RTD x 16 Bit

Parameters	Value range		Default[2]	Parameter type	Scope
Enable					
• Diagnostic interrupt[1] • Hardware interrupt[1]	Yes/no Yes/no		No No	Dynamic	Module
• Destination CPU for interrupt	1 to 4		-	Static	Module
Trigger for hardware interrupt[3)]			-	Dynamic	Channel
• High limit • Low limit	32767 to - 32768 - 32768 to 32767				
Diagnostics					
• Wire break • Underflow • Overflow	Yes/no Yes/no Yes/no		No No No	Static	Channel
Measurement					
• Measuring method	Disabled		RTD-3L		
	RTD-4L	Thermal resistance (linear, 4-conductor connection)			
	RTD-3L	Thermal resistance (linear, 3-conductor connection)			
• Measuring range	Refer to the respective section for the measuring ranges of the input channels that you can set.		Pt 100 Standard		
• Temperature unit	Degrees Celsius; degrees Fahrenheit		Degrees Celsius	Static	Module

Parameters	Value range	Default[2]	Parameter type	Scope
• Temperature coefficient for temperature measurement with thermal resistance (RTD)	For platinum (Pt) 0.00385 Ω/Ω/ °C 0.003916 Ω/Ω/ °C 0.003902 Ω/Ω/ °C 0.003920 Ω/Ω/ °C For nickel (Ni) 0.00618 Ω/Ω/ °C 0.00672 Ω/Ω/ °C	0,00385	Static	Channel
• Noise suppression	60 Hz; 50 Hz; none	60 Hz		
Smoothing	None Weak Medium Strong	None	Static	Channel
[1] If you use the module in ER-1/ER-2, you must set this parameter to "No" because the interrupt lines are not available in ER-1/ ER-2. [2] Only in the CR (central rack) is it possible to start up the analog modules with the default settings. [3] The limit values must be within the temperature range of the connected sensor.				

Measured value smoothing

You will find information that is generally applicable to the smoothing of analog values in the respective section.

The following figure shows for the module the number of module cycles, in the case of a step response, after which the smoothed analog value is applied to almost 100%, depending on the smoothing setting. The figure applies to every change of signal at an analog input.

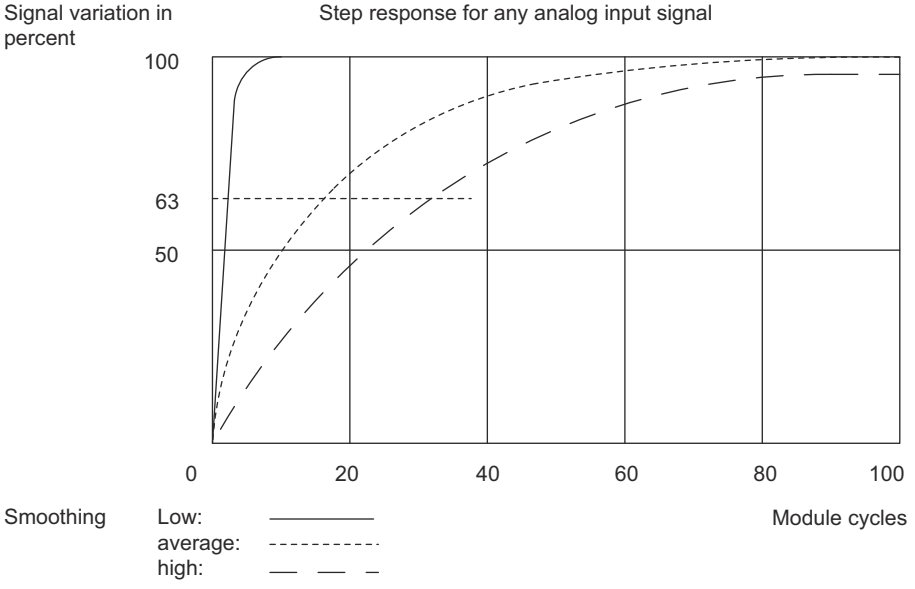


Figure 5-37 Step response of the SM 431; AI 8 x RTD x 16 Bit

Displaying parameter assignment errors

The SM 431; AI 8 x RTD x 16 Bit is capable of diagnostics. Below you will find an overview of the displays that are possible for modules with parameter assignment errors.

Table 5-69 Diagnostic information of the SM 431; AI 8 x RTD x 16 Bit

Incorrect parameter assignment	Possible display	Explanation
Of the module	• Module error • Internal error • Incorrect parameters • No module parameters	You will find explanations of the diagnostics information in the respective tables.
Affecting certain channels	• Module error • Internal error • Channel error • Incorrect parameters • Channel information available • Channel error vector • Channel parameter assignment error • User calibration does not correspond to the parameter assignment	

See also

Parameters of analog input modules (Page 180)

Conversion, cycle, settling and response time of analog modules (Page 175)

General information about diagnostic messages (Page 82)

5.24.3 Measuring methods and measuring ranges of the SM 431; AI 8 x RTD x 16 Bit

Measuring methods

You can set the temperature measurement as the measuring method for the input channels.

Unused channels

For unused channels, set the "measuring method" parameter to "deactivated". This reduces the module's cycle time.

Measuring ranges

Set the measuring ranges by means of the "Measuring range" parameter in STEP 7.

Table 5-70 Measuring ranges of the SM 431; AI 8 x RTD x 16 Bit

Selected measuring method	Measuring range	Description
RTD-3L: Thermal resistance (linear, 3-conductor connection) (temperature measurement)	Pt 100 Standard Pt 200 Standard Pt 500 Standard Pt 1000 Standard Ni 100 Standard Ni 1000 Standard	The digitized analog values are listed in the section "Analog Values of the Analog Input Channels" in the temperature range.
RTD-4L: Thermal resistance (linear, 4-conductor connection) (temperature measurement)		

Default

The default settings of the module in STEP 7 are "Thermal resistor (linear, 3-conductor connection)" for the measuring method and "Pt 100 Standard" for the measuring range. You can use this measuring method with this measuring range without configuring the SM 431; AI 8 x RTD x 16 Bit with STEP 7.

See also

Representation of analog values of analog input channels (Page 148)

5.25 Analog input module SM 431; AI 8 x 16 Bit (6ES7431-7KF00-0AB0)

5.25.1 Features

Overview

The analog input module SM 431; AI 8 x 16 bit has the following features:

- 8 isolated differential inputs for voltage/current/ temperature measurement
- 26 measuring range settings
- Linearization of characteristic curves of the thermocouple
- Resolution 16 bits
- Configurable diagnostics
- Configurable diagnostic interrupt
- Configurable limit alarm
- Analog section isolated from CPU
- Maximum permitted common mode voltage between channels or between channel and central grounding point 120 V AC
- Field connection (6ES7431-7K00-6AA0) with internal reference temperature (included in scope of delivery)

Calibration software

The calibration software is only available over the Internet. You will find the latest version of the calibration software under entry ID 12443337.

Following the installation of this software, you can specify user-specific calibration values for each channel and each input range. Further information can be found under ID 12436891 on the Customer Support FAQ page.

Circuit diagram for SM 431; AI 8 x 16 bit

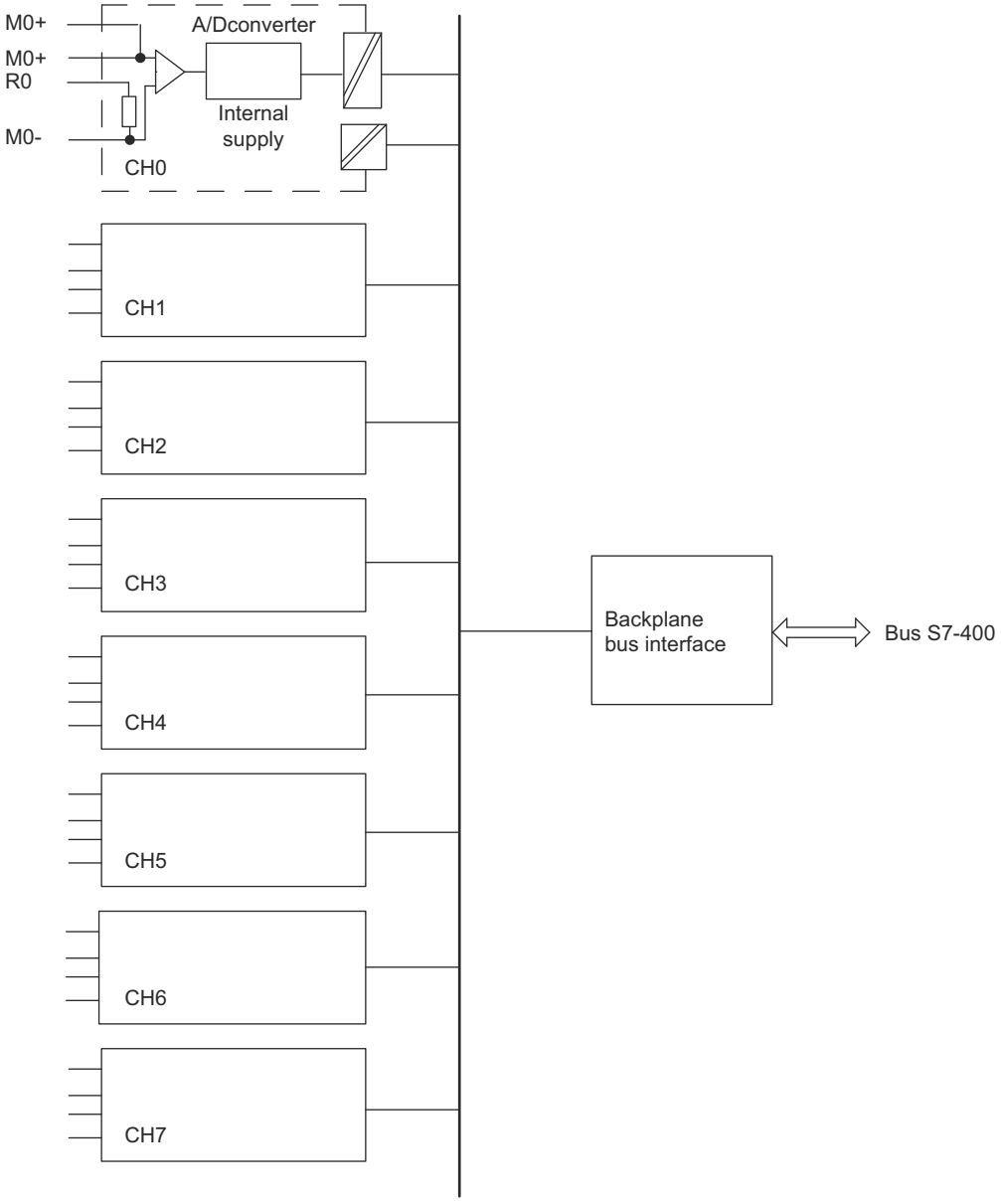


Figure 5-38 Circuit diagram for SM 431; AI 8 x 16 bit

Note

An external protective network for the signal lines is required in accordance with IEC 61000-4-5 (12 V Blitzductor, model CT919-506, connected in series with all inputs as recommended by the manufacturer).

Circuit diagram for SM 431; AI 8 x 16 bit

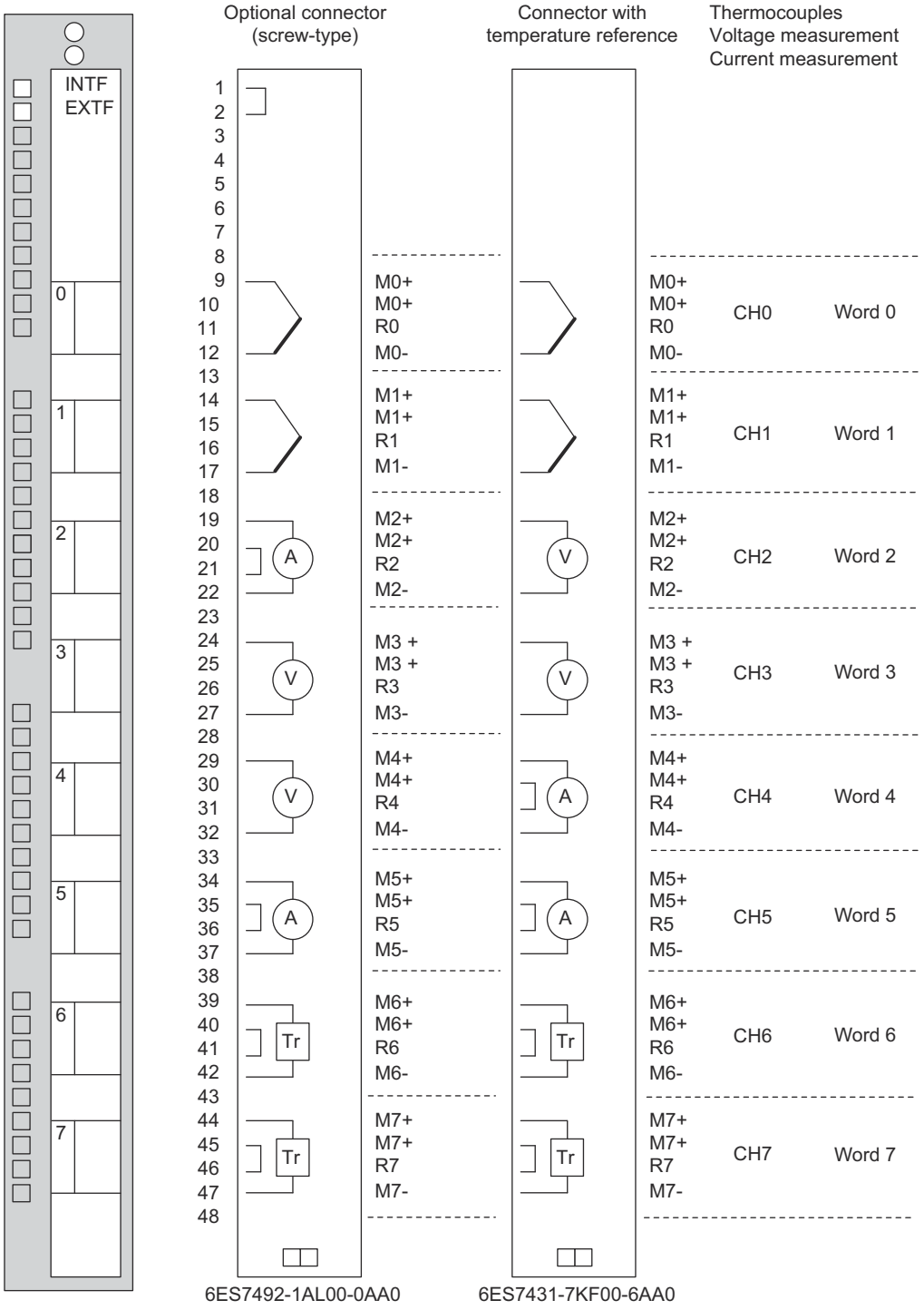


Figure 5-39 Circuit diagram for SM 431; AI 8 x 16 bit

Technical specifications for SM 431; AI 8 x 16 bit

Article number	6ES7431-7KF00-0AB0
Input current	
from backplane bus 5 V DC, max.	1 200 mA
Power loss	
Power loss, typ.	4.6 W
Analog inputs	
Number of analog inputs	8
• For voltage/current measurement	8
permissible input voltage for voltage input (destruction limit), max.	35 V; 35 V continuous, 75 V for max. 1 s (mark to space ratio 1:20)
permissible input current for current input (destruction limit), max.	32 mA
Input ranges	
• Voltage	Yes
• Current	Yes
• Thermocouple	Yes
• Resistance thermometer	No
• Resistance	No
Input ranges (rated values), voltages	
• 1 V to 5 V	Yes
– Input resistance (1 V to 5 V)	> 2 000 ohms
• -1 V to +1 V	Yes
• -10 V to +10 V	Yes
• -100 mV to +100 mV	Yes
• -2.5 V to +2.5 V	Yes
• -20 mV to +20 mV	Yes
• -250 mV to +250 mV	Yes
• -5 V to +5 V	Yes
• -50 mV to +50 mV	Yes
• -500 mV to +500 mV	Yes
• -80 mV to +80 mV	Yes
Input ranges (rated values), currents	
• 0 to 20 mA	Yes
• -10 mA to +10 mA	Yes
• -20 mA to +20 mA	Yes
• -3.2 mA to +3.2 mA	Yes
• 4 mA to 20 mA	Yes
– Input resistance (4 mA to 20 mA)	50 Ω
• -5 mA to +5 mA	Yes
Input ranges (rated values), thermocouples	
• Type B	Yes
– Input resistance (Type B)	> 2 000 ohms

Article number	**6ES7431-7KF00-0AB0**
• Type E	Yes
• Type J	Yes
• Type K	Yes
• Type L	Yes
• Type N	Yes
– Input resistance (Type N)	> 2 000 ohms
• Type R	Yes
• Type S	Yes
• Type T	Yes
• Type U	Yes
Thermocouple (TC)	
Temperature compensation	
– connection for compensating the cold junction	6ES7431-7KF00-6AA0
– parameterizable	Yes
– internal temperature compensation	Yes
– external temperature compensation with compensations socket	Yes
– dynamic reference temperature value	Yes
Characteristic linearization	
• parameterizable	Yes
– for thermocouples	Type B, E, J, K, L, N, R, S, T, U
Cable length	
• shielded, max.	200 m
Analog value generation for the inputs	
Measurement principle	integrating
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	16 bit
• Integration time, parameterizable	Yes
• Basic conversion time (ms)	10 / 16,7 / 20 / 100
• Integration time (ms)	2,5 / 16,7 / 20 / 100
• Basic conversion time, including integration time (ms)	
– additional conversion time for wire-break monitoring and resistance measurement	1 ms (module)
• Interference voltage suppression for interference frequency f1 in Hz	400 / 60 / 50 / 10 Hz
Smoothing of measured values	
• parameterizable	Parameters can be assigned in the 4 levels
Encoder	
Connection of signal encoders	

Article number	6ES7431-7KF00-0AB0
• for voltage measurement	Yes; possible
• for current measurement as 4-wire transducer	Yes
• for resistance measurement with four-wire connection	Yes
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.05 %
Crosstalk between the inputs, min.	95 dB; > 95 dB for voltage range ≥ 2.5 V; >120 dB for current, thermocouple and voltage range ≥ 2.5 V
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	0.05 %
Operational error limit in overall temperature range	
• Voltage, relative to input range, (+/-)	0.3 %
• Current, relative to input range, (+/-)	0.5 %
Basic error limit (operational limit at 25 °C)	
• Voltage, relative to input range, (+/-)	0.1 %
• Current, relative to input range, (+/-)	0.17 %
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
• Series mode interference (peak value of interference < rated value of input range), min.	80 dB
• Common mode interference, min.	95 dB; > 95 dB for voltage range ≥ 2.5 V; >120 dB for current, thermocouple and voltage range ≥ 2.5 V
Interrupts/diagnostics/status information	
Diagnostics function	Yes; Parameterizable
Alarms	
• Diagnostic alarm	Yes; Parameterizable
• Limit value alarm	Yes
• Hardware interrupt	Yes; Parameterizable
Diagnoses	
• Diagnostic information readable	Yes; possible
Potential separation	
Potential separation analog inputs	
• Potential separation analog inputs	Yes; internal/external
• between the channels	Yes
• between the channels and backplane bus	Yes
Permissible potential difference	
between the inputs (UCM)	60 V DC/30 V AC
between MANA and M internally (UISO)	60 V DC/30 V AC
Isolation	
Isolation tested with	1 500 V DC
Dimensions	

Article number	**6ES7431-7KF00-0AB0**
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	650 g

5.25.2 Commissioning the SM 431; AI 8 x 16 Bit

Setting the operating mode

You set the operating mode of the SM 431; AI 8 x16 Bit in STEP 7.

Parameters

You will find a description of the general procedure for assigning parameters to analog modules in the respective sections.

The table below provides an overview of configurable parameters, including defaults.

Table 5-71 Parameters of the SM 431; AI 8 x 16 Bit

Parameters	Value range		Default[2]	Parameter type	Scope
Enable					
• Diagnostic interrupt[1]	Yes/no		No	Dynamic	Module
• Hardware interrupt[1]	Yes/no		No	Dynamic	
• Destination CPU for interrupt	1 to 4		-	Static	
Trigger for hardware interrupt[3)]					
• High limit	32767 to - 32768		-	Dynamic	Channel
• Low limit	- 32768 to 32767		-		
Diagnostics					
• Wire break	Yes/no		No	Static	Channel
• Reference channel error	Yes/no		No		
• Underflow	Yes/no		No		
• Overflow	Yes/no		No		
Measurement					
• Measuring method	Disabled		TC-L	Static	Channel
	U	Voltage			
	4DMU	Current (4-wire transducer)			
	TC-L	Thermocouple (linear)			
• Measuring range	For information on configurable measuring ranges of input channels, refer to the section "Measuring methods and measuring ranges of SM 431, AI 8 x 16 Bit".		Type J		
• Reference temperature	- 273.15 to 327.67 °C -327.68 to 327.67 °C		100 °C	Dynamic	Module

Parameters	Value range	Default[2]	Parameter type	Scope
• Temperature unit[4]	Degrees Celsius; degrees Fahrenheit	Degrees Celsius	Static	Module
• Noise suppression	400 Hz; 60 Hz; 50 Hz; 10 Hz	60 Hz		
• Smoothing	None, weak, medium, strong	None		
• Reference junction (reference to the cold junction)	None Internal Reference temperature value dynamic	Internal	Static	Module

[1] If you use the module in ER-1/ER-2, you must set this parameter to "No" because the interrupt lines are not available in ER-1/ER-2.

[2] Only in the CR (central rack) is it possible to start up the analog modules with the default settings.

[3] The limit values must be within the temperature range of the connected sensor.

[4] Valid for the format of the output temperature and the dynamic reference temperature

Measured value smoothing

For generally valid information on analog value smoothing, refer to the section "Conversion and cycle and response times of analog modules".

The cycle time of the module is a constant in the SM 431; AI 8 x 16 Bit that is not dependent on the number of channels that are enabled. It therefore has no effect on the step response, which is defined by the parameter assignment of interference frequency suppression and smoothing.

Step response

Table 5-72 How response times depend on the configured interference frequency suppression and smoothing of the SM 431; AI 8 x 16 Bit

Interference frequency suppression in Hz	Response time in ms with configured smoothing:			
	None	Weak	Medium	Strong
10	100	200	1600	3200
50	20	40	320	640
60	16,7	33,3	267	533
400	10	20	160	320

The following figures illustrate the contents of table above. They show the response time required for a step response before the smoothed analog value is almost applied to 100%. The figures apply to every change of signal at an analog input.

Step response at an interference frequency suppression of 10 Hz

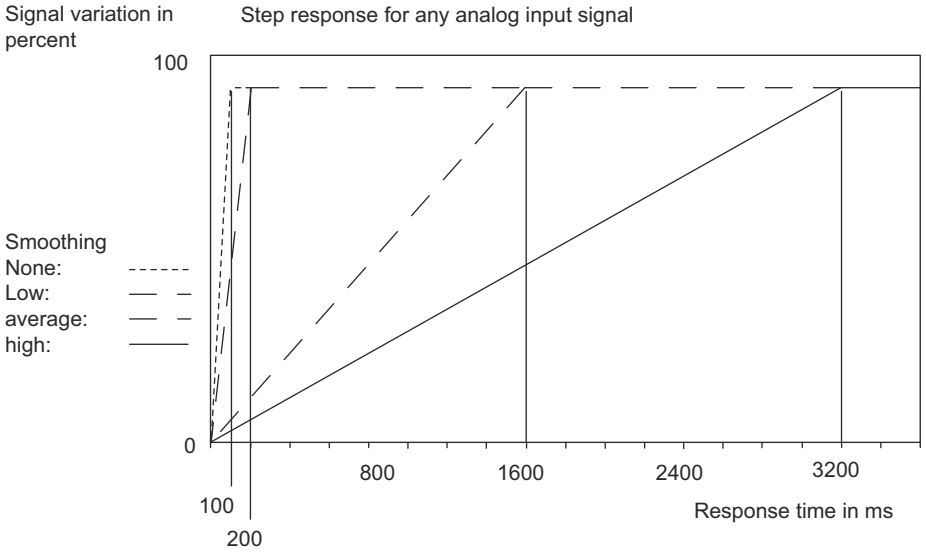


Figure 5-40 Step response at 10 Hz interference frequency suppression of the SM 431; AI 8 x 16 Bit

Step response at an interference frequency suppression of 50 Hz

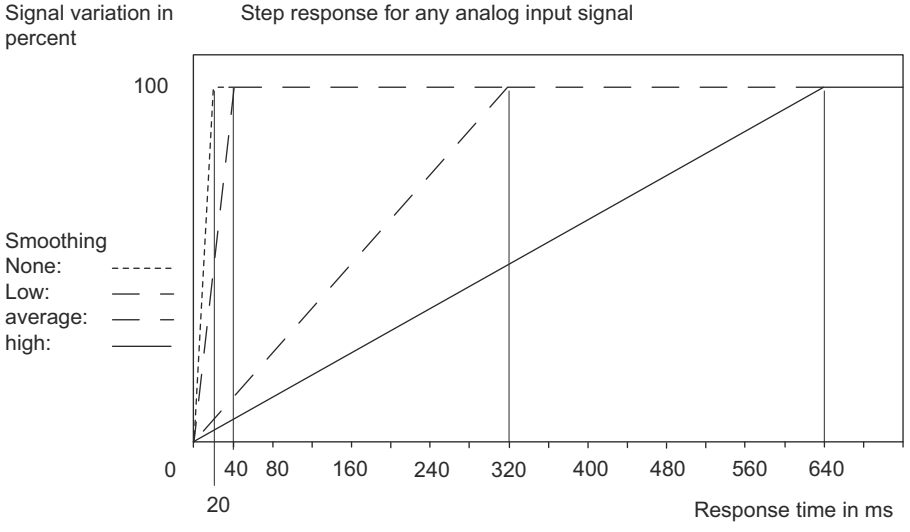


Figure 5-41 Step response at 50 Hz interference frequency suppression of the SM 431; AI 8 x 16 Bit

Step response at an interference frequency suppression of 60 Hz

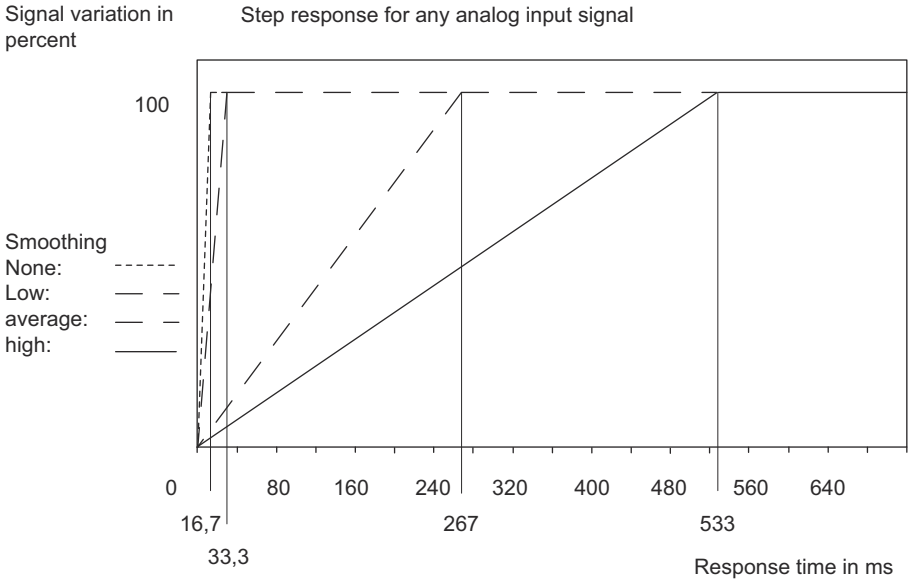


Figure 5-42 Step response at 60 Hz interference frequency suppression of the SM 431; AI 8 x 16 Bit

Step response at an interference frequency suppression of 400 Hz

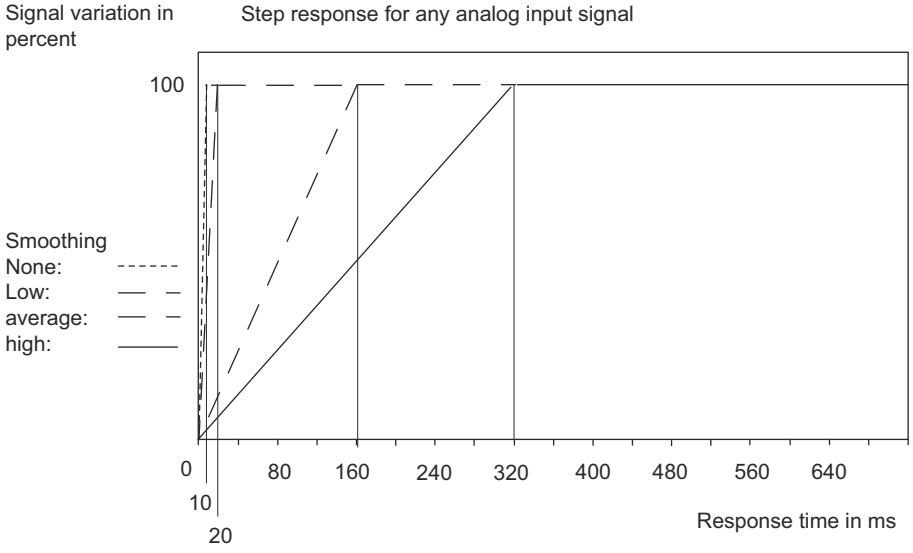


Figure 5-43 Step response at 400 Hz interference frequency suppression of the SM 431; AI 8 x 16 Bit

Displaying parameter assignment errors

The SM 431; AI 8 x 16 Bit has diagnostics capability. Below you will find an overview of the displays that are possible for modules with parameter assignment errors.

Table 5-73 Diagnostic information of the SM 431; AI 8 x 16 Bit

Incorrect parameter assignment	Possible display	Explanation
Of the module	• Module error • Internal error • Incorrect parameters • No module parameters	You will find explanations of the diagnostics information in the respective tables.
Affecting certain channels	• Module error • Internal error • Channel error • Incorrect parameters • Channel information available • Channel error vector • Channel parameter assignment error • User calibration does not correspond to the parameter assignment	

See also

General information about parameter assignment (Page 178)

Conversion, cycle, settling and response time of analog modules (Page 175)

General information about diagnostic messages (Page 82)

5.25.3 Measuring methods and measuring ranges of SM 431; AI 8 x 16 Bit

Measuring methods

You can set the measuring method at the input channels:

- Voltage measurement
- Current measurement
- Temperature measurement

You perform the setting with the "measuring method" parameter in STEP 7.

Unused channels

For unused channels, set the "measuring method" parameter to "deactivated". This reduces the module's cycle time.

Measuring ranges

Set the measuring ranges by means of the "Measuring range" parameter in STEP 7.

Table 5-74 Measuring ranges of the SM 431; AI 8 x 16 Bit

Selected measuring method	Measuring range	Description
V: Voltage	±25 mV ±50 mV ±80 mV ±100 mV ±250 mV ±500 mV ±1 V ±2.5 V ±5 V ±10 V from 1 to 5 V	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the voltage measuring range.
4DMU: Current (4-wire sensor)	±3.2 mA ±5 mA ±10 mA ±20 mA from 0 to 20 mA from 4 to 20 mA	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the current measuring range.
TC-L: Thermocouple (linear) (Temperature measurement)	Type B Type N Type E Type R Type S Type J Type L Type T Type K Type U	The digitized analog values are listed in the section "Representation of analog values for analog input channels" in the temperature range.

Default

The default settings of the module in STEP 7 are "Thermocouple (linear)" for the measuring method and "Type J" for the measuring range. You can use this combination of measuring method and measuring range without configuring the SM 431; AI 8 x 16 Bit in STEP 7.

5.26 Analog output module SM 432; AO 8 x 13 Bit (6ES7432-1HF00-0AB0)

5.26.1 Features

Overview

SM 432; AO 8 x 13 bit has the following properties:

- 8 outputs
- the output can be selected for each channel as
  - Voltage output
  - current output
- Resolution 13 bits
- Analog section potential-free relative to CPU and load voltage
- Maximum permissible common mode voltage between the channels or between channels and M_{ANA} 3 V DC

Block diagram of SM 432; AO 8 x 13 bit

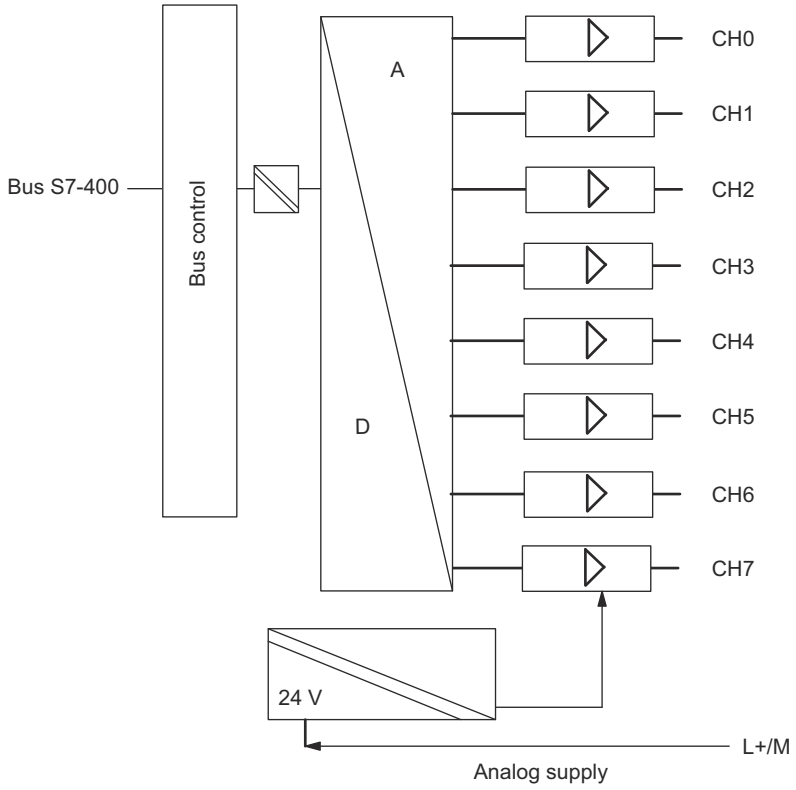


Figure 5-44 Block diagram of SM 432; AO 8 x 13 bit

Connection diagram of SM 432; AO 8 x 13 bit

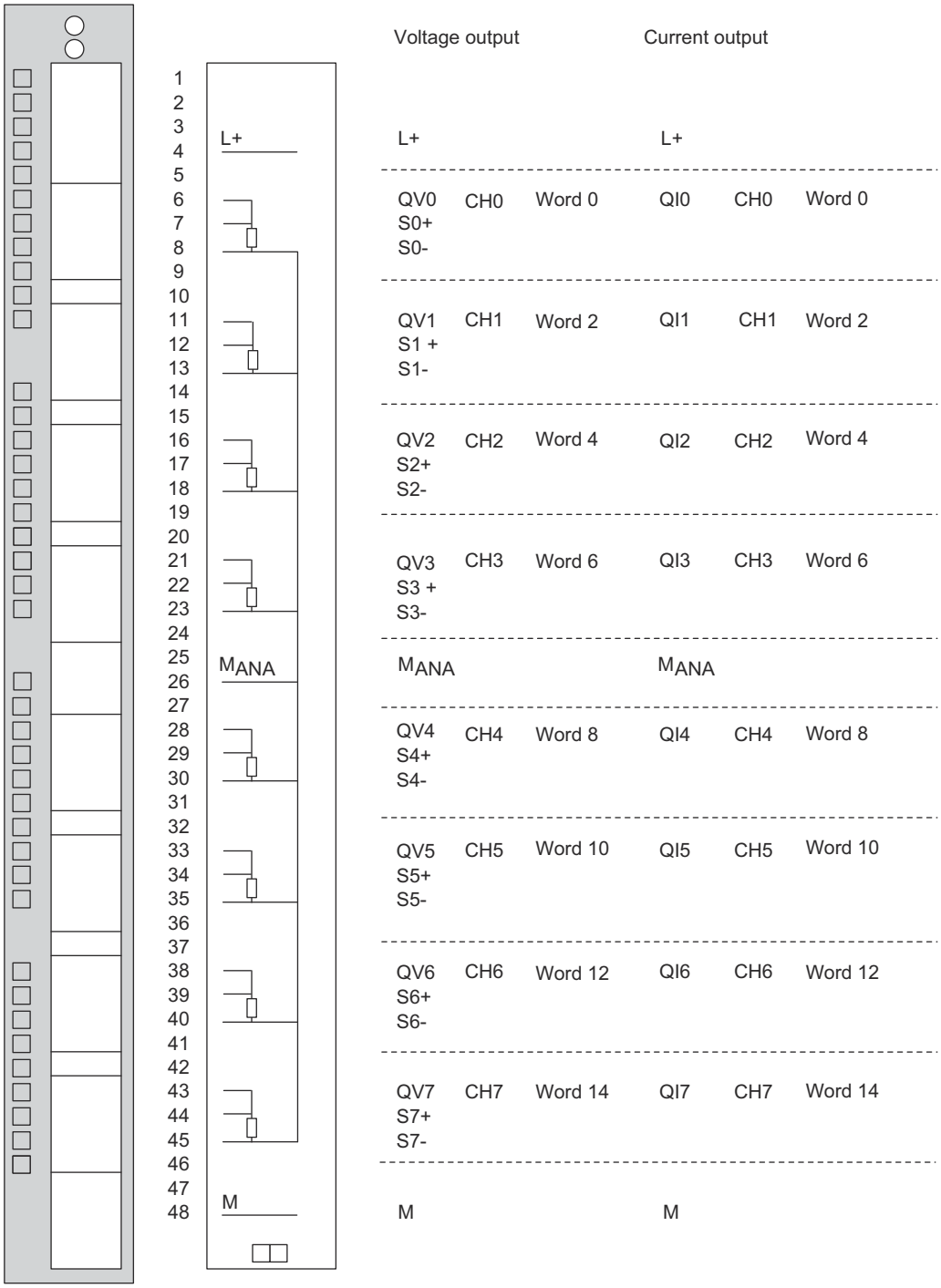


Figure 5-45 Connection diagram of SM 432; AO 8 x 13 bit

Technical specifications of the SM 432; AO 8 x 13 bit

Article number	6ES7432-1HF00-0AB0
Supply voltage	
Load voltage L+	
• Rated value (DC)	24 V
• Reverse polarity protection	Yes
Input current	
from supply and load voltage L+ (without load), max.	200 mA; at rated load: max. 400 mA
from backplane bus 5 V DC, max.	150 mA
Power loss	
Power loss, typ.	9 W
Analog outputs	
Number of analog outputs	8
Voltage output, short-circuit protection	Yes
Voltage output, short-circuit current, max.	30 mA
Current output, no-load voltage, max.	19 V
Output ranges, voltage	
• 0 to 10 V	Yes
• 1 V to 5 V	Yes
• -10 V to +10 V	Yes
Output ranges, current	
• 0 to 20 mA	Yes
• -20 mA to +20 mA	Yes
• 4 mA to 20 mA	Yes
Connection of actuators	
• for voltage output two-wire connection	Yes; possible, without compensation of the line resistances
• for voltage output four-wire connection	Yes; possible
• for current output two-wire connection	Yes; possible
Load impedance (in rated range of output)	
• with voltage outputs, min.	1 kΩ
• with voltage outputs, capacitive load, max.	1 µF
• with current outputs, max.	500 Ω; 600 ohms if common-mode-voltage reduced to <1 V
Destruction limits against externally applied voltages and currents	
• Voltages at the outputs towards MANA	20 V; max. 20 V continuous; 75 V for 1 ms (mark to space ratio 1: 20)
• Current, max.	40 mA; Permanent
Cable length	
• shielded, max.	200 m
Analog value generation for the outputs	

Article number	6ES7432-1HF00-0AB0
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	13 bit
• Conversion time (per channel)	420 µs; 420 µs in the ranges 1 to 5 V and 4 to 20 mA; 300 µs in all ranges
• Basic execution time of the module (all channels released)	3.36 ms; 3.36 ms in the ranges 1 to 5 V and 4 to 20 mA; 2.4 ms in all other ranges
Settling time	
• for resistive load	0.1 ms
• for capacitive load	3.5 ms
• for inductive load	0.5 ms
Errors/accuracies	
Output ripple (relative to output range, bandwidth 0 to 50 kHz), (+/-)	0.05 %
Linearity error (relative to output range), (+/-)	0.05 %
Temperature error (relative to output range), (+/-)	0.02 %/K
Crosstalk between the outputs, min.	40 dB
Repeat accuracy in steady state at 25 °C (relative to output range), (+/-)	0.05 %
Operational error limit in overall temperature range	
• Voltage, relative to output range, (+/-)	0.5 %; ±10 V, 0 to 10 V, 1 to 5 V
• Current, relative to output range, (+/-)	1 %; ±20 mA, 4 to 20 mV
Basic error limit (operational limit at 25 °C)	
• Voltage, relative to output range, (+/-)	0.5 %; ±10 V, 0 to 10 V, 1 to 5 V
• Current, relative to output range, (+/-)	0.5 %; ±20 mA, 0 to 20 mA
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	
• Common mode interference, min.	60 dB
Interrupts/diagnostics/status information	
Alarms	No
Diagnostics function	No
Substitute values connectable	No
Potential separation	
Potential separation analog outputs	
• between the channels	No
• between the channels and backplane bus	Yes
• Between the channels and load voltage L+	Yes
Permissible potential difference	
between the outputs (UCM)	3 V DC
between MANA and M internally (UISO)	60 V DC/30 V AC
between S- and MANA (UCM)	3 V DC
Isolation	

Article number	**6ES7432-1HF00-0AB0**
Isolation tested with	2 120 V DC between bus and L+/M; 2 120 V DC between bus and analog section; 500 V DC between bus and local ground; 500 V DC between analog section and L+/M; 2 120 V DC between analog section and local ground; 2 120 V DC between L+/M and local ground
Dimensions	
Width	25 mm
Height	290 mm
Depth	210 mm
Weights	
Weight, approx.	650 g

5.26.2 Commissioning the SM 432; AO 8 x 13 Bit

Parameters

You will find a description of the general procedure for assigning parameters to analog modules in the respective sections.

For an overview of configurable parameters and defaults, refer to the "Parameters of analog output modules" table.

Assigning parameters to channels

The parameters can be set separately at each output channel of SM 432; AO 8 x 13 Bit. You can thus assign individual parameters to each output channel.

See also

General information about parameter assignment (Page 178)

5.26.3 Output ranges of the SM 432; AO 8 x 13 Bit

Configuration of analog output circuits

You can configure the outputs for operation as voltage or current outputs, or disable these. You configure the output circuits at the "output type" parameter in *STEP 7*.

Unused channels

To make sure that unused output channels of SM 432; AO 8 x 13 Bit are de-energized, set the "Output type" parameter to "deactivated" and leave the terminal open.

Output ranges

You program the output ranges for voltage and current outputs in *STEP 7*.

Table 5-75 Output ranges of the SM 432; AO 8 x 13 Bit

Selected type of output	Output range	Description
Voltage	1 V to 5 V 0 V to 10 V ± 10 V	The digitized analog values are listed in the section "Representation of analog values for analog output channels" in the voltage or current output range.
Current	0 to 20 mA 4 to 20 mA ± 20 mA	

Default

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 432; AO 8 x 13 Bit in *STEP 7*.

Interface modules

6

6.1 Common features of the interface modules

Function

Interface modules (a send IM and a receive IM) are required if one or more expansion racks (ER) are to be connected to a central rack (CR). This configuration is described in the *Installation manual*.

Configuration

Interface modules must always be used together. The send modules (send IMs) are inserted in the CR, whilst the corresponding receive modules (receive IMs) are plugged into the series-connected ER.

Table 6-1 Interface modules of the S7-400

Partner	Areas of application
IM 460-0	Send IM for local link without PS transfer; with communication bus
IM 461-0	Receive IM for local link without PS transfer; with communication bus
IM 460-1	Send IM for local link with PS transfer; without communication bus
IM 461-1	Receive IM for local link with PS transfer; without communication bus
IM 460-3	Send IM for remote link up to 102.25 m; with communication bus
IM 461-3	Receive IM for remote link up to 102.25 m; with communication bus
IM 460-4	Send IM for remote link up to 605 m; without communication bus
IM 461-4	Receive IM for remote link up to 605 m; without communication bus

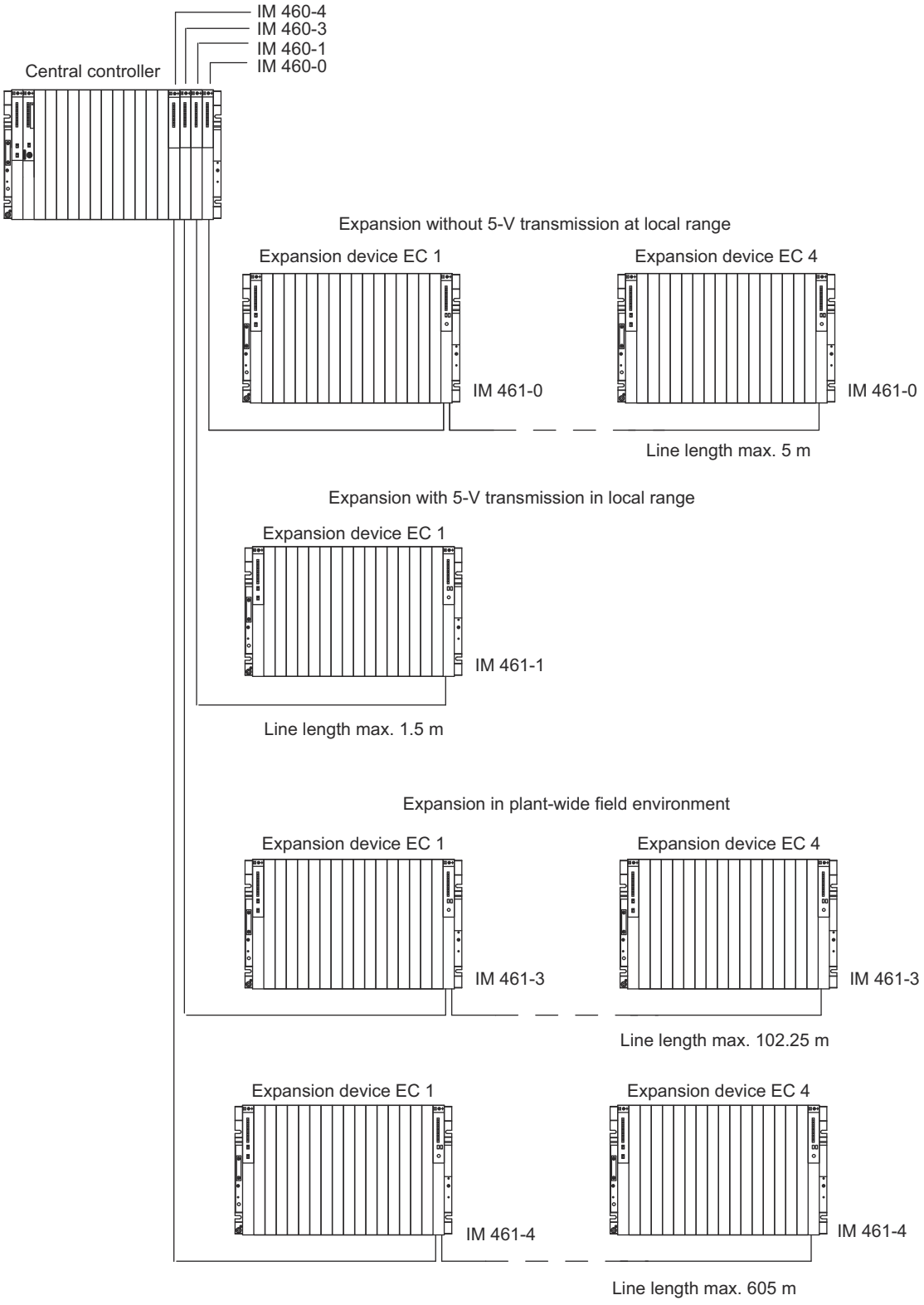
Overview of the connections

Note the rules for connections in the section after next.

Table 6-2 Overview of the connections

	Local connection		Remote connection	
Send IM	460-0	460-1	460-3	460-4
Receive IM	461-0	461-1	461-3	461-4
Max. number of connectable EMs per line	4	1	4	4
Max. distance	5 m	1.5 m	102.25 m	605 m
V transfer	No	Yes	No	No
Max. current transfer per interface	-	5 A	-	-
Communication bus transmission	Yes	No	Yes	No

Connection possibilities for central racks and expansion racks



Rules for connection

When you connect a central rack to expansion racks, you must observe the following rules:

- You can connect up to 21 ERs of the S7-400 to one CR.
- The ERs are assigned numbers to identify them. The rack number must be set on the coding switch of the receive IM. Any rack number between 1 and 21 may be assigned. Numbers must not be duplicated.
- You may insert up to six send IMs in one CR. However, only two send IMs with 5 V transfer are allowed in one CR.
- Each line connected to the interface of a send IM can comprise up to four ERs (without 5 V transfer) or one ER (with 5 V transfer).
- The exchange of data via the communication bus is limited to 7 racks, meaning the CR and ER numbers 1 to 6.
- The maximum (total) cable lengths specified for the type of connection must not be exceeded.

Table 6-3 Cable for different connections

Connection type	Maximum (total) line length
Local connection with 5 V transfer via IM 460-1 and IM 461-1	1.5 m
Local connection without 5 V transfer via IM 460-0 and IM 461-0	5 m
Remote connection via IM 460-3 and IM 461-3	102.25 m
Remote connection via IM 460-4 and IM 461-4	605 m

Terminator

The bus must be terminated in the last EU of a line. To do this, plug in the appropriate terminator in the lower front connector of the receive IM in the last EU of the line. Unused front connectors in a send IM do not have to be terminated. The IM 461-1 does not require a terminator.

Table 6-4 Terminators for the Receive IMs

Receive IM	Terminator
IM 461-0	6ES7461-0AA00-7AA0
IM 461-3	6ES7461-3AA00-7AA0
IM 461-4	6ES7461-4AA00-7AA0

The following figure shows you a typical configuration with send IMs, receive IMs and terminators.

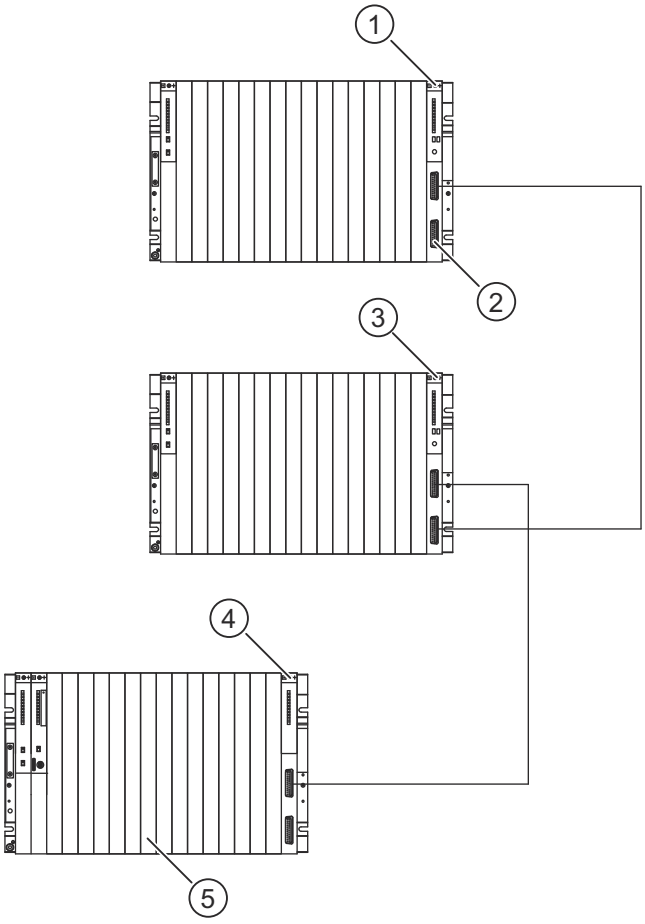


Figure 6-1 Example: Configuration with send IMs, receive IMs and terminators

(1) Receive IM

(2) Terminator

(3) Receive IM

(4) Send IM

(5) CR

Cables

Precut cables are available in different fixed lengths for connecting the individual interface modules. (See Appendix "Accessories and spare parts").

Table 6-5 Cables for interface modules

Interface modules	Cables
IM 460-0 and IM 461-0 IM 460-3 and IM 461-3	6ES7468-1... (P bus and communication bus are transferred)
IM 460-1 and IM 461-1	6ES7468-3... (P bus is transferred; mounting rack is supplied with current via the IM)
IM 460-4 and IM 461-4	6ES7468-1...

Installation and removal of the modules during operation

Please read the following warning on the insertion and removal of the interface modules and associated cables.

CAUTION

Data may be lost or corrupted.

Removing or inserting the interface modules and/or their associated cables under voltage can result in the loss or corruption of data.

Switch off the power supply modules to the CR and ERs you are working on before you carry out any changes.

6.2 Interface modules IM 460-0 (6ES7 460-0AA01-0AB0) and IM 461-0 (6ES7 461-0AA01-0AA0)

Function

The interface module pair IM 460-0 (send IM) and IM 461-0 (receive IM) are used for a local link.

Position of the operator controls and indicators of the IM 460-0 and IM 461-0

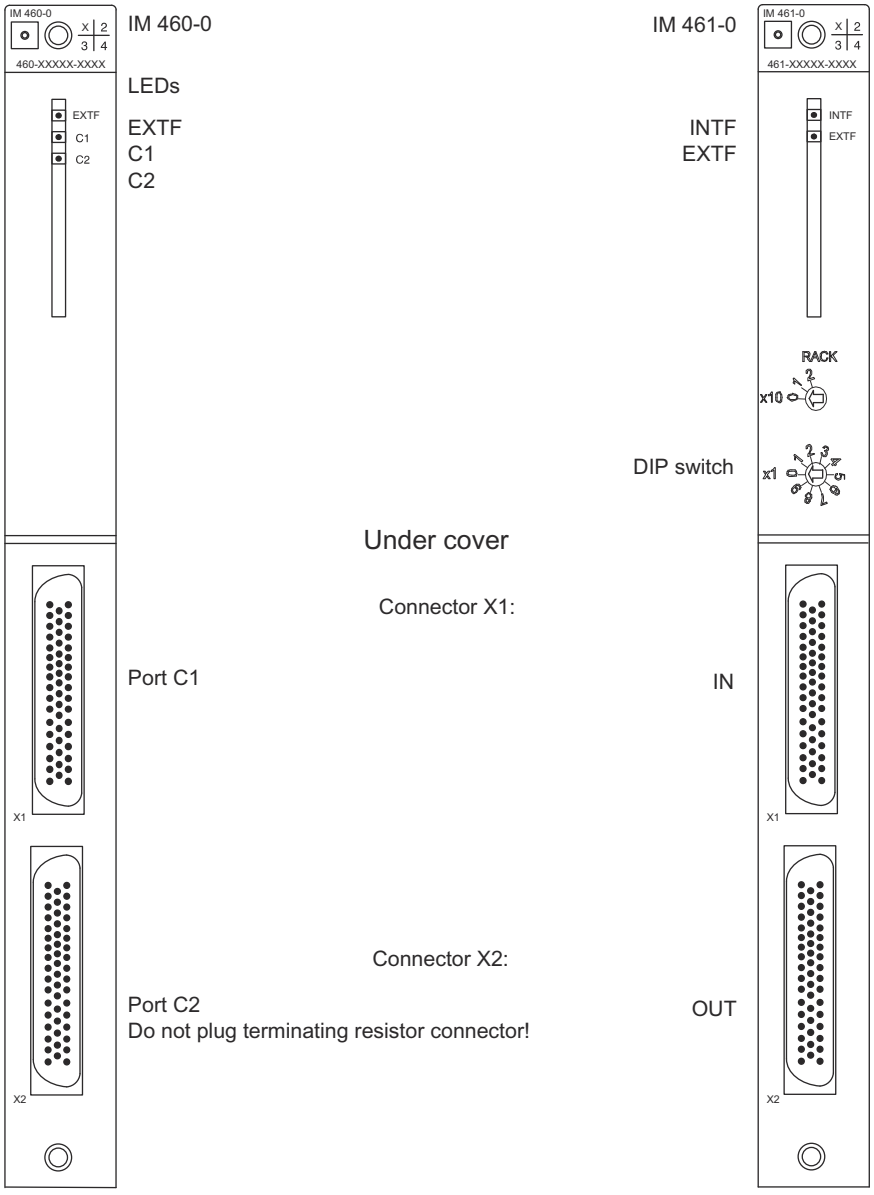


Figure 6-2 Position of the operator controls and indicators of the IM 460-0 and IM 461-0

Operator controls and indicators on the send IM

Table 6-6 Operator controls and indicators on the send IM

LEDs	Meaning
EXTF LED (red)	Lights up in the event of an external fault. Line 1 or line 2 is faulty (terminator missing or broken cable)
C1 LED (green)	Line 1 (via front connector X1, connection 1) is correct.
C1 LED (flashing green)	An expansion rack in the line is not ready for operation because: • The power supply module is not switched on • A module has not yet completed the initialization process
C2 LED (green)	Line 2 (via front connector X2, connection 2) is correct.
C2 LED (flashing green)	An expansion rack in the line is not ready for operation because: • The power supply module is not switched on • A module has not yet completed the initialization process
Front connectors X1 and X2	Connector (output) for line 1 and line 2 X1 = upper front connector; X2 = lower front connector

The LEDs EXTF, C1 and C2 do not light up if the terminator is not inserted or the line is interrupted when in POWER ON mode. In this case the IM 460 identifies an unoccupied interface.

Operator controls and indicators of the receive IM

Table 6-7 Operator controls and indicators of the receive IM

LEDs	Meaning
INTF LED (red)	Lights up if a rack number > 21 or = 0 was set. Lights up if you have changed the rack number under voltage.
EXTF LED (red)	Lights up in the event of an external fault (line fault, for example, if the terminator is not inserted or if a module has not yet completed the initialization process).
DIP switch	DIP switch to set the number of the mounting rack.
Front connector X1	Upper connector (input) for the cable from the previous interface module.
Front connector X2	Lower connector (output) for the cable to the next interface module or for the terminator.

Parameter assignment for the mounting rack number

Using the DIP switch on the front panel of the module, you must set the number of the mounting rack in which the receive IM is installed. The permitted range is 1 to 21.

Setting/changing the number

Proceed as follows:

1. Set the switch of the power supply module in the expansion rack in which you want to make the change to the ⏻ position (output voltage 0 V).
2. Enter the number using the DIP switch.
3. Switch the power supply module on again.

Specifications of the IM 460-0 and IM 461-0

Article number	6ES7460-0AA01-0AB0	6ES7461-0AA01-0AA0
Input current		
from backplane bus 5 V DC, max.	140 mA	290 mA
Power loss		
Power loss, max.	700 mW	1 450 mW
Hardware configuration		
Cable length between first and last interface module, max.	5 m	
connection method / header		
termination plug	6ES7461-0AA0-7AA0	6ES7461-0AA0-7AA1
Dimensions		
Width	25 mm	
Height	290 mm	
Depth	280 mm	
Weights		
Weight, approx.	600 g	610 g

6.3 Interface modules IM 460-1 (6ES7460-1BA01-0AB0) and IM 461-1 (6ES7461-1BA01-0AA0)

Function

The interface module pair IM 460-1 (send IM) and IM 461-1 (receive IM) are used for a local link (up to a maximum 1.5 m in total). A 5 V supply voltage is also transferred with these interface modules. Please particularly remember the following points:

- The current requirements of the module plugged into the ER must not exceed 5 V/5 A.
- You can only connect one ER per line.
- The modules in this mounting rack are not supplied with 24 V and are not backed up.
- The communication bus is not transferred with the interface module pair IM 460-1 and IM 461-1.
- You must not use a power supply module in the ER.

Note

If you connect an ER via a local link with 5 V transmission, ungrounded operation is prescribed for the ER (see Installation Manual).

Position of the operator controls and indicators of the IM 460-1 and IM 461-1

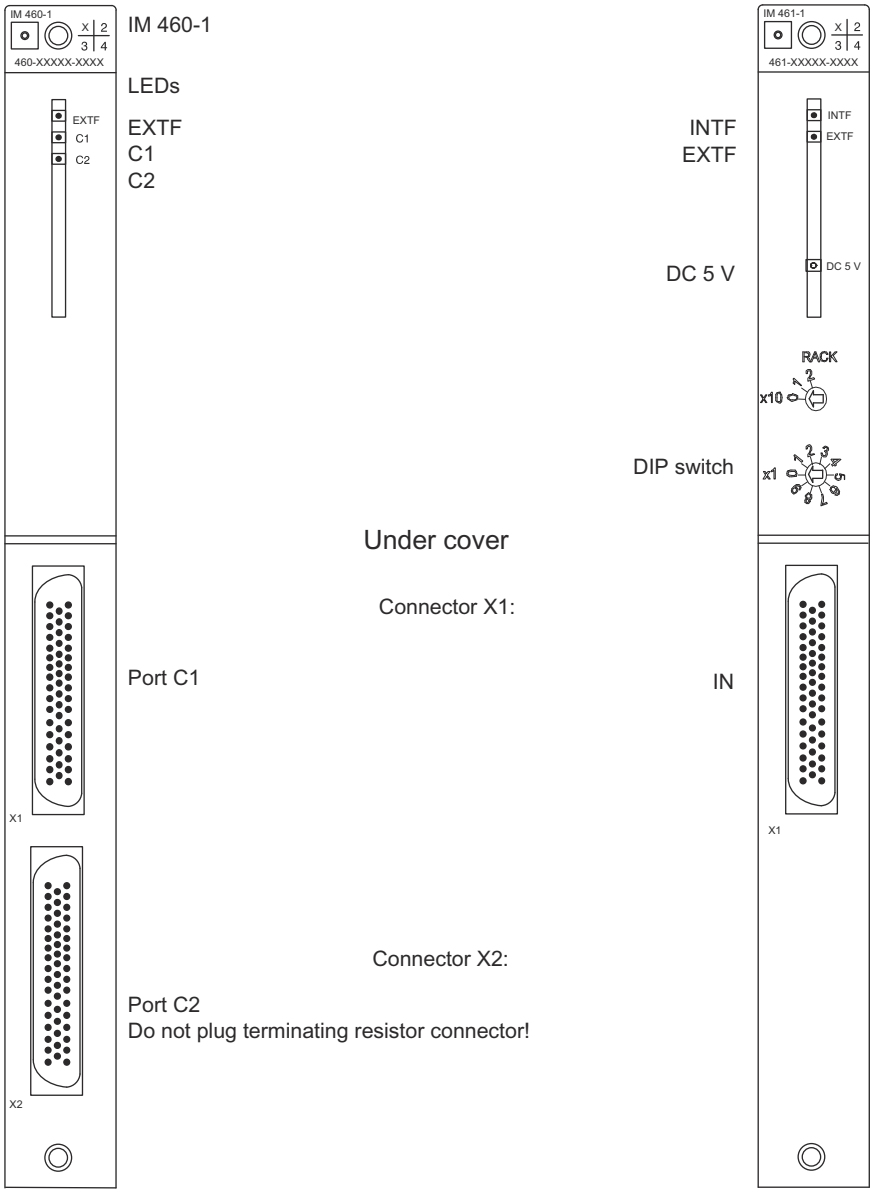


Figure 6-3 Position of the operator controls and indicators of the IM 460-1 and IM 461-1

Operator controls and indicators on the send IM

Table 6-8 Operator controls and indicators on the send IM

LEDs	Meaning
EXTF LED (red)	Lights up in the event of an external fault. Line 1 or line 2 is faulty (wire break)
C1 LED (green)	Line 1 (via front connector X1, connection 1) is correct.
C1 LED (flashing green)	A module has not yet completed the initialization process.

LEDs	Meaning
C2 LED (green)	Line 2 (via front connector X2, connection 2) is correct.
C2 LED (flashing green)	A module has not yet completed the initialization process.
Front connectors X1 and X2	Connector (output) for line 1 and line 2 X1 = upper front connector; X2 = lower front connector

The LEDs EXTF, C1 and C2 do not light up if the line is interrupted when in POWER ON mode. In this case the IM 460 identifies an unoccupied interface.

Operator controls and indicators of the receive IM

Table 6-9 Operator controls and indicators of the receive IM

LEDs	Meaning
INTF LED (red)	Lights up if a rack number > 21 or = 0 was set. Lights up if you have changed the rack number under voltage.
EXTF LED (red)	Lights up in the event of an external fault (line fault, for example, if a module has not yet completed the initialization process but not when the CC is switched off)
5 VDC (green)	Power supply in the ER is correct.
DIP switch	DIP switch to set the number of the mounting rack.
Front connector X1	Upper connector (input) for the cable from the previous interface module.

⚠ CAUTION

Modules can be damaged.

If you want to connect an expansion rack via the IM 461-1 interface module and use a power supply module in this expansion rack, modules may be damaged

Do not use a power supply module in the expansion rack that you want to connect to the central rack via the IM 461-1 interface module.

Parameter assignment for the mounting rack number

Using the DIP switch on the front panel of the module, you must set the number of the mounting rack in which the receive IM is installed. The permitted range is 1 to 21.

Setting/changing the number

Proceed as follows:

1. Set the power supply module in the CR to the ⏻ position (Output voltage 0 V).
2. Enter the number using the DIP switch.
3. Switch the power supply module on again.

Specifications of the IM 460-1 and IM 461-1

Article number	6ES7460-1BA01-0AB0	6ES7461-1BA01-0AA0
Input current		
from backplane bus 5 V DC, max.	85 mA	120 mA
Power loss		
Power loss, max.	425 mW	600 mW
Hardware configuration		
Cable length between first and last interface module, max.	1.5 m	
Dimensions		
Width	25 mm	
Height	290 mm	
Depth	280 mm	
Weights		
Weight, approx.	600 g	610 g

6.4 Interface modules IM 460-3 (6ES7460-3AA01-0AB0) and IM 461-3 (6ES7461-3AA01-0AA0)

Function

The interface module pair IM 460-3 (send IM) and IM 461-3 (receive IM) are used for a remote link of up to a maximum 102.25 m (exactly: 100 m plus inputs/outputs of 0.75 m in the line).

Position of operator control and display elements

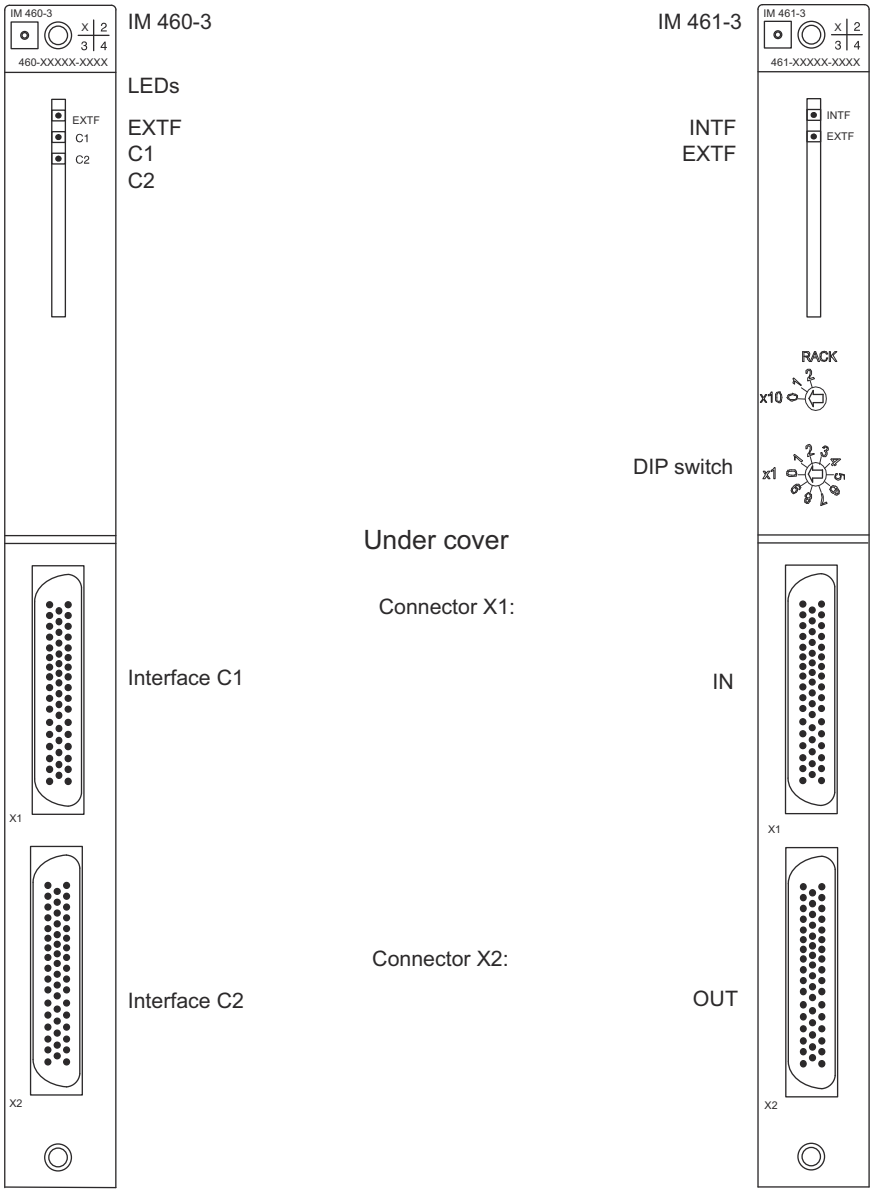


Figure 6-4 Position of the operator controls and indicators of the IM 460-3 and IM 461-3

Operator controls and indicators on the send IM

Table 6-10 Operator controls and indicators on the send IM

LEDs	Meaning
EXTF LED (red)	Lights up in the event of an external fault. Line 1 or line 2 is faulty (wire break)
C1 LED (green)	Line 1 (via front connector X1, connection 1) is correct.
C1 LED (flashing green)	An expansion rack in the line is not ready for operation because: • The power supply module is not switched on • A module has not yet completed the initialization process
C2 LED (green)	Line 2 (via front connector X2, connection 2) is correct.
C2 LED (flashing green)	An expansion rack in the line is not ready for operation because: • The power supply module is not switched on • A module has not yet completed the initialization process

The LEDs EXTF, C1 and C2 do not light up if the terminator is not inserted or the line is interrupted when in POWER ON mode. In this case the IM 460 identifies an unoccupied interface.

Operator controls and indicators of the receive IM

Table 6-11 Operator controls and indicators of the receive IM

LEDs	Meaning
INTF LED (red)	Lights up if a rack number > 21 or = 0 was set. Lights up if you have changed the rack number under voltage.
EXTF LED (red)	Lights up in the event of an external fault (line fault, for example, if the terminator is not inserted or if a module has not yet completed the initialization process, or if the CC is switched off)
DIP switch	DIP switch to set the number of the mounting rack.
Front connector X1	Upper connector (input) for the cable from the previous interface module.
Front connector X2	Lower connector (output) for the cable to the next interface module or for the terminator.

Parameter assignment

Using the DIP switch on the front panel of the module, you must set the number of the mounting rack in which the receive IM is installed. The permitted range is 1 to 21.

If required, you can change the distance setting for the line on the programming device using STEP 7.

The default setting for the distance is 100 m.

Ensure that the distance corresponds as closely as possible to the current length (the sum of all the cables per line) as this will accelerate data transmission.

Note

The distance set must always be longer than the actual length of cable per line.

Setting/changing the number

Proceed as follows:

1. Set the switch of the power supply module in the expansion rack in which you want to make the change to the ⏻ position (output voltage 0 V).
2. Enter the number using the DIP switch.
3. Switch the power supply module on again.

Specifications of the IM 460-3 and IM 461-3

Article number	6ES7460-3AA01-0AB0	6ES7461-3AA01-0AA0
Input current		
from backplane bus 5 V DC, max.	1 550 mA	620 mA
Power loss		
Power loss, max.	7 750 mW	3 100 mW
Hardware configuration		
Cable length between first and last interface module, max.	102.25 m	
connection method / header		
termination plug	6ES7461-3AA0-7AA0	6ES7461-3AA0-7AA1
Dimensions		
Width	25 mm	
Height	290 mm	
Depth	280 mm	
Weights		
Weight, approx.	630 g	620 g

S5 interface IM 463-2

7

7.1 Using SIMATIC S5 expansion units in an S7-400

Order number

6ES7463-2AA00-0AA0

Area of application

The IM 463-2 interface module is used for distributed connection of S5 expansion racks to an S7-400. You can plug the IM 463-2 into the central rack of the S7-400. You insert an IM 314 in the S5 expansion rack.

This allows you to connect the following S5 expansion racks to an S7-400:

- EG 183U with IM 314 in slot 3
- EG 185U with IM 314 in slot 3
- EG 186U with IM 314 in slot 3
- ER 701-2 with IM 314 in slot 7
- ER 701-3 with IM 314 in slot 7

Accordingly, you can use all digital and analog I/O modules that fit into these.

Constraints

If you connect an S5 expansion rack to a central rack of the S7-400 via the IM 463-2, the constraints regarding EMI resistance, ambient conditions etc. that are valid for the SIMATIC S5, apply to the complete system.

Note

If the environment is contaminated by radiated interference, you must connect the shield of the cable type 721 (see *Installation manual)*.

Mounting and removing the IM 463-2 during operation

Observe the following warning when mounting and removing the IM 463-2 and associated connecting cables.

⚠ CAUTION

Data may be lost or corrupted. If you remove or mount the IM 463-2 and/or associated connecting cable under voltage, data may be lost or corrupted. Switch off the power supply modules of the central rack on which you are working before making any interventions.

7.2 Rules for connecting S5 expansion units

Introduction

When you connect S5 expansion units to an S7-400 via the IM 463-2, there are rules to observe with regard to cable length, maximum expansion, use of a terminating connector and permissible potential differences.

Cable length

The maximum cable length per IM 463-2 from the CR of the S7-400 to the last S5 expansion unit is 600 m. You set the actual cable length at the IM 463-2.

Maximum configuration

You can use up to four IM 463-2s in one S7-400 CR.

At each IM 463-2 interface (C1 and C2), you can connect up to four S5 expansion units in a distributed configuration.

You can connect further EUs centrally to the EUs connected in the distributed configuration.

Addressing of the S5 modules

All S5 address areas are available (P, Q, IM3, IM4)

Note

Note that every S5 address can only be used once, even **across different lines**.

Terminator

You must terminate the IM 314 of the last EU in each line with the 6ES5760-1AA11 terminating connector.

Permissible potential differences

For the safe functioning of the distributed configuration, you must ensure that the potential difference between two devices is not more than 7 V. Use an equipotential bonding conductor.

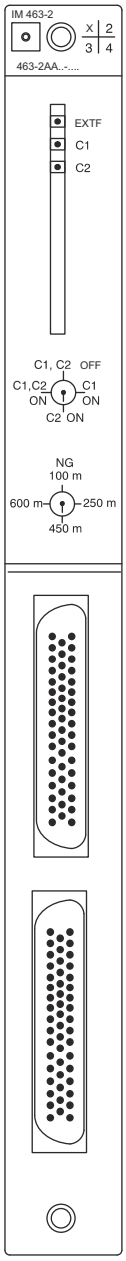
See also

Operator controls and indicators (Page 318)

7.3 Operator controls and indicators

Introduction

All controls and indicators on the IM 463-2 are arranged on the front plate. The following figure shows the arrangement of the controls and indicators.



LEDs EXTF, C1, C 2

Interface Selector Switch Interface selector switch

Cable Length Selector Selector Cable length selector switch

X1 connector
Interface C1

X2 connector
Interface C2

Figure 7-1 Layout of the controls and indicators of the IM 463-2

LEDs

Table 7-1 LEDs of the IM 463-2

LED	Meaning
EXTF LED (red)	Lights up in the event of an external fault. Line 1 or line 2 has a fault (power supply failed in the EU; terminating connector missing; wire break, or interface selector switch wrongly set).
C1 LED (green)	Line 1 (via front connector X1, connection 1) is correct.
C2 LED (green)	Line 2 (via front connector X2, connection 2) is correct.
Front connectors X1 and X2	Connector (output) for line 1 and line 2 X1 = upper front connector; X2 = lower front connector

Interface selector switch

Table 7-2 Switch position: Interface selector of the IM 463-2

Switch setting	Meaning
C1 ON	You use only interface C1.
C2 ON	You use only interface C2.
C1, C2 ON	You use both interfaces.
C1, C2 OFF	You use neither of the two interfaces. You do not want to operate an S5 EU at present.

Cable length selector switch

Table 7-3 Switch position: Cable length selector of the IM 463-2

Switch setting	Meaning
100	Cable length 1 to 100 m
250	Cable length 100 to 250 m
450	Cable length 250 to 450 m
600	Cable length 450 to 600 m

WARNING

Danger of data loss.

Changing the setting of the interface selector switch and the cable length selector switch in RUN mode can result in loss of data.

Change the settings of these switches only in STOP mode of the CPU.

7.4 Installing and connecting the IM 463-2

Overview

To install an IM 463-2 in a CR of the S7-400, proceed in the same way as when installing other S7-400 modules (see *Installation manual*).

To connect an IM 463-2, follow the steps outlined below:

1. Prepare the cable
2. Plug in the cable
3. Select the interface
4. Select the cable length

Prepare the cable

You can use the cable 721. However, you must change the connector housing on the connection side of the IM 463-2.

Two connector housings are enclosed with every IM 463-2. You can prepare a cable for an IM 463-2 using one of these connector housings and a 721 cable (see *Catalog ST 54.1*). Proceed as follows:

1. Remove one connector housing on the 721 cable.
2. Open one of the connector housings enclosed with the IM 463-2.
3. Attach this connector housing to the 721 cable.
4. Close the connector housing.

Plug in the cable

To plug in the cable, follow the steps outlined below:

1. Open the cover of the IM 463-2.
2. Plug the new connector of the cable into one of the connectors of the IM 463-2.
   Interface C1 corresponds to the upper connector;
   Interface C2 corresponds to the lower connector.
3. Screw the connector of the cable onto the connector of the IM 463-2.
4. Close the cover.

Select the interface

You select the interface with the selector switch on the front plate. Set the interface(s) here that you want to use. Make the settings on the IM 463-2 only when the CPU is in STOP mode.

Select the cable length

You select the cable length with the selector switch on the front plate. Set the range corresponding to the line length. Make the settings on the IM 463-2 only when the CPU is in STOP mode.

7.5 Setting the operating modes of the IM 314

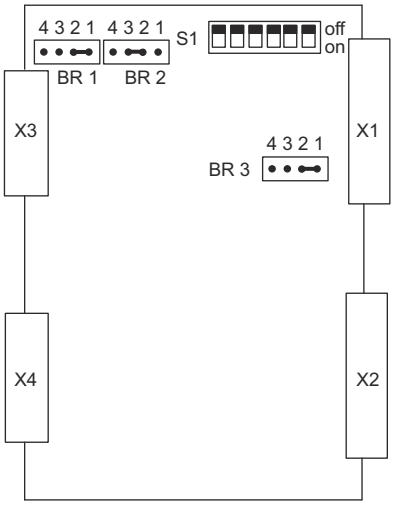
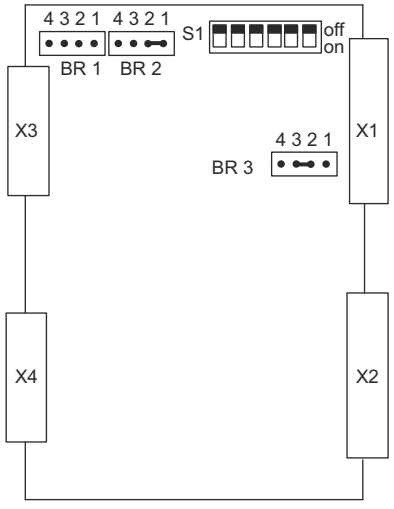
Introduction

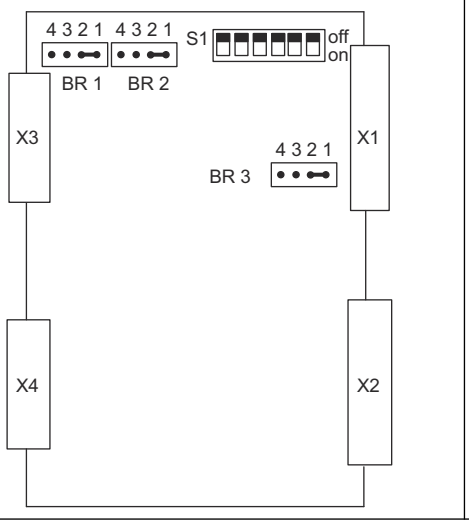
To operate the IM 463-2, you must set on the IM 314 the S5 expansion unit used and the address area of the S5 I/O modules.

Setting the S5 expansion unit

You set the S5 expansion unit in which you want to use the IM 314 using jumpers BR1, BR2, and BR3 on the IM 314. The following figure shows where these jumpers are located on the IM 314 and which setting corresponds to which expansion unit.

Table 7-4 Settings of the IM 314 using expansion units

	Used in EU 185U, EU 186U
	Used in EU 183 U



Used in ER 701-2, ER 701-3

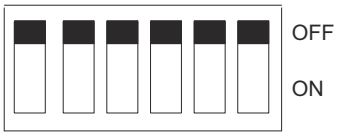
Setting the address area

The address area of the S5 I/O modules is set on the IM 314. This setting applies only for the digital and analog I/O modules.

The address areas P, Q, IM3, and IM4 are available. Set the switch to the relevant position to address the digital and analog I/O modules in these areas.

Table 7-5 Settings address areas on the IM 314

I/O area address	Switch position		
	O = OFF, 1 = ON		The first two switches on the left are not relevant.
P area: F000 - F0FF	S1:	0000 *	
Q area: F100 - F1FF		0001	
IM3 area: FC00 - FCFF		1100	
IM4 area: FD00 - FDFF		1101	
* Factory state			



7.6 Configuring S5 modules for operation in the S7-400

Example

You program S5 modules in *STEP 7*. Refer to the description in the *STEP 7* manual or the *online help* to learn how this is done.

The following figure shows a possible connection of CRs and EUs via the IM 463-2 and IM 314.

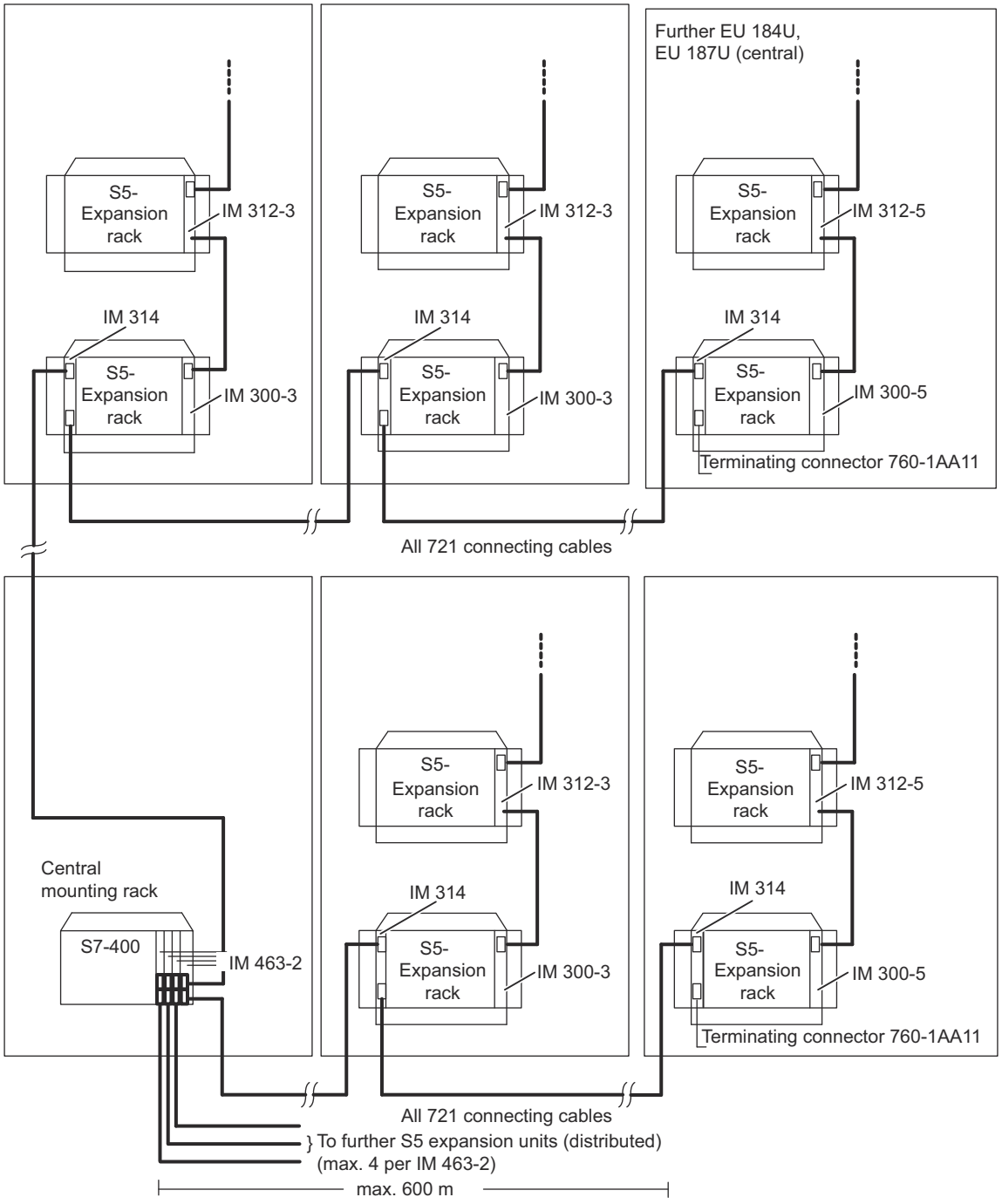


Figure 7-2 Connection variant for CCs and EUs via the IM 463-2 and IM 314

7.7 Pin assignments of the 721 cable

Pin assignments of the 721 cable

Table 7-6 Pin assignments of the 721 cable





Connector		Bundle ID sheath	Identification foil	Core color	Connector	
50-pin	Contact				50-pin	Contact
20		1 No. 16	Red	white	20	
21				brown	21	
4				green	4	
5				yellow	5	
18				gray	18	
19				pink	19	
2				blue	2	
3				red	3	
24		2 No. 17	green	white	24	
25				brown	25	
8				green	8	
9				yellow	9	
22				gray	22	
23				pink	23	
6				blue	6	
7				red	7	
26		3 No. 18	yellow	white	26	
27				brown	27	
10				green	10	
11				yellow	11	
42				gray	42	
43				pink	43	
44				blue	44	
45				red	45	
28		4 No. 19	brown	white	28	
29				brown	29	
12				green	12	
13				yellow	13	
46				gray	46	
47				pink	47	
30				blue	30	
31				red	31	

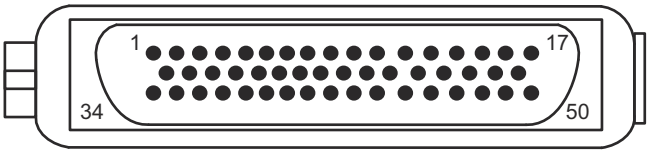
34	5 No. 20	black	white	34
35			brown	35
36			green	36
37			yellow	37
38			gray	38
39			pink	39
40			blue	40
41			red	41
48	6 No. 21	blue	white	48
49			brown	49
14			green	14
15			yellow	15
32			gray	32
33			pink	33
-	Shield			-

7.8 Terminating connector for IM 314

Introduction

The IM 314 of the last expansion unit of each line is terminated with the 6ES5 760-1AA11 terminating connector.

Table 7-7 Assignment of the terminator 760-1AA11

Assignment of the terminator 760-1AA11			
			
Plug connection	**180-Ohm resistance or jumper**		**Plug connection**
28			8
29			9
26			6
27			7
46			4
47			5
44			2
45			3
42			24
43			25
38	[1] 		22
39			23
34	[1] 		20
35			21
36	[1] 		18
37			19

Assignment of the terminator 760-1AA11			
40	[1] 		12
41			13
48	[2] 		10
49			11
15			30
16			31
14			
50			

[1] 100 Ω
[2] 200Ω

7.9 Specifications IM463-2 (6ES7463-2AA00-0AA0)

Article number	6ES7463-2AA00-0AA0
Input current	
from backplane bus 5 V DC, max.	1 320 mA
Power loss	
Power loss, max.	6 600 mW
Hardware configuration	
Cable length between first and last interface module, max.	600 m
Dimensions	
Width	25 mm
Height	290 mm
Depth	217 mm
Weights	
Weight, approx.	360 g

Parameter sets of signal modules

A

A.1 How to assign the parameters for signal modules in the user program

Parameter assignment in the user program

You have already assigned parameters to the modules in STEP 7.

In the user program, you can use an SFC:

- To assign new parameters to the module
- To transfer the parameters from the CPU to the addressed signal module

Parameters stored in data records

The signal module parameters are stored in data records 0 and 1.

Modifiable 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 parameter assignment

SFCs available for programming signal modules in the user program:

Table A-1 SFCs for assigning parameters to signal modules

SFC No.	Identifier	Application
55	WR_PARM	Transfer modifiable parameters (data record 1) to the addressed signal module.
56	WR_DPARM	Transfer parameters (data record 0 or 1) from the CPU to the addressed signal module.
57	PARM_MOD	Transfer all parameters (data record 0 and 1) from the CPU to the addressed signal module.

Description of the parameters

The next chapters describe all modifiable parameters of the various module classes. The parameters of the signal modules are described:

- In the online help of STEP 7
- In this reference manual
  The sections dealing with the various signal modules also show you the corresponding configurable parameters.

Further references

An in-depth description of the principle of assigning parameters to signal modules in the user program and a description of the SFCs that can be used for that purpose will be found in the STEP 7 manuals.

A.2 Parameters of digital input modules

Parameters

The table below lists the parameters you can set for digital input modules.

The comparison illustrates the parameters you can edit:

- In STEP 7
- Using SFC 55 "WR_PARM"

The parameters set with STEP 7 can also be transferred with SFCs 56 and 57 to the module (refer to the STEP 7 manuals).

Table A-2 Parameters of digital input modules

Parameters	Data record number	Parameter assignment with SFC 55	Parameter assignment with STEP 7
Destination CPU for interrupt	0	No	Yes
Input delay		No	Yes
Diagnostics		No	Yes
Hardware interrupt enable	1	**Yes**	Yes
Diagnostics interrupt enable		**Yes**	Yes
Reaction to error*		**Yes**	Yes
Hardware interrupt at positive edge		**Yes**	Yes
Hardware interrupt at negative edge		**Yes**	Yes
Enable substitute value "1"*		**Yes**	Yes
* Only for 6ES7 421-7BH0x-0AB0			

Note

If you want to enable the diagnostic interrupt in the user program in data record 1, you must enable the diagnostics in data record 0 beforehand using STEP 7.

Structure of data record 1

A data record consists of several bytes, the bits of which can be active or inactive:

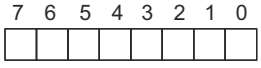


Figure A-1 For example, byte 1 with the bits 0 - 7

The figure below shows the structure of data record 1 (bytes 0, 1, 2 and 3) for the parameters of digital input modules.

You enable a parameter by setting a logical "1" at the corresponding bit.

Table A-3 Data record 1 for parameters of digital input modules

Byte	Bit	Meaning
Byte 0	7	Hardware interrupt enable
	6	Diagnostics interrupt enable
	0	Reaction to error[1]
Byte 1 **Hardware interrupt**	7	On rising edge at channel 7
	6	On rising edge at channel 6
	5	On rising edge at channel 5
	4	On rising edge at channel 4
	3	On rising edge at channel 3
	2	On rising edge at channel 2
	1	On rising edge at channel 1
	0	On rising edge at channel 0
Byte 2 **Hardware interrupt**	7	On rising edge at channel 15
	6	On rising edge at channel 14
	5	On rising edge at channel 13
	4	On rising edge at channel 12
	3	On rising edge at channel 11
	2	On rising edge at channel 10
	1	On rising edge at channel 9
	0	On rising edge at channel 8
Byte 3 **Hardware interrupt**	7	On falling edge at channel 7
	6	On falling edge at channel 6
	5	On falling edge at channel 5
	4	On falling edge at channel 4
	3	On falling edge at channel 3
	2	On falling edge at channel 2
	1	On falling edge at channel 1
	0	On falling edge at channel 0
[1] Only for 6ES7 421-7BH0x-0AB0		

The following table shows the structure of data record 1 (bytes 4, 5, and 6) for the parameters of digital input modules.

You enable a parameter by setting a logical "1" at the corresponding bit.

Table A-4 Data record 1 for parameters of digital input modules

Byte	Bit	Meaning
Byte 4	7	On falling edge at channel 15
	6	On falling edge at channel 14
	5	On falling edge at channel 13
	4	On falling edge at channel 12
	3	On falling edge at channel 11
	2	On falling edge at channel 10
	1	On falling edge at channel 9
	0	On falling edge at channel 8
Byte 5	7	Enable substitute value 1 on channel 7
Substitute value[1]	6	Enable substitute value 1 on channel 6
	5	Enable substitute value 1 on channel 5
	4	Enable substitute value 1 on channel 4
	3	Enable substitute value 1 on channel 3
	2	Enable substitute value 1 on channel 2
	1	Enable substitute value 1 on channel 1
	0	Enable substitute value 1 on channel 0
Byte 6	7	Enable substitute value 1 on channel 15
Substitute value[1]	6	Enable substitute value 1 on channel 14
	5	Enable substitute value 1 on channel 13
	4	Enable substitute value 1 on channel 12
	3	Enable substitute value 1 on channel 11
	2	Enable substitute value 1 on channel 10
	1	Enable substitute value 1 on channel 9
	0	Enable substitute value 1 on channel 8
[1] Only for 6ES7 421-7BH0x-0AB0		

A.3 Parameters of digital output modules

Parameters

The table below contains all parameters you can set for digital output modules. The comparison shows:

- Which parameters you can change with STEP 7 and
- Which parameters you can change using SFC 55 "WR_PARM".

The parameters set with STEP 7 can also be transferred with SFCs 56 and 57 to the module (refer to the STEP 7 manuals).

Table A-5 Parameters of the digital output modules

Parameters	Data record no.	Parameter assignment with SFC 55	Parameter assignment with STEP 7
Destination CPU for interrupt	0	No	Yes
Diagnostics		No	Yes
Diagnostics interrupt enable	1	**Yes**	Yes
Reaction to CPU STOP		**Yes**	Yes
Enable substitute value "1"*****		**Yes**	Yes

Note

If you want to enable the diagnostic interrupt in the user program in data record 1, you must enable the diagnostics in data record 0 beforehand using STEP 7.

Structure of data record 1

The figure below shows the structure of data record 1 (bytes 0, 1 and 2) for the parameters of digital output modules.

You enable a parameter by setting a logical "1" at the corresponding bit.

Table A-6 Data record 1 for parameters of digital output modules

Byte	Bit	Meaning
Byte 0	7	
	6	Diagnostics interrupt enable
	5	
	4	
	3	
	2	
	1	
	0	Reaction to CPU STOP
Byte 1 **Substitute value**	7	Enable substitute value 1 on channel 7
	6	Enable substitute value 1 on channel 6
	5	Enable substitute value 1 on channel 5
	4	Enable substitute value 1 on channel 4
	3	Enable substitute value 1 on channel 3
	2	Enable substitute value 1 on channel 2
	1	Enable substitute value 1 on channel 1
	0	Enable substitute value 1 on channel 0
Byte 2 **Substitute value**	7	Enable substitute value 1 on channel 15
	6	Enable substitute value 1 on channel 14
	5	Enable substitute value 1 on channel 13
	4	Enable substitute value 1 on channel 12
	3	Enable substitute value 1 on channel 11
	2	Enable substitute value 1 on channel 10
	1	Enable substitute value 1 on channel 9
	0	Enable substitute value 1 on channel 8

The following table shows the structure of data record 1 (bytes 3, and 4) for the parameters of digital output modules.

You enable a parameter by setting a logical "1" at the corresponding bit.

Table A-7 Data record 1 for parameters of digital output modules

Byte	Bit	Meaning
Byte 3* **Substitute value**	7	Enable substitute value 1 on channel 23
	6	Enable substitute value 1 on channel 22
	5	Enable substitute value 1 on channel 21
	4	Enable substitute value 1 on channel 20
	3	Enable substitute value 1 on channel 19
	2	Enable substitute value 1 on channel 18
	1	Enable substitute value 1 on channel 17
	0	Enable substitute value 1 on channel 16

Byte	Bit	Meaning
Byte 4*	7	Enable substitute value 1 on channel 31
Substitute value	6	Enable substitute value 1 on channel 30
	5	Enable substitute value 1 on channel 29
	4	Enable substitute value 1 on channel 28
	3	Enable substitute value 1 on channel 27
	2	Enable substitute value 1 on channel 26
	1	Enable substitute value 1 on channel 25
	0	Enable substitute value 1 on channel 26
* Bytes 3 and 4 are not relevant for SM 421;DO 16 x DC 20-125 V/1.5A		

A.4 Parameters of analog input modules

Parameters

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 SFC 55 "WR_PARM"

The parameters set with STEP 7 can also be transferred with SFCs 56 and 57 to the module (refer to the STEP 7 manuals).

Table A-8 Parameters of analog input modules

Parameters	Data record no.	Parameter assignment with SFC 55	Parameter assignment with STEP 7
Destination CPU for interrupt	0	No	Yes
Measuring method		No	Yes
Measuring range		No	Yes
Diagnostics		No	Yes
Temperature unit		No	Yes
Temperature coefficient		No	Yes
Noise suppression		No	Yes
Smoothing		No	Yes
Reference junction		No	Yes
End of cycle interrupt		No	Yes
Diagnostics interrupt enable	1	**Yes**	Yes
Hardware interrupt enable		**Yes**	Yes
Reference temperature	1	**Yes**	Yes
High limit	1	**Yes**	Yes
Low limit	1	**Yes**	Yes

Note

If you want to enable the diagnostic interrupt in the user program in data record 1, you must enable the diagnostics in data record 0 beforehand using STEP 7.

Structure of data record 1

The figure below shows the structure of data record 1 for the parameters of analog input modules.

You enable a parameter by setting a logical "1" at the corresponding bit.

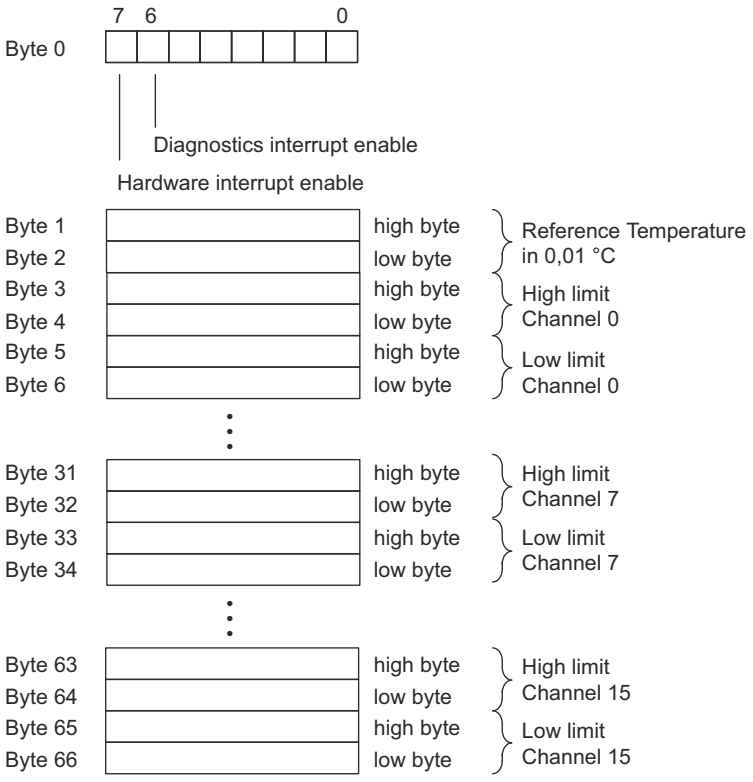


Figure A-2 Data record 1 for the parameters of analog input modules

Note

The representation of limits and the reference temperature corresponds to the analog value representation. Observe range limits when setting the limit values.

Diagnostic data of signal modules

B

B.1 Evaluating diagnostic data of signal modules in the user program

This section

This section describes the diagnostic data structure in system data. You must be familiar with this configuration if you want to evaluate the diagnostic data of the signal module in the STEP 7 user program.

Diagnostic data stored in data records

Module diagnostic data may have a length of max. 43 bytes, and are contained in data records 0 and 1:

- Data record 0 contains 4 bytes of diagnostic data describing the current state of an automation system.
- Data record 1 contains the 4 bytes of diagnostic data that are also contained in data record 0 and as many as 39 bytes of module specific diagnostic data.

Further references

An in-depth description of the principle of evaluating the diagnostic data of signal modules in the user program and a description of the SFCs that can be used for that purpose will be found in the STEP 7 manuals.

B.2 Structure and contents of diagnostic data bytes 0 and 1

Overview

The section below describes the structure and content of the various bytes in diagnostic data. General rule: When an error occurs, the bit concerned is set to "1".

Bytes 0 and 1

Table B-1 Bytes 0 and 1 of diagnostic data

Byte	Bit	Meaning
Byte 0	7	Incorrect parameter in the module
	6	No module parameters
	5	Front connector missing
	4	External auxiliary voltage missing
	3	Channel error
	2	External error
	1	Internal error
	0	Module error
Byte 1	7	0
	6	0
	5	0
	4	Channel information available
	3	Module type (see table "Codes of the module types")
	2	
	1	
	0	

Module types

The table below lists the module type IDs (bits 0 to 3 in byte 1).

Table B-2 Codes of the module types

ID	Module type
0101	Analog module
0110	CPU
1000	Function module
1100	CP
1111	Digital module

B.3 Diagnostic data of the digital input modules as of byte 2

Overview

The structure and contents of the different bytes of the diagnostic data for special digital input modules are described below. General rule: When an error occurs, the bit concerned is set to "1".

You will find a description of possible error causes and appropriate remedies in the section "Diagnostics of the modules".

Bytes 2 and 3 of the SM 421; DI 16 x DC 24 V

Table B-3 Bytes 2 and 3 of the diagnostic data of the SM 421; DI 16 x DC 24 V

Byte	Bit	Meaning
Byte 2	7	0
	6	0
	5	0
	4	Module-internal supply voltage failure
	3	0
	2	Operating mode 0: RUN; 1: STOP
	1	0
	0	0
Byte 3	7	0
	6	Hardware interrupt lost
	5	0
	4	0
	3	0
	2	EPROM error
	1	0
	0	0

Bytes 4 to 8 of the SM 421; DI 16 x DC 24 V

Table B-4 Bytes 4 to 8 of the diagnostic data of the SM 421; DI 16 x DC 24 V

Byte	Bit	Meaning
Byte 4	7	0
	6	Channel type B#16#70: Digital input
	5	
	4	
	3	
	2	
	1	
	0	

Byte	Bit	Meaning
Byte 5	7	Number of diagnostics bits that the module outputs per channel: 8 bits long
	0	
Byte 6	7	Number of channels of the same type in one module: 16 channels
	0	
Byte 7	5	Channel error 7
	6	Channel error 6
	5	...
	4	...
	3	...
	2	...
	1	Channel error 1
	0	Channel error 0
Byte 8	7	Channel error 15
	6	Channel error 14
	5	...
	4	...
	3	...
	2	...
	1	Channel error 9
	0	Channel error 8

Bytes 9 to 24 of the SM 421; DI 16 x DC 24 V

Data record 1 contains the channel-specific diagnostic data, starting at bytes 9 to 24. The figure below shows the assignment of the diagnostic byte for a channel of the module.

Table B-5 Diagnostic byte for a channel of the SM 421; DI 16 x DC 24 V

Byte	Bit	Meaning
Bytes 9 - 24	7	0
	6	0
	5	Sensor supply missing
	4	Wire break
	3	0
	2	0
	1	0
	0	Configuring/parameter assignment error

Bytes 2 and 3 of the SM 421; DI 16 x UC 24/60 V

Table B-6 Bytes 2 and 3 of the diagnostic data of the SM 421; DI 16 x UC 24/60 V

Byte	Bit	Meaning
Byte 2	7	0
	6	0
	5	0
	4	0
	3	0
	2	Operating mode 0: RUN; 1: STOP
	1	0
	0	0
Byte 3	7	0
	6	Hardware interrupt lost
	5	0
	4	0
	3	0
	2	EPROM error
	1	0
	0	0

Bytes 4 to 8 of the SM 421; DI 16 x UC 24/60 V

Table B-7 Bytes 4 to 8 of the diagnostic data of the SM 421; DI 16 x UC 24/60 V

Byte	Bit	Meaning
Byte 4	7	0
	6	Channel type B#16#70: Digital input
	5	
	4	
	3	
	2	
	1	
	0	
Byte 5	7	Number of diagnostics bits that the module outputs per channel: 8 bits long
	0	
Byte 6	7	Number of channels of the same type in one module: 16 channels
	0	
Byte 7	7	Channel error 7
	6	Channel error 6
	5	**...**
	4	**...**
	3	**...**
	2	**...**
	1	Channel error 1
	0	Channel error 0

Byte	Bit	Meaning
Byte 8	7	Channel error 15
	6	Channel error 14
	5	...
	4	...
	3	...
	2	...
	1	Channel error 9
	0	Channel error 8

Bytes 9 to 24 of the SM 421; DI 16 x UC 24/60 V

Data record 1 contains the channel-specific diagnostic data, starting at bytes 9 to 24. The figure below shows the assignment of the diagnostic byte for a channel of the module.

Table B-8 Diagnostic byte for a channel of the SM 421; DI 16 x DC 24 V

Byte	Bit	Meaning
Byte 9-24	7	0
	6	0
	5	0
	4	Wire break
	3	0
	2	0
	1	0
	0	Configuring/parameter assignment error

B.4 Diagnostic data of the digital output modules as of byte 2

Overview

The structure and contents of the different bytes of the diagnostic data for special digital output modules are described below. General rule: When an error occurs, the bit concerned is set to "1".

You will find a description of possible error causes and appropriate remedies in the section on the special module.

Bytes 2 and 3 of the SM 422; DO 16 x DC 20-125 V/1.5 A

Table B-9 Bytes 2 and 3 of the diagnostic data of the SM 422; DO 16 x DC 20-125 V/1.5 A

Byte	Bit	Meaning
Byte 2	7	0
	6	0
	5	0
	4	0
	3	0
	2	Operating mode 0: RUN; 1: STOP
	1	0
	0	0
Byte 3	7	0
	6	0
	5	0
	4	0
	3	0
	2	EPROM error
	1	0
	0	0

Bytes 4 and 8 of the SM 422; DO 16 x DC 20-125 V/1.5 A

Table B-10 Bytes 4 to 8 of the diagnostic data of the SM 422; DO 16 x DC 20-125 V/1.5 A

Byte	Bit	Meaning
Byte 4	7	0
	6	Channel type B#16#72: digital output
	5	
	4	
	3	
	2	
	1	
	0	

Byte	Bit	Meaning
Byte 5	7	Number of diagnostics bits that the module outputs per channel: 8 bits long
	0	
Byte 6	7	Number of channels of the same type in one module: 16 channels
	0	
Byte 7	7	Channel error 7
	6	Channel error 6
	5	...
	4	...
	3	...
	2	...
	1	Channel error 1
	0	Channel error 0
Byte 8	7	Channel error 15
	6	Channel error 14
	5	...
	4	...
	3	...
	2	...
	1	Channel error 9
	0	Channel error 8

Bytes 9 and 24 of the SM 421; DO 16 x DC 20-125 V/1.5 A

Data record 1 contains the channel-specific diagnostic data, starting at bytes 9 to 24. The figure below shows the assignment of the diagnostic byte for a channel of the module.

Table B-11 Diagnostic byte for a channel of the SM 422; DO 16 x DC 20-125 V/1.5 A

Byte	Bit	Meaning
Bytes 9 - 24	7	0
	6	External load voltage missing
	5	0
	4	0
	3	Short-circuit to M
	2	0
	1	0
	0	Configuring/parameter assignment error

Bytes 2 and 3 of the SM 422; DO 32 x DC 24 V/0.5 A

Table B-12 Bytes 2 and 3 of the diagnostic data of the SM 422; DO 32 x DC 24 V/0.5 A

Byte	Bit	Meaning
Byte 2	7	0
	6	0
	5	0
	4	Module-internal supply voltage failure
	3	0
	2	Operating mode 0: RUN; 1: STOP
	1	0
	0	0
Byte 3	7	0
	6	0
	5	0
	4	0
	3	0
	2	EPROM error
	1	0
	0	0

Bytes 4 to 10 of the SM 422; DO 32 x DC 24 V/0.5 A

Table B-13 Bytes 4 to 10 of the diagnostic data of the SM 422; DO 32 x DC 24 V/0.5 A

Byte	Bit	Meaning
Byte 4	7	0
	6	Channel type B#16#72: digital output
	5	
	4	
	3	
	2	
	1	
	0	
Byte 5	7	Number of diagnostics bits that the module outputs per channel: 8 bits long
	0	
Byte 6	7	Number of channels of the same type in one module: 32 channels
	0	
Byte 7	7	Channel error 7
	6	Channel error 6
	5	**...**
	4	**...**
	3	**...**
	2	**...**
	1	Channel error 1
	0	Channel error 0

Byte	Bit	Meaning
Byte 8	7	Channel error 15
	6	Channel error 14
	5	...
	4	...
	3	...
	2	...
	1	Channel error 9
	0	Channel error 8
Byte 9	7	Channel error 23
	6	Channel error 22
	5	...
	4	...
	3	...
	2	...
	1	Channel error 17
	0	Channel error 16
Byte 10	7	Channel error 31
	6	Channel error 30
	5	...
	4	...
	3	...
	2	...
	1	Channel error 25
	0	Channel error 24

Bytes 11 to 42 of the SM 422; DO 32 x DC 24 V/0.5 A

Data record 1 contains the channel-specific diagnostic data, starting at bytes 11 to 42. The figure below shows the assignment of the diagnostic byte for a channel of the module.

Table B-14 Diagnostic byte for a channel of the SM 422; DO 32 x DC 24 V/0.5 A

Byte	Bit	Meaning
Bytes 11 - 42	7	0
	6	External load voltage missing
	5	0
	4	Wire break
	3	Short-circuit to M
	2	Short-circuit to L+
	1	0
	0	Configuring/parameter assignment error

Bytes 2 and 3 of the SM 422; DO 16 x AC 20-120 V/2 A

Table B-15 Bytes 2 and 3 of the diagnostic data of the SM 422; DO 16 x AC 20-120 V/2 A

Byte	Bit	Meaning
Byte 2	7	0
	6	0
	5	0
	4	0
	3	0
	2	Operating mode 0: RUN; 1: STOP
	1	0
	0	0
Byte 3	7	0
	6	0
	5	0
	4	0
	3	0
	2	EPROM error
	1	0
	0	0

Bytes 4 to 8 of the SM 422; DO 16 x AC 20-120 V/2 A

Table B-16 Bytes 4 to 8 of the diagnostic data of the SM 422; DO 16 x AC 20-120 V/2 A

Byte	Bit	Meaning
Byte 4	7	0
	6	Channel type B#16#72: digital output
	5	
	4	
	3	
	2	
	1	
	0	
Byte 5	7	Number of diagnostics bits that the module outputs per channel: 8 bits long
	0	

Byte	Bit	Meaning
Byte 6	7	Number of channels of the same type in one module: 16 channels
	0	
Byte 7	7	Channel error 7
	6	Channel error 6
	5	...
	4	...
	3	...
	2	...
	1	Channel error 1
	0	Channel error 0
Byte 8	7	Channel error 15
	6	Channel error 14
	5	...
	4	...
	3	...
	2	...
	1	Channel error 9
	0	Channel error 8

Bytes 9 to 24 of the SM 422; DO 16 x AC 20-120 V/2 A

Data record 1 contains the channel-specific diagnostic data, starting at bytes 9 to 24. The figure below shows the assignment of the diagnostic byte for a channel of the module.

Table B-17 Diagnostic byte for a channel of the SM 422; DO 16 x AC 20-120 V/2 A

Byte	Bit	Meaning
Bytes 9 - 24	7	0
	6	0
	5	Fuse blown
	4	0
	3	0
	2	0
	1	0
	0	Configuring/parameter assignment error

B.5 Diagnostic data of the analog input modules as of byte 2

Overview

The structure and contents of the different bytes of the diagnostic data for the special analog input modules are described below. General rule: When an error occurs, the bit concerned is set to "1".

You will find a description of possible error causes and appropriate remedies in the section on the special module.

Bytes 2 and 3 of the SM 431; AI 16 x 16 bit

Table B-18 Bytes 2 and 3 of the diagnostic data of the SM 431; AI 16 x 16 bit

Byte	Bit	Meaning
Byte 2	7	0
	6	0
	5	0
	4	0
	3	0
	2	Operating mode 0: RUN; 1: STOP
	1	0
	0	Measuring range module incorrect or missing
Byte 3	7	0
	6	Hardware interrupt lost
	5	0
	4	ADC/DAC error
	3	RAM error
	2	EPROM error
	1	0
	0	0

Bytes 4 to 8 of the SM 431; AI 16 x 16 bit

Table B-19 Bytes 4 to 8 of the diagnostic data of the SM 431; AI 16 x 16 bit

Byte	Bit	Meaning
Byte 4	7	0
	6	Channel type B#16#71: Analog input
	5	
	4	
	3	
	2	
	1	
	0	
Byte 5	7	Number of diagnostics bits that the module outputs per channel: 8 bits long
	0	
Byte 6	7	Number of channels of the same type in one module: 16 channels
	0	
Byte 7	7	Channel error 7
	6	Channel error 6
	5	**...**
	4	**...**
	3	**...**
	2	**...**
	1	Channel error 1
	0	Channel error 0

Byte	Bit	Meaning
Byte 8	7	Channel error 15
	6	Channel error 14
	5	...
	4	...
	3	...
	2	...
	1	Channel error 9
	0	Channel error 8

Bytes 9 to 24 of the SM 431; AI 16 x 16 bit

Data record 1 contains the channel-specific diagnostic data, starting at bytes 9 to 24. The figure below shows the assignment of the diagnostic byte for a channel of the module.

Table B-20 Diagnostic byte for a channel of the SM 431; AI 16 x 16 bit

Byte	Bit	Meaning
Byte 9-24	7	Overflow
	6	Underflow
	5	Reference channel error
	4	Wire break
	3	Short-circuit to M
	2	0
	1	0
	0	Configuring/parameter assignment error

Bytes 2 and 3 of the SM 431; AI 8 x RTD x 16 bit

Table B-21 Bytes 2 and 3 of the diagnostic data of the SM 431; AI 8 x RTD x 16 bit

Byte	Bit	Meaning
Byte 2	7	0
	6	0
	5	0
	4	0
	3	0
	2	Operating mode 0: RUN; 1: STOP
	1	0
	0	0

Byte	Bit	Meaning
Byte 3	7	0
	6	Hardware interrupt lost
	5	0
	4	ADC/DAC error
	3	0
	2	EPROM error
	1	0
	0	0

Bytes 4 and 7 of the SM 431; AI 8 x RTD x 16 bit

Table B-22 Bytes 4 to 7 of the diagnostic data of the SM 431; AI 8 x RTD x 16 bit

Byte	Bit	Meaning
Byte 4	7	0
	6	Channel type B#16#71: Analog input
	5	
	4	
	3	
	2	
	1	
	0	
Byte 5	7	Number of diagnostics bits that the module outputs per channel: 16 bits long
	0	
Byte 6	7	Number of channels of the same type in one module: 8 channels
	0	

Byte	Bit	Meaning
Byte 7	7	Channel error 7
	6	Channel error 6
	5	...
	4	...
	3	...
	2	...
	1	Channel error 1
	0	Channel error 0

Bytes 8 and 23 of the SM 431; AI 8 x RTD x 16 bit

Data record 1 contains the channel-specific diagnostic data, starting at bytes 8 to 23. The following table shows the assignment of the **even** diagnostic bytes (bytes 8, 10, to 22) for a channel of the module.

Table B-23 Even diagnostic byte for a channel of the SM 431; AI 8 x RTD x 16 bit

Byte	Bit	Meaning
Byte 8-23 even	7	Overflow
	6	Underflow
	5	0
	4	Wire break
	3	0
	2	0
	1	0
	0	Configuring/parameter assignment error

The following table shows the assignment of the **odd** diagnostic bytes (bytes 9, 11, to 23) for a channel of the module.

Table B-24 Odd diagnostic byte for a channel of the SM 431; AI 8 x RTD x 16 bit

Byte	Bit	Meaning
Byte 8-23 odd	7	User calibration does not correspond to the parameter assignment
	6	Open conductor in the current source
	5	0
	4	Underrange or overrange
	3	Run time calibration error
	2	Open conductor in - direction
	1	Open conductor in + direction
	0	User connection not wired

Bytes 2 and 3 of the SM 431; AI 8 x 16 bit

Table B-25 Bytes 2 and 3 of the diagnostic data of the SM 431; AI 8 x 16 bit

Byte	Bit	Meaning
Byte 2	7	0
	6	0
	5	0
	4	0
	3	0
	2	Operating mode 0: RUN; 1: STOP
	1	0
	0	Thermocouple connection error
Byte 3	7	0
	6	Hardware interrupt lost
	5	0
	4	ADC/DAC error
	3	RAM error
	2	EPROM error
	1	0
	0	0

Bytes 4 to 7 of the SM 431; AI 8 x 16 bit

Table B-26 Bytes 4 to 7 of the diagnostic data of the SM 431; AI 8 x 16 bit

Byte	Bit	Meaning
Byte 4	7	0
	6	Channel type B#16#71: Analog input
	5	
	4	
	3	
	2	
	1	
	0	
Byte 5	7	Number of diagnostics bits that the module outputs per channel: 16 bits long
	0	

Byte	Bit	Meaning
Byte 6	7	Number of channels of the same type in one module: 8 channels
	0	
Byte 7	7	Channel error 7
	6	Channel error 6
	5	.....
	4	.....
	3	.....
	2	.....
	1	Channel error 1
	0	Channel error 0

Bytes 8 to 23 of the SM 431; AI 8 x 16 bit

Data record 1 contains the channel-specific diagnostic data, starting at bytes 8 to 23. The following table shows the assignment of the **even** diagnostic bytes (bytes 8, 10, to 22) for a channel of the module.

Table B-27 Even diagnostic byte for a channel of the SM 431; AI 8 x 16 bit

Byte	Bit	Meaning
Bytes 8-23 even	7	Overflow
	6	Underflow
	5	Reference channel error
	4	Wire break
	3	0
	2	0
	1	0
	0	Configuring/parameter assignment error

The following table shows the assignment of the **odd** diagnostic bytes (bytes 9, 11, to 23) for a channel of the module.

Table B-28 Odd diagnostic byte for a channel of the SM 431; AI 8 x 16 bit

Byte	Bit	Meaning
Byte 8-23	7	User calibration does not correspond to the parameter assignment
odd	6	0
	5	0
	4	0
	3	Runtime calibration error
	2	0
	1	0
	0	0

Accessories and spare parts

C

C.1 Accessories and spare parts

Accessories and spare parts

Accessories - spare parts	Order number
For racks	
Number wheel for slot labeling	C79165-Z1523-A22
Spare slot covers (qty 10)	6ES7490-1AA00-0AA0
Application module FM458-1 DP	6DD1607-0AA2
EXM 438-1 I/O extension	6DD1607-0CA1
EXM 448-2 Communication extension	6DD1607-0EA2
For power supplies	
Spare connector for PS 405 (DC)	6ES7490-0A00-0AA0
Spare connector for PS 407 (AC)	6ES7490-0AB00-0AA0
Backup battery	6ES7971-0BA00
For digital modules/analog modules	
Cover foil (10 x) for labeling strips of the SMs	6ES7492-2XX00-0AA0
Cover flap for fuse receptacle on the AC modules	6ES7422-0XX00-7AA0
Measuring range module for analog modules	6ES7974-0AA00-0AA0
Front connector screw-type connection	6ES7492-1AL00-0AA0
Front connector spring connection	6ES7492-1BL00-0AA0
Front connector crimp connection	6ES7492-1CL00-0AA0
Panel for front connector, 5 pieces	6ES7492-2XL00-0AA0
Crimping tool for crimp contacts	6XX3 071
Crimp contacts (package of 250)	6XX3 070
Fuses, 8 A, quick blow	
• Wickmann	194-1800-0
• Schurter	SP001.1013
• Littelfuse	217.008
Labeling sheet for the front connector, petrol blue	6ES7492-2AX00-0AA0
Labeling sheet for the front connector, light	6ES7492-2BX00-0AA0
Labeling sheet for the front connector, yellow	6ES7492-2CX00-0AA0
Labeling sheet for the front connector, red	6ES7492-2DX00-0AA0
For IMs	
Terminator for IM 461–0	6ES7461-0AA00-7AA0
Terminator for IM 461–3	6ES7461-3AA00-7AA0
IM 463-, send IM, 600 m to IM 314 of the S5	6ES7463-2AA00-0AA0
IM cable with communication bus, 0,75 m	6ES7468-1AH50-0AA0

Accessories - spare parts	Order number
IM cable with communication bus, 1.5 m	6ES7468-1BB50-0AA0
IM cable with communication bus, 5 m	6ES7468-1BF00-0AA0
IM cable with communication bus, 10 m	6ES7468-1CB00-0AA0
IM cable with communication bus, 25 m	6ES7468-1CC50-0AA0
IM cable with communication bus, 50 m	6ES7468-1CF00-0AA0
IM cable with communication bus, 100 m	6ES7468-1DB00-0AA0
IM cable with current transmission, 0,75 m	6ES7468-3AH50-0AA0
IM cable with current transmission, 1.5 m	6ES7468-3BB50-0AA0
Package with plug adapters for IM 467 FO	6ES7195-1BE00-0XA0
Package with simplex plugs and polishing set for IM 467 FO	6GK1901-0FB00-0AA0
For interfacing / networking	
Standard mounting rail 35 mm	6ES5710-8MA...
PROFIBUS	6XV1830-3BH10
PROFIBUS bus connector with PG socket	6ES7972-0BB10-0XA0
PROFIBUS bus connector without PG socket, with angled cable outlet	6ES7972-0BA40-0X40
PROFIBUS bus connector with PG socket, with angled cable outlet	6ES7972-0BB40-0X40
PROFIBUS RS 485 bus terminal	6GK1500-0AB00 6GK1500-0DA00
PC/MPI cable (5 m)	6ES7901-2BF00-0AA0
Cabinets	
Cabinet 2200 x 800 x 400 with extension set for SIMATIC S7-	8MC 2281-7FC11-8DA1
Extension set for SIMATIC S7-	8MC 1605–BS70–AA0
Cables for printers with	
Connector housing, gray	
• 9-pin	V42254-A6000-G109
• 15-pin	V42254-A6000-G115
• 25-pin	V42254-A6000-G125
Connector housing, black	
• 9-pin	V42254-A6001-G309
• 15-pin	V42254-A6001-G315
• 25-pin	V42254-A6001-G325

Directive on handling electrostatic sensitive devices (ESD)

D

D.1 ESD: What are the directives for handling electrostatic sensitive devices?

Definition

All electronic modules are equipped with large-scale integrated ICs or components. Due to their design, these electronic components are highly sensitive to overvoltage, and thus to any electrostatic discharge.

These **E**lectrostatic **S**ensitive **D**evices/**M**odules are commonly abbreviated **ESD**.

Electrostatic sensitive devices are labeled with the following symbol:



CAUTION

Electrostatic sensitive devices can be destroyed by voltages far below the level perceived by human beings. These voltages are generated when you touch a component or electrical connections of a module without having discharged your body. In most cases, the damage caused by overvoltage is not evident immediately, and results in damage only after a prolonged period of operation.

D.2 Electrostatic charging of persons

Electrostatic charging

Any person with a non-conductive connection to the electrical potential of its surroundings may be exposed to electrostatic charge.

The figure shows the maximum electrostatic voltage which may build up on a person coming into contact with the materials indicated. These values are in conformity with the specifications of IEC 61000-4-2.

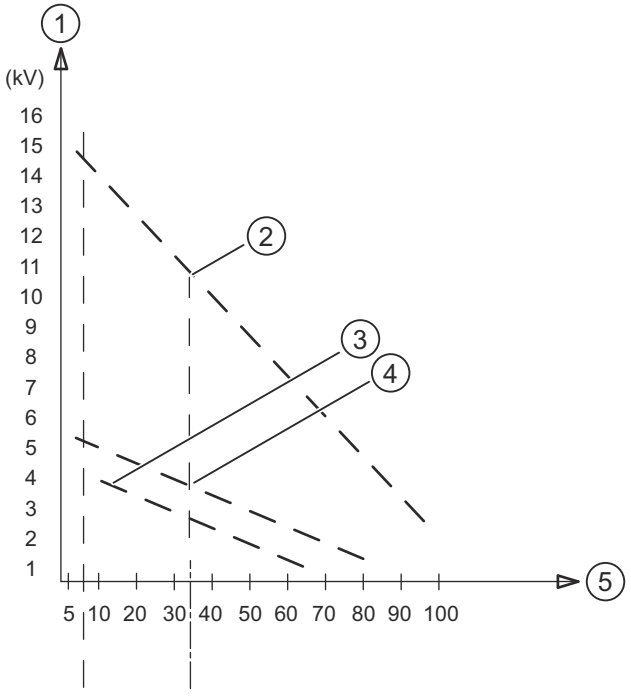


Figure D-1 Electrostatic voltages which can build up on a person

(1) Voltage in kV

(2) Synthetic material

(3) Wool

(4) Antistatic materials, such as wood or concrete

(5) Relative air humidity in %

D.3 Basic protective measures against electrostatic discharge

Ensure sufficient grounding

Make sure all persons, workplaces and packaging are sufficiently grounded when ESD components are being handled. This prevents electrostatic charging.

Avoid direct contact

You should only touch ESD components if this is 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.

List of abbreviations

E

E.1 List of abbreviations

List of abbreviations

Abbreviations	Explanations
AC	Alternating current
ADC	Analog-to-digital converter
AI	Analog input
AO	Analog output
AS	Automation system
STL	Statement list (type of representation in STEP 7)
BAF	Battery failure
BUS1F; BUS2F	LED bus failure on the MPI/PROFIBUS DP interface 1 or 2
CH	Channel
COMP	Compensation circuit
CP	Communications processor
CPU	Central processing unit of the PLC
CR	Central rack
DAC	Digital-to-analog converter
DB	Data block
DC	Direct current
DI	Digital input
DO	Digital output
ESD	Electrostatic sensitive device
EMC	Electromagnetic compatibility
EEPROM	Electrically erasable programmable read-only memory
EPROM	Erasable programmable read-only memory
ER	Expansion rack
ID	Input delay
SV	Set substitution value
EXM	Extension module
EXTF	Error LED "external fault"
FB	Function block
FC	Function
FEPROM	Flash erasable programmable read-only memory
FM	Function module
FRCE	Fiber-optic cable
FC	Function block diagram

Abbreviations	Explanations
GD	Global data communication
ES	Sensor supply
IC	Constant-current line
IFM1F; IFM2F	LED error at interface module 1/2
IM	Interface module
INTF	Error LED "internal fault"
IP	Intelligent I/O
L+	Terminal for 24 VDC supply voltage
HLV	KLV
FOC	Fiber-optic cable
LAD	Ladder logic diagram
M	Chassis ground
M+	Measuring line (positive)
M-	Measuring line (negative)
M_{ANA}	Reference potential of the analog measuring circuit
MPI	Multipoint interface
MRES	Master reset position of the toggle switch for general reset of the CPU
MSTR	Master
OB	Organization block
OP	Operator panel
OS	Operator system
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
REDF	Redundancy fault
R_L:	Load impedance
S +	Sensing line (positive)
S-	Sensing line (negative)
SCL	Structured control language
SFB	System function block
SFC	System function
SM	Signal module
PLC	Programmable logic controller
SSL	Signal module
TD	HMI (text display)
SSL	Transducer
UC	Universal current
TD	Universal rack
U_{CM}	Common mode voltage

Abbreviations	Explanations
U_H:	Auxiliary voltage
U_{iso}	Potential difference between M_{ANA} and local ground
USR	User
Vs	Sensor voltage
Sign	Sign
CR	Central rack

Glossary

2/3/4-wire connection

Type of connection to the module, e.g. from resistance thermometers/ resistors to the front connector of the analog input module or from loads to the voltage output of an analog output module.

2-wire transducer/4-wire transducer

Type of transducer (2-wire transducer: supply via connection terminals of the

analog input module; 4-wire transducer: supply via separate connections of the transducer)

Address

An address identifies a certain operand or operand range, examples: input I 12.1; memory word MW 25; data block DB 3.

Automation system

An automation system is a → programmable logic controller consisting of a → central rack, a CPU and various input/output modules.

Backplane bus

The backplane bus is a serial data bus over which modules communicate with each other and are supplied with the necessary voltage. The connection between the modules is established by bus connectors.

Backup battery

The backup battery ensures that the → user program in the → CPU is not lost in the event of a power failure and that defined data areas, bit memory, timers and counters are → stored retentively.

Backup voltage, external

The same backup as with a backup battery can be achieved if a backup voltage (DC voltage between 5 V and 15 V) is applied to the "EXT. BATT." socket of the CPU.

The external backup voltage is required to replace a power supply module if the user program and data stored in a RAM (e.g. bit memory, timers, counters, system data, integrated clock) need to be backed up for the duration of the module replacement.

Basic error limit

The basic error limit is the operational limit at 25 °C in relation to the nominal range of the analog module.

Baud rate

Data transmission speed (bps)

Central rack

An S7-400 consists of a central rack to which expansion racks can be assigned if required. The central rack is the rack that contains the → CPU.

Cold restart

→ Restart of the automation system and its user program after all dynamic data (variables of the input/output image, internal registers, timers, counters, etc. and associated program sections) have been reset to a predefined value.

A cold restart can be triggered automatically (for example, after a power failure, a loss of information in dynamic memory areas, etc.).

Common mode voltage

Voltage that is common to all terminals of a group and that is measured between this group and any reference point (usually ground).

Communication load

Load on cyclic program execution of a CPU caused by communication processes (PROFIBUS DP).

To prevent communication processes from putting too much load on cyclic program execution, the maximum permissible cycle load caused by communication can be defined via parameter assignment in STEP 7.

Communications processor

Programmable module for communication tasks, such as networking, point-to-point connection.

Compensating box

Compensating boxes can be used when measuring temperatures with thermocouples connected to analog input modules. The compensating box is a compensation circuit for compensating temperature fluctuations at the → reference junction.

Constant bus cycle time

"Constant bus cycle time" means a DP bus cycle accurate to a few microseconds that can be configured in STEP 7.

CP

→ Communications processor

Data block

Data blocks (DB) are data areas in the user program that contain user data. There are global data blocks that can be accessed by all logic blocks and there are instance data blocks that are assigned to a specific FB call.

Declaration

Definition of variables (e.g. parameters or local data of a block) with name, data type, comment, etc.

Default setting

The default setting is a practical basic setting that is always used if no other value is entered.

Destruction limit

Limit of the permissible input voltage/current. If this limit is exceeded, then the measurement accuracy may deteriorate. If the destruction limit is exceeded significantly, the internal measuring circuitry may be destroyed.

Diagnostic buffer

The diagnostic buffer is a buffered memory area in the CPU where diagnostic events are stored in order of occurrence.

For troubleshooting purposes, the user can read out the exact cause of the error from the diagnostic buffer with STEP 7 (PLC -> Module information menu command).

Diagnostic data

All diagnostic events that have occurred are collected in the CPU and entered in the → diagnostic buffer. If error OB exists, it is started.

Diagnostic interrupt

Modules with diagnostic capability signal detected system errors to the → CPU using diagnostic interrupts. The operating system of the CPU calls OB 82 when a diagnostic interrupt occurs.

Diagnostics

Generic term for → system diagnostics, process fault diagnostics and user-defined diagnostics.

Direct data exchange

Direct data exchange In direct data exchange, local input address areas of an intelligent DP device (e.g. CPU 315-2 with PROFIBUS DP connection) or a DP master are assigned to the input address areas of a PROFIBUS DP partner. The intelligent DP device or DP master receives the input data that the PROFIBUS DP partner sends to its DP master via these assigned input address areas.

DP device

A device that is operated on PROFIBUS with the PROFIBUS DP protocol is called a DP device.

DP master

A station with master functionality in PROFIBUS DP. A master that operates in conformance with IEC 61784-1:2002 Ed1 CP 3/1 with the DP protocol is a DP master. The token allowing access to the bus is exclusively passed on among the masters. The devices, in this case DP devices, can only react when requested by a master. A distinction must be made between the following:

DP master (class 1): handles user data exchange with the DP devices assigned to it.

DP master (class 2): provides services such as: reading input/output data, diagnostics, global control.

Equipotential bonding

Electrical connection (equipotential bonding conductor) that brings exposed conductive parts of electrical equipment and external conductive parts to the same or almost the same potential to prevent interfering or dangerous voltages between these parts.

FB

→ Function block

FC

→ Function

Fiber-optic cable

A fiber-optic cable is a transmission medium made of glass fiber or plastic. Fiber-optic cables are insensitive to electromagnetic interference and allow high data transmission rates.

Floating

In floating input/output modules, the reference potentials of the control and load circuits are galvanically isolated; e.g. by optocoupler, relay contact, or transformer. Input/output circuits can be connected to a common potential.

Force

The "Force" function overwrites a variable (e.g. bit memory, output) with a value defined by the user.

At the same time, the variable is write-protected so that the value cannot be changed from any other location (thus, also not from the user program). This value is retained even after the programming device has been disconnected.

Only when the "Unforce" function is called is the write protection removed and the variable written again with the value specified by the user program.

The "Force" function can be used, for example, during commissioning to set specific outputs to "ON" state for any length of time even if the logic operations in the user program are not fulfilled (e.g. due to missing wiring of inputs).

FREEZE

Control command, inputs of the → DP devices are frozen at the current value.

Function

According to IEC 1131-3, a function (FC) is a → logic block without → static data. A function allows parameters to be passed in the user program. This makes it suitable for programming frequently recurring complex functions such as calculations.

Function block

According to IEC 1131-3, a function block (FB) is a → logic block with → static data. An FB has "memory" so that it is possible to access its parameters (for example, outputs) from any part of the user program.

Functional grounding

Grounding with the sole purpose of ensuring the intended function of the electrical equipment. The functional grounding short-circuits interference voltages that would otherwise lead to impermissible influences on the equipment.

Fuse blown

Parameter in STEP 7 for digital output modules. When the parameter is enabled, the blowing of one or more fuses is detected by the module. If the parameter is set accordingly, a → diagnostic interrupt is triggered.

Grounding

Grounding means connecting an electrically conductive part to the ground electrode (one or more conductive parts that make good contact with the ground) via a grounding system.

Hardware interrupt

A hardware interrupt is triggered by interrupt-triggering modules due to a certain event in the process (violation of the high or low limit; module has completed the cyclic conversion of its channels).

The hardware interrupt is signaled to the CPU. In keeping with the priority of this interrupt, the assigned → organization block is then executed.

Hot restart

When a CPU starts up (e.g. through operation of the mode selector or after power ON), either OB101 (hot restart), OB100 (warm restart) or OB102 (cold restart) is executed before the cyclic program execution (OB1). Backup of the CPU is essential for the "hot restart".

The following applies: All data areas (timers, counters, bit memory, data blocks) and their contents are retained. The → process image input is read and execution of the STEP 7 user program is continued from the point at which it was last stopped (STOP, power OFF).

The other startup modes available are → cold restart and → warm restart.

I/O bus

Part of the → backplane bus in the automation system, optimized for fast exchange of signals between the CPU(s) and the signal modules.

User data (e.g. digital input signals of a signal module) and system data (e.g. default parameter data records of a signal module) are transferred via the I/O bus.

Input delay

Parameter in STEP 7 for digital input modules. The input delay is used to suppress coupled interference. Interference pulses from 0 ms up to the set input delay are suppressed.

The set input delay is subject to a tolerance that can be found in the technical specifications of the module. A high input delay suppresses longer interference pulses, a low input delay suppresses shorter interference pulses.

The permissible input delay depends on the cable length between the sensor and module. For example, a high input delay must be set for long, unshielded supply lines to the sensor (over 100 m).

Integration time

The integration time is the inverse value of the → interference frequency suppression in ms.

Interference frequency suppression

Parameter in STEP 7 for analog input modules. The frequency of the alternating voltage supply system may interfere with the measured value, in particular when measuring withing small voltage ranges and with thermocouples. With this parameter, the user specifies the predominant line frequency in the system.

Interrupt

SIMATIC S7 recognizes 28 different priority classes that control the processing of the

user program. These priority classes include interrupts, e.g. hardware interrupts. When an interrupt occurs, the operating system automatically calls an assigned organization block in which the user can program the desired reaction (e.g. in an FB).

Interrupt reaction time

The interrupt reaction time is the time from the first occurrence of an interrupt signal to the call of the first instruction in the interrupt OB. General rule: Higher priority interrupts are handled first. This means that the interrupt reaction time is extended by the program execution time of the higher-priority interrupt OBs and interrupt OBs with the same priority that occurred earlier but not yet been processed (queue).

Keep last valid value (KLV)

Module retains the last value output before the STOP state.

Linearity error

The linearity error indicates the maximum deviation of the measured/output value from the ideal linear relationship between measured/output signal and digital value. It is specified as a percentage in relation to the nominal range of the analog module.

Load memory

The load memory is part of a programmable module (CPU, CP). It contains objects generated by the programming device (load objects). It is implemented either as a plug-in memory card or as permanently integrated memory.

Local data

Local data is the data assigned to a → logic block that is declared in its → declaration section or its variable declaration. It includes (block-specific): formal parameters, → static data, → temporary data.

Measuring principle, instantaneous value encoding

A module with instantaneous value encoding is always used for very fast measurements or for variables that change very quickly. With this method, the module accesses the variable to be measured as quickly as possible and returns an instantaneous recording

of the signal at a specific time. Note that this measuring method makes modules "more sensitive" than modules using the integrating measuring method. Therefore, interference in the measurement signal may result in false values. When using these modules, you must ensure a "clean" measurement signal, e.g. by strictly adhering to the installation guidelines.

Measuring principle, integrating

A module with integrating measuring method is always used for measurements that are not time-critical. The integration time is inversely proportional to the line frequency. You set the line frequency in STEP 7 - this then results in the integration time. With a line frequency of 50 Hz, the integration time is 20 ms or even multiples thereof. Since the measured value is integrated over exactly this period, at least one or more whole periods of the line frequency that may be superimposed on the measured signal are always included. The mean value of the interference is thus integrated to zero (positive component of the first half period = negative component of the second half period) and, as a result of the principle, only the useful signal is detected.

Measuring range module

Measuring range modules are plugged onto the analog input modules to adapt them to various measuring ranges.

Memory reset

The following memories of the CPU are erased during a memory reset: work memory, read/write area of the load memory, system memory.

The MPI parameters and the diagnostic buffer are preserved.

Mode selector

The mode selector allows the user to set the current mode of the CPU (RUN, STOP) or to reset the memory of the CPU (MRES).

Non-isolated

In non-isolated input/output modules, the reference potentials of the control and load circuits are electrically connected.

Operating mode

Operating mode means:

1. The operating state of the CPU as selected with the mode selector or PG
2. The mode of program execution in the CPU

Operating state

The automation systems of SIMATIC S7 recognize the following operating states: STOP, → STARTUP, RUN and HOLD.

Operational limit

The operational limit is the measurement or output error of the analog module across the entire temperature range in relation to the nominal range of the analog module.

Parameter

1. Variable of a → logic block
2. Variable for setting the properties of a module (one or more per module). When shipped, every module has practical basic parameter settings, which the user can change in STEP 7.

Point-to-point connection

In a point-to-point connection, only two stations are physically connected to each other. This type of communication connection is used when the use of a communication network is not practical or, for example, when different types of partners are connected (e.g. PLC with process computer).

Priority class

The S7-CPU operating system provides up to 28 priority classes (= program execution levels), e.g. for cyclic program execution, hardware interrupt-controlled program execution.

Each priority class is assigned → organization blocks in which the user can program a reaction. The OBs have different default priorities that determine the order in which they are executed or interrupt each other if they occur simultaneously. The default priorities can be changed by the user.

Process image

The signal states of the digital input and output modules are stored on the CPU in a process image.

A distinction is made between the process image inputs and process image output. The process image input (PII) is read from the input modules by the operating system before execution of the user program. The process image output (PIQ) is transferred from the operating system to the output modules at the end of the program execution.

Product version

The product version distinguishes products with the same order number. The product version is incremented when upwards-compatible functional enhancements are made, when there are modifications relating solely to production (use of new components) and when bugs are fixed.

PROFIBUS DP

Digital, analog and intelligent modules as well as a wide range of field devices according to IEC 61784-1:2002 Ed1 CP 3/1, such as drives and valve terminals, are relocated from the automation system to the local process, over a distance of up to 23 km.

The modules and field devices are connected to the automation system via the PROFIBUS DP fieldbus and addressed like central I/Os.

Programming device

A programming device (PG) is a personal computer in a special compact design, suitable for industrial conditions. A programming device is fully equipped for programming the SIMATIC automation systems.

RC element

Series connection of ohmic resistor and capacitor. When a load is switched off, overvoltage occurs in circuits with an inductive load, which can lead to an arc and reduce the service life of the contacts. To extinguish this arc, the contact can be bridged by an RC element.

Reaction time

The reaction time is the time from detection of an input signal to the change of an output signal linked to it.

The actual reaction time lies between the shortest and the longest reaction time. When configuring a system, the longest reaction time must always be taken into account.

Reference channel error

Parameter in STEP 7 for analog input modules. This parameter is used to enable the group error signal of the reference junction when thermocouples are used. When thermocouples are used, a reference channel error occurs in the following cases:

- A fault (e.g. wire break) occurs in a reference channel to which a thermal resistor (RTD) is connected to compensate temperature drift (channel 0).
- The → reference temperature is outside the permissible value range.

Each input channel to which the reference junction "RTD on channel 0" is assigned has the reference channel error in the case described above - the measured temperature is no longer compensated.

Reference junction

Parameter in STEP 7 for analog input modules. This parameter is used to specify the reference junction (location with known temperature) when using thermocouples. Reference junctions can be: Resistance thermometer on channel 0 of the module; → compensating box, → reference temperature.

Reference potential

Potential based on which the voltages of the circuits involved are examined and measured.

Reference temperature

Parameter in STEP 7 for analog input modules. The reference temperature is the temperature of the reference junction when thermocouples are used. The reference temperature enables correct temperature measurement using thermocouples. The temperature of the reference junction must be known, since a thermocouple always detects the temperature difference between the measuring point and reference junction.

Repeatability

Repeatability is the maximum deviation of the measured/output values that occurs when the same input signal is applied or the same output value is specified repeatedly. Repeatability is in relation to the nominal range of the module and applies to the steady state of the temperature.

Resolution

In analog modules, number of bits that represent the digitized analog value in binary form. The resolution depends on the module and, in the case of analog input modules, on the → integration time. The longer the integration time, the more precise the resolution of the measured value. The resolution can be up to 16 bits including sign.

Retentivity

Data areas in data blocks as well as timers, counters and bit memory are retentive if their content is retained after a restart or power OFF.

S7 basic communication

Communication functions integrated in the CPU of SIMATIC S7/C7 that can be called by the user. The functions are called in the user program with → system functions. The user data length is up to 76 bytes (small amounts of data). S7 basic communication is realized via → MPI.

S7 communication

Communication functions integrated in the CPU of SIMATIC S7/C7 that can be called by the user. The functions are called in the user program with → system function blocks. The user data length is up to 64 KB (large amounts of data). S7 communication provides a network-independent interface between devices of SIMATIC S7/C7 and PG/PC type.

Segment

→ Bus segment

Shunt

Low-resistance conductor connected in parallel in electric circuits.

Signal module

Signal modules (SMs) form the interface between the process and the automation system. There are input modules, output modules, input/output modules (in each case, digital and analog).

Smoothing

Parameter in STEP 7 for analog input modules. The measured values are smoothed using digital filtering. It is possible to choose between no, weak, medium and strong smoothing for each individual module. The stronger the smoothing, the higher the time constant of the digital filter.

Standard communication

Communication via standardized protocols such as PROFIBUS DP, PROFIBUS FMS.

Static data

Static data is data that is only used within a → function block. This data is stored in an instance data block belonging to the function block. The data stored in this way is retained until the next function block call.

Substitute value

Substitute values are values that are output to the process if a signal output module is defective or that are used in the user program instead of a process value if a signal input module is defective.

The substitute values can be configured by the user in STEP 7 (keep last value, substitute value 0 or 1). They are the values that the output(s) are to output at CPU-STOP.

SYNC

Control command of the → master to the device: freezing of the outputs at their current value.

System diagnostics

System diagnostics is the detection, evaluation and signaling of errors that occur within the automation system. Examples of such errors are: Program errors or failures on modules. System errors can be indicated with LED displays or in STEP 7.

Temperature coefficient

Parameter in STEP 7 for analog input modules when temperature is measured with a resistance thermometer (RTD). The temperature coefficient is selected according to the resistance thermometer used (according to DIN standard).

Temperature error

The temperature error is the drift of the measured/output values caused by changes in the ambient temperature of the analog module. It is specified as a percentage per degree Kelvin in relation to the nominal range of the analog module.

Temperature error of internal compensation

The temperature error of the internal compensation only occurs when measuring with thermocouples. It indicates the error to be taken into account in addition to the actual temperature error when "Internal comparison" mode is selected. The error is specified either as a percentage in relation to the physical nominal range of the analog module or as an absolute value in °C.

Temporary data

Temporary data is → local data of a block that is stored in the local data stack during execution of a block and is no longer available on completion of execution.

Total current

Total of the currents of all output channels of a digital output module.

Unforce

→ Force

Ungrounded

Having no electrical connection to ground

Warm restart

Restart after a power failure, with a set of dynamic data programmed by the user and a user program section defined in the system.

A warm restart is characterized by the setting of a status bit or other appropriate means that can be read by the user program and that indicates that the shutdown of the automation system due to power failure has been detected in RUN mode.

Wire break

Parameter in STEP 7. A wire-break check is used to monitor the connection from the input to the sensor or from the output to the actuator. In the event of a wire break, the module detects a current flow at the correspondingly configured input/output.

Work memory

The work memory is a → RAM memory in the → CPU that is accessed by the processor during execution of the user program.

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