SIEMENS

SIMATIC

S7-300 and M7-300 Programmable Controllers Module Specifications

Reference manual

This manual is part of the following documentation packages with order nos:
S7–300 Programmable Controller:
6ES7 398–8AA03–8BA0
ET 200M Distributed I/O Device:
6ES7 153–1AA00–8BA0

EWA 4NEB 710 6067-02 01

Edition 2

Safety Guidelines

This manual contains notices which you should observe to ensure your own personal safety, as well as to protect the product and connected equipment. These notices are highlighted in the manual by a warning triangle and are marked as follows according to the level of danger:

Danger

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

Warning

indicates that death, severe personal injury or substantial property damage **can** result if proper precautions are not taken.

Caution

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

Note

draws your attention to particularly important information on the product, handling the product, or to a particular part of the documentation.

Qualified Personnel

Only **qualified personnel** should be allowed to install and work on this equipment. Qualified persons are defined as persons who are authorized to commission, to ground, and to tag circuits, equipment, and systems in accordance with established safety practices and standards.

Correct Usage

Note the following:

Warning

This device and its components may only be used for the applications described in the catalog or the technical descriptions, and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens.

This product can only function correctly and safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended.

Trademarks

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Some of other designations used in these documents are also registered trademarks; the owner's rights may be violated if they are used by third parties for their own purposes.

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Automation and Drives (A&D)
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Preface

Purpose

The information contained in this manual will enable you to look up operator actions, function descriptions and the technical specifications of the signal modules, power supply modules and interface modules of the S7-300.

How to configure, assemble and wire these modules in an S7-300, M7-300 or ET 200M system is described in the installation manuals for each system.

Audience

This manual describes the modules of the S7-300 which are used in the S7-300, M7-300 and ET 200M systems. It includes data sheets for the signal modules, power supply modules and interface modules of the S7-300.

Modifications Since the Last Version

The following modifications have been made since the last version of the “Module Data” reference manual:

- new is Chapter 1.7 “SIMATIC Outdoor Modules” for use under extended environmental conditions
- new is Chapter 9 “SIMATIC TOP connect TPA”
- the following signal modules have been added:
  - SM 321; DI 32 x 120 VAC
  - SM 322; DO 32 x 120 VAC/1.0 A
  - SM 322; DO 8 x Rel. 230 VAC/5 A
  - SM 331; AI 8 x 16 Bit
  - SM 332; AO 4 x 16 Bit
  - SM 334; AI 4/AO 2 x 12 Bit
  - SM 338 POS input module

Note: You can recognize the previous version of this “Module Data” reference manual by the number EWA 4NEB 710 6067-0x in the footer.

The current number is: EWA 4NEB 710 6067-0x 01.

Standards and Approvals

The S7-300 fulfills the requirements and criteria of the IEC 1131, Part 2. The S7-300 fulfills the requirements for CE marking. The approbations for CSA, UL and FM are available for the S7-300.

Details on the approbations and standards are given in Section 1.1.

Scope of the Documentation Package

This manual forms part of the documentation for the S7-300, M7-300 and ET 200M.

System	Documentation Package
S7-300	• *S7-300 Programmable Controller, Installation and Hardware* • *S7-300, M7-300 Programmable Controllers, Module Specifications* • *S7-300 Instruction List*
M7-300	• *M7-300 Programmable Controller, Installation and Hardware* • *S7-300, M7-300 Programmable Controllers, Module Specifications*
ET 200M	• *ET 200M Distributed I/O Device* • *S7-300, M7-300 Programmable Controllers, Module Specifications*

CD-ROM

Note: You can also order the complete SIMATIC S7 documentation on CD-ROM.

How to Use this Manual

To help you find special information quickly, the manual contains the following access aids:

- At the start of the manual you will find a complete table of contents and a list of the diagrams and tables that appear in the manual.
- An overview of the contents of each section is provided in the left column on each page of each chapter.
- You will find a glossary in the appendix at the end of the manual. The glossary contains definitions of the main technical terms used in the manual.
- At the end of the manual you will find a comprehensive index which gives you fast access to the information you need.

Attributes of Technical Data

Several values of the technical data are specified with attributes in the module data sheets.

These attributes for the values in the technical data mean:

Attribute	Meaning
minimum/maximum	A minimum/maximum value represents a limit or operating value guaranteed by SIEMENS. The minimum or maximum of this value must not be exceeded within other operating limit values during operation. As a user, you must stay within the limits of this value.
typical	The typical value is reached under nominal conditions and an ambient temperature of 25° C. Values may fall below or exceed the typical value due to component tolerances.
approx.	The “approx.” value denotes a rounded value, for example the weight of a module.
without attributes	Values without attributes are rated values with no tolerances.

Additional Assistance

Please contact your local Siemens representative if you have any queries about the products described in this manual.

If you have any questions or suggestions concerning this manual, please fill in the form at the end of this manual and return it to the specified address. Please feel free to enter your personal assessment of the manual in the form provided.

We offer a range of courses to help you to get started with the SIMATIC S7 programmable controller. Please contact your local training center or the central training center in Nuremberg, D-90327 Germany, Tel. +49 911 895 3154.

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Figures

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General Technical Specifications 1

What are General Technical Specifications?

The general technical specifications include standards and test specifications which the S7-300 meets and fulfills and which were used during testing of the S7-300.

Contents

This chapter includes the following sections relating to the general technical specifications:

1.1 Standards and Approvals

Introduction

This section provides information on the modules and components of the S7-300 with reference to

- the most important standards whose criteria are met by the S7-300 and
- approbations for the S7-300.

IEC 1131

The S7-300 programmable controller meets the requirements and criteria of standard IEC 1131, Part 2.

CE Marking

Our products meet the requirements and protection objectives of the following EC Directives and comply with the harmonized European standards (EN) issued in the Official Journal of the European Communities with regard to programmable controllers:

- 89/336/EEC “Electromagnetic Compatibility” (EMC Directive)
- 73/23/EEC “Electrical Equipment Designed for Use between Certain Voltage Limits” (Low-Voltage Directive)

The declarations of conformity are held at the disposal of the competent authorities at the address below:

Siemens Aktiengesellschaft
Bereich Automatisierungstechnik
A&D AS E 4
Postfach 1963
D-92209 Amberg
Germany

EMC Directive

SIMATIC products have been designed for use in industrial environments.

Area of Application	Requirements in respect of:	
	Emitted interference	Immunity
Industry	EN 50081-2 : 1993	EN 50082-2 : 1995

If you operate an S7-300 in a residential area, you must ensure Limit Value Class B in accordance with EN 55011 to guard against radio interference emissions.

Measures to achieve interference suppression according to Limit Value Class B:

- mounting the S7–300 in a grounded cabinet or case
- use of filters in supply lines

UL Approval

UL Recognition Mark
Underwriters Laboratories (UL) to
Standard UL 508, Report 116536

CSA Approval

CSA Certification Mark
Canadian Standard Association (CSA) to
Standard C22.2 No. 142, Report LR 48323

FM Approval

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

Warning

Personal injury or property damage can result.

In areas subject to danger of explosion, personal injury or property damage can result if you withdraw connectors while an S7-300 is in operation.

Always isolate the S7-300 in areas subject to danger of explosion before withdrawing connectors.

UL, CSA, FM Approval for SIMATIC Outdoor Modules

For the SIMATIC Outdoor Modules for use under extended environmental conditions the respective UL, CSA, and FM approvals have been applied for.

1.2 Electromagnetic Compatibility of S7-300 Modules

Definition

Electromagnetic compatibility is the ability of an item of electrical equipment to function satisfactorily in its electromagnetic environment without having an adverse effect on that environment.

The S7-300 modules satisfy the requirements of EMC legislation of the European national market.

You will find below some information on the noise immunity of S7-300 modules and their RI specifications.

Pulse-Shaped Interference

The table below shows the electromagnetic compatibility of S7-300 modules with regard to pulse-shaped interference. A prerequisite is that the S7-300/M7-300/ET 200M conforms to the specifications and guidelines for the electrical configuration.

Pulse-Shaped Interference	Tested With	Corr. to Severity Class
Electrostatic discharge to IEC 801-2 (DIN VDE 0843 Part 2)	8 kV 4 kV	3 (discharge in air) 2 (contact discharge)
Bursts (fast transient bursts) to IEC 801-4 (VDE 0843, Part 4)	2 kV (supply cable) 2 kV (signal cable)	3
Surges to IEC 801-5 (DIN VDE 0839, Part 10) External protection circuit required (see manual *S7-300 Programmable Controller, Hardware and Installation*, Chap. “Lightning Protection”)		
Asymmetrical coupling	2 kV (supply cable) 2 kV (signal/data cable)	3
Symmetrical coupling	1 kV (supply cable) 1 kV (signal/data cable)	

Sinusoidal Interference

High-frequency radiation to the device in accordance with ENV 50140 (corresponds to IEC 801-3):

- Electromagnetic high-frequency field, amplitude modulated
  - from 80 to 1000 MHz
  - 10 V/m
  - 80 % AM (1 kHz)
- Electromagnetic high-frequency field, pulse modulated
  - 900 ± 5 MHz
  - 10 V/m
  - 50 % ED
  - 200 Hz repetition frequency
- High-frequency interference on signal and data lines, etc. in accordance with ENV 50141 (corresponds to IEC 801-6), high-frequency, asymmetrical, amplitude modulated
  - from 0.15 to 80 MHz
  - 10 V effective value, unmodulated
  - 80 % AM (1 kHz)
  - 150 Ω source impedance

Emission of Radio Interference

Interference emission of electromagnetic fields in accordance with EN 55011: Limit value class A, Group 1.

From 20 to 230 MHz	< 30 dB (μV/m)Q
From 230 to 1000 MHz	< 37 dB (μV/m)Q
Measured at a distance of 30 m (98.4 ft.)	

Interference emission via the mains AC power supply in accordance with EN 55011: Limit value class A, Group 1.

From 0.15 to 0.5 MHz	< 79 dB (μV)Q < 66 dB (μV)M
From 0.5 to 5 MHz	< 73 dB (μV)Q < 60 dB (μV)M
From 5 to 30 MHz	< 73 dB (μV)Q < 60 dB (μV)M

1.3 Transport and Storage Conditions for S7-300 Modules and Backup Batteries

S7-300 Modules

As regards transport and storage conditions, S7-300 modules more than meet the requirements of IEC 1131, Part 2. The following data applies to S7-300 modules transported or stored in their original packing.

Condition	Permissible Range
Free fall	≤ 1m (3.28 ft)
Temperature	– 40°C to + 70°C (– 40°F to + 158°F)
Atmospheric pressure	1080 to 660 hPa (corresponding to an altitude of – 1000 to 3500 m)
Relative humidity	5 to 95 %, no condensation

Transporting Backup Batteries

Wherever possible, transport backup batteries in their original packing. Special approval does not have to be obtained for transporting backup batteries for S7-300 systems. A backup battery contains about 0.25 g of lithium.

Note: According to the transport regulations for air freight, backup batteries are materials of danger class 9.

Storing Backup Batteries

Store backup batteries in a dry and cool place.

Backup batteries can be stored for five years.

Warning

If backup batteries are not treated properly, they can ignite, explode and cause severe burning.

Store backup batteries in a dry and cool place.

1.4 Mechanical and Climatic Environmental Conditions for Operating S7-300s

Operating Conditions

S7-300 systems are intended for stationary use in locations protected against the weather. The operating conditions exceed the requirements of IEC 1131-2.

The S7-300 fulfills the operating conditions of class 3C3 according to DIN EN 60721 3-3 (installation locations with high traffic density and in immediate proximity to industrial plants with chemical emissions).

Where Not to Use S7-300 Systems

Unless the appropriate extra measures are taken, S7-300 systems **must not** be used

- in locations exposed to a high degree of ionizing radiation
- in hostile environments caused, for instance, by
  - dust accumulation
  - corrosive vapors or gases.
- in installations requiring special monitoring, for example
  - elevators
  - electrical installations in particularly hazardous locations.

One of the extra measures you can take to widen the application of S7-300 systems, for instance, is to install them in cabinets.

Climatic Conditions

You can use S7-300s under the following climatic conditions:

Climatic Conditions	Range	Remarks
Temperature: Horizontal arrangement: Vertical arrangement:	 0 to 60°C (32 to 140°F) 0 to 40°C (32 to 104°F)	–
Relative atmospheric humidity	5 to 95 %	No condensation; corresponds to a rel. humidity stress level of 2 to IEC 131-2
Atmospheric pressure	1080 to 795 hPa	Corresponding to an altitude of – 1000 to2000 m
Concentration of contaminants	SO_2: < 0.5 ppm; relative humidity < 60 %, no condensation H_2S: < 0.1 ppm; relative humidity < 60 %, no condensation	Test: 10 ppm; 4 days 1 ppm; 4 days

Ambient Mechanical Conditions

The ambient mechanical conditions for S7-300 modules are listed in the following table in the form of sinusoidal oscillations.

Frequency Range (Hz)	Continuous	Occasional
$10 \leq f \leq 58$	0.0375 mm amplitude	0.075 mm amplitude
$58 \leq f \leq 150$	0.5 g constant acceleration	1 g constant acceleration

Reducing Vibrations

If your S7-300 modules are exposed to severe shock and/or vibrations, you must take the appropriate measures to reduce the acceleration and/or amplitude, respectively.

We recommend that you install the rail on vibration-damping material (for example rubber-metal antivibration mountings).

Ambient Mechanical Conditions Test

The following table contains important information on the type and scope of tests for ambient mechanical conditions.

Test ...	Test Standard	Remarks
Vibrations	Vibration test to IEC 68, Parts 2-6 (sinusoidal)	Type of oscillation: Frequency sweeps with a rate of change of 1 octave/minute. 10 Hz $\leq$ F $\leq$ 58 Hz, constant amplitude 0.075 mm 58 Hz $\leq$ F $\leq$ 150 Hz, constant acceleration 1 g Duration of oscillation: 10 frequency sweeps per axis in each of 3 axes normal to each other
Shock	Shock test to IEC 68, Parts 2-27	Type of shock: Semisinusoidal Severity of shock: 15 g peak value, 11 ms duration Direction: 3 shocks each in +/– direction in each of the 3 axes normal to each other

1.5 Information on Insulation Tests, Protection Class and Degree of Protection

Test Voltages

The dieletric strength of the insulation was proven with the following test voltages to IEC 1131 Part 2.

Circuits With Rated Voltage U_e to Other Circuits or to Ground	Test Voltage
$0\ V < U_e \leq 50\ V$	500 VDC
$100\ V < U_e \leq 300\ V$	$(2\ U_N + 1000)$ VAC

Example

According to the above table, the test voltage for 230 VAC is 1460 VAC.

Protection Class

Protection class 1 to IEC 536 (VDE 0106, Part 1), that is, the protective grounding conductor must be connected to the rail!

Protection Against Ingress of Foreign Bodies and Water

Degree of protection IP 20 to IEC 529, that is, protection against contact with standard probes.

Also: Protected against the ingress of foreign bodies with diameters of more than 12.5 mm.

No special protection against water.

1.6 Rated Voltages of the S7-300

Rated Operating Voltages

The S7-300 and its various modules operate at different rated voltages. Table 1-1 lists these rated voltages and the relevant tolerances for the S7-300.

Table 1-1 Rated Voltages of the S7-300

Rated Voltage	Tolerance Range
24 VDC	20.4 to 28.8 VDC
120 VAC	93 to 132 VAC
230 VAC	187 to 264 VAC

1.7 SIMATIC Outdoor Modules

SIMATIC outdoor modules are modules that can be used under extended environmental conditions. Extended environmental conditions means:

- operation possible at temperatures from – 25 °C to + 60 °C
- occasional, brief condensation permitted
- increased mechanical stress permissible

Comparison with “standard” modules

The functional scope and technical specifications for the SIMATIC outdoor modules correspond to those of the “standard” modules.

The climatic and mechanical environmental conditions as well as the methods used to test them have changed.

The SIMATIC outdoor modules have their own Order Numbers (see Table 1–1)

Configuring in STEP 7

Do you have a STEP 7 version in which the SIMATIC outdoor modules are not in the hardware catalog?

Simply configure your system with the corresponding “standard” modules (see Table 1-2).

Modules

Table 1-2 lists all modules which satisfy the extended environmental conditions.

The Order No. of the corresponding ”standard” module has additionally been included in the Table as a configuring aid. Refer to these ”standard” modules for a detailed description and technical specifications.

Table 1-2 Modules for extended environmental conditions

Module	SIMATIC outdoor module for use under extended environmental conditions	“Standard” modules
	as of order no.	
IM 153-1	6ES7 153-1AA**82**-0XB0	6ES7 153-1AA02-0XB0
IM 153-2 FO	6ES7 153-2AB**80**-0XB0	6ES7 153-2AB00-0XB0
CPU 315-2 DP	6ES7 315-2AF**82**-0AB0	6ES7 315-2AF02-0AB0
CPU 312	6ES7 312-5AC**81**-0AB0	6ES7 312-5AC01-0AB0
CPU 314	6ES7 314-1AE**83**-0AB0	6ES7 314-1AE03-0AB0
CPU 314 IFM	6ES7 314-5AE**83**-0AB0	6ES7 314-5AE03-0AB0
IM 365	6ES7 365-0BA**81**-0AA0	6ES7 365-0BA01-0AA0
SM 321 digital input module;		
SM 321; DI 16 × 24 VDC	6ES7 321-1BH**81**-0AA0	6ES7 321-1BH01-0AA0
SM 321; DI 32 × 24 VDC	6ES7 321-1BL**80**-0AA0	6ES7 321-1BL00-0AA0
SM 321; DI 16 × 24 VDC	6ES7 321-7BH**80**-0AA0	6ES7 321-7BH00-0AB0
SM 321; DI 8 × 120/230 VAC	6ES7 321-1FF**81**-0AA0	6ES7 321-1FF01-0AB0
SM 322 digital output module;		
SM 322; DO 16 × 24 VDC/0.5 A	6ES7 322-1BH**81**-0AA0	6ES7 322-1BH01-0AA0
SM 322; DO 8 × Rel. 230 VAC/5 A	6ES7 322-1HF**80**-0AA0	6ES7 322-1HF10-0AA0
SM 322; DO 32 × 24 VDC/0,5 A	6ES7 322-1BL**80**-0AA0	6ES7 322-1BL00-0AA0
SM 322; DO 8 × 120/230 VAC/2 A	6ES7 322-1FF**81**-0AA0	6ES7 322-1FF01-0AA0
SM 323 digital I/O module;		
DI8/DO8 × 24 VDC/0.5 A	6ES7 323-1BH**80**-0AA0	6ES7 323-1BH00-0AA0
SM 331 analog input module; AI 2 × 12 Bit	6ES7 331-1KB**81**-0AB0	6ES7 331-1KB01-0AB0
SM 332 analog output module; AO 2 × 12 Bit	6ES7 332-5HB**81**-0AB0	6ES7 332-5HB01-0AB0
SM 334 analog I/O module;		
AI4/AO 2 × 12 Bit	6ES7 334-0KE**80**-0AB0	6ES7 334-0KE00-0AB0
FEPROM 64 KByte memory card	6ES7 951-0KF**80**-0AA0	6ES7 951-0KF00-0AA0
FEPROM 32 kByte memory card	6ES7 951-0KE**80**-0AA0	6ES7 951-0KE00-0AA0
FEPROM 16 kByte memory card	6ES7 951-0KD**80**-0AA0	6ES7 951-0KD00-0AA0
Bus connector	6ES7 972-0BAx0-0XA0 6ES7 972-0BBx0-0XA0	

Climatic environmental conditions

The SIMATIC outdoor modules for extended environmental conditions may be used under the following climatic conditions:

Installation category: According to IEC 721 3-3, Class 3K5.

Environmental conditions	Range of application	Remarks
Temperature: Horizontal installation Vertical installation	 –25 °C to 60 °C –25 °C to 40 °C	–
Relative humidity	From 5 to 95 %	**Occasional, brief condensation**, corresponds to relative humidity (RH) class 2 to IEC 1131-2
Atmospheric pressure	1080 to 795 hPa	Corresponds to a height of –1000 to 2000 m
Pollutant concentration (to IEC 721 3-3; class 3C3)	 SO_2: < 0.5 ppm; Relative humidity < 60 % H_2S: < 0.1 ppm; Relative humidity < 60 %	Test: 10 ppm; 4 days 1 ppm; 4 days

Mechanical environmental conditions

Installation category: to IEC 721 3-3, class 3M4.

Testing of mechanical conditions

The table below provides information on the type and scope of the mechanical condition tests for SIMATIC outdoor modules.

Test for ...	Test standard	Remarks
Vibration	Vibration test to IEC 68 Part 2-6 (sinusoidal)	Mode of vibration: Frequency sweeps with a sweep rate of 1 octave/minute. 2 Hz $\leq$ f $\leq$ 9 Hz, const. amplitude 3.5 mm 10 Hz $\leq$ f $\leq$ 150 Hz, const. acceleration 1 g Period of vibration: 10 frequency sweeps per axis in each of the 3 perpendicular axes
Shock	Shock test to IEC 68 Part 2-27	Type of shock: Semi–sinusoidal Schock intensity: 15 g peak value, 11 ms duration Shock direction: 3 shocks, each in +/– direction in each of the perpendicular axes

Power Supply Modules 2

Introduction

Various power supply modules are available to supply your S7-300 programmable controller and the sensors/actuactors with 24 VDC.

Power Supply Modules

This chapter describes the technical specifications of the power supply modules of the S7-300 programmable controller.

In addition to the technical specifications, this chapter describes the following:

- Characteristics
- Wiring schematic
- Basic circuit diagram
- Line protection
- Reaction to atypical operating conditions

Contents

This chapter describes the following power supply modules:

2.1 The PS 307 Power Supply Module (2 A)

Order Number

6ES7 307-1BA00-0AA0

Characteristics

The PS 307 power supply module (2 A) has the following salient features:

- Output current 2 A
- Output voltage 24 VDC; proof against short-circuit and open circuit
- Connection to single-phase AC system

  (input voltage 120/230 VAC, 50/60 Hz)
- Reliable isolation to EN 60 950
- Can be used as load power supply

Wiring Schematic

Figure 2-1 shows the wiring schematic of the PS 307 power supply module (2 A). You will find a detailed technical description of the module on the following pages.

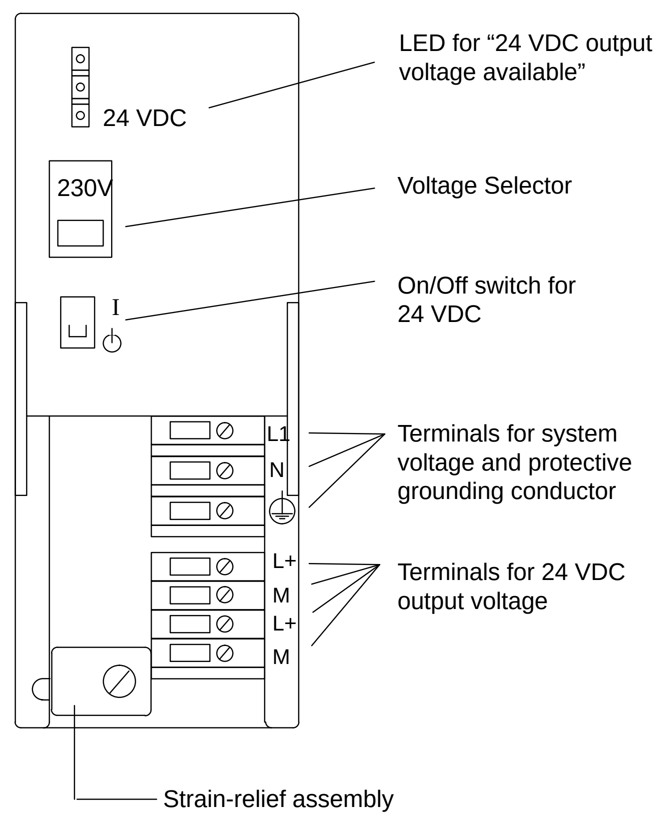


Figure 2-1 Wiring Schematic of the PS 307 Power Supply Module (2 A)

Basic Circuit Diagram

Figure 2-2 shows the basic circuit diagram of the PS 307 power supply module (2 A).

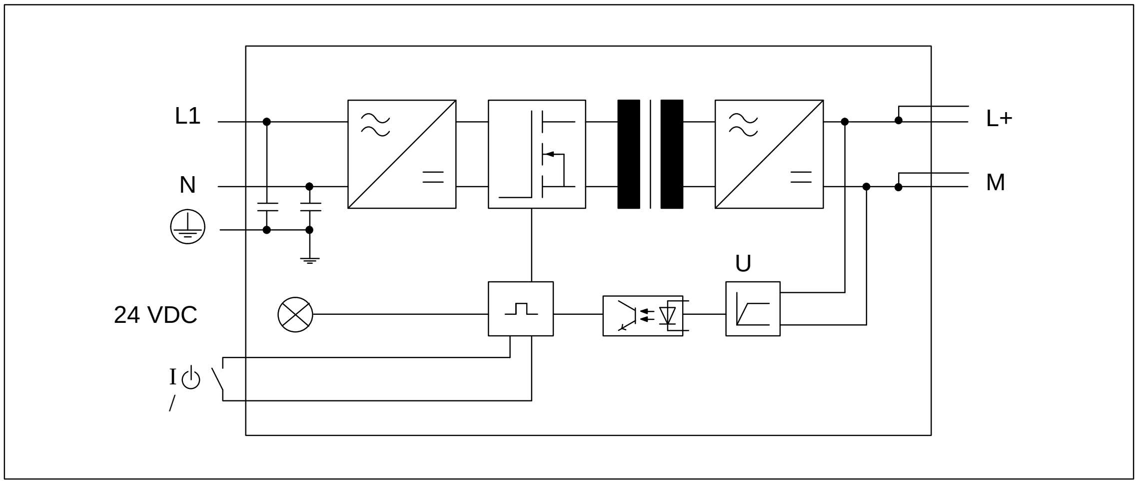


Figure 2-2 Basic Circuit Diagram of the PS 307 Power Supply Module (2 A)

Line Protection

We recommend that you install a miniature circuit-breaker (MCB) (for example Siemens 5SN1 series) with the following rating to protect the incoming supply cable of the PS 307 power supply module (2 A):

- Rated current at 230 VAC: 6 A
- Tripping characteristic (type): B or C

Reaction to Atypical Operating Conditions

Table 2-1 gives information on the reaction of the power supply module to atypical operating conditions.

Table 2-1 Reaction of the PS 307 Power Supply Module (2 A) to Atypical Operating Conditions

If ...	... Then ...	24 VDC LED
... the output circuit is overloaded:		
• I > 2.6 A (dynamic)	Voltage dip, autom. volt. recovery	Flashes
• 2 A < I ≤ 2.6 A (steady state)	Voltage drop, shortening of service life	
... the output is short-circuited	Output voltage 0 V; automatic voltage recovery after short circuit has been eliminated	Dark

Table 2-1 Reaction of the PS 307 Power Supply Module (2 A) to Atypical Operating Conditions

If ...	... Then ...	24 VDC LED
an overvoltage occurs on the primary side	Possible destruction	-
there is an undervoltage on the primary side	Automatic disconnection; automatic voltage recovery	Dark

Technical Specifications

The technical specifications of the PS 307 power supply module (2 A) are listed below.

Dimensions and Weight	
Dimensions W × H × D	50 × 125 × 120 mm (1.95×4.88×4.68 in.)
Weight	approx. 420 g (14.7 oz.)
Input Rating	
Input voltage	
• Rated value	120 / 230 VAC
System frequency	
• Rated value	50 Hz or 60 Hz
• Permiss. range	47 Hz to 63 Hz
Rated input current	
• at 230 V	0.5 A
• at 120 V	0.8 A
Inrush current (at 25°C/77°F)	20 A
I^2t (at inrush current)	2.2 A^2s
Output Rating	
Output voltage	
• Rated value	24 VDC
• Permiss. range	24 V ±5 %, proof against open-circuit
• Ramp-up time	max. 2.5 s
Output current	
• Rated value	2 A, cannot be connected in parallel configurations

Output Rating, continued	
Short-circuit protection	Electronic, nonlatching, 1.1 to 1.3 × I_N
Residual ripple	max. 150 mVss
Other Parameters	
Protection class to IEC 536 (DIN VDE 0106, Part 1)	I, with protective grounding conductor
Insulation	
• Rated insulation level (24 V to L1)	250 VAC
• Tested with	2800 VDC
Reliable isolation	to DIN VDE 0106, Part 101
Bridging of power failures (at 93 and/or 187 V)	min. 20 ms
• Repeat rate	min 1 s
Efficiency	83 %
Power input	58 W
Power losses	typ. 10 W
Diagnostics	
LED for output voltage available	Yes, green LED

2.2 The PS 307 Power Supply Module (5 A)

Order Number

6ES7 307-1EA00-0AA0

Eigenschaften

The PS 307 power supply module (5 A) has the following salient features:

- Output current 5 A
- Output voltage 24 VDC; proof against short-circuit and open circuit
- Connection to single-phase AC system

  (input voltage 120/230 VAC, 50/60 Hz)
- Safe electrical isolation to EN 60 950
- Can be used as load power supply

Wiring Schematic

Figure 2-3 shows the wiring schematic of the PS 307 power supply module (5 A). You will find a detailed technical description of the module on the following pages.

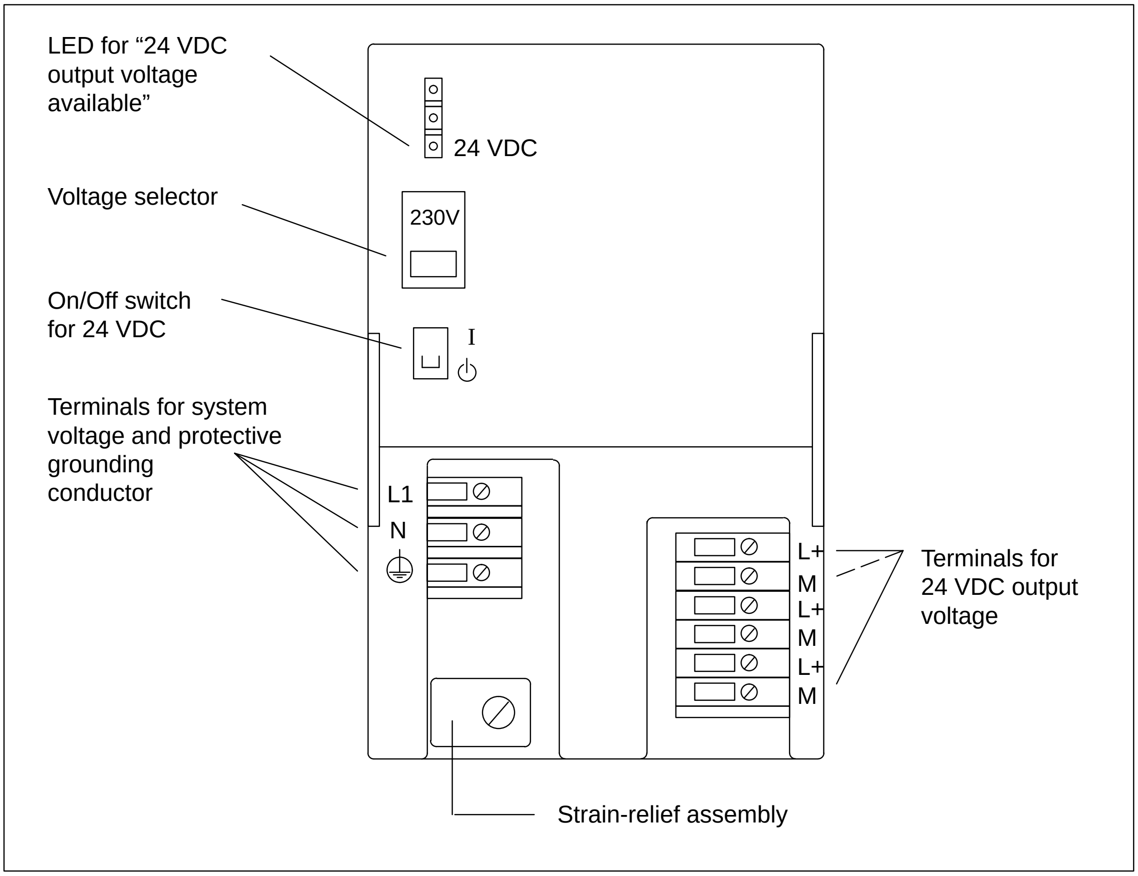


Figure 2-3 Wiring Schematic of the PS 307 Power Supply Module (5 A)

Basic Circuit Diagram

Figure 2-4 is the basic circuit diagram of the PS 307 power supply module (5 A).

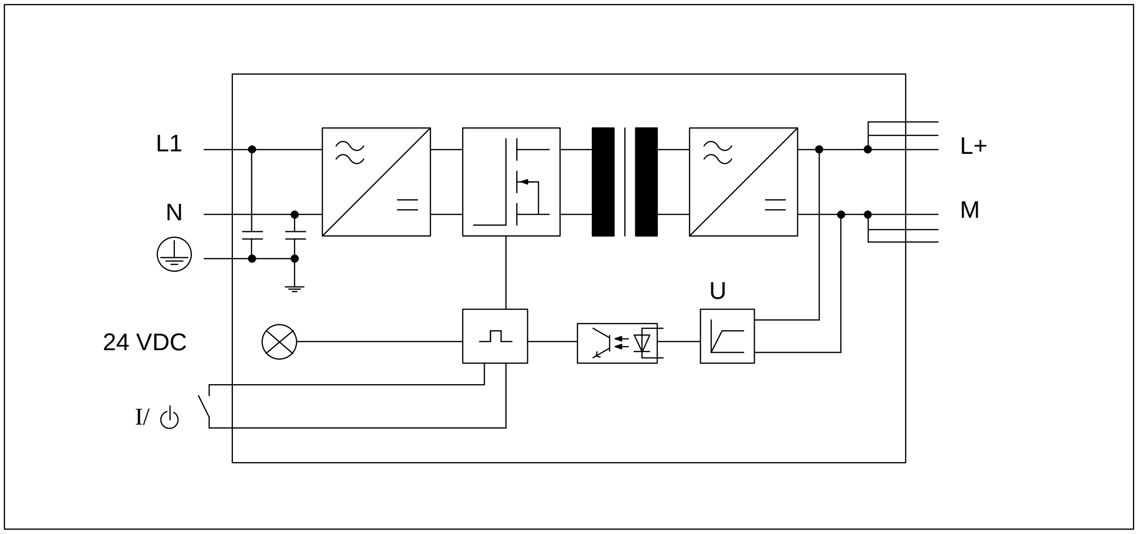


Figure 2-4 Basic Circuit Diagram of the PS 307 Power Supply Module (5 A)

Line Protection

We recommend that you install a miniature circuit-breaker (MCB) (for example Siemens 5SN1 series) with the following rating to protect the incoming supply cable of the PS 307 power supply module (5 A):

- Rated current at 230 VAC: 10 A
- Tripping characteristic (type): B or C

Reaction to Atypical Operating Conditions

Table 2-2 gives information on the reaction of the power supply module to atypical operating conditions.

Table 2-2 Reaction of the PS 307 Power Supply Module (5 A) to Atypical Operating Conditions

If ...	... Then ...	24 VDC LED
... the output circuit is overloaded: • $I > 6.5$ A (dynamic) • 5 A $< I \leq$ 6.5 A (steady state)	 Voltage dip, automatic voltage recovery Voltage drop, shortening of service life	Flashes
... the output is short-circuited	Output voltage 0 V; automatic voltage recovery after short circuit has been eliminated	Dark
an overvoltage occurs on the primary side	Possible destruction	–
there is an undervoltage on the primary side	Automatic disconnection; automatic voltage recovery	Dark

Technical Specifications

The technical specifications of the PS 307 power supply module (5 A) are listed below.

Dimensions and Weight	
Dimensions (W × H × D)	80 × 125 × 120 mm (3.12 × 4.88 × 4.68 in)
Weight	approx. 740 g (25.9 oz.)
Input Rating	
Input voltage	
• Rated value	120 V / 230 VAC
System frequency	
• Rated value	50 Hz or 60 Hz
• Permiss. range	47 Hz to 63 Hz
Rated input current	
• at 230 V	1 A
• at 120 V	2 A
Inrush current (at 25°C/77°F)	45 A
I^2t (at inrush current)	4.32 A^2s
Output Rating	
Output voltage	
• Rated value	24 VDC
• Permiss. range	24 V ± 5 %, proof against open-circuit
• Ramp-up time	max. 2.5 s
Output current	
• Rated value	5A cannot be connected in parallel configurations
Short-circuit protection	Electronic, nonlatching, 1.1 to 1.3 × I_N
Residual ripple	max. 150 mV_{pp}

Other Parameters	
Protection class to IEC 536 (DIN VDE 0106, Part 1)	I, with protective grounding conductor
Insulation	
• Rated insulation level (24 V to L1)	250 VAC
• Tested with	2800 VDC
Reliable isolation	to DIN VDE 0106, Part 101
Bridging of power failures	
(at 93 and/or 187 V)	min. 20 ms
• Repeat rate	min 1 s
Efficiency	87 %
Power input	138 W
Power losses	typ. 18 W
Diagnostics	
LED for output voltage available	Yes, green LED

2.3 The PS 307 Power Supply Module (10 A)

Order Number

6ES7 307-1KA00-0AA0

Characteristics

The PS 307 power supply module (10 A) has the following salient features:

- Output current 10 A
- Output voltage 24 VDC; proof against short-circuit and open circuit
- Connection to single-phase AC system
  (input voltage 120/230 VAC, 50/60 Hz)
- Reliable isolation to EN 60 950
- Can be used as load power supply

Wiring Schematic

Figure 2-5 shows the wiring schematic of the PS 307 power supply module (10 A). You will find a detailed technical description of the module on the following pages.

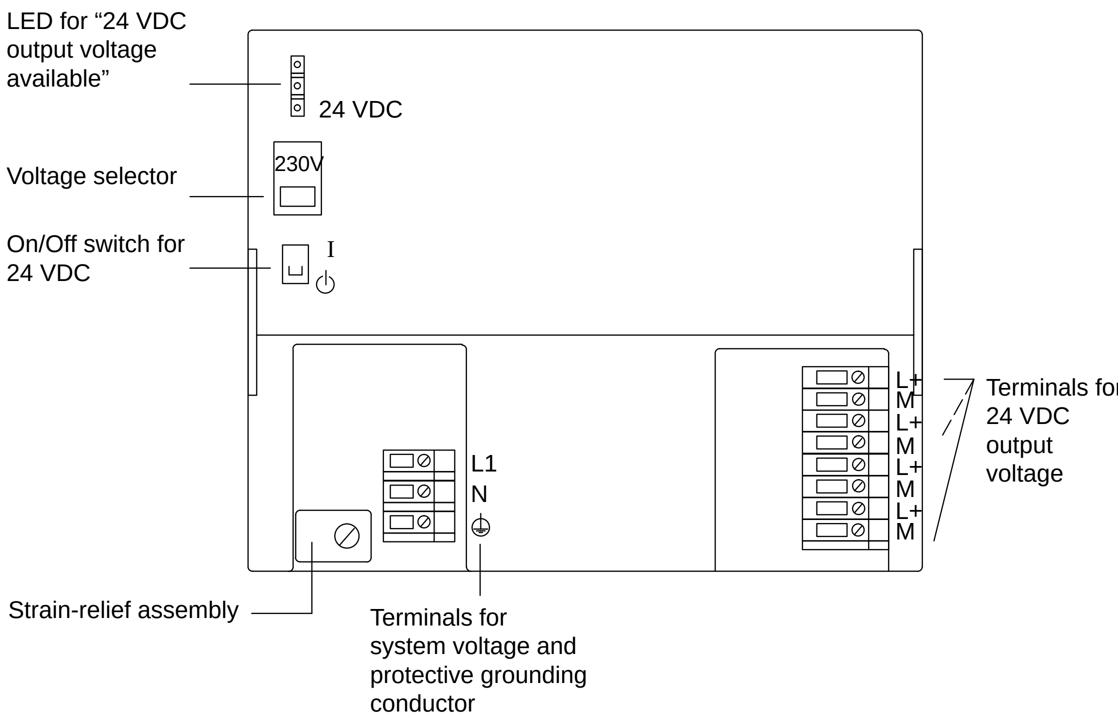


Figure 2-5 Wiring Schematic of the PS 307 Power Supply Module (10 A)

Basic Circuit Diagram

Figure 2-6 shows the basic circuit diagram of the PS 307 power supply module (10 A).

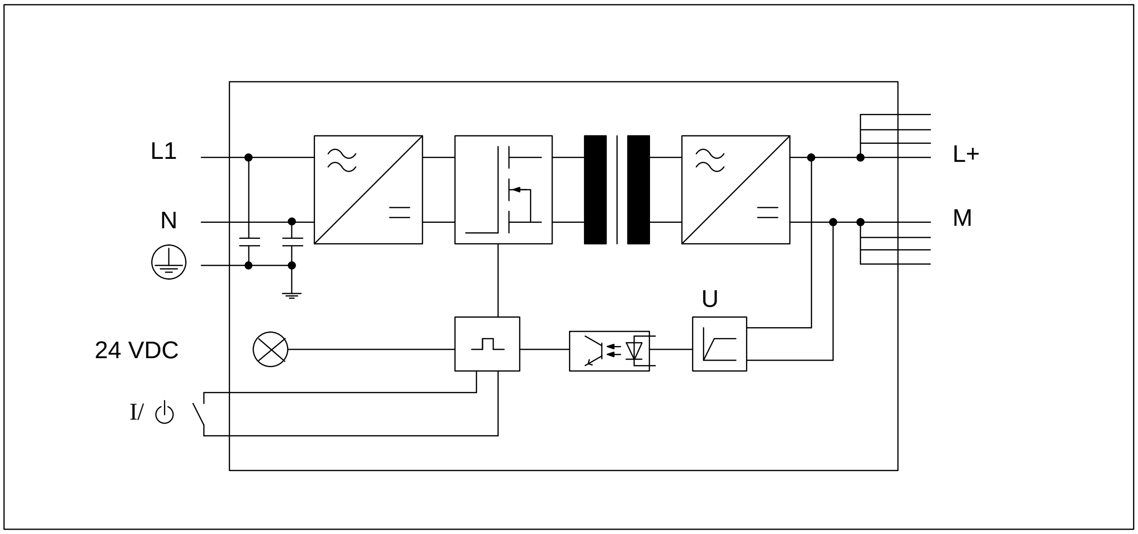


Figure 2-6 Basic Circuit Diagram of the PS 307 Power Supply Module (10 A)

Line Protection

We recommend that you install a miniature circuit-breaker (MCB) (for example, Siemens 5SN1 series) with the following rating to protect the incoming supply cable of the PS 307 power supply module (10 A):

- Rated current at 230 VAC: 16 A
- Tripping characteristic (type): B or C

Reaction to Atypical Operating Conditions

Table 2-3 gives information on the reaction of the power supply module to atypical operating conditions.

Table 2-3 Reaction of the PS 307 Power Supply Module (10 A) to Atypical Operating Conditions

If ...	**... Then ...**	**24 VDC LED**
... the output circuit is overloaded: • I > 13 A (dynamic) • 10 A < I $\leqq$ 13 A (steady state)	 Voltage dip, automatic voltage recovery Voltage drop, shortening of service life	Flashes
... the output is short-circuited	Output voltage 0 V; automatic voltage recovery after short circuit has been eliminated	Dark
an overvoltage occurs on the primary side	Possible destruction	–
there is an undervoltage on the primary side	Automatic disconnection; automatic voltage recovery	Dark

Technical Specifications

The technical specifications of the PS 307 power supply module (10 A) are listed below.

Dimensions and Weight	
Dimensions (W × H × D)	200 × 125 × 120 mm (7.8 × 4.88 × 4.68 in.)
Weight	1.2 kg (2.64 lb.)
Input Rating	
Input voltage	
• Rated value	120 V/230 VAC
System frequency	
• Rated value	50 Hz or 60 Hz
• Permiss. range	47 Hz to 63 Hz
Rated input current	
• at 230 V	1.7 A
• at 120 V	3.5 A
Inrush current (at 25°C/77°F)	55 A
I^2t (at inrush current)	9 A^2s
Output Rating	
Output voltage	
• Rated value	24 VDC
• Permiss. range	24 V ± 5 %, proof against open circuit
• Ramp-up time	max. 2.5 s
Output current	
• Rated value	10 A, cannot be connected in parallel configurations
Short-circuit protection	Electronic, nonlatching 1.1 to 1.3 × I_N
Residual ripple	max. 150 mVss

Other Parameters	
Protection class to IEC 536 (DIN VDE 0106, Part 1)	I, with protective grounding conductor
Insulation	
• Rated insulation level (24 V to L1)	250 VAC
• Tested with	2800 VDC
Reliable isolation	to DIN VDE 0106, Part 101
Bridging of power failures	
(at 93 and/or 187 V)	min. 20 ms
• Repeat rate	min 1 s
Efficiency	89 %
Power input	270 W
Power losses	typ. 30 W
Diagnostics	
LED for output voltage available	Yes, green LED

Digital Modules 3

Introduction

A range of digital modules are available for the S7-300 programmable controller to connect sensors/transducers and/or loads/actuators.

Digital Modules

This chapter contains the technical specifications of the digital modules of the S7-300.

Apart from the technical specifications, this chapter also describes:

- The characteristics
- The special features
- The module view and the block diagram of the digital modules

Contents

This chapter contains the technical specifications for the following groups of digital modules:

3.1 Digital Input Modules

List of Digital Input Modules

This chapter describes the following digital input modules:

- SM 321; DI 32 × 24 VDC
- SM 321; DI 16 × 24 VDC
- SM 321; DI 16 × 24 VDC; with process and diagnostics interrupts
- SM 321; DI 16 × 120 VAC
- SM 321; DI 8 × 120/230 VAC
- SM 321; DI 16 × 24 VDC; source input
- SM 321; DI 32 × 120 VAC

3.1.1 Digital Input Module SM 321; DI 32 × 24 VDC

Order Number

6ES7 321-1BL00-0AA0

Characteristics

The digital input module SM 321; DI 32 × 24 VDC has the following salient features:

- 32 input points, isolated in groups of 32
- 24 VDC rated input voltage
- Suitable for switches and 2/3/4-wire BEROs (proximity switches).

Terminal Connection Diagram and Block Diagram

Figure 3-1 shows the terminal connection diagram and block diagram of the digital input module SM 321; DI 32 × 24 VDC.

You will find the detailed technical specifications of the SM 321; DI 32 × 24 VDC on the following page.

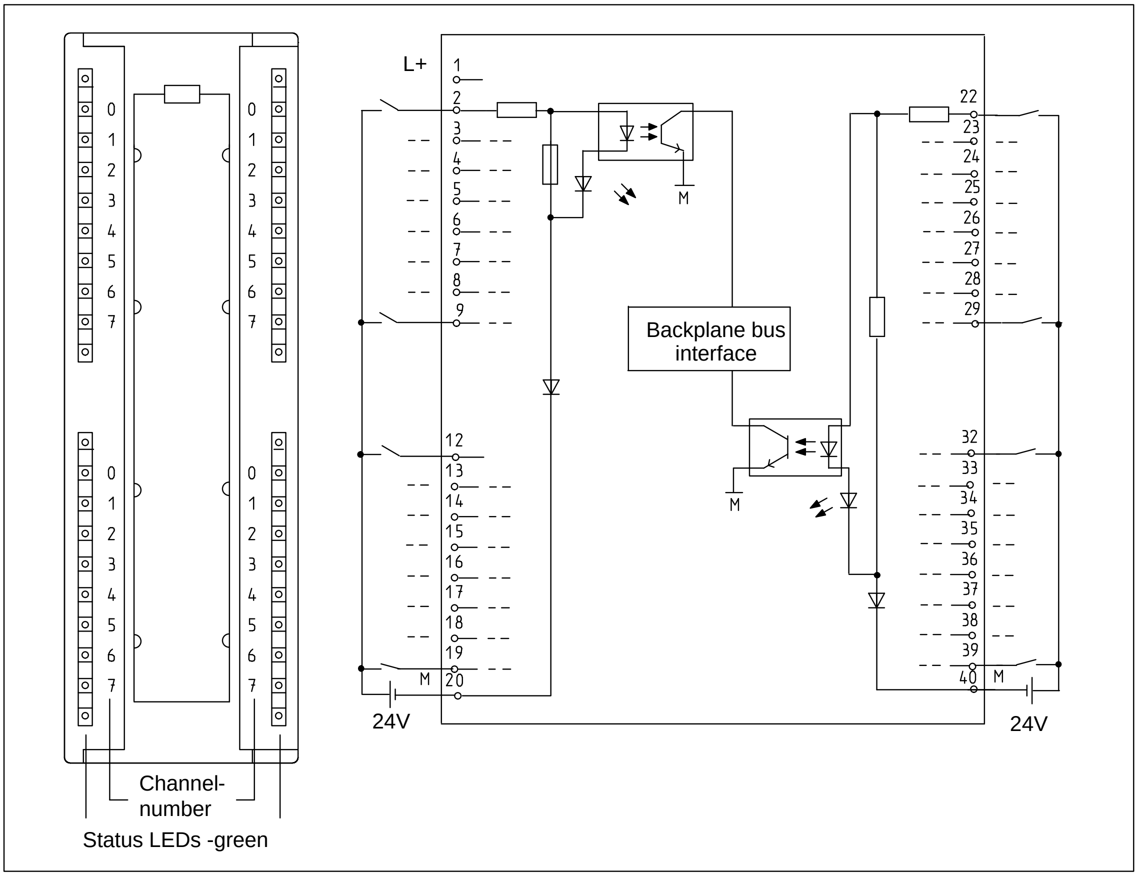
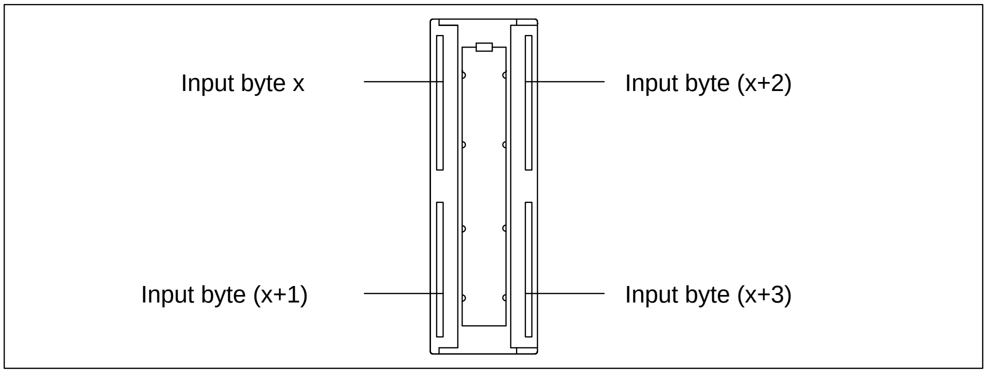


Figure 3-1 Module View and Block Diagram of the Digital Input Module SM 321; DI 32 × 24VDC

Terminal Assignment

The following figure shows the assignment of the channels to the addresses.



Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 260 g
Module-Specific Data	
Number of input points	32
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated load voltage L+	24 VDC
• Reverse polarity protection	Yes
Number of input points that can be driven simultaneously	
• Horizontal installation	
up to 40 °C	32
up to 60 °C	16
• Vertical installation	
up to 40 °C	32
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels in groups of	Yes 16
Permiss. potential differences	
• between different circuits	75 VDC 60 VAC
Insulation tested with	500 VDC
Current drawn	
• from backplane bus	max. 15 mA
• from load voltage L+	–
Module power losses	typ. 6.5 W
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostic functions	None

Sensor Selection Data	
Input voltage	
• Rated value	24 VDC
• for “1” signal	13 to 30 V
• for “0” signal	– 3 to 5 V
Input current	
• at “1” signal	typ. 7 mA
Input delay	
• from “0” to “1”	1.2 to 4.8 ms
• from “1” to “0”	1.2 to 4.8 ms
Input characteristic	To IEC 1131, type 1
Connection of 2-wire BEROs	Possible
• Permissible closed-circuit current	max. 1.5 mA

3.1.2 Digital Input Module SM 321; DI 16 × 24 VDC

Order No.

Characteristics

The digital input module SM 321; DI 16 × 24 VDC has the following salient features:

- 16 input points, isolated in groups of 16
- 24 VDC rated input voltage
- Suitable for switches and 2/3/4-wire BEROs (proximity switches).

Terminal Connection Diagram and Block Diagram

Figure 3-2 shows the terminal connection diagram and block diagram of the digital input module SM 321; DI 16 × 24 VDC.

You will find the detailed technical specifications of the module on the following page.

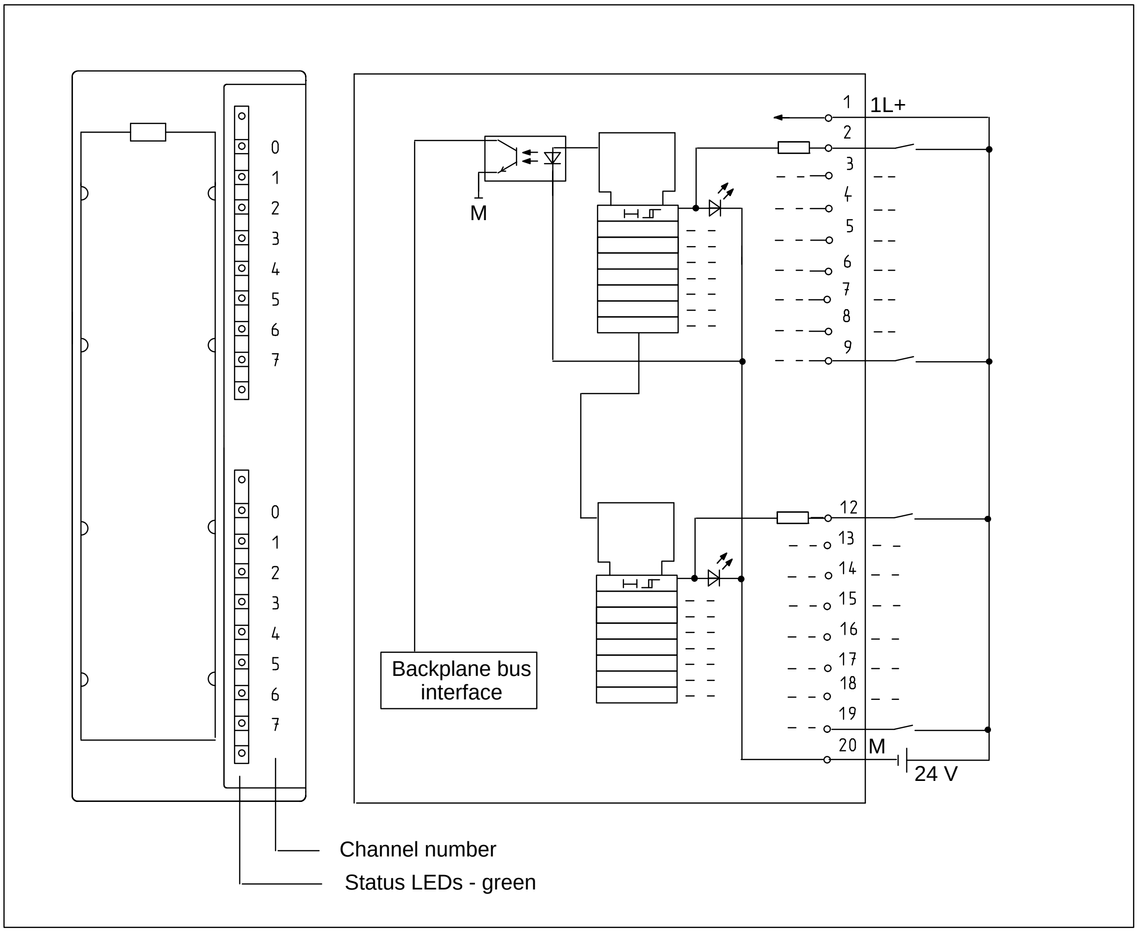


Figure 3-2 Module View and Block Diagram of Digital Input Module SM 321; DI 16 × 24 VDC

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 200 g (7 oz.)
Module-Specific Data	
Number of input points	16
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated load voltage L +	24 VDC
• Reverse polarity protection	Yes
Number of input points that can be driven simultaneously	
• Horizontal installation up to 60 °C	16
• Vertical installation up to 40 °C	16
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels	No
Permiss. potential differences	
• between different circuits	75 VDC 60 VAC
Insulation tested with	500 VDC
Current drawn	
• from backplane bus	max. 25 mA
• from load voltage L +	max. 25 mA
Module power losses	typ. 3.5 W
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	None

Sensor Selection Data	
Input voltage	
• Rated value	24 VDC
• for “1” signal	13 to 30 V
• for “0” signal	– 3 to 5 V
Input current	
• at “1” signal	typ. 7 mA
Input delay	
• from “0” to “1”	1.2 to 4.8 ms
• from “1” to “0”	1.2 to 4.8 ms
Input characteristic	To IEC 1131, type 2
Connection of 2-wire BEROs	Possible
• Permissible closed-circuit current	max. 1.5 mA

3.1.3 Digital Input Module SM 321; DI 16 × 24 VDC; with Process and Diagnostics Interrupts

Order Number

6ES7 321-7BH00-0AB0

Characteristics

The digital input module SM 321; DI 16 × 24 VDC with process and diagnostics interrupts has the following salient features:

- 16 input points, isolated in groups of 16
- 24 VDC rated input voltage
- Suitable for switches and 2/3/4-wire BEROs (proximity switches)
- 2 short-circuit-proof sensor supplies for 8 channels each
- External redundant power supply possible for sensors
- "Sensor supply (Vs) O.K." status LEDs
- Group fault LED
- Configurable diagnostics
- Configurable diagnostics interrupt
- Configurable process interrupt
- Settable input delays

Use in

This I/O modules can be used in the

- **S7-300** (centralized configuration) with the CPU
  312 IFM from 6ES7 312-5AC00-0AB0, revision level 5
  313 from 6ES7 313-1AD00-0AB0, revision level 3
  314 from 6ES7 314-1AE01-0AB0, revision level 6
  314 IFM from 6ES7 314-5AE00-0AB0, revision level 1
  315 from 6ES7 315-1AF00-0AB0, revision level 3
  315-2 from 6ES7 315-2AF00-0AB0, revision level 3
  614 from 6ES7 614-1AH01-0AB3, revision level 6.
- **ET 200M** with the
  IM 153-1 from 6ES7 153-1AA02-0XB0, revision level 1
  IM 153-2 from 6ES7 153-2Ax00-0XB0, revision level 1
  IM 153-3 from 6ES7 153-3AA00-0XB0, revision level 1
  and with the following **DP masters**:
  IM 308C from 6ES5 308-3UC11, revision level 3, and
  CPUs 41x from 6ES7 41x-2XG00-0AB0; revision level 2.

Terminal Connection Diagram

Figure 3-3 shows the terminal diagram and the block diagram of the SM 321; DI 16 × 24 VDC; with process and diagnostics interrupts.

Detailed technical specifications for the SM 321; DI 16 × 24 VDC with process and diagnostics interrupts follow on the next pages.

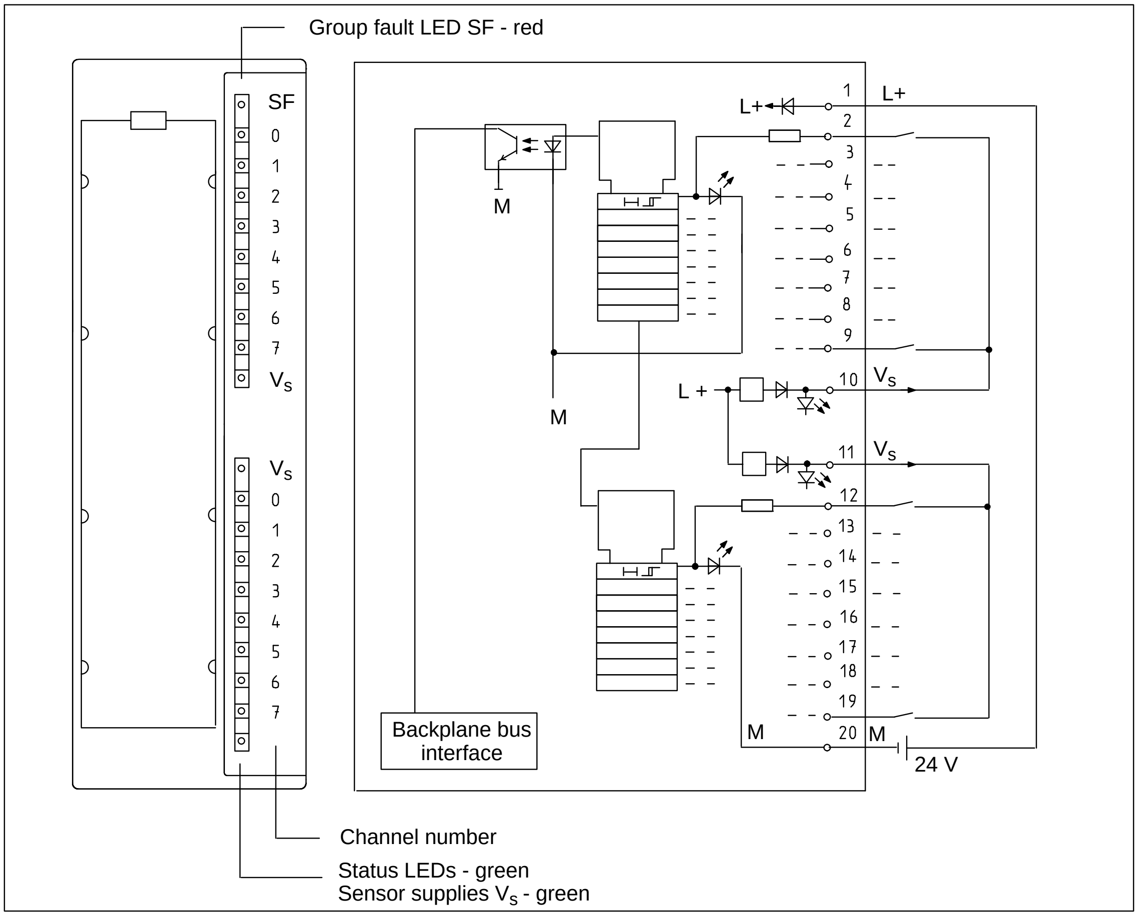


Figure 3-3 Module View and Block Diagram of the SM 321; DI 16 × 24 VDC with Process and Diagnostics Interrupts

Redundant Sensor Supply

Figure 3-4 shows how sensors can be supplied via Vs from an additional power source (e.g. from another module).

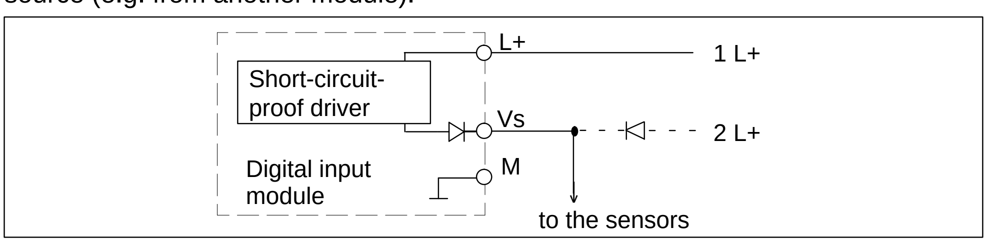


Figure 3-4 Terminal Connection Diagram for the Redundant Supply of Sensors

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 200 g (7 oz.)
Module-Specific Data	
Number of input points	16
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated load voltage L +	24 VDC
• Reverse polarity protection	Yes
Number of input points that can be driven simultaneously	
• Horizontal installation up to 60 °C	16
• Vertical installation up to 40 °C	16
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels	No
• between load voltage L+ and sensor supply V_S	No
Permiss. potential differences	
• between different circuits	75 VDC 60 VAC
Insulation tested with	500 VDC
Current drawn	
• from backplane bus	max. 55 mA
• from load voltage L + (without sensor supply V_S)	max. 40 mA
Module power losses	typ. 4 W
Status, Interrupts, Diagnostics	
Status display	
• Inputs	Green LED per channel
• Sensor supplies (Vs)	Green LED per output
Interrupts	
• Process interrupt	Configurable
• Diagnostics interrupt	Configurable

Status, Interrupts, Diagnostics, continued	
Diagnostics functions	Configurable
• Group fault LED (SF)	Red LED
• Diagnostics information readable	Possible
Sensor Supply Outputs	
Outputs	2
Output voltage	
• with load	min. L+ (– 2.5 V)
Output current	
• Rated value	120 mA
• Permissible range	0 to 150 mA
Additional (redundant) supply	Permitted
Short-circuit protection	Yes, electronic
Sensor Selection Data	
Input voltage	
• Rated value	24 VDC
• for signal “1”	13 to 30 V
• for signal “0”	– 3 to 5 V
Input current	
• at signal “1”	typ. 7 mA
Input characteristic	to IEC 1131, type 2
Connection of 2-wire BEROs	Possible
• Permissible closed-circuit current	max. 1.5 mA
Time/Frequency	
Internal interrupt processing time without input delay for	
• interrupt processing only	max. 250 μs
• interrupt and diagnostics processing	max. 250 μs
Input delay	
• Configurable	Yes
• Rated value	typ. 0.1/0.5/3/15/ 20 ms
Input frequency (with 0.1 ms delay time)	≤ 2 kHz

Setting the Parameters

You set the parameters for the SM 321; DI 16 × 24 VDC with process and diagnostics interrupts using *STEP 7*. Table 3-3 indicates the digital module parameters that can be set. You must enter the settings when the CPU is in the STOP state. The parameters are transferred from the programming device to the CPU of the S7-300 and stored there. The CPU transfers them to the digital module.

You can also change some of the parameters in the user program with the SFC 55 (see Reference Manual *System and Standard Functions*).

According to the two alternative ways of setting the parameters, they are divided into

- Static parameters
- Dynamic parameters

Table 3-1 below describes the properties of the static and dynamic parameters.

Table 3-1 Static and Dynamic Parameters of the SM 321; DI 16 × 24 VDC with Process and Diagnostics Interrupts

Parameter	Settable with	Operating State of the CPU
Static	Programming device	STOP
Dynamic	Programming device	STOP
Dynamic	SFC 55 in user program	RUN

Default Settings

The SM 321; DI 16 × 24 VDC with process and diagnostics interrupts has the following default settings for diagnostics, interrupts, etc (see Table 3-3).

These default settings are active if you have not set any parameters with *STEP 7*.

Assignment of Sensor Supplies

The two sensor supplies are used to supply two groups of channels: inputs 0 to 7 and inputs 8 to 15. You can also set the diagnostics for the sensor supply in these channel groups (see Table 3-2).

Parameter Assignment

Table 3-2 shows the parameter assignment for the respective inputs of the SM 321; DI 16 × 24 VDC; with process and diagnostics interrupts. You can configure the module in these input groups (channel groups). You will need the numbers of the channel groups to configure the user program with SFCs (see also Figure A-3 in Appendix A).

Table 3-2 Assignment of Parameters to the 16 Digital Inputs of the SM 321; DI 16 × 24 VDC; with Process and Diagnostics Interrupts

Parameter...	Can be Set in the Following Channel Groups		Channel Group Number
Process interrupt (on falling or rising edge)	Inputs	0 and 1	0
		2 and 3	1
		4 and 5	2
		6 and 7	3
		8 and 9	4
		10 and 11	5
		12 and 13	6
		14 and 15	7
Diagnostics interrupt (sensor supply missing)	Inputs	0 to 7 8 to 15	-

Parameters of the Digital Input Module

Table 3-3 provides an overview of the parameters of the SM 321; DI 16 × 24 VDC with process and diagnostics interrupts and shows, which parameters

- are static or dynamic or
- can be set for the complete module or for one channel group each.

Table 3-3 Parameters of the SM 321; DI 16 × 24 VDC with Process and Diagnostics Interrupts

Parameter	SM 321; DI 16 × DC24V; with Process and Diagnostics Interrupts			
	Value Range	Default	Type	Scope
Input delay (ms)	0.1/0.5/3/15/20	3	Static	Module
Enable				
• Process interrupt	Yes/no	No	Dynamic	Module
• Diagnostics interrupt	Yes/no	No	Dynamic	Module
Diagnostics				
• Sensor supply missing	Yes/no	No	Static	Channel group
Trigger for process interrupt				
• Rising edge	Yes/no	No	Dynamic	Channel group
• Falling edge	Yes/no	No	Dynamic	Channel group

Input Delay

Table 3-4 shows the possible settings and their tolerances for the input delay times of the SM 321; DI 16 $\times$ 24 VDC with process and diagnostics interrupts.

Table 3-4 Delay Times of the Input Signal of the SM 321; DI 16 $\times$ 24 VDC with Process and Diagnostics Interrupts

Input Delay	Tolerance
0.1 ms	87.5 to 112.5 μs
0.5 ms	0.43 to 0.57 ms
3 ms (default)	2.62 to 3.38 ms
15 ms	13.1 to 16.9 ms
20 ms	20 to 25 ms

Diagnostics

With the diagnostics feature you can determine if errors occur on signal acquisition.

Diagnostics Parameters

Use *STEP 7* to set the diagnostics parameters.

Diagnostics Evaluation

For the diagnostics evaluation, a distinction has to be made between configurable and non-configurable diagnostics messages. In the event of the configurable diagnostics message “Sensor supply missing” the diagnostics message is output only if diagnostics evaluation has been enabled (in parameter “diagnostics: sensor supply missing”).

In the event of non-configurable diagnostics messages, the diagnostics messages are always output, irrespective of the parameter settings.

Output of a diagnostics message triggers a diagnostics interrupt only if the diagnostics interrupt has been enabled in the relevant parameter.

Irrespective of the parameter configuration, the group fault (SF) LED will light up if errors have been detected, and the relevant Vs LED will be extinguished in case of a short circuit on the sensor supply.

The group fault (SF) LED also lights up in case of external errors (short circuit of sensor supply), independent of the operating status of the CPU (if power is on).

Diagnostics of Digital Input Module

Table 3-5 provides you with an overview of the diagnostics messages of the SM 321; DI 16 × 24 VDC with process and diagnostics interrupts. You enable the diagnostics parameters in *STEP 7* (see Table 3-3).

The diagnostics information is assigned either to the channel groups or to the module as a whole.

Table 3-5 Diagnostics Messages of the SM 321; DI 16 × 24 VDC with Process and Diagnostics Interrupts

Diagnostic Message	Scope of the Diagnostics	Configurable
Sensor supply missing	Channel group	Yes
External auxiliary power missing	Module	No
Internal auxiliary power missing	Module	
Fuse blown	Module	
Incorrect parameter on module	Module	
Watchdog timeout	Module	
EPROM error	Module	
RAM error	Module	
Process interrupt lost	Module	

Diagnostics Message Read-Out

You can read out the detailed diagnostics messages using *STEP 7*. Detailed diagnostics messages can be read out in the user program with the SFC 59 (see Appendix B and Reference Manual *System and Standard Functions*).

Error Causes and Error Correction

In Table 3-6, the diagnostics messages for the possible error causes and measures for error correction are listed.

Please note that the signal module must be configured so as to detect the missing sensor supply.

Table 3-6 Diagnostics Messages, Error Causes and Error Correction

Diagnostics Message	Possible Error Cause	Error Correction
Sensor supply missing	Overload of sensor supply	Eliminate overload
	Short circuit of sensor supply to M	Eliminate short circuit
External auxiliary power missing	Power supply L+ to module missing	Supply L+
Internal auxiliary power missing	Power supply L+ to module missing	Supply L+
	Fuse in module defective	Replace module
Fuse blown	Fuse in module defective	Replace module
Incorrect parameter on module	Illegal parameter transferred to module	Reconfigure module parameter
Watchdog time-out	Temporary high electromagnetic interferences	Eliminate interferences
	Module defective	Replace module
EPROM error	Temporary high electromagnetic interferences	Eliminate interferences and switch on/off power supply of CPU
	Module defective	Replace module
RAM error	Temporary high electromagnetic interferences	Eliminate interferences and switch on/off power supply of CPU
	Module defective	Replace module
Process interrupt lost	Quick succession of process interrupts cannot be processed by CPU	Change interrupt processing in CPU and reconfigure module parameters, if required

Interrupts

The following interrupts exist with the SM 321; DI 16 × 24VDC with process and diagnostics interrupts:

- Diagnostics interrupt
- Process interrupt.

Configuring Interrupts

Use *STEP 7* to configure the interrupts.

Default Setting

The default setting for interrupts is disabled.

Diagnostics Interrupt

If an error (for example, sensor supply missing) is detected or remedied, the module triggers a diagnostics interrupt, provided the diagnostics interrupt is enabled. The CPU interrupts the execution of the user program or of priority classes with low priority and processes the diagnostics interrupt block (OB 82).

Process Interrupt

Depending on the configuration, the module can trigger for each channel group a process interrupt, either in case of rising, falling or both edges of a signal state change. In the user program, you can use SFCs to find out which one of the two channels of a channel group has triggered the interrupt (see Reference Manual *System and Standard Functions*).

Pending process interrupts trigger process interrupt processing in the CPU (OB 40). The CPU interrupts the execution of the user program or of the priority classes with low priority. The signal module can buffer one interrupt per channel. If no priority classes with higher priority are to be processed, the buffered interrupts (of all modules) are processed in the sequence in which they have occurred.

Process Interrupt Lost

In an interrupt has been buffered for a channel and another interrupt occurs on that channel before it has been processed by the CPU, a diagnostics interrupt “process interrupt lost” is triggered.

More interrupts on this channel are not acquired until processing of the interrupt buffered on this channel has been executed.

Impact of the Power Supply and the Operating State

The input values on the SM 321; DI 16 × 24 VDC with process and diagnostics interrupts depend on the power supply of the digital module and the operating state of the CPU.

Table 3-7 provides you with an overview of these relationships.

Table 3-7 Dependence of the Input Values on the Operating State of the CPU and the Power Supply L+ of the SM 321; DI 16 × 24 VDC with Process and Diagnostics Interrupts

CPU Operating State		Power Supply L+ to Digital Module	Input Value of Digital Module
POWER ON	RUN	L+ exists	Process value
		L+ missing	0 signal
	STOP	L+ exists	Process value
		L+ missing	0 signal
POWER OFF	–	L+ exists	–
		L+ missing	–

A failure in the power supply to the SM 321; DI 16 × 24 VDC with process and diagnostics interrupts is always indicated by the group fault LED on the front panel of the module, and is also entered in the diagnostics log.

In case of a failure in the power supply L+ to the module, the input value is maintained for 20 to 40 ms before the 0 signal is transferred to the CPU. Power supply dips < 20 ms do not cause a change in the process value.

Note

If an external redundant source is applied simultaneously to the sensor supply (Vs), a failure in the internal sensor supply causes a failure of the internal and/or external sensor supply and/or a blown fuse to be indicated instead of a regular sensor supply failure.

The initiation of a diagnostics interrupt depends on the parameters (see Table 3-3).

3.1.4 Digital Input Module SM 321; DI 16 × 24 VDC (Source Input)

Order Number

6ES7 321-1BH5-AA0

Characteristics

The SM 321; DI 16 × 24 VDC (source input) has the following salient features:

- 16 input points, source input, isolated in groups of 16
- 24 VDC rated input voltage
- Suitable for switches and 2/3/4-wire proximity switches (BEROs)

Terminal Connection Diagram and Block Diagram

Figure 3-5 shows the terminal connection diagram and block diagram of the SM 321; DI 16 × 24 VDC (source input).

You will find the detailed technical specifications of the SM 321; DI 16 × 24 VDC (source input) on the following page.

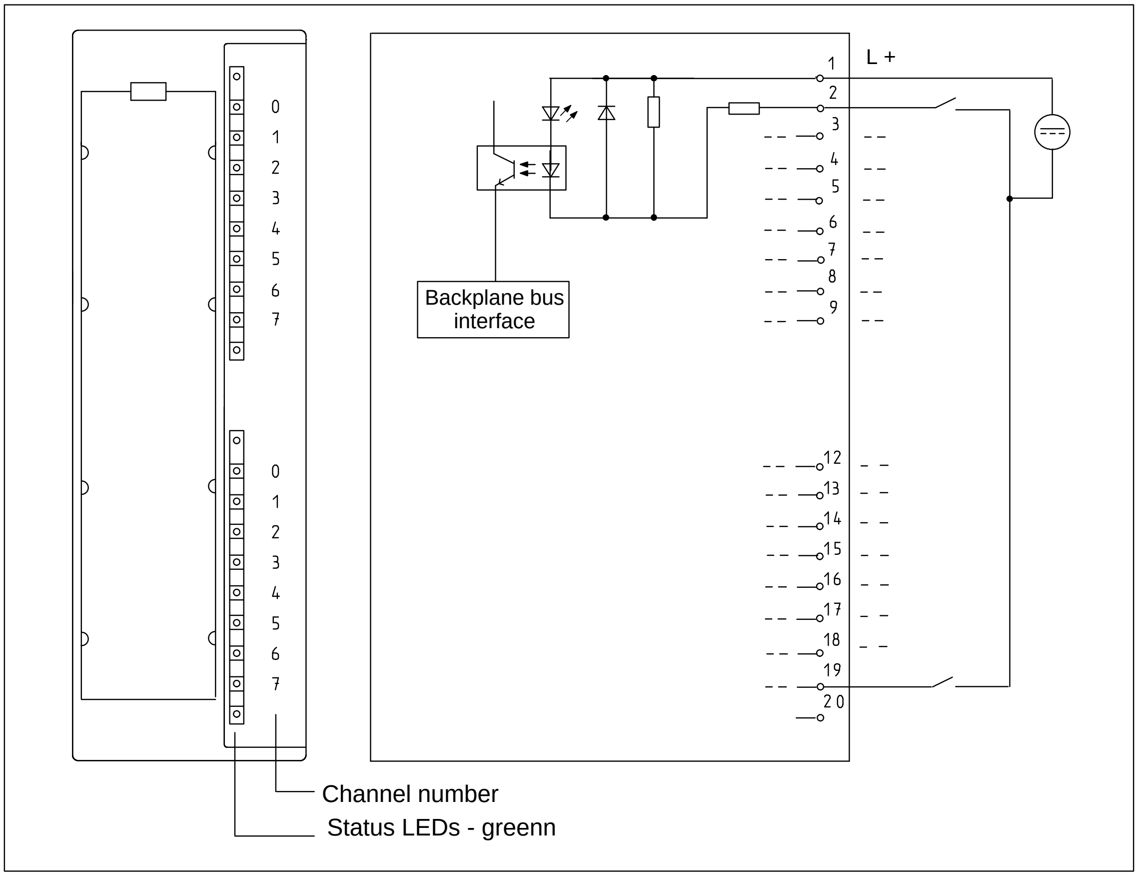


Figure 3-5 Module View and Block Diagram of Digital Input Module SM 321; DI 16 × 24 VDC (Source Input)

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 200 g
Module-Specific Data	
Number of input points	16
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated load voltage L +	24 VDC
• Reverse polarity protection	Yes
Number of input points that can be driven simultaneously	
• Horizontal installation up to 60 °C	16
• Vertical installation up to 40 °C	16
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels	No
Permiss. potential differences	
• between different circuits	75 VDC 60 VAC
Insulation tested with	500 VDC
Current drawn	
• from backplane bus	max. 10 mA
• from load voltage L+	–
Module power losses	typ. 3.5 W
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	None

Sensor Selection Data	
Input voltage	
• Rated value	24 VDC
• for “1” signal	+13 to +30 V
• for “0” signal	–3 to +5 V
Input current	
• at “1” signal	typ. 7 mA
Input delay	
• from “0” to “1”	1.2 to 4.8 ms
• from “1” to “0”	1.2 to 4.8 ms
Input characteristic	to IEC 1131, type 1
Connection of 2-wire BEROs	Possible
• Permissible closed-circuit current	max.1.5 mA

3.1.5 Digital Input Module SM 321; DI 16 × 120 VAC

Order No.

6ES7 321-1EH01-0AA0

Characteristics

The digital input module SM 321; DI 16 × 120 VAC has the following salient features:

- 16 input points, isolated in groups of 4
- 120 VAC rated input voltage
- Suitable for switches and 2/3/-wire AC proximity switches

Terminal Connection Diagram and Block Diagram

Figure 3-6 shows the terminal connection diagram and block diagram of the digital input module SM 321; DI 16 × 120 VAC.

You will find the detailed technical specifications of the SM 321; DI 16 × 120 VAC on the following page.

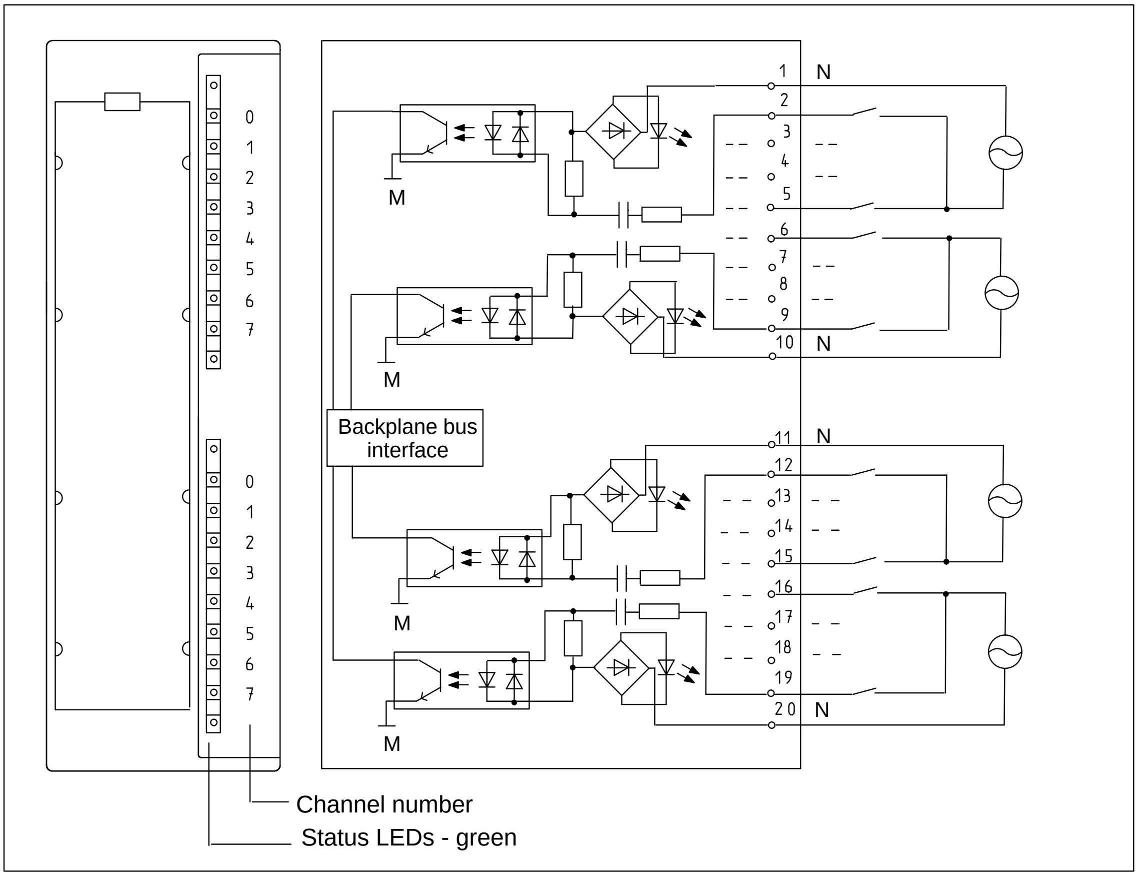


Figure 3-6 Module View and Block Diagram of Digital Input Module SM 321; DI 16 × 120 VAC

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 225 g (7.88 oz.)
Module-Specific Data	
Number of input points	16
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated load voltage L1	–
Number of input points that can be driven simultaneously	
• Horizontal installation up to 60 °C	16
• Vertical installation up to 40 °C	16
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels	Yes
in groups of	4
Permiss. potential differences	
• between $M_{internal}$ and the inputs	120 VAC
• between the inputs of different groups	250 VAC
Insulation tested with	1500 VAC
Current drawn	
• from backplane bus	max. 16 mA
Module power losses	typ. 4.1 W
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	None

Sensor Selection Data	
Input voltage	
• Rated value	120 VAC
• for “1” signal	79 to 132 V
• for “0” signal	0 to 20 V
• Frequency range	47 to 63 Hz
Input current	
• at “1” signal	typ. 6 mA
Input delay	
• from “0” to “1”	max. 25 ms
• from “1” to “0”	max. 25 ms
Input characteristic	to IEC 1131, type 1
Connection of 2-wire BEROs	Possible
• Permissible closed-circuit current	max. 1 mA

3.1.6 Digital Input Module SM 321; DI 8 × 120/230 VAC

Order No.

6ES7 321-1FF01-0AA0

Characteristics

The digital input module SM 321; DI 8 × 120/230 VAC has the following salient features:

- 8 input points, isolated in groups of 2
- 120/230 VAC rated input voltage
- Suitable for switches and 2/3/-wire AC proximity switches

Terminal Connection Diagram and Block Diagram

Figure 3-7 shows the terminal connection diagram and block diagram of the digital input module SM 321; DI 8 × 120/230 VAC.

You will find the detailed technical specifications of the SM 321; DI 8 × 120/230 VAC on the following page.

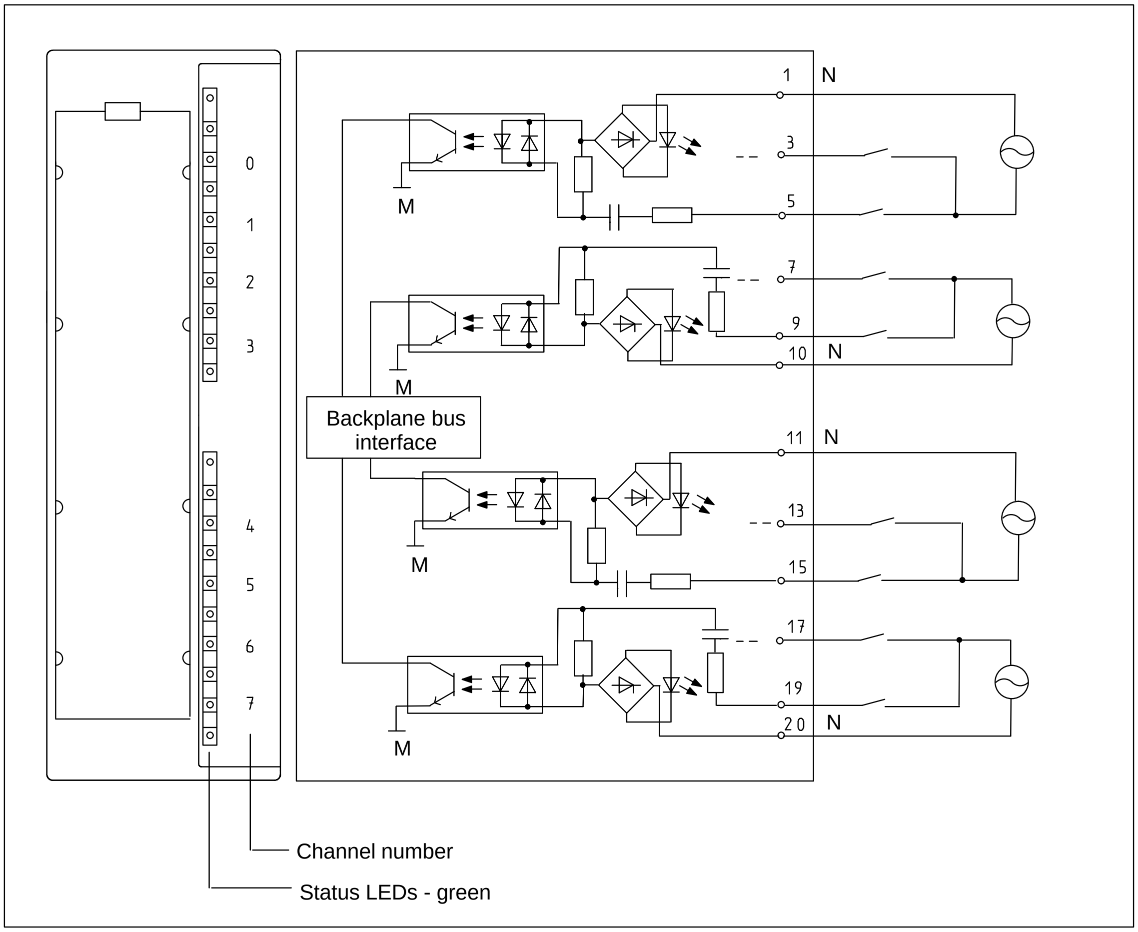


Figure 3-7   Module View and Block Diagram of Digital Input Module SM 321; DI 8 × 120/230 VAC

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 240 g (8.4 oz.)
Module-Specific Data	
Number of input points	8
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated load voltage L1	–
Number of input points that can be driven simultaneously	
• Horizontal installation up to 60 °C	8
• Vertical installation up to 40 °C	8
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels	Yes
in groups of	2
Permiss. potential differences	
• between $M_{internal}$ and the inputs	230 VAC
• between the inputs of different groups	500 VAC
Insulation tested with	1500 VAC
Current drawn	
• from backplane bus	max. 29 mA
Module power losses	typ. 4.9 W
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	None

Sensor Selection Data	
Input voltage	
• Rated value	120/230 VAC
• for “1” signal	79 to 264 V
• for “0” signal	0 to 40 V
• Frequency range	47 to 63 Hz
Input current at “1” signal	
• for signal ”1”	
120 V, 60 Hz	typ. 6.5 mA
230 V, 50 Hz	typ. 11 mA
Input delay	
• from “0” to “1”	max. 25 ms
• from “1” to “0”	max. 25 ms
Input characteristic	to IEC 1131, type 1
Connection of 2-wire BEROs	Possible
• Permissible closed-circuit current	max. 2 mA

3.1.7 Digital Input Module SM 321; DI 32 × 120 VAC

Order No.

6ES7 321-1EL00-0AA0

Characteristics

The digital input module, SM 321; DI 32 × 120 VAC, has the following salient features:

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

Terminal Connection Diagram and Block Diagram

Figure 3-8 shows the terminal connection diagram and block diagram of the digital input module SM 321; DI 32 × 120 VAC.

You will find detailed technical specifications of the SM 321; DI 32 × 120 VAC on the following page.

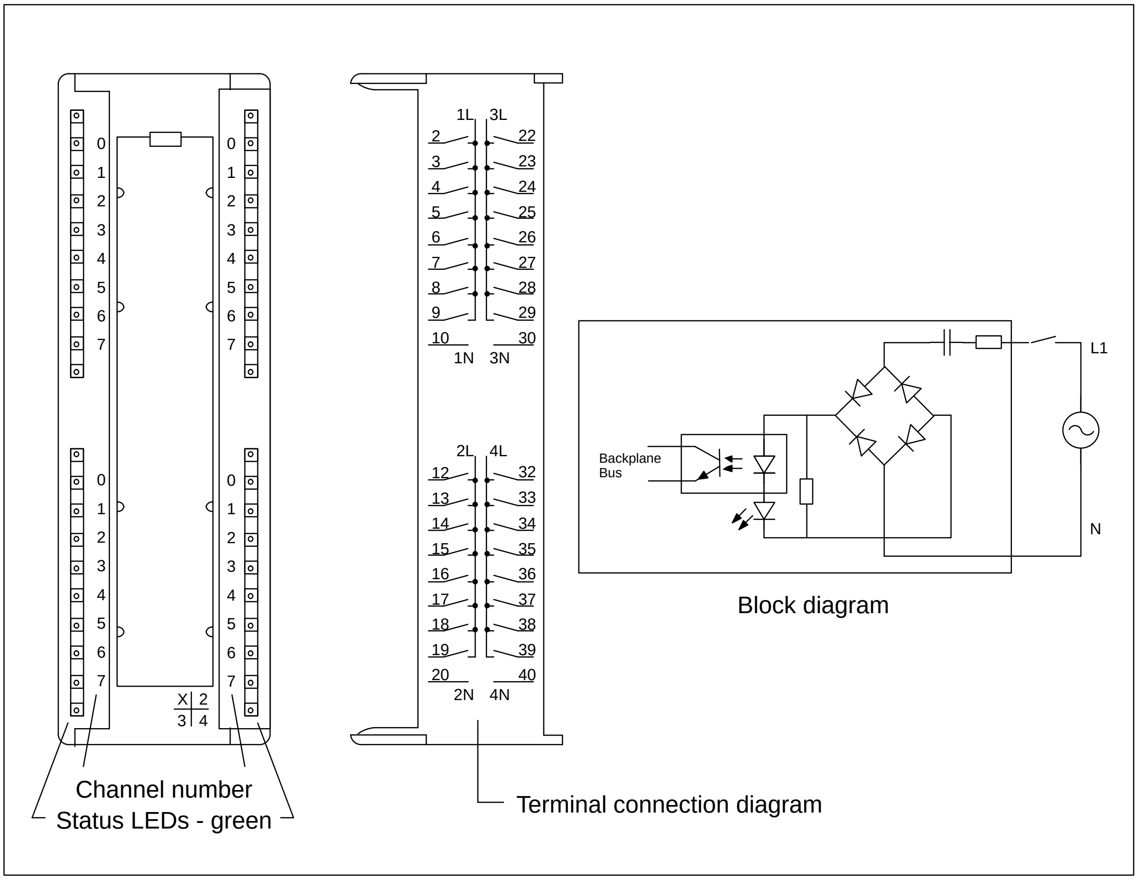


Figure 3-8 Terminal Connection Diagram and Block Diagram of Digital Input Module SM 321; DI 32 × 120 VAC

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 300 g (10.6 oz.)
Module-Specific Data	
Number of input points	32
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated input voltage L1	120 VAC
Number of input points that can be driven simultaneously	
• Horizontal installation up to 60° C/140° F	24
• Horizontal or vertical installation up to 40° C/104° F	32
Galvanic isolation	
• To backplane bus	Yes (optocoupler)
• Between the channels in groups of	Yes 8
Permiss. potential differences	
• Between N terminals of the groups	250 VAC
• Between the input (N terminal) and central grounding point	1500 VAC
• Insulation tested with	1500 VAC
Current drawn	
• from backplane bus	max. 16 mA
Module power losses	typ. 4 W

Status, Interrupts, Diagnostics	
Status display	Yes; green LED per channel
Interrupts	No
Diagnostics functions	No
Sensor Selection Data	
Input voltage	
• Rated value	AC 120 V
• Frequency	47 to 63 Hz
• For “1” signal	74 to 132 V
• For “0” signal	0 to 20 V
Input current	
• At “1” signal	max. 27 mA typ. 21 mA
Input delay	
• Programmable	No
• From “0” to “1”	max. 15 ms
• From “1” to “0”	max. 25 ms
Input characteristic	to IEC 1131, Type 2
Connection of 2-wire BEROs	Possible
• Permiss. closed-circuit current	< 4 mA

3.2 Digital Output Modules

List of Digital Output Modules

The following digital output modules are described in this chapter:

- SM 322; DO 32 × 24 VDC/0.5 A
- SM 322; DO 16 × 24 VDC/0.5 A
- SM 322; DO 8 × 24 VDC/0.5 A with diagnostics interrupt
- SM 322; DO 8 × 24 VDC/2 A
- SM 322; DO 16 × 120 VAC/1 A
- SM 322; DO 8 × 120/230 VAC/2 A
- SM 322; DO 32× 120 VAC/1.0 A

3.2.1 Digital Output Module SM 322; DO 32 × 24 VDC/0.5 A

Order No.

6ES7 322-1BL00-0AA0

Characteristics

The digital output module SM 322; DO 32 × 24 VDC/0.5 A has the following salient features:

- 32 output points, isolated in groups of 8
- 0.5 A output current
- 24 VDC rated load voltage
- Suitable for solenoid valves, DC contactors and indicator lights

Special Feature

When the power supply is switched on via a mechanical contact, the digital output module SM 322; SO 32 × 24 VDC/0.5 A sends a “1” signal to its outputs for approximately 50 μs. You must observe this when using the digital output module SM 322; DO 32 × 24 VDC/0.5 A for high-speed counters.

Terminal Connection Diagram and Block Diagram

Figure 3-9 shows the terminal connection diagram and block diagram of the digital output module SM 322; DO 32 × 24 VDC/0.5 A.

You will find the detailed technical specifications of the module SM 322; DO 32 × 24 VDC/0.5 A on the following page.

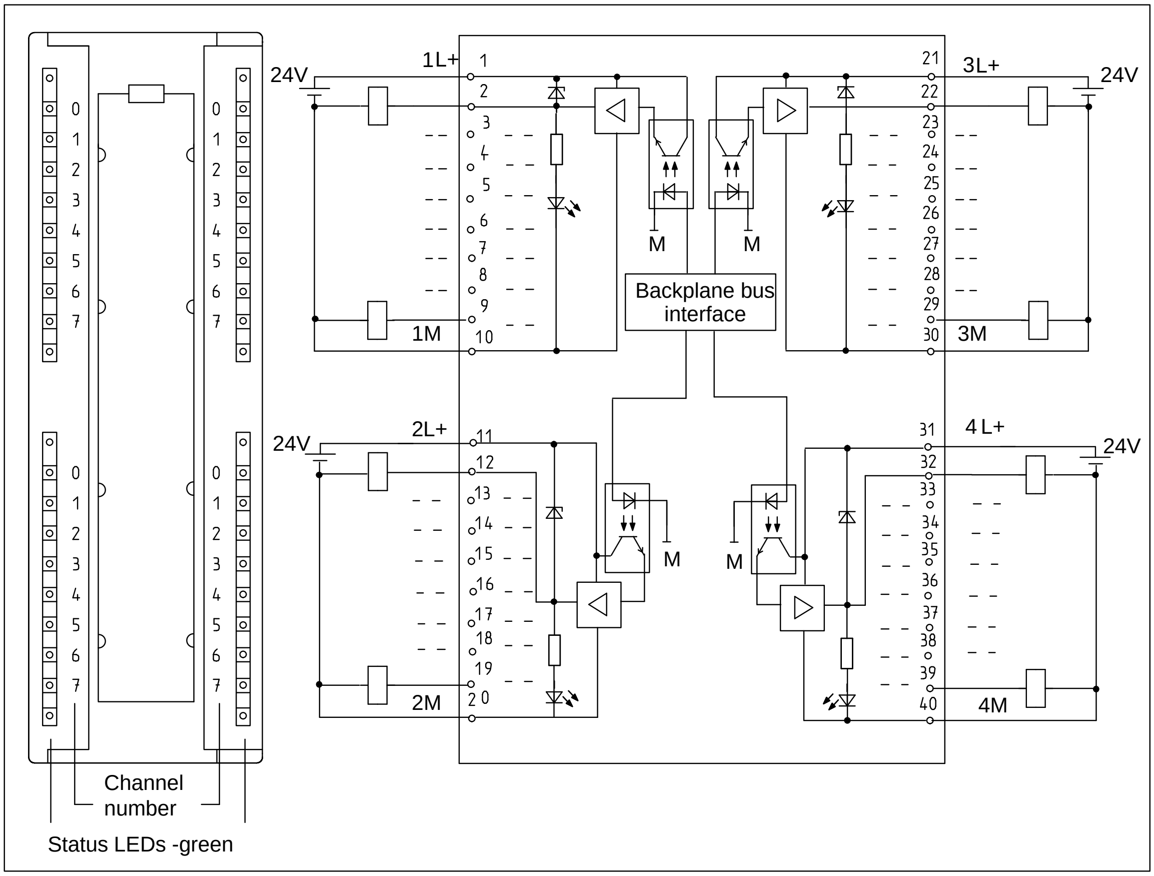
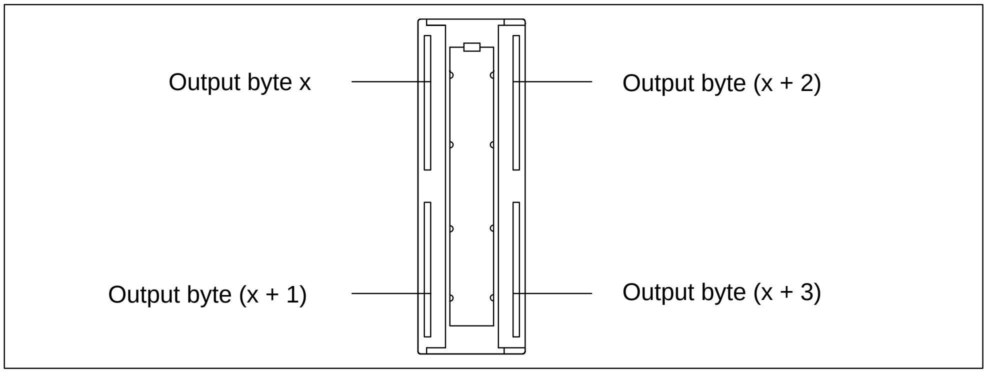


Figure 3-9 Module View and Block Diagram of Digital Output Module SM 322; DO 32 × 24 VDC/0.5 A

Terminal Assignment

The following figure shows the assignment of the channels to the addresses.



Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 260 g
Module-Specific Data	
Number of output points	32
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd)
Voltages, Currents, Potentials	
Rated load voltage L +	24 VDC
Total current of the outputs (per group)	
• horizontal installation	
up to 20 °C / 68 °F	max. 4 A
up to 40 °C / 104 °F	max. 3 A
up to 60 °C / 140 °F	max. 2 A
• vertical installation	
up to 40 °C / 104 °F	max. 2 A
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels	Yes
in groups of	8
Permiss. potential differences	
• between different circuits	75 VDC 60 VAC
Insulation tested with	500 VDC
Current drawn	
• from backplane bus	max. 90 mA
• from load voltage L+ (without load)	max. 200 mA
Module power losses	typ. 6.6 W
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	None

Actuator Selection Data	
Output voltage	
• at “1” signal	min. L + (– 0.8 V)
Output current	
• at “1” signal	
Rated value	0.5 A
Permiss. range	5 mA to 0.6 A
• at signal “0”	
Residual current	max. 0.5 mA
Load impedance	48 Ω to 4 kΩ
Lamp load	max. 5 W
Parallel connection of 2 outputs	
• for redundant actuation of a load	Possible (only outputs of the same group)
• to increase power	Not possible
Actuation of digital input	Possible
Switching frequency	
• Resistive loads	max. 100 Hz
• Inductive loads to IEC 947-5-1, DC 13	max. 0.5 Hz
• Lamp loads	max. 10 Hz
Voltage limited on circuit interruption reduced (internally) to	L + (– 48 V), typ.
Short-circuit protection of output	Yes, electronic
• Response threshold	1 A, typ.

3.2.2 Digital Output Module SM 322; DO 16 × 24 VDC/0.5 A

Order No.

6ES7 322-1BH01-0AA0

Characteristics

The digital output module SM 322; DO 16 × 24 VDC/0.5 A has the following salient features:

- 16 output points, isolated in groups of 8
- 0.5 A output current
- 24 VDC rated load voltage
- Suitable for solenoid valves, DC contactors and indicator signals.

Special Feature

When the 24 V power supply is switched on via a mechanical contact, the digital output module SM 322; DO 16 × 24 VDC/0.5 A sends a “1” signal to its outputs for approximately 50 μs. You must observe this when using the digital output module SM 322; DO 16 × 24 VDC/0.5 A for high-speed counters!

Terminal Connection Diagram and Block Diagram

Figure 3-10 shows the terminal connection diagram and block diagram of the digital output module SM 322; DO 16 × 24 VDC/0.5 A.

You will find the detailed technical specifications of the module SM 322; DO 16 × 24 VDC/0.5 A on the following page.

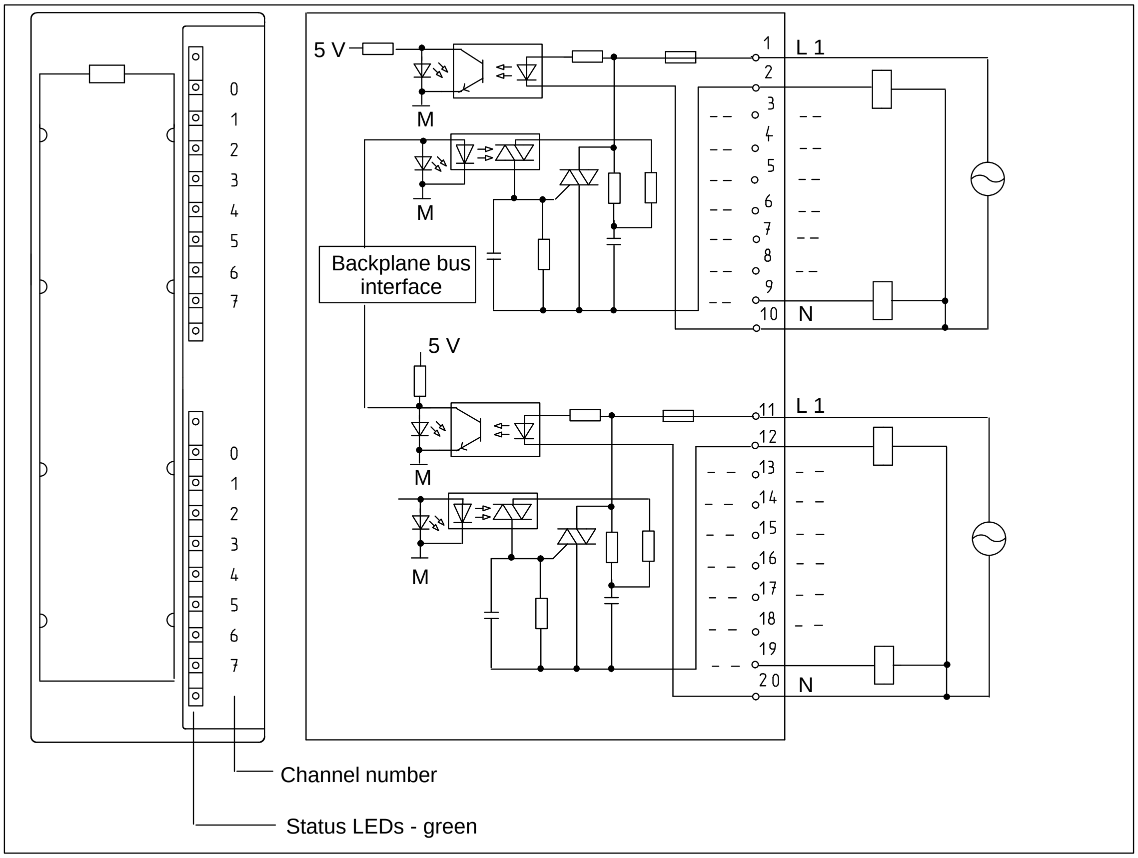


Figure 3-10 Module View and Block Diagram of Digital Output Module SM 322; DO 16 × 24 VDC/0.5 A

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 190 g (6.65 oz.)
Module-Specific Data	
Number of output points	16
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd)
Voltages, Currents, Potentials	
Rated load voltage L +	24 VDC
Total current of the outputs (per group)	
• horizontal installation	
up to 20 °C / 68 °F	max. 4 A
up to 60 °C / 140 °F	max. 2 A
• vertical installation	
up to 40 °C / 104 °F	max. 2 A
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels	Yes
in groups of	8
Permiss. potential differences	
• between different circuits	75 VDC 60 VAC
• Insulation tested with	500 VDC
Current drawn	
• from backplane bus	max. 80 mA
• from L+ (without load)	max. 120 mA
Module power losses	typ. 4.9 W
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	None

Actuator Selection Data	
Output voltage	
• at “1” signal	min. L + (– 0.8 V)
Output current	
• at “1” signal Rated value Permiss. range	 0.5 A 5 mA to 0.6 A
• at “0” signal Residual current	 max. 0.5 mA
Load impedance	48 Ω to 4 kΩ
Lamp load	max. 5 W
Parallel connection of 2 outputs	
• for redundant actuation of a load	Possible (only outputs of the same group)
• to increase power	Not possible
Actuation of digital input	Possible
Switching frequency	
• Resistive loads	max. 100 Hz
• Inductive loads to IEC 947-5-1, DC 13	max. 0.5 Hz
• Lamp loads	max. 10 Hz
Voltage limited on circuit interruption reduced (internally) to	typ. L + (– 48 V)
Short-circuit protection of output	Yes, electronic
• Response threshold	1 A, typ.

3.2.3 Digital Output Module SM 322; DO 8 × 24 VDC/0.5 A; with Diagnostics Interrupt

Order No.

6ES7 322-8BF00-0AB0

Characteristics

The digital output module SM 322; DO 8 × 24 VDC/0.5 A; with diagnostics interrupt has the following salient features:

- 8 output points, isolated in groups of 8
- 0.5 A output current
- 24 VDC rated load voltage
- Suitable for solenoid valves, DC contactors and signal lights
- 2 terminals per output
  - Output without series diode
  - Output with series diode (for redundant load control)
- Configurable diagnostics
- Configurable diagnostics interrupt
- Configurable substitute value output
- Group fault LED
- Channel-specific status and error LEDs

Use in

This I/O modules can be used in the

- **S7-300** (centralized configuration) with the CPU
  312 IFM from 6ES7 312-5AC00-0AB0, revision level 5
  313 from 6ES7 313-1AD00-0AB0, revision level 3
  314 from 6ES7 314-1AE01-0AB0, revision level 6
  314 IFM from 6ES7 314-5AE00-0AB0, revision level 1
  315 from 6ES7 315-1AF00-0AB0, revision level 3
  315-2 from 6ES7 315-2AF00-0AB0, revision level 3
  614 from 6ES7 614-1AH01-0AB3, revision level 6.
- **ET 200M** with the
  IM 153-1 from 6ES7 153-1AA02-0XB0, revision level 1
  IM 153-2 from 6ES7 153-2Ax00-0XB0, revision level 1
  IM 153-3 from 6ES7 153-3AA00-0XB0, revision level 1
  and with the following **DP masters**:
  IM 308C from 6ES5 308-3UC11, revision level 3, and
  CPUs 41x from 6ES7 41x-2XG00-0AB0; revision level 2.

Terminal Connection Diagram and Block Diagram

Figure 3-11 shows the terminal connection diagram and block diagram of the digital output module SM 322; DO 8 × 24 VDC/0.5 A; with diagnostics interrupt.

You will find the block diagram and the detailed technical specifications for the SM 322; DO 8 × 24 VDC/0.5 A with diagnostics interrupt on the following pages.

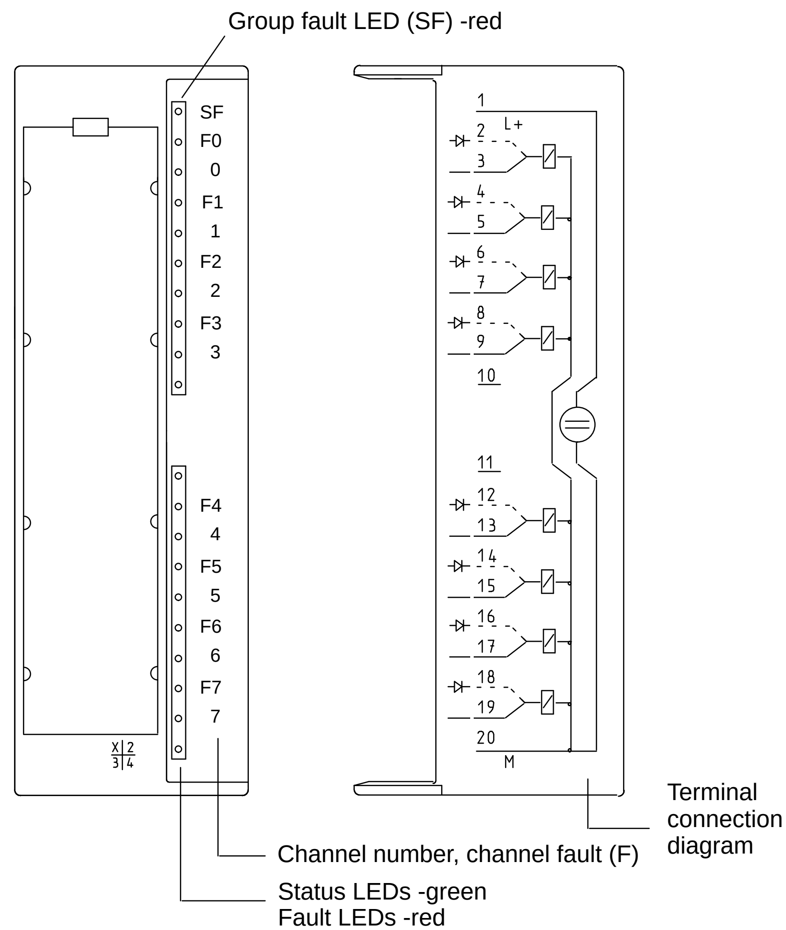


Figure 3-11 Terminal Connection Diagram and Block Diagram of Digital Output Module SM 322; DO 8 × 24 VDC/0.5 A; with Diagnostics Interrupt

Block Diagram

Figure 3-12 shows the block diagram of the SM 322; DO 8 × 24 VDC/0.5 A; with diagnostics interrupt.

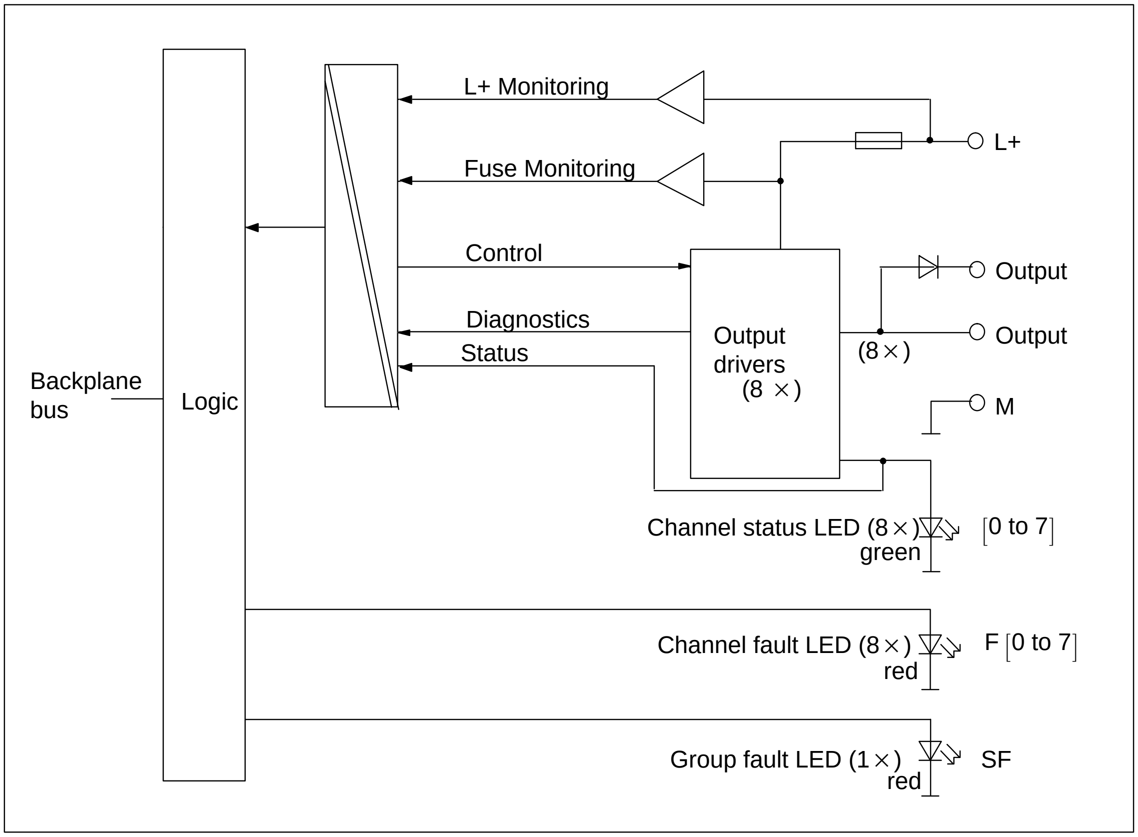


Figure 3-12 Block Diagram of Digital Input Module SM 322; DO 8 × 24 VDC/0.5 A; with Diagnostics Interrupt

Redundant Output Signals

The output with series diode can be used for the redundant control of an actuator. The redundant control can be triggered by two different modules without an external circuit. Both signal modules must have the same reference potential M.

Note

If the output with series diode is used, external P connections cannot be detected.

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56×4.88×4.68 in.)
Weight	approx. 210 g
Module-Specific Data	
Number of output points	8
Length of cable	
• Unshielded	max. 600m (654 yd.)
• Shielded	max. 1000m (1090 yd)
Voltages, Currents, Potentials	
Rated load voltage L +	24 VDC
• Reverse polarity protection	Yes
Total current of the outputs without series diode (per group)	
• horizontal installation up to 40 °C / 104 °F up to 60 °C / 140 °F	 max. 4 A max. 3 A
• vertical installation up to 40 °C / 104 °F	 max. 4 A
Total current of the outputs with series diode (per group)	
• horizontal installation up to 20 °C / 68 °F up to 40 °C / 104 °F up to 60 °C / 140 °F	 max. 4A max. 3 A max. 2 A
• vertical installation up to 40 °C / 104 °F	 max. 3 A
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels	No
Permiss. potential differences	
• between different circuits	75 VDC 60 VAC
Insulation tested with	500 VDC
Current drawn	
• from backplane bus	max. 70 mA
• from load voltage L+ (without load)	max. 90 mA
Module power losses	typ. 5 W

Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	
• Diagnostics interrupts	Configurable
Diagnostics functions	Configurable
• Group fault display (SF)	Red LED (SF)
• Channel fault display (F)	Red LED (F) per channel
• Diagnostics information readable	Possible
Actuator Selection Data	
Output voltage	
• at “1” signal Output without series diode at “1” signal Output with series diode at “1” signal	 min. L + (– 0.8 V) min. L + (– 1.6 V)
Output current	
• at “1” signal Rated value Permiss. range	 0.5 A 10 mA to 0.6 A
• at “0” signal (Residual current)	 max. 0.5 mA
Output delay with resistive load	
• from “0” to “1”	max. 180 μs
• from “1” to “0”	max. 245 μs
Load impedance	48 Ω to 3 kΩ
Lamp load	max. 5 W
Parallel connection of 2 outputs	
• for redundant actuationof a load	Output with series diode only, must have the same reference potential
• for power increase	Not possible
Actuationof digital input	Poss., 1 binary input to IEC 1131 2 type 2
Switching frequency	
• Resistive load	max. 100 Hz
• Inductive load to IEC 947-5-1, DC 13	max. 2 Hz
• Lamp load	max. 10 Hz
Voltage limited on circuit interruption reduced (internally) to	typ. L + (– 45 V)
Short-circuit protection of output	Yes, electronic
• Response threshold	0.75 to 1.5 A

Setting the Parameters

You set the parameters for the SM 322; DO 8 × 24 VDC/0.5 A with diagnostics interrupt using *STEP 7*. Table 3-9 indicates the digital output module parameters that can be set. You must enter the settings when the CPU is in the STOP state. The parameters are transferred from the programming device to the CPU of the S7-300 and stored there. These parameters are passed by the CPU to the digital module.

You can also change some of the parameters in the user program with the SFC 55 (see Reference Manual *System and Standard Functions*).

According to the two alternative ways of setting the parameters, they are divided into:

- Static parameters
- Dynamic parameters

Table 3-8 below describes the properties of the static and dynamic parameters.

Table 3-8 Static and Dynamic Parameters of the SM 322; DO 8 × 24 VDC/0.5 A with Diagnostics Interrupt

Parameter	Settable with	Operating State of the CPU
Static	Programming device	STOP
Dynamic	Programming device	STOP
	SFC 55 in user program	RUN

Default Settings

The SM 322; DO 8 × 24 VDC/0.5 A with diagnostics interrupt has the following default settings for diagnostics, substitute values, etc. (see Table 3-9).

These default settings are active if you have not set any parameters with *STEP 7*.

Parameter Assignment

With the SM 322; DO 8×DC 24V/0.5 A; using diagnostics interrupts you can configure each output individually.

Parameters of the Digital Output Module

Table 3-9 provides an overview of the parameters of the SM 322; DO 8 × 24 VDC/0.5 A with diagnostics interrupt and shows which parameters

- are static or dynamic, and which
- can be set for the complete module or individual channels.

Table 3-9 Parameters of the SM 322; DO 8 × 24 VDC/0.5 A with Diagnostics Interrupt

Parameter	SM 322; DO 8×24 VDC/0.5A; with Diagnostics Interrupt			
	Value Range	**Default**	**Type**	**Scope**
Enable • Diagnostics interrupt	Yes/no	No	Dynamic	Module
Response on CPU STOP • Hold last value (LWH) • Substitute a value (EWS)	 Yes/no Yes/no	 No No	 Dynamic Dynamic	 Module Module
Substitute value	0/1	0	Dynamic	Module
Group diagnostics (Test for: Short circuit to M Short circuit to L+ Wire break[1] Missing load voltage L+)	Yes/no	No	Static	Channel

[1] If the wire break diagnostics enable parameter is not set, the channel fault error LEDs do not indicate a fault on a wire break.

Diagnostics

With the diagnostics feature you can determine if errors occur on signal output.

Configuration of Diagnostics

Use *STEP 7* to set the diagnostics parameters.

Diagnostics Evaluation

For the diagnostics evaluation, a distinction has to be made between configurable and non-configurable diagnostics messages. In the event of a configurable diagnostics message (for example M short-circuit), the diagnostics message is output only if diagnostics evaluation has been enabled (in parameter “diagnostics short-circuit to M”).

In the event of a non-configurable diagnostics message, the diagnostics message is always output, irrepespective of the parameter settings.

SF-LED

Output of a diagnostics message triggers a diagnostics interrupt only if the diagnostics interrupt has been enabled in the relevant parameter.

Irrespective of the parameter configuration, the group fault (SF) LED or the relevant channel error LED will light up if module errors have been detected, independent of the operating state of the CPU (POWER ON).

Exception: A wire break only results in the group error LED or relevant channel error LED lighting up if the parameters have been set accordingly.

Diagnostics of Digital Ouput Module

Table 3-10 provides you with an overview of the diagnostics messages of the SM 322; DO 8 × 24VDC/0.5 A with diagnostics interrupt. You enable the diagnostics parameters in *STEP 7* (see Table 3-9).

The diagnostics information is assigned either to the individual channels or to the module as a whole.

Table 3-10 Diagnostics Messages of the SM 322; DO 8 × 24 VDC/0.5 A; with Diagnostics Interrupt

Diagnostics Message	Scope of Diagnostics	Configurable
Short-circuit to M	Channel	Yes
Short-circuit to P		
Wire break		
Load voltage missing		
External auxiliary power missing	Module	No
Internal auxiliary power missing		
Fuse blown		
Watchdog timeout		
EPROM error		
RAM error		

Wire Break Detection

Wire break detection is at a current of < 1mA.

Diagnostics Message Read-Out

You can read out the system diagnostics with *STEP 7* . Detailed diagnostics messages can be read out from the module in the user program with the SFC 59 (see Appendix B and Reference Manual *System and Standard Functions*).

Error Causes and Error Correction

In the following table the possible error causes, conditions for error detection and measures for error correction are listed for the individual diagnostics messages.

Please note that the module must be configured so that it can detect the errors for which configurable diagnostics messages are output.

Table 3-11 Diagnostics Messages, Error Causes and Error Correction

Diagnostics Message	Error Detection ...	Possible Error Cause	Remedy
Short-circuit to P	Always	Short-circuit at output to L+ of module supply	Eliminate short-circuit
Short circuit to M	Only with output to “1”	Overload of output	Eliminate overload
		Short-circuit of output to M	Eliminate short-circuit
Wire break	Only with output to “1”	Open circuit between module and actuator	Establish wire connection
		Channel not used (open)	Disable for the channel by setting parameter “diagnostics wirebreak”
Load voltage missing	Only with output to “1”	Defective output	Replace module
External auxiliary power missing	Always	Power supply L+ to module missing	Feed supply L+
Internal auxiliary power missing	Always	Power supply L+ to module missing	Feed supply L+
		Fuse in module defective	Replace module
Fuse blown	Always	Fuse in module defective	Replace module
Watchdog timeout	Always	Temporary high electromagnetic interferences	Eliminate interferences
		Module defective	Replace module
EPROM error	Always	Temporary high electromagnetic interferences	Eliminate interferences and switch on/off power supply of CPU
		Module defective	Replace module
RAM error	Always	Temporary high electromagnetic interferences	Eliminate interferences and switch on/off power supply of CPU
		Module defective	Replace module

Interrupts

The digital module can trigger a diagnostics interrupt.

Configuring Interrupts

Use *STEP 7* to configure the interrupts.

Default Setting

The default setting for interrupts is disabled.

Diagnostics Interrupt

If an error (for example, short-circuit to M) is detected or eliminated, the digital module triggers a diagnostics interrupt, provided the diagnostics interrupt is enabled. The CPU interrupts the execution of the user program and processes the diagnostics alarm block (OB 82).

Impact of the Power Supply and the Operating State

The input values on the SM 322; DO 8 × 24 VDC/0.5 A with diagnostics interrupt depend on the power supply of the digital module and the operating state of the CPU.

Table 3-12 provides you with an overview of these relationships.

Table 3-12 Dependence of the Input Values on the Operating State of the CPU and the Power Supply L+ of the SM 322; DO 8 × 24 VDC/0.5 A with Diagnostics Interrupt

CPU Operating State		Power Supply L+ to Digital Module	Output Value of Digital Module
POWER ON	RUN	L+ exists	CPU value
		L+ missing	0 signal
	STOP	L+ exists	Substitute value / last value (0 signal default)
		L+ missing	0 signal
POWER OFF	–	L+ exists	0 signal
		L+ missing	0 signal

A failure in the power supply to the SM 322; DO 8 × 24 VDC/0.5 A with diagnostics interrupt is always indicated by the group fault LED on the front panel of the module, and is also entered in the diagnostics log.

The initiation of a diagnostics interrupt depends on the parameters.

3.2.4 Digital Output Module SM 322; DO 8 × 24 VDC/2 A

Order No.

322-1BF01-0AA0

Characteristics

The digital output module SM 322; DO 8 × 24VDC/2 A has the following salient features.

- 8 output points, isolated in groups of 4
- 2 A output current
- 24 VDC rated load voltage
- Suitable for solenoid valves, DC contactors and indicator lights.

Special Feature

When the power supply is switched on via a mechanical contact, the digital output module SM 322; DO 8 × 24 VDC/2 A sends a “1” signal to its outputs for approximately 50 μs. You must observe this when using the digital output module SM 322; DO 8 × 24 VDC/2 A for high-speed counters!

Terminal Connection Diagram and Block Diagram

Figure 3-13 shows the terminal connection diagram and block diagram of the module SM 322; DO 8 × 24 VDC/2 A.

You will find the detailed technical specifications of the module SM 322; DO 8 × 24 VDC/2 A on the following page.

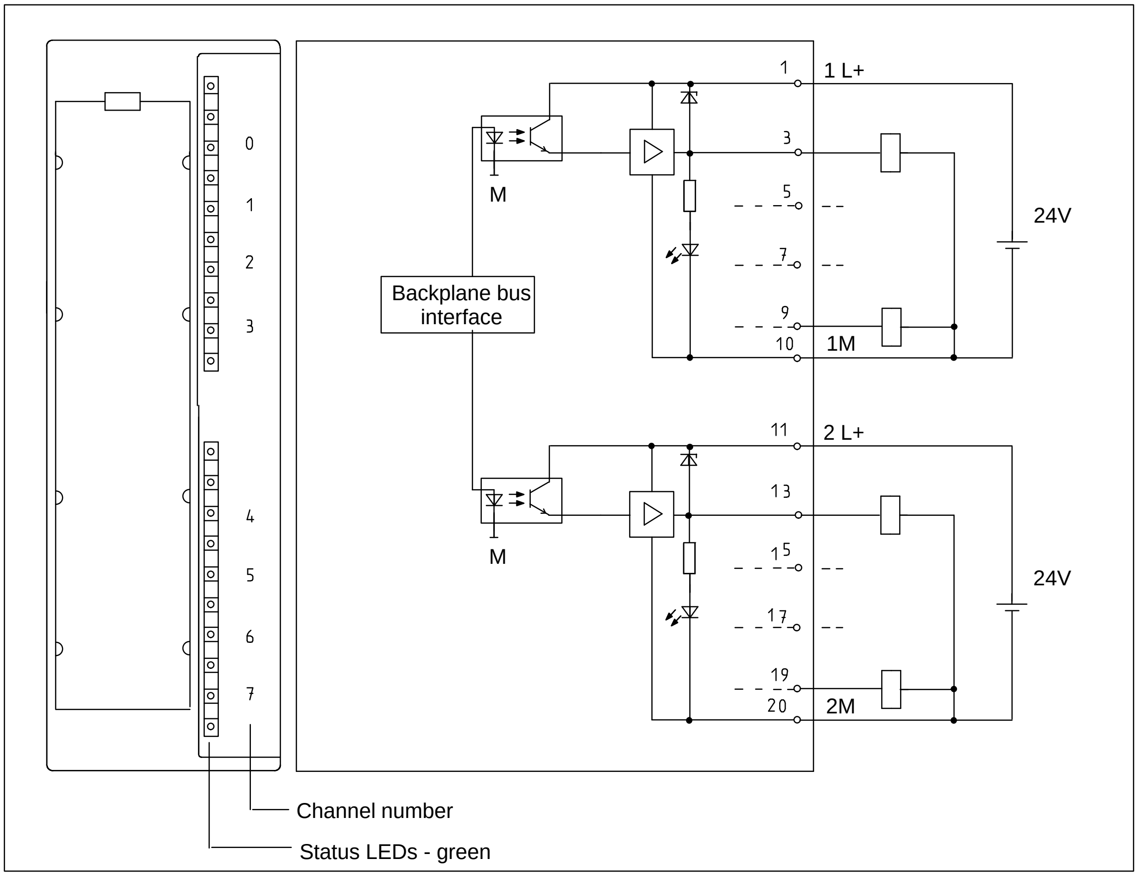


Figure 3-13 Module View and Block Diagram of Digital Output Module SM 322; DO 8 × 24 VDC/2 A

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 190 g (6.65 oz.)
Module-Specific Data	
Number of output points	8
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated load voltage L +	24 VDC
Total current of the outputs (per group)	
• horizontal installation	
up to 20 °C / 68°F	max. 6 A
up to 60 °C / 140°F	max. 4 A
• vertical installation	
up to 40 °C / 104°F	max. 4 A
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels	Yes
in groups of	4
Permiss. potential differences	
• between different circuits	75 VDC 60 VAC
Insulation tested with	500 VDC
Current drawn	
• from backplane bus	max. 40 mA
• from load voltage L+ (without load)	max. 60 mA
Module power losses	typ. 6.8 W
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	None

Actuator Selection Data	
Output voltage	
• at “1” signal	min. L + – 0.8 V
Output current	
• at “1” signal	
Rated value	2 A
Permiss. range	5 mA to 2.4 A
• at “0” signal	
Residual current	max. 0.5 mA
Load impedance range	12 Ω to 4 kΩ
Lamp load	max. 10 W
Parallel connection of 2 outputs	
• for redundant actuation of a load	Possible (only outputs of the same group)
• to increase power	Not possible
Actuation of digital input	Possible
Switching frequency	
• Resistive loads	max. 100 Hz
• Inductive loads to IEC 947-5-1, DC 13	max. 0.5 Hz
• Lamp loads	max. 10 Hz
Voltage induced on circuit interruption limited (internally) to	typ. L + – 48 V
Short-circuit protection of output	Yes, electronic
• Response threshold	typ. 3 A

3.2.5 Digital Output Module SM 322; DO 16 × 120 VAC/1 A

Order No.

6ES7 322-1EH01-0AA0

Characteristics

The digital output module SM 322; DO 16 × 120 VAC/1 A has the following salient features:

- 16 output points, fused and isolated in groups of 8
- 1 A output current
- 120 VAC rated load voltage
- Suitable for AC solenoid valves, contactors, motor starters, fractional h.p. motors and indicator lights.

Terminal Connection Diagram and Block Diagram

Figure 3-14 shows the terminal connection diagram and block diagram of the digital output module SM 322; DO 16 × 120 VAC/1 A.

You will find the detailed technical specifications of the module SM 322; DO 16 × 120 VAC/1 A on the following page.

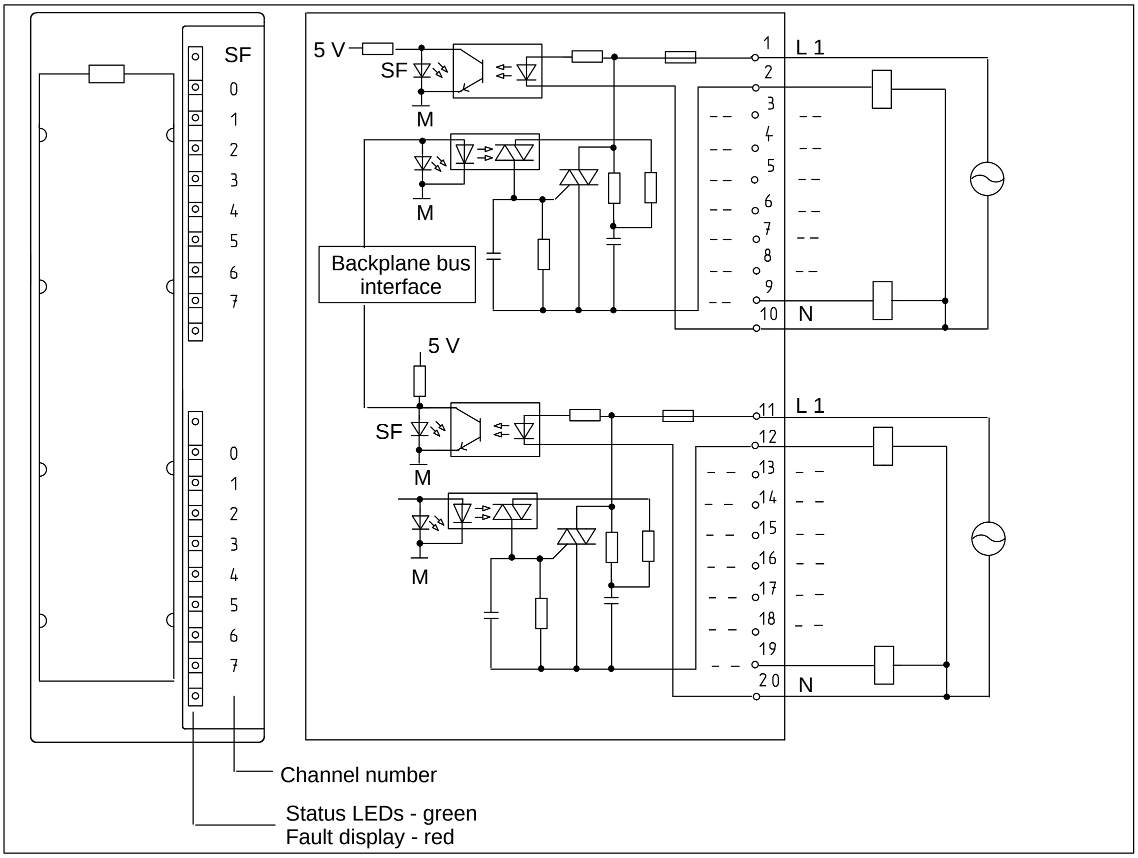


Figure 3-14 Module View and Block Diagram of Digital Output Module SM 322; DO 16 × 120 VAC/1 A

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 300 g (10.5 oz.)
Module-Specific Data	
Number of output points	16
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Load voltage L1	120 VAC
Total current of the outputs (per group)	
• horizontal installation up to 40 °C / 104°F up to 60 °C / 140°F	 max. 4 A max. 2 A
• vertical installation up to 40 °C / 104°F	 max. 2 A
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels	Yes
in groups of	8
Permiss. potential differences	
• between $M_{internal}$ and the outputs	120 VAC
• between the outputs of different groups	250 VAC
Insulation tested with	1500 VAC
Current drawn	
• from backplane bus	max. 184 mA
• from load voltage L1 (without load)	max. 3 mA
Module power losses	typ. max. 9 W
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	
• Group fault display on the module (fuse or no L1/N)	Red LED (SF)

Actuator Selection Data	
Output voltage	
• at “1” signal	min. L1 (– 8.5 V)
Output current	
• at “1” signal Rated value Permiss. current for 0 °C to 40 °C Permiss. current for 40 °C to 60 °C Permiss. surge current (per group)	 1 A 10 mA to 1 A 10 mA to 0.5 A max. 10 A (with 2 half waves)
• at “0” signal (Residual current)	max. 1 mA
Zero cross inhibit voltage	Non-zero cross outputs
Size of motor starter	max. size 3 to NEMA
Lamp load	max. 25 W
Parallel connection of 2 outputs	
• for redundant actuation of a load	Possible (only outputs of the same group)
• to increase power	Not possible
Actuation of a digital input	Possible
Max. switching frequency	
• Resistive loads	max. 10 Hz
• Inductive loads, to IEC 947–5–1, AC 15	max. 0.5 Hz
• Lamp loads	1 Hz
Short-circuit protection of output	8 A fuse, 250 V; per group
• Min. current required for fuse to blow	min. 40 A
• Max. response time	max. 300 ms
Spare fuses	8 A fuse/quick-acting
• Wickmann	19 194-8 A
• Schurter	SP001.1013
• Littlefuse	217.008
Fuse holder	
• Wickmann	19 653

3.2.6 Digital Output Module SM 322; DO 8 × 120/230 VAC/2 A

Order No.

6ES7 322-1FF01-0AA0

Characteristics

The digital output module SM 322; DO 8 × 120/230 VAC/2 A has the following salient features:

- 8 output points, fused and isolated in groups of 4
- 2 A output current
- 120/230 VAC rated load voltage
- Suitable for AC solenoid valves, contactors, motor starters, fractional h.p. motors and lamps indicator lights.

Terminal Connection Diagram and Block Diagram

Figure 3-15 shows the terminal connection diagram and block diagram of the module SM 322; DO 8 × 120/230 VAC/2 A.

You will find the detailed technical specifications of the module SM 322; DO 8 × 120/230 VAC/2 A on the following page.

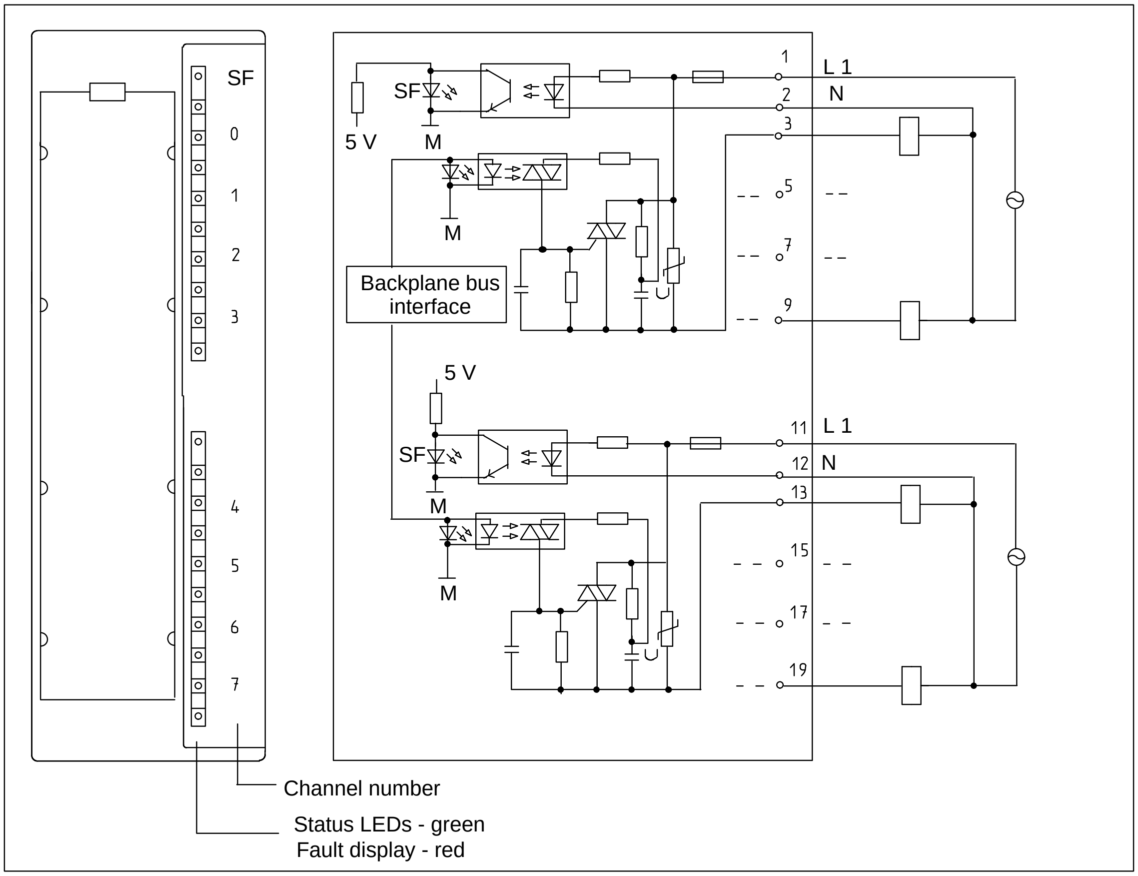


Figure 3-15 Module View and Block Diagram of the Digital Output Module SM 322; DO 8 × AC 120/230 V/2 A

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 275 g (9.63 oz.)
Module-Specific Data	
Number of output points	8
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated load voltage L1	120/230 VAC
Total current of the outputs (per group)	
• horizontal installation up to 40 °C / 104°F up to 60 °C / 140°F	 max. 4 A max. 2 A
• vertical installation up to 40 °C / 104°F	 max. 2 A
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels	Yes
in groups of	4
Permiss. potential differences	
• between $M_{internal}$ and the outputs	230 VAC
• between the outputs of different groups	500 VAC
Insulation tested with	1500 VAC
Current drawn	
• from backplane bus	max. 100 mA
• from load voltage L1 (without load)	max. 2 mA
Module power losses	typ. 8.6 W
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	
• Group fault display on the module (fuse or no L1/N)	Red LED (SF)

Actuator Selection Data	
Output voltage	
• at “1” signal	min. L1 (– 8.5 V)
Output current	
• at “1” signal Rated value Permiss. current for 0 °C to 40 °C Permiss. current for 40 °C to 60 °C Permiss. surge current (per group)	 2 A 10 mA to 2 A 10 mA to 1 A max. 20 A (with 2 half waves)
• at “0” signal (Residual current)	max. 2 mA
Zero cross inhibit voltage	max. 60 V
Size of motor starter	max. size 5 to NEMA
Lamp load	max. 50 W
Parallel connection of 2 outputs	
• for redundant actuation of a load	Possible (only outputs of the same group)
• to increase power	Not possible
Actuation of digital input	Possible
Switching frequency	
• Resistive loads	max. 10 Hz
• Inductive loads to IEC 947–5–1, AC 15	max. 0.5 Hz
• Lamp loads	max. 1 Hz
Short-circuit protection of output	8 A fuse, 250 V; per group
• Min. current required for fuse to blow	min. 40 A
• Max. response time	max. 300 ms
Spare fuses	8 A fuse/ quick-acting
• Wickmann	19 194-8 A
• Schurter	SP001.1013
• Littlefuse	217.008
Fuse holder	
• Wickmann	19 653

3.2.7 Digital Output Module SM 322; D0 32 × 120 VAC/1.0 A

Order No.

6ES7 322-1EL00-0AA0

Characteristics

The digital output module, SM 322; DO 32 × 120 VAC/1.0 A has the following salient features:

- 32 output points, fused and isolated in groups of 8
- 1.0 A output current
- 120 VAC rated load voltage
- Blown fuse indicator for each group
- Suitable for AC solenoid valves, contactors, motor starters, fractional h.p. motors and indicator lights

Terminal Connection Diagram and Block Diagram

Figure 3-16 shows the terminal connection diagram and block diagram of the digital output module SM 322; D0 32 × 120 VAC/1.0 A.

You will find the detailed technical specifications of the module SM 322; D0 32 × 120 VAC/1.0 A on the following page.

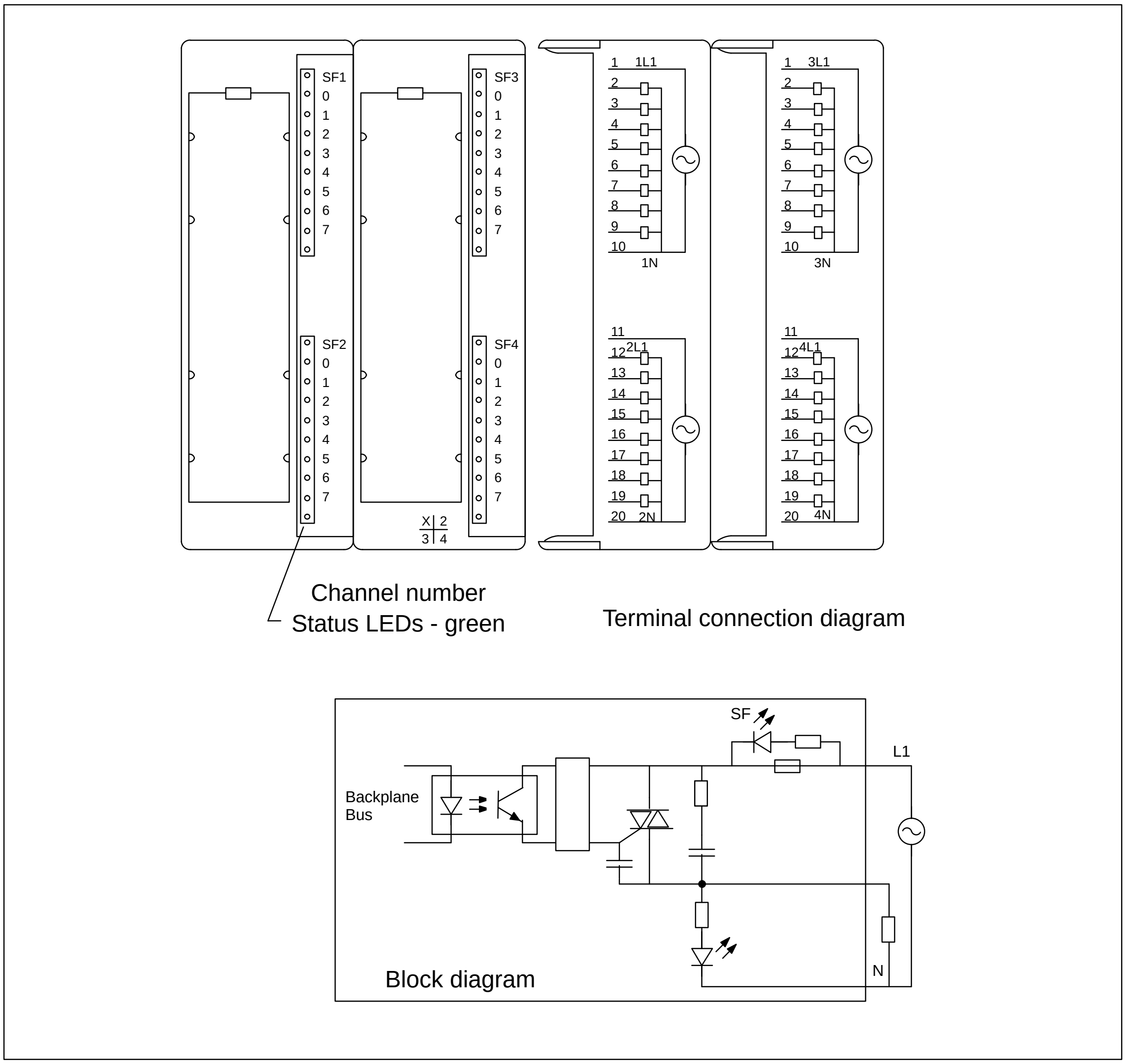


Figure 3-16 Terminal Connection Diagram and Block Diagram of Digital Output Module SM 322; D0 32 × 120 VAC/1.0 A

Dimensions and Weight	
Dimensions W × H × D	80 × 125 × 120 mm (3.15 × 4.88 × 4.68 in.)
Weight	approx. 500 g (19.3 oz.)
Module-Specific Data	
Number of output points	32
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated load voltage L1	120 VAC
Total current of the outputs (per group)	
• Horizontal installation up to 20° C/68° F up to 60° C/140° F	 max. 6 A max. 3 A
• Vertical installation up to 40 °C/104 °F	 max. 4 A
Galvanic isolation	
• To backplane bus	Yes
• Between the channels in groups of	Yes 8
Permiss. potential differences	
• Between the L1 terminals of the groups	250 VAC
• Between the input (L1 terminal) and the central grounding point	120 VAC
• Insulation tested with	1500 VAC
Current drawn	
• From backplane bus	max. 100 mA
• From L1 (without load)	max. 275 mA
Module power losses	typ. max. 25 W

Status, Interrupts, Diagnostics	
Status display	Yes; green LED per channel
Interrupts	No
Diagnostics functions	Yes
• Group fault display on the module (fuse)	Yes
Actuator Selection Data	
Output voltage	
• At “1” signal	L1 – 1.5 V
Output current	
• At “1” signal Rated current Min. current Permiss. surge current (per group)	 1 A 10 mA max. 10 A (with 2 half waves)
• At “0” signal Residual current	 max. 3 mA
Zero cross inhibit voltage	Non-zero cross outputs
Size of motor starter	max. size 4 to NEMA
Output power	
• Lamp load	max. 25 W
Parallel connection of 2 outputs	
• For logic operations	Possible (only outputs of the same group)
• To increase power	Not possible
Driving of digital input	Possible
Max. switching frequency	
• Resistive loads	max. 10 Hz
• Inductive loads	max. 0.5 Hz
• Lamp loads	1 Hz
Short-circuit protection of output	7 A fuse, 125 V per group, not replaceable

3.3 Relay Output Modules

List of Relay Output Modules

The following relay output modules are described in this chapter.

- SM 322; DO 16 × 120 VAC REL.
- SM 322; DO 8 × 230 VAC REL.
- SM 322; DO 8 × 230 VAC/5A REL.

3.3.1 Relay Output Module SM 322; DO 16 × 120 VAC REL.

Order No.

6ES7 322-1HH00-0AA0

Characteristics

The relay output module SM 322; DO 16 × 120 VAC REL. has the following salient features:

- 16 output points, isolated in groups of 8
- Load voltage 24 VDC to 120 VDC, 48 VAC to 120 VAC
- Suitable for AC/DC solenoid valves, contactors, motor starters, fractional h.p. motors and indicator lights.

Note

When the power supply is switched off, the capacitor still stores energy for about 200 ms. The relay can therefore still be driven briefly within this time by the user program.

Terminal Connection Diagram and Block Diagram

Figure 3-17 shows the terminal connection diagram and block diagram of the module SM 322; DO 16 × 120 VAC REL.

You will find the detailed technical specifications of the SM 322; DO 16 × 120 VAC REL on the following page.

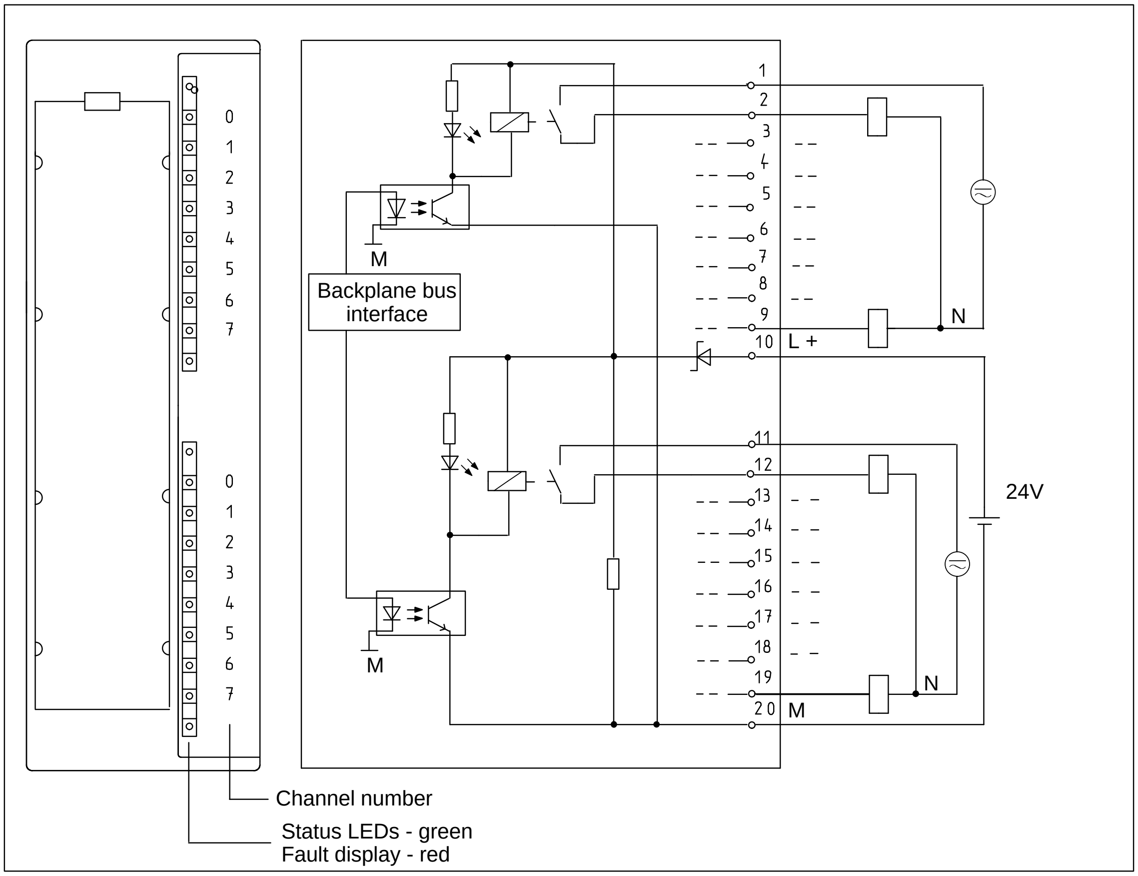


Figure 3-17 Module View and Block Diagram of Relay Output Module SM 322; DO 16 × 120 VAC REL.

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56×4.88×4.68 in.)
Weight	approx. 250 g
Module-Specific Data	
Number of output points	16
Length of cable	
• Unshielded	max. 600m (654 yd.)
• Shielded	max. 1000m (1090 yd)
Voltages, Currents, Potentials	
Rated supply voltage of the relay L +	24 VDC
Number of outputs that can be driven simultaneously	16
Total current of the outputs (per group)	max. 8 A
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels in groups of	Yes 8
Permiss. potential differences:	
• between $M_{internal}$ and supply voltage of the relays	75 VDC 60 VAC
• between $M_{internal}$ and supply voltage of the relays and the outputs	120 VAC
• between the outputs of different groups	250 VAC
Insultation tested with:	
• between $M_{internal}$ and supply voltage of the relays	500 VDC
• between $M_{internal}$ and supply voltage of the relays and the outputs	1500 VAC
• between the outputs of different groups	1500 VAC
Current drawn	
• from backplane bus	max. 100 mA
• from supply voltage L+	max. 250 mA
Module power losses	typ. 4.5 W

Status, Interrupts, Diagnostics	
Status display	Green LED p. channel
Interrupts	None
Diagnostics functions	None
Actuator Selection Data	
Thermic permanent current	max. 2 A

Switching capacity and service life of the contacts

- Resistive load

Voltage	Current	No. of switching cyc. (typ.)
24 VDC	2.0 A	0.1 mill
24 VDC	1.0 A	0.2 mill
24 VDC	0.5 A	1.0 mill
60 VDC	0.5 A	0.2 mill
120 VDC	0.2 A	0.6 mill
48 VAC	1.5 A	1.5 mill
60 VAC	1.5 A	1.5 mill
120 VAC	2.0 A	1.0 mill
120 VAC	1.0 A	1.5 mill
120 VAC	0.5 A	2.0 mill

- Inductive load to IEC 947-5-1 DC13/AC15

Voltage	Current	No. of switching cyc. (typ.
24 VDC	2.0 A	0.05 mill
24 VDC	1.0 A	0.1 mill
24 VDC	0.5 A	0.5 mill
60 VDC	0.5 A	0.1 mill
120 VDC	0.2 A	0.3 mill
48 VAC	1.5 A	1 mill
60 VAC	1.5 A	1 mill
120 VAC	2.0 A	0.7 mill
120 VAC	1.0 A	1.0 mill
120 VAC	0.5 A	1.5 mill

• Lamp load	max. 50 W
• Size of motor starter	max. size 5 to NEMA

You will achieve a longer service life with an external suppressor circuit

Paral. connection of 2 outputs	
• for redundant actuation of a load	Possible (only outputs of the same group)
• to increase power	Not possible
Actuation of a digital output	Possible
Switching frequency	
• Mechanical	max. 10 Hz
• Resistive loads	max. 1 Hz
• Inductive loads to IEC 947–5–1, DC 13/AC 15	max. 0.5 Hz
• Lamp loads	max. 1 Hz

3.3.2 Relay Output Module SM 322; DO 8 × 230 VAC REL.

Order No.

6ES7 322-1HF00-0AA0

Characteristics

The relay output module SM 322; DO 8 × 230 VAC REL. has the following salient features:

- 8 output points, isolated in groups of 2
- Rated load voltage 24 VDC to 120 VDC, 48VAC to 230VAC
- Suitable for AC/DC solenoid valves, contactors, motor starters, fractional h.p. motors and indicator lights.

Note

When the power supply is switched off, the capacitor still stores energy for about 200 ms. The relay can therefore still be driven briefly within this time by the user program.

Terminal Connection Diagram and Block Diagram

Figure 3-18 shows the terminal connection diagram and block diagram of the module SM 322; DO 8 × 230 VAC REL.

You will find the detailed technical specifications of the module SM 322; DO 8 × 230 VAC REL. on the following page.

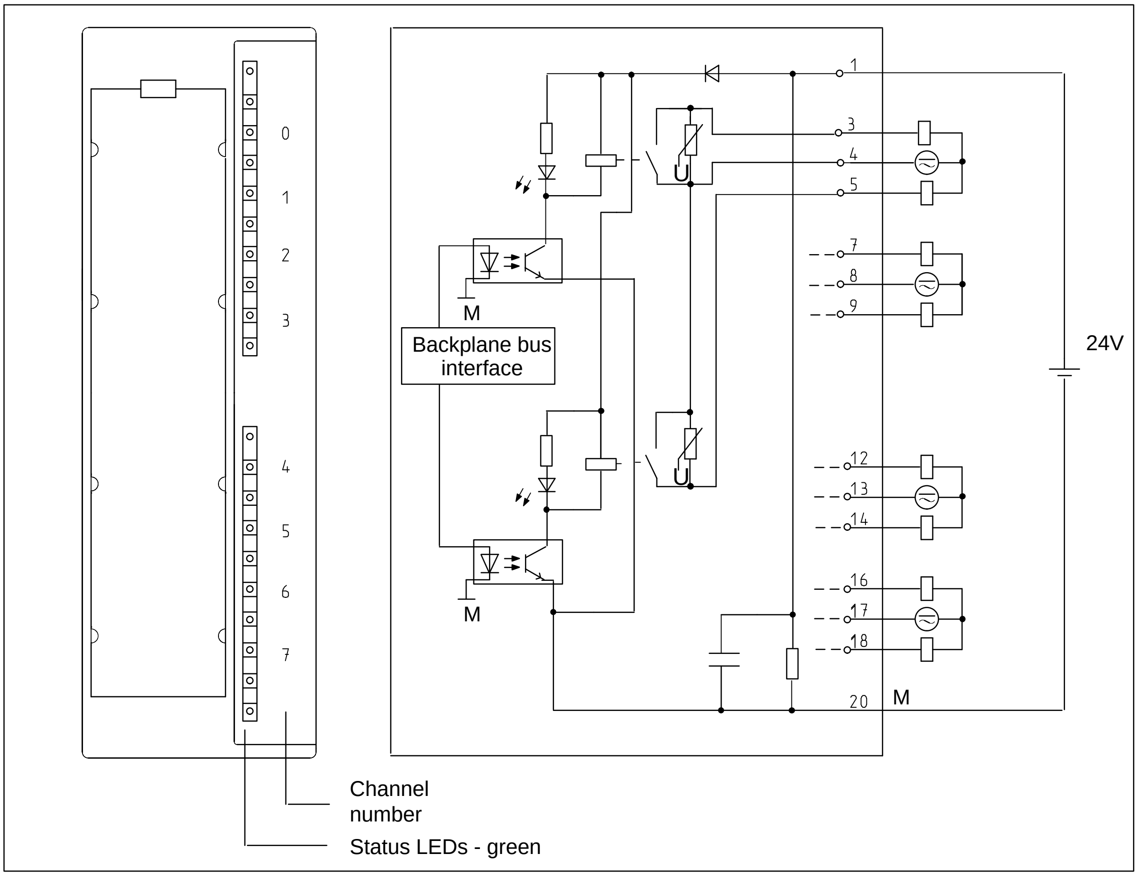


Figure 3-18 Module View and Block Diagram of Relay Output Module SM 322; DO 8 × 230 VAC REL.

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 190 g (6.65 oz.)
Module-Specific Data	
Number of output points	8
Length of cable	
• Unshielded	max. 600 m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated supply voltage of the relay L +	24 VDC
Total current of the outputs (per group)	max. 4 A
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels in groups of	Yes 2
Permiss. potential differences:	
• between $M_{internal}$ and supply voltage of the relays	75 VDC 60 VAC
• between $M_{internal}$ or supply voltage of the relays and the outputs	230 VAC
• between the outputs of different groups	400 VAC
Insulation tested with:	
• between $M_{internal}$ and supply voltage of the relays	500 VDC
• between $M_{internal}$ or supply voltage of the relays and the outputs	1500 VAC
• between the outputs of different groups	1500 VAC
Current drawn	
• from backplane bus	max. 40 mA
• from supply voltage L+	max. 110 mA
Module power losses	typ. 2.2 W

Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	None
Actuator Selection Data	
Thermic permanent current	max. 3 A

Switching capacity and service life of the contacts

- Resistive load

Voltage	Current	No. of switching cyc. (typ.)
24 VDC	2.0 A	0.7 mill
24 VDC	1.0 A	1.6 mill
24 VDC	0.5 A	4.0 mill
60 VDC	0.5 A	1.6 mill
120 VDC	0.2 A	1.6 mill
48 VAC	2.0 A	1.6 mill
60 VAC	2.0 A	1.2 mill
120 VAC	2.0 A	0.4 mill
120 VAC	1.0 A	1.2 mill
120 VAC	0.5 A	5.0 mill
230 VAC	2.0 A	0.2 mill
230 VAC	1.0 A	0.4 mill
230 VAC	0.5 A	1.5 mill

- Inductive load to IEC 947-5-1 DC13/AC15

Voltage	Current	No. of switching cyc. (typ.)
24 VDC	2.0 A	0.3 mill.
24 VDC	1.0 A	0.5 mill.
24 VDC	0.5 A	1.0 mill.
60 VDC	0.5 A	0.5 mill.
120 VDC	0.2 A	0.5 mill.
48 VAC	1.5 A	1 mill.
60 VAC	1.5 A	1 mill.
120 VAC	2.0 A	0.2 mill.
120 VAC	1.0 A	0.7 mill.
120 VAC	0.7 A	1 mill.
120 VAC	0.5 A	2.0 mill.
230 VAC	2,0 A	0.1 mill.
230 VAC	1.0 A	0.2 mill.
230 VAC	0.5 A	1 mill.

Lamp load	max. 50 W

You will achieve a longer service life with an external suppressor circuit

Actuator Selection Data, continued	
Contact circuit (internal)	Varistor SIOV-CU4032 K275 G
Parallel connection of 2 outputs	
• for redundant actuation of a load	Possible (only outputs of the same group)
• to increase power	Not possible
Actuation of a digital output	Possible
Switching frequency	
• Mechanical	max. 10 Hz
• Resistive loads	max. 2 Hz
• Inductive loads to IEC 947–5–1, DC 13/AC 15	max. 0.5 Hz
• Lamp loads	max. 2 Hz

3.3.3 Digital output Module SM 322; DO 8 × Rel. 230 VAC/5 A

Order No.

6ES7 322-1HF10-0AA0

Characteristics

The digital output module SM 322; DO 8 × Rel. 230 VAC/5 A has the following features:

- 8 outputs, isolated in groups of 1
- Load current 24 V to 120 V DC, 48 V to 230 V AC
- Suitable for AC/DC solenoid valves, contactors, motor starters, fractional h.p. motors and indicator lights

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Note

In the case of currents greater than 3 A, a conductor cross-section of 1.5 mm^2 must be selected in order to minimize the additional heating of the module at the connector.

When the front-panel connector with spring-loaded terminals is implemented, the connector with the order number 6ES7 392-1BM01-0AA0 must be used.

Terminal Connection Diagram and Block Diagram

Figure 3-19 shows the terminal connection diagram and block diagram of the digital output module SM 322; DO 8 × Rel. 230 VAC/5 A.

You will find the detailed technical specifications of the module SM 322; DO 8 × Rel. 230 VAC/5 A on the following pages.

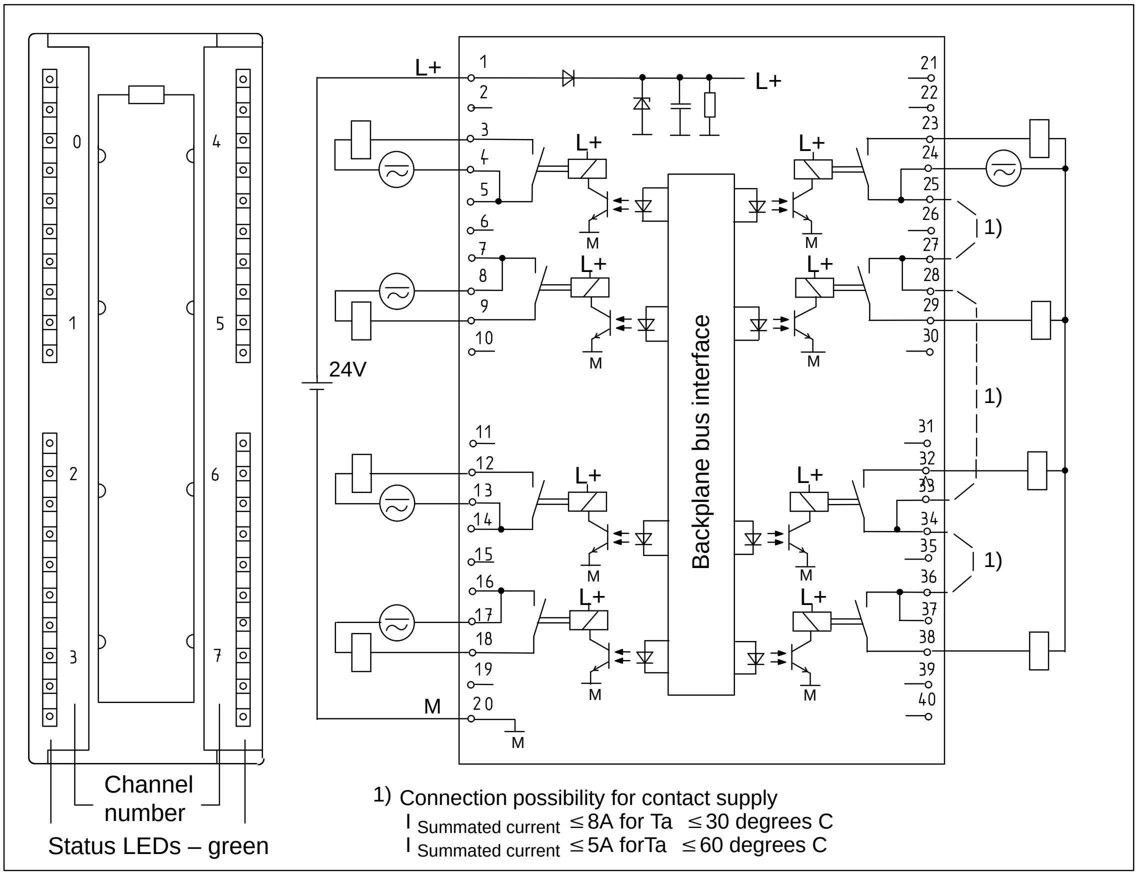


Figure 3-19 Module View and Block Diagram of Digital Output Module SM 322; DO 8 × Rel. 230 VAC/5 A

Dimensions and Weight	
Dimensions W × H × D (mm)	40 × 125 × 120 mm (1.56 x 4.88 x 4.68 in.)
Weight	approx. 320 g (11.2 oz.)
Module-Specific Data	
Number of output points	8
Length of cable	
• Unshielded	max. 600m (654 yd.)
• Shielded	max. 1000 m (1090 yd.)
Voltages, Currents, Potentials	
Rated supply voltage for relay L +	24 V DC
Current of the outputs	
• horizontal installation	
up to 30 °C	max. 8 A
up to 60 °C	max. 5A
• vertical installation up to 40 °C	max. 5A
Galvanic isolation	
• between channels and backplane bus	yes
• between the channels	yes
Permiss. potential differences:	
• between $M_{internal}$ and the supply voltage of the relays	75 V DC 60 V AC
• between $M_{internal}$ or supply voltage of the relays and the outputs	250 V AC
• between the outputs	00 V AC
Insulation tested with	
• between $M_{internal}$ and the supply voltage of the relays	500 V DC
• between $M_{internal}$ or supply voltage of the relays and the outputs	1500 V AC
• between the outputs	2000 V AC
Current drawn	
• from backplane bus	max. 40 mA
• from supply voltage L +	max. 125 mA
Module power loss	typ. 4.2 W

Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	None
Actuator Selection Data	
Thermic permanent current	max. 8 A
Short-circuit-proof with circuit-breaker of characteristic B (to IEC 947-5-1) for	
• cos ϕ 1.0	600 A
• cos ϕ 0.5–0.7	900 A
Short-circuit-proof with fusible link	
• Diazed 8 A	1000 A
Switching capacity and service life of contacts	
• for resistive load (heating)	

Voltage	Current	No. of switching cycles (typ.)
	8.0 A	0.1 mill.
24 V DC	4.0 A	0.3 mill.
	2.0 A	0.7 mill.
	0.5 A	4.0 mill.
	0.5 A	1.6 mill.
60 V DC	0.2 A	1.6 mill.
120 V DC	8.0 A	0.1mill.
48 V AC	2.0 A	1.6 mill.
	8.0 A	0.1 mill.
60 V AC	2.0 A	1.2 mill.
	8.0 A	0.1 mill.
120 V AC	4.0 A	0.3 mill.
	2.0 A	0.5 mill.
	1.0 A	0.7 mill.
	0.5 A	1.5 mill.
	8.0 A	0.1 mill.
230 V AC	4.0 A	0.3 mill.
	2.0 A	0.5 mill.
	1.0 A	0.7 mill.
	0.5 A	1.5 mill.

Actuator Selection Data, continued		
Switching capacity and service life of contacts		
• for inductive loads IEC 947-5-1 DC13/AC15		
Voltage	Current	No. of switching cycles (typ.)
24 V DC	2.0 A	0.3 mill.
	1.0 A	0.5 mill.
	0.5 A	1 mill.
60 V DC	0.5 A	0.5 mill.
	0.3 A	1 mill.
120 V DC	0.2 A	0.5 mill.
48 V AC	3.0A	0.5 mill.
	1.5 A	1 mill.
60 V AC	3.0A	0.3 mill.
	1.5A	1 mill.
120 V AC	3.0 A	0.2 mill.
	2.0 A	0.3 mill.
	1.0 A	0.7 mill.
	0.5 A	2 mill.
230 V AC	3.0 A	0.1 mill.
	2.0 A	0.3 mill.
	1.0 A	0.7 mill.
	0.5 A	2.0 mill.
Aux. contactors Size 0 (3TH28)		30 mill.
Lamps (230 V AC)	1000W	25000
	1500W	10000
Energy saving lamps/ fluorescent lamps with electronic balast	10 × 58W	25000
Fluorescent lamps conventionally compensated	1 × 58W	25000
Fluorescent lamps uncompensated	10 × 58W	25000
An external protection circuit that is adapted to the load will enhance the service life of the contacts.		

Actuator Selection Data, continued	
Contact circuit (internal)	None
Parallel connection of 2 outputs	
• for redundant actuation of a load	Possible
• to increase power	Not possible
Actuation of a digital input	Possible
Switching frequency	
• Mechanical	max. 10 Hz
• Resistive loads	max. 2 Hz
• Inductive loads to IEC 947-5-1, DC 13/AC 15	max. 0.5 Hz
• Lamp loads	max. 2 Hz

3.4 Digital Input/Output Modules

List of Digital Input/Output Modules

The following digital input/output modules are described in this chapter:

- SM 323; DI 16/DO 16 × 24 VDC/0.5 A
- SM 323; DI 8/DO 8 × 24 VDC/0.5 A

3.4.1 Digital Input/Output Module SM 323; DI 16/DO 16 × 24 VDC/0.5 A

Order No.

6ES7 323–1BL00–0AA0

Characteristics

The digital input/output module 323; DI 16/DO 16 × 24 VDC/0.5 A has the following salient features:

- 16 output points, isolated in groups of 16
- 16 output points, isolated in groups of 8.
- Rated input voltage 24 VDC
- 24 VDC rated load voltage
- Inputs suitable for switches and 2/3/4-wire proximity switches (BEROs).
- Outputs suitable for solenoid valves, DC contactors and indicator lights.

Special Feature

When the power supply is switched on via a mechanical contact, the digital output module SM 323; DI 16/DO 16 × 24 VDC/0.5 A sends a “1” signal to its outputs for approximately 50 μs. You must observe this when using the digital output module SM 323; DI 16/DO 16 × 24 VDC/0.5 A for high-speed counters!

Terminal Connection Diagram and Block Diagram

Figure 3-20 shows the terminal connection diagram and block diagram of the SM 323; DI 16/DO 16 × 24 VDC/0.5 A.

You will find the detailed technical specifications of the module SM 323; DI 16/DO 16 × 24 VDC/0.5 A on the following page.

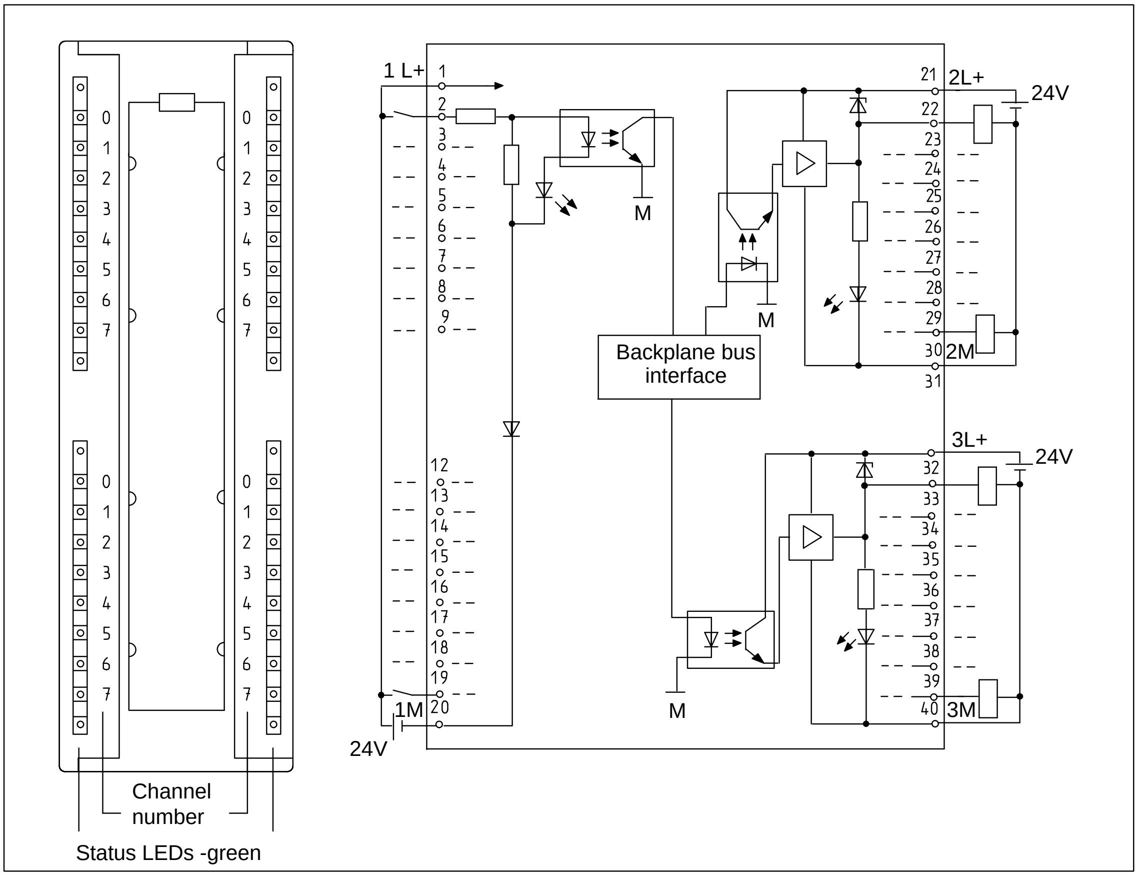
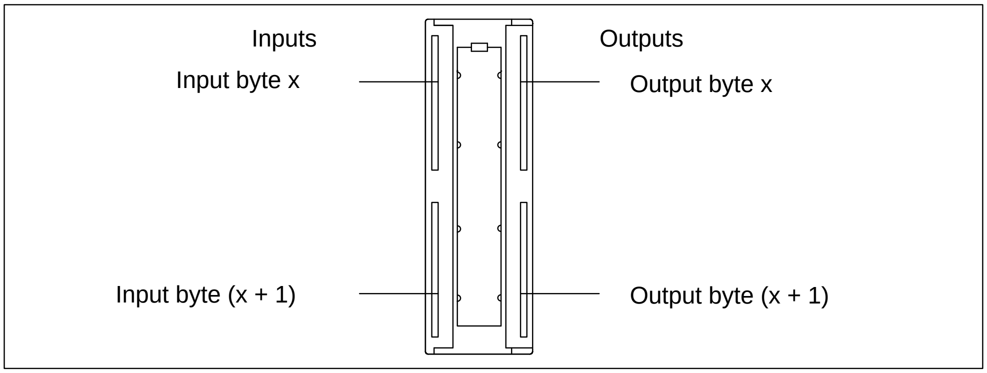


Figure 3-20 Module View and Block Diagram of the SM 323; DI 16/DO 16 × 24 VDC/0.5 A

Terminal Assignment

The following figure shows the assignment of the channels to the input/output addresses.



Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56×4.88×4.68 in.)
Weight	approx. 260 g
Module-Specific Data	
Number of input points	16
Number of output points	16
Length of cable	
• Unshielded	max. 600m (654 yd.)
• Shielded	max. 1000m (1090 yd)
Voltages, Currents, Potentials	
Rated load voltage L+	24 VDC
• Reverse polarity protection for input supply	Yes
No. of inputs controllable simultaneously	
• Horizontal installation up to 40 °C up to 60 °C	 16 8
• Vertical installation up to 40 °C	 16

Voltages, Currents, Potentials, continued	
Total current of the outputs (per group)	
• Horizontal installation up to 20 °C up to 40 °C up to 60 °C	 max. 4 A max. 3 A max. 2 A
• Vertical installation up to 40 °C	 max. 2 A
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels Inputs in groups of Outputs in groups of	Yes 16 8
Permiss. potential differences	
• between different circuits	75 VDC 60 VAC
Insulation tested with	500 VDC
Current drawn	
• from backplane bus	max. 55 mA
• from load voltage L+ (without load)	max. 100 mA
Module power losses	typ. 6.5 W
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	None
Diagnostics functions	None

Sensor Selection Data	
Input voltage	
• Rated value	24 VDC
• at “1” signal	13 to 30 V
• at “0” signal	-3 to 5 V
Input current	
• at “1” signal	typ. 7 mA
Input delay time	
• from “0” to “1”	1.2 to 4.8 ms
• from “1” to “0”	1.2 to 4.8 ms
Input characteristic	to IEC 1131, type 1
Connection of 2-wire BEROs	Possible
• Permissible bias current	max. 1.5 mA

Actuator Selection Data	
Output voltage	
• at “1” signal	min. L + (– 0.5 V)
Output current	
• at “1” signal	
Rated value	0.5 A
Permiss. range	5 mA to 0.6 A
• at “0” signal	
Residual current	max. 0.5 mA
Load impedance	48 Ω to 4kΩ
Lamp load	max. 5 W
Parallel connection of 2 outputs	
• for redundant actuation of a load	Possible (only outputs of the same group)
• to increase power	Not possible
Actuation of digital input	Possible
Switching frequency	
• Resistive loads	max. 100 Hz
• Inductive loads to IEC 947–5–1, DC 13	max. 0.5 Hz
• Lamp loads	max. 10 Hz

Actuator Selection Data, continued	
Voltage induced on circuit interruption limited (internally) to	typ. L + (– 48 V)
Short-circuit protection of output	Yes, electronic
• Response threshold	typ. 1 A

3.4.2 Digital Input/Output Module SM 323; DI 8/DO 8 × 24 VDC/0.5 A

Order No.

6ES7 323-1BH00-0AA0

Characteristics

The digital input/output module SM 323; DI 8/DO 8 × 24 VDC/0.5 A has the following salient features:

- 8 output points, isolated in groups of 8
- 8 input points, isolated in groups of 8
- Rated input voltage 24 VDC
- Rated load voltage 24 VDC
- Outputs suitable for switches and 2/3/4-wire proximity switches (BEROs).
- Inputs suitable for solenoid valves, DC contactors and indicator lights

Special Feature

When the power supply is switched on via a mechanical contact, the digital output module SM 323; DI 8/DO 8 × 24 VDC/0.5 A sends a “1” signal to its outputs for approximately 50 μs. You must observe this when using the digital output module SM 323; DI 8/DO 8 × 24 VDC/0.5 A for high-speed counters!

Terminal Connection Diagram and Block Diagram

Figure 3-21 shows the terminal connection diagram and block diagram of the digital input/output module SM 323; DI 8/DO 8 × 24 VDC/0.5 A.

You will find the detailed technical specifications of the SM 323; DI 8/DO 8 × 24 VDC/0.5 A on the following page.

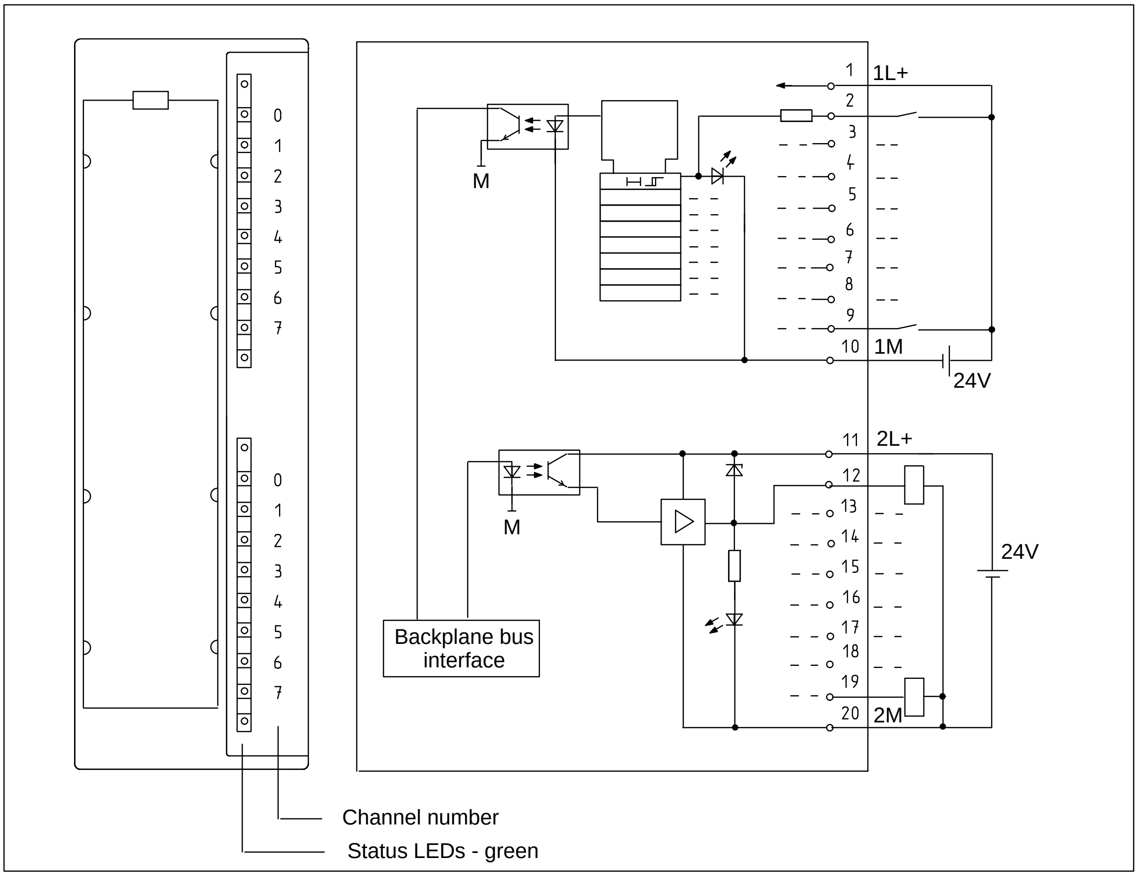


Figure 3-21 Module View and Block Diagram of Digital Input/Output Module SM 323; DI 8/DO 8 × 24 VDC/0.5 A

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56×4.88×4.68 in.)
Weight	approx. 200 g
Module-Specific Data	
Number of input points	8
Number of output points	8
Length of cable	
• Unshielded	max. 600m (654 yd.)
• Shielded	max. 1000m (1090 yd)
Voltages, Currents, Potentials	
Rated load voltage L+	24 VDC
• Reverse polarity protection for input supply	Yes
No. of inputs controllable simultaneously	
• Horizontal installation up to 60 °C	8
• Vertical installation up to 40 °C	8
Total current of the outputs (per group)	
• Horizontal installation up to 60 °C	max. 4 A
• Vertical installation up to 40 °C	max. 4 A
Galvanic isolation	
• between channels and backplane bus	Yes
• between the channels Inputs in groups of Outputs in groups of	Yes 8 8
Permiss. potential differences	
• between different circuits	75 VDC 60 VAC
Insulation	500 VDC
Current drawn	
• from backplane bus	max. 40 mA
• from load voltage L+ (without load)	max. 20 mA
Module power losses	typ. 3.5 W
Status, Interrupts, Diagnostics	
Status display	Green LED per chan.
Interrupts	None

Diagnostics functions	None
Sensor Selection Data	
Input voltage	
• Rated value	24 VDC
• at “1” signal	11 to 30 V
• at “0” signal	-3 to 5 V
Input current	
• at “1” signal	typ. 7 mA
Input delay time	
• from “0” to “1”	1.2 to 4.8 ms
• from “1” to “0”	1.2 to 4.8 ms
Input characteristic	to IEC 1131, type 2
Connection of 2-wire BEROs	Possible
• Permissible closed-circuit current	max. 2 mA
Actuator Selection Data	
Output voltage	
• at “1” signal	min. L + (– 0.5 V)
Output current	
• at “1” signal Rated value Permiss. range	 0.5 A 5 mA to 0.6 A
• at “0” signal Residual current	 max. 0.5 mA
Load impedance	48 Ω to 4 kΩ
Lamp load	max. 5 W
Parallel connection of 2 outputs	
• for redundant actuation of a load	Possible (only outputs of the same group)
• to increase power	Not possible
Actuation of a digital output	Possible
Max. switching frequency	
• for resistive load	max. 100 Hz
• for inductive load to IEC 947-5-1, DC 13	max. 0.5 Hz
• for lamp load	max. 10 Hz
Voltage induced on circuit interruption limited (internally) to	typ. L + (– 48 V)
Short-circuit protection of output	Yes, electronic
• Response threshold	typ. 1 A

Analog Modules

4

Introduction

The S7-300 system has a number of analog modules for connecting to sensors and/or loads/actuators.

Contents

In this chapter we describe the basic principles of analog technology and the analog modules of the S7-300:

4.1 Analog Value Representation

Analog Values

In all S7-300 analog modules, the analog value is represented in binary form in the same way.

This chapter describes the analog values for **all** the measuring and/or output ranges you can use with your S7-300 analog modules.

4.1.1 Representation of Analog Input and Output Values

Converting Analog Values

The CPU processes the analog values in binary form only.

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

Analog output modules convert the digital output value into an analog signal.

Analog Value Representation

The digitized analog value is the same for both input and output values having the same nominal range.

The analog values are represented as two's complement.

Table 4-1 shows how the analog values of the analog modules are represented:

Table 4-1 Analog Value Representation

Resolution	Analog Value															
Number of bits	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Bit weighting	VZ	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}

Sign

The sign (S) of the analog value is always in bit number 15:

- "0" → +
- "1" → –

Resolutions of Less than 15 Bits

If the resolution of an analog module has fewer than 15 bits, the analog value is entered left-justified in the accumulator. The lower-order bit positions not used are padded with zeros (**"0"**).

Table 4-2 contains a bit pattern to show you how to write zeros (**"0"**) into the unassigned bit positions for a resolution with fewer than 15 bits.

Table 4-2 Bit Pattern of a 15-Bit and a 12-Bit Analog Value (Example)

Resolution	Analog Value															
Number of bits	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
15-bit analog value (+ S)	0	1	0	0	0	1	1	0	0	1	1	1	0	0	1	1
12-bit analog value (+ S)	0	1	0	0	0	1	1	0	0	1	1	1	0	**0**	**0**	**0**
8-bit analog value (+ S)	0	1	0	0	0	1	1	0	0	**0**	**0**	**0**	**0**	**0**	**0**	**0**

4.1.2 Analog Value Representation of the Measuring Ranges of the Analog Inputs

Introduction

The tables in this chapter contain the digitized analog values for the various measuring ranges of the analog modules.

Table 4-3 shows you the binary representation of the analog values and the associated decimal and hexadecimal notation of the units of the analog values.

How to Read the Measured-Value Tables

Tables 4-4 to 4-15 contain the digitized analog values for the various measuring ranges.

Since the binary representation of the analog values is always the same, these tables only contain the measured values and the units.

This makes the tables clearer and easier to read. You will find the binary representations corresponding to the measured values in Table 4-3.

Measured-Value Resolution

The resolution of the analog values may vary, depending on the analog module and the parameters assigned to it. For the resolutions < 15 bits, the bits marked with an “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 4-8 to 4-15).

Table 4-3 Possible Resolutions of the Analog Values

Resolution in Bits (+ S)	Units		Analog Value	
	Decimal	Hexa-decimal	High-Order Byte	Low-Order Byte
8	128	80_H	VZ 0 0 0 0 0 0 0	1 x x x x x x x
9	64	40_H	VZ 0 0 0 0 0 0 0	0 1 x x x x x x
10	32	20_H	VZ 0 0 0 0 0 0 0	0 0 1 x x x x x
11	16	10_H	VZ 0 0 0 0 0 0 0	0 0 0 1 x x x x
12	8	8_H	VZ 0 0 0 0 0 0 0	0 0 0 0 1 x x x
13	4	4_H	VZ 0 0 0 0 0 0 0	0 0 0 0 0 1 x x
14	2	2_H	VZ 0 0 0 0 0 0 0	0 0 0 0 0 0 1 x
15	1	1_H	VZ 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1

Voltage Measuring Ranges

Table 4-4 shows the representation of the digitized measured value for the voltage measuring ranges ± 80 mV, ± 250 mV, ± 500 mV, ± 1 V, ±2.5 V.

Table 4-4 Representation of the Digitized Measured Value of an Analog Input Module (Voltage Ranges)

Measuring Range ± 80 mV	Measuring Range ± 250 mV	Measuring Range ± 500 mV	Measuring Range ± 1 V	Measuring Range ± 2.5 V	Units		Range
					Deci-mal	Hexa-decimal	
> 94.071	> 293.97	> 587.94	> 1.175	> 2.9397	32767	$7FFF_H$	Overflow
94.071	293.97	587.94	1.175	2.9397	32511	$7EFF_H$	
:	:	:	:	:	:	:	Overrange
80.003	250.01	500.02	1.00004	2.5001	27649	$6C01_H$	
80.000	250.00	500.00	1.000	2.500	27648	$6C00_H$	
60.000	187.50	375.00	0.750	1.875	20736	5100_H	
:	:	:	:	:	:	:	Nominal range
– 60.000	– 187.50	– 375.00	– 0.750	– 1.875	–20736	$AF00_H$	
– 80.000	– 250.00	– 500.00	–1.000	– 2.500	–27648	9400_H	
– 80.003	– 250.01	– 500.02	– 1.00004	– 2.5001	–27649	$93FF_H$	
:	:	:	:	:	:	:	Underrange
– 94.74	– 293.98	– 587.96	– 1.175	– 2.93398	–32512	8100_H	
<– 94.074	<– 293.98	<– 587.96	<– 1.175	<– 2.93398	–32768	8000_H	Underflow

Voltage and Current Measuring Ranges

Table 4-5 shows the representation of the digitized measured value

- for the voltage measuring ranges ± 5 V, ± 10 V and
- for the current measuring ranges ± 10 mA, ± 3.2 mA, ± 20 mA.

Table 4-5 Representation of the Digitized Measured Value of an Analog Input Module (Voltage and Current Measuring Ranges)

Measuring Range ± 5 V	Measuring Range ± 10 V ± 10 mA	Measuring Range ± 3.2 mA	Measuring Range ± 20 mA	Units		Range
				Deci-mal	Hexa-decimal	
> 5.8794	> 11.7589	> 3.7628	> 23.515	32767	$7FFF_H$	Overflow
5.8794	11.7589	3.7628	23.515	32511	$7EFF_H$	Overrange
:	:	:	:	:	:	
5.0002	10.0004	3.2001	20.0007	27649	$6C01_H$	
5.00	10.00	3.200	20.000	27648	$6C00_H$	Nominal range
3.75	7.50	2.400	14.998	20736	5100_H	
:	:	:	:	:	:	
– 3.75	– 7.50	– 2.400	– 14.998	–20736	$AF00_H$	
– 5.00	– 10.00	– 3.200	– 20.000	–27648	9400_H	
– 5.0002	– 10.0004	– 3.2001	– 20.0007	–27649	$93FF_H$	Underrange
:	:	:	:	:	:	
– 5.8796	– 11.759	– 3.7629	– 23.516	–32512	8100_H	
<– 5.8796	<– 11.759	<– 3.7629	<– 23.516	–32768	8000_H	Underflow

Voltage and Current Measuring Ranges

Table 4-6 shows the representation of the digitized measured value

- for the voltage measuring ranges 1 to 5 V and
- for the current measuring ranges 0 to 20 mA, 4 to 20 mA.

Table 4-6 Representation of the Digitized Measured Value of an Analog Input Module (Voltage and Current Measuring Ranges)

Measuring Range 1 to 5 V	Measuring Range 0 20 mA	Measuring Range 4 to 20 mA	Units		Range
			Deci-mal	Hexa-decimal	
> 5.7036	> 23.515	> 22.810	32767	$7FFF_H$	Overflow
5.7036	23.515	22.810	32511	$7EFF_H$	Overrange
:	:	:	:	:	
5.0001	20.0007	20.0005	27649	$6C01_H$	
5.000	20.000	20.000	27648	$6C00_H$	Nominal range
4.000	14.998	16.000	20736	5100_H	
:	:	:	:	:	
1.000	0.000	4.000	0	0_H	
0.9999	-0.0007	3.9995	–1	$FFFF_H$	Underrange
:	:	:	:	:	
0.2963	–3.5185	1.1852	–4864	$ED00_H$	
< 0.2963	<–3.5185	< 1.1852	–32768	8000_H	Underflow

Resistance-Type Sensors Measuring Ranges

Table 4-7 shows the representation of the digitized measured value for resistance-type sensors with the measuring ranges 150 Ω, 300 Ω and 600 Ω.

Table 4-7 Representation of the Digitized Measured Value of an Analog Input Module (Resistance-Type Sensors)

Measuring Range 150 Ω	Measuring Range 300 Ω	Measuring Range 600 Ω	Units		Range
			Decimal	Hexadecimal	
> 176.383	> 352.767	> 705.534	32767	$7FFF_H$	Overflow
176.383	352.767	705.534	32511	$7EFF_H$	Overrange
:	:	:	:	:	
150.005	300.011	600.022	27649	$6C01_H$	
150.000	300.000	600.000	27648	$6C00_H$	Nominal range
112.500	225.000	450.000	20736	5100_H	
:	:	:	:	:	
0.000	0.000	0.000	0	0_H	
(negative values physically not possible)			–1	$FFFF_H$	Underrange
			:	:	
			–4864	$ED00_H$	
-	-	-	–32768	8000_H	Underflow

Standard Temperature Range Pt 100

Table 4-8 shows the representation of the digitized measured value for the standard temperature range of the Pt 100 sensor.

Table 4-8 Representation of the Digitized Measured Value of an Analog Input Module (Standard Temperature Range, Pt 100)

Standard Temperature Range Pt 100 850 °C	Units		Range
	Decimal	Hexa-decimal	
> 1000.0	32767	$7FFF_H$	Overflow
1000.0 : 850.1	10000 : 8501	2710_H : 2135_H	Overrange
850.0 : –200.0	8500 : –2000	2134_H : $F830_H$	Nominal range
–200.1 : –243.0	–2001 : –2430	$F82F_H$: $F682_H$	Underrange
<– 243.0	–32768	8000_H	Underflow

Climate Temperature Range Pt 100

Table 4-9 shows the representation of the digitized measured value for the climate temperature range of the Pt 100 sensor.

Table 4-9 Representation of the Digitized Measured Value of an Analog Input Module (Climate Temperature Range, Pt 100)

Standard Temperature Range Pt 100 130 °C	Units		Range
	Decimal	Hexa-decimal	
> 155.00	32767	$7FFF_H$	Overflow
155.00 : 130.01	15500 : 13001	$3C8C_H$: $32C9_H$	Overrange
130.00 : –120.00	13000 : –12000	$32C8_H$: $D120_H$	Nominal range
–120.01 : –145.00	–12001 : –14500	$D11F_H$: $C75C_H$	Underrange
<– 145.00	–32768	8000_H	Underflow

Standard Temperature Range Ni 100

Table 4-10 shows the representation of the digitized measured value for the standard temperature range of the Ni 100 sensor.

Table 4-10 Representation of the Digitized Measured Value of an Analog Input Module (Standard Temperature Range, Ni 100)

Standard Temperature Range Ni 100 250 °C	Units		Range
	Decimal	Hexa-decimal	
>295.0	32767	$7FFF_H$	Overflow
295.0 : 250.1	2950 : 2501	$B86_H$: $9C5_H$	Overrange
250.0 : –60.0	2500 : –600	$9C4_H$: $FDA8_H$	Nominal range
–60.1 : –105.0	–601 : –1050	$FDA7_H$: $FBE6_H$	Underrange
<– 105,0	–32768	8000_H	Underflow

Climate Temperature Range, Ni 100

Table 4-11 shows the representation of the digitized measured value for the climate temperature range of the Ni 100 sensor.

Table 4-11 Representation of the Digitized Measured Value of an Analog Input Module (Climate Temperature Range, Ni 100)

Standard Temperature Range Ni 100 250 °C	Units		Range
	Decimal	Hexa-decimal	
>295.00	32767	$7FFF_H$	Overflow
295.00 : 250.01	29500 : 25001	$733C_H$: $61A9_H$	Overrange
250.00 : –60.00	25000 : –6000	$61A8_H$: $E890_H$	Nominal range
–60.01 : –105.00	–6001 : –10500	$E88F_H$: $D6FC_H$	Underrange
<– 105.00	–32768	8000_H	Underflow

Temperature Range Type K

Table 4-12 shows the representation of the digitized measured value for the temperature range, sensor type K.

Table 4-12 Representation of the Digitized Measured Value of an Analog Input Module (Temperature Range, Type K)

Temperature Range in °C Type K	Units		Range
	Decimal	Hexa-decimal	
>1622	32767	$7FFF_H$	Overflow
1622 : 1373	16220 : 13730	$3FSC_H$: $35A2_H$	Overrange
1372 : –270	13720 : –2700	3598_H : $F574_H$	Nominal range
<–270	<–2700	$<F574_H$	Underrange
In the case of incorrect wiring (e. g. polarity reversal or open inputs) or of a sensor error in the negative range (e. g. incorrect thermocouple type), the analog input module signals underflow below $F0C5_H$ and outputs 8000_H.			

Temperature Range Type N

Table 4-13 shows the representation of the digitized measured value for the temperature range, sensor type N.

Table 4-13 Representation of the Digitized Measured Value of an Analog Input Module (Temperature Range, Type N)

Temperature Range in °C Type N	Units		Range
	Decimal	Hexadecimal	
>1550	32767	$7C8C_H$	Overflow
1550 : 1301	15500 : 13010	$3C8C_H$: $32D2_H$	Overrange
1300 : –270	13000 : –2700	$32C8_H$: $F574_H$	Nominal range
<–270	<–2700	<$F574_H$	Underrange
In the case of incorrect wiring (e. g. polarity reversal or open inputs) or of a sensor error in the negative range (e. g. incorrect thermocouple type), the analog input module signals underflow below $F0C5_H$ and outputs 8000_H.			

Temperature Range Type J

Table 4-14 shows the representation of the digitized measured value for the temperature range, sensor type J.

Table 4-14 Representation of the Digitized Measured Value of an Analog Input Module (Temperature Range, Type J)

Temperature Range in °C Type J	Units		Range
	Decimal	Hexadecimal	
>1450	32767	$7FFF_H$	Overflow
1450 : 1201	14500 : 12010	$38A4_H$: $2EEA_H$	Overrange
1200 : –210.0	12000 : –2100	$2EE0_H$: $F7CC_H$	Nominal range
<–210	<–2100	<$F7CC_H$	Underrange
In the case of incorrect wiring (e. g. polarity reversal or open inputs) or of a sensor error in the negative range (e. g. incorrect thermocouple type), the analog input module signals underflow below $F0C5_H$ and outputs 8000_H.			

Temperature Range Type E

Table 4-15 shows the representation of the digitized measured value for the temperature range, sensor type E.

Table 4-15 Representation of the Digitized Measured Value of an Analog Input Module (Temperature Ranges, Type E)

Temperature Range in °C Type E	Units		Range
	Decimal	Hexadecimal	
>1201	32767	$7FFF_H$	Overflow
1200 : 1001	12000 : 10010	$2EE0_H$: $271A_H$	Overrange
1000 : –270	10000 : –2700	2710_H : $F574_H$	Nominal range
<–271	<–2700	$<F574_H$	Underrange
In the case of incorrect wiring (e. g. polarity reversal or open inputs) or of a sensor error in the negative range (e. g. incorrect thermocouple type), the analog input module signals underflow below $F0C5_H$ and outputs 8000_H.			

Temperature Range Type L

Table 4-16 shows the representation of the digitized measured value for the temperature range, sensor type L.

Table 4-16 Representation of the Digitized Measured Value of an Analog Input Module (Temperature Range, Type L)

Temperature Range in °C Type L	Units		Range
	Decimal	Hexadecimal	
>1150	32767	$7FFF_H$	Overflow
1150 : 901	11500 : 9010	$2CEC_H$: 2332_H	Overrange
900 : –200	9000 : –2000	2328_H : $F830_H$	Nominal range
<–200	<–2000	$<F830_H$	Underrange
In the case of incorrect wiring (e. g. polarity reversal or open inputs) or of a sensor error in the negative range (e. g. incorrect thermocouple type), the analog input module signals underflow below $F0C5_H$ and outputs 8000_H.			

Measuring Ranges for the SM 334

The analog input/output module SM 334; AI 4/AO 2 × 8/8 Bit has the measuring ranges 0 to 10 V and 0 to 20 mA. In contrast to other analog modules, however, the analog input/output module SM 334 has a lower resolution and no negative measuring ranges. Please observe this when reading Tables 4-5 and 4-6.

4.1.3 Analog Value Representation of the Output Ranges of the Analog Outputs

Tables for Output Ranges

Tables 4-17 and 4-18 show the analog output ranges of the analog output module.

Voltage Output Ranges

Table 4-17 shows the representation of the voltage output ranges 0 to 10 V, 1 to 5 V and ± 10 V.

Table 4-17 Representation of the Analog Output Range of the Analog Output Modules (Voltage Output Ranges)

Output Range 0 to 10 V	Output Range 1 to 5 V	Output Range ± 10 V	Units		Range
			Decimal	Hexa-decimal	
0	0	0	>32511	>7EFF$_H$	Overflow
11.7589	5.8794	11.7589	32511	7EFF$_H$	
:	:	:	:	:	Overrange
10.0004	5.0002	10.0004	27649	6C01$_H$	
10.0000	5.0000	10.0000	27648	6C00$_H$	
:	:	:	:	:	
0	1.0000	0	0	0$_H$	
0	:0.9999		:	:	
	0	:	– 6912	E500$_H$	Nomial range
	0		– 6913	E4FF$_H$	
			:	:	
		– 10.0000	– 27648	9400$_H$	
		10.0004	– 27649	93FF$_H$	
		:	:	:	Underrange
		– 11.7589	– 32512	8100$_H$	
		0	<– 32512	<8100$_H$	Underflow

Current Output Ranges

Table 4-18 shows the representation of the current output ranges 0 to 20 mA, 4 to 20 mA and ± 20 mA.

Table 4-18 Representation of the Analog Output Range of the Analog Output Modules (Current Output Ranges)

Output Range 0 to 20 mA	Output Range 4 to 20 mA	Output Range ± 20 mA	Units		Range
			Decimal	Hexa-decimal	
0	0	0	>32511	>7EFF$_H$	Overflow
23.515	22.81	23.515	32511	7EFF$_H$	
:	:	:	:	:	Overrange
20.0007	20.005	20.0007	27649	6C01$_H$	
20.000	20.000	20.000	27648	6C00$_H$	
:	:		:	:	
0	4.000	0	0	0$_H$	
0	3.9995		:	:	
	0	:	– 6912	E500$_H$	Nominal range
	0		– 6913	E4FF$_H$	
			:	:	
		– 20.000	– 27648	9400$_H$	
			– 27649	93FF$_H$	
		:	:	:	Underrange
		– 23.515	– 32512	8100$_H$	
		0	<– 32512	<8100$_H$	Underflow

Output Ranges for the SM 334

The analog input/output module SM 334; AI 4/AO 2 × 8/8 Bit has the output ranges 0 to 10 V and 0 to 20 mA. In contrast to other analog modules, however, the analog input/output module SM 334 has a lower resolution and no overranges. Please observe this when reading Tables 4-17 and 4-18.

4.2 Connecting Sensors/Transducers and Loads/Actuators to Analog Modules

In this Chapter

In this chapter, you will find:

- Fundamentals on how to connect sensors and transducers
- A description of thermocouples
  - Design and principle of operation of thermocouples
  - Use of compensating boxes
- A description of how to connect up thermocouples to analog inputs
- A description of how to connect up other sensors and transducers to analog inputs
  - Connection of voltage sensors
  - Connection of resistance thermometers
  - Connection of current sensors
  - Connection of other sensors and transducers
- A description of how to connect up loads/actuators to analog inputs

4.2.1 Connecting Sensors/Transducers to Analog Inputs

Introduction

You can connect various types of transducers and sensors to your analog input modules:

- Voltage sensors
- Current sensors as
  - 2-wire transducers
  - 4-wire transducers
- Resistors

This chapter tells you how to connect up your sensors and transducers and what precautions you have to take when doing so.

Cables for Analog Signals

To reduce electrical interference, you should use twisted-pair shielded cables for the analog signals. The shield of the analog signal cables should be grounded at both cable ends. If there are potential differences between the cable ends, an equipotential bonding current can flow over the shield, which leads to an interference of the analog signals. In such a case, you should ground the shield at one end of the cable only.

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 the M terminal of the CPU.

You must use isolated analog input modules if a potential difference U_{ISO} can occur between the reference point of the measuring circuit M_{ANA} and the M terminal of the CPU. Make sure that U_{ISO} does not exceed the permissible value. If it is possible that the permissible value is exceeded, establish a connection between the M_{ANA} terminal and the M terminal of the CPU.

Non-Isolated Analog Input Modules

With the non-isolated analog input modules, you must establish a connection between the reference point of the measuring circuit M_{ANA} and the M terminal of the CPU or IM 153. Therefore, connect the M_{ANA} terminal with the M terminal of the CPU or IM 153. A potential difference between M_{ANA} and the M terminal of the CPU or IM 153 can lead to a corruption of the analog signal.

Connection of Sensors to Analog Inputs

Only a limited potential difference U_{CM} (common mode voltage) may occur between the measuring lines M– of the input channels 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, depending on the potential connection of the sensors (isolated, non-isolated). These actions are described in this section.

When connecting resistance-type sensors or 2-wire transducers for current measurement, you cannot make the connection from M– to $M_{ANA.}$ This also applies to inputs which are not used.

Abbreviations and Mnemonics

The abbreviations and mnemonics used in Figures 4-1 to 4-4 have the following meanings:

M +:	Measuring lead (positive)
M –:	Measuring lead (negative)
M_{ANA}:	Reference potential of the analog measuring circuit
M:	Ground terminal
L +:	Terminal for 24 VDC supply voltage
U_{CM}:	Potential difference between inputs and reference potential of the M_{ANA} measuring circuit
U_{ISO}:	Potential difference between M_{ANA} and M terminal of CPU

Isolated Sensors

The isolated sensors are not connected with the local ground potential. They can be operated free of potential. Caused by local conditions or interferences potential differences U_{CM} (static or dynamic) can occur between the measuring lines M– of the input channels and the reference point of the measuring circuit $M_{ANA.}$

In order to prevent the permissible value for U_{CM} from being exceeded when operating in areas with heavy EMC interference, the following applies:

- for analog input modules SM 331 with order no. 331-7K.**00**:
  Connect M– with M_{ANA}!
- for analog input modules SM 331 with order no. 331-7K.**01**:
  We recommend you to connect M– with M_{ANA}.

Do not connect M– to M_{ANA} when connecting 2-wire measuring transducers for current measurement and resistance-type sensors.

You can operate the CPU as follows:

Analog input module	CPU
Isolated	Non-floating (bridge between ⏚ and M) or floating (no bridge between ⏚ and M)

Isolated Sensors, continued

Figure 4-1 shows the principle of connecting isolated sensors to an isolated analog input module.

Please observe that you must not make the connection from M– to M_{ANA} when connecting 2-wire transducers for current measurement or resistance-type sensors. This also applies to configured inputs which are not used.

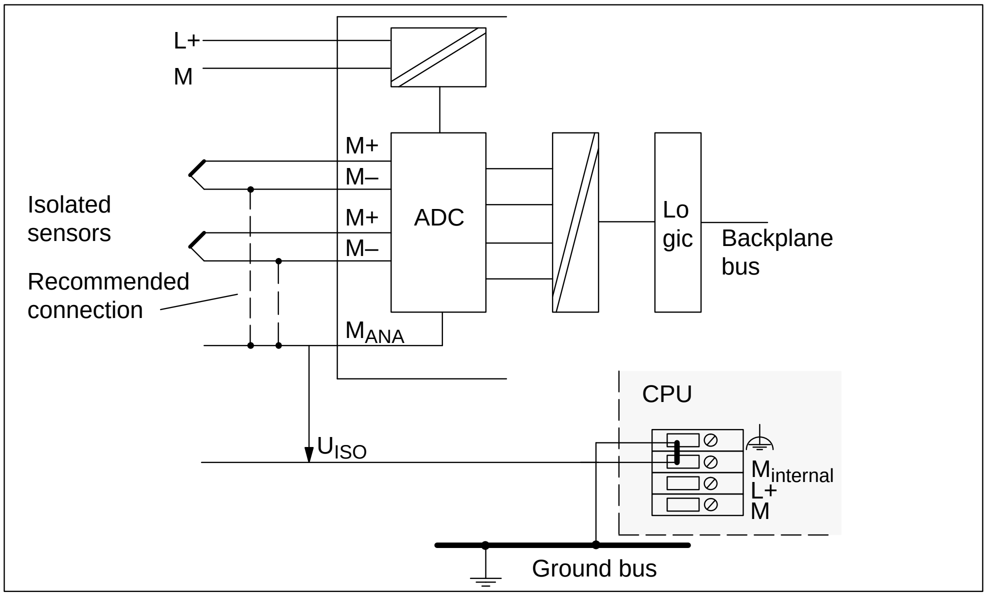


Figure 4-1 Connecting Isolated Sensors to an Isolated Analog Input Module

Figure 4-2 shows the principle of connecting isolated sensors to a non-isolated analog input module.

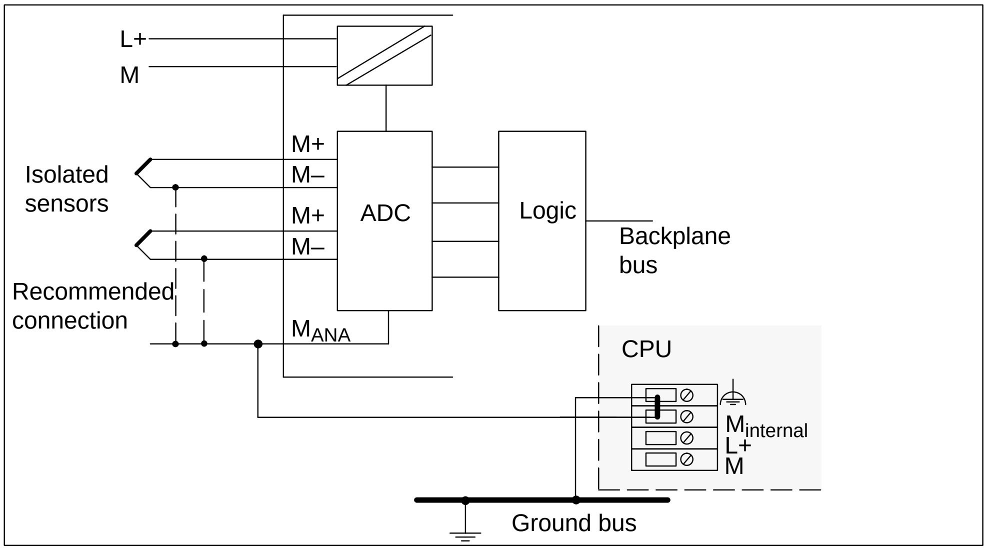


Figure 4-2 Connecting Isolated Sensors to a Non-Isolated Analog Input Module

Non-Isolated Sensors

The non-isolated sensors are connected locally to ground potential. M_{ANA} must be connected to ground potential. Caused by local conditions or interferences potential differences U_{CM} (static or dynamic) can occur between the locally distributed individual measuring points.

If the potential difference U_{CM} exceeds the permissible value, you must provide equipotential bonding conductors between the measuring points.

You can operate the CPU as follows:

Analog Input module	CPU
Isolated	Non-floating (bridge between ⏚ and M) or floating (no bridge between ⏚ and M)
Non-isolated	Non-floating (bridge between ⏚ and M)

Figure 4-3 shows the principle of connecting non-isolated sensors to an isolated analog input module.

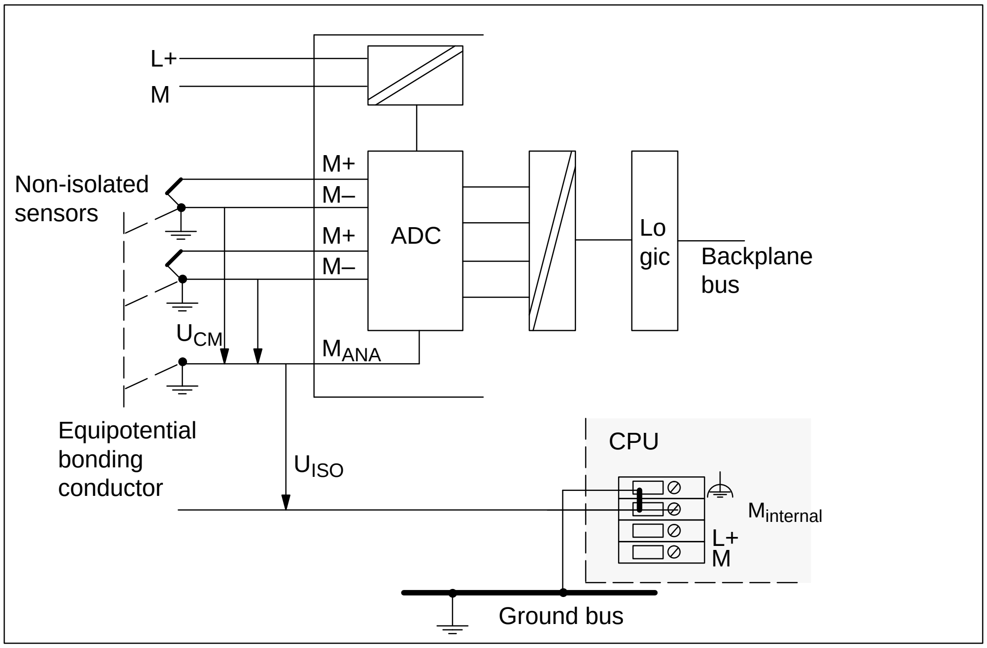


Figure 4-3 Connecting Non-Isolated Sensors to an Isolated Analog Input Module

Non-Isolated Sensors, continued

Figure 4-4 shows the principle of connecting non-isolated sensors to a non-isolated analog input module.

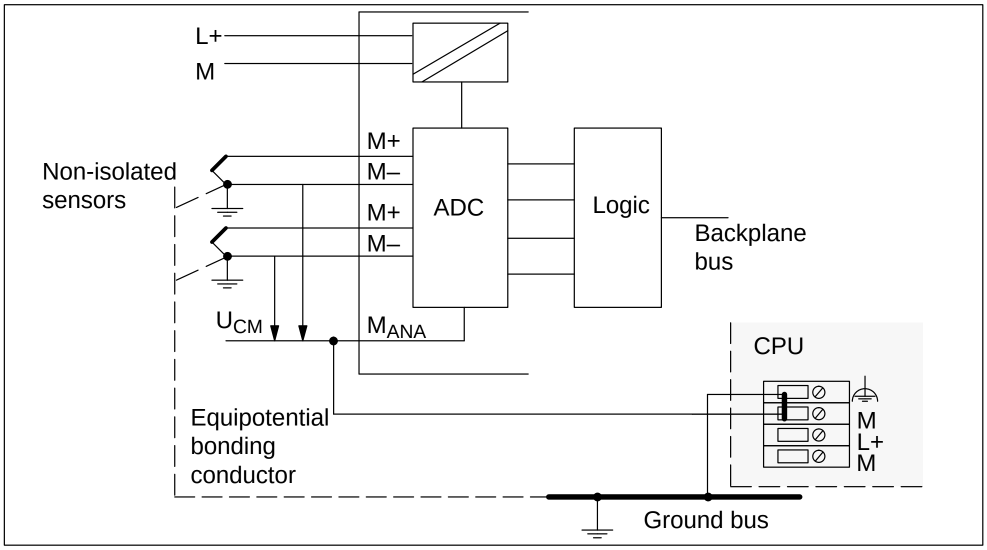


Figure 4-4 Connecting Non-Isolated Sensors to a Non-Isolated Analog Input Module

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

4.2.2 Using Thermocouples

Introduction

This section describes the design of thermocouples and what you must observe when connecting thermocouples.

Design of Thermocouples

A thermocouple consists of

- the thermocouple proper (sensor) and
- the necessary mounting 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, for example K, J and N thermocouples, depending on the composition of the material used. The measuring principle of all thermocouple is the same, irrespective of their type.

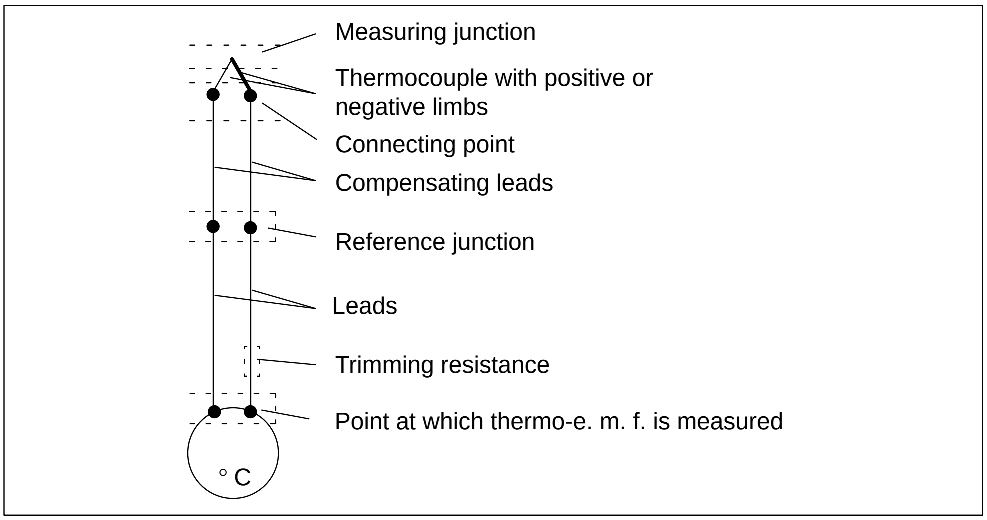


Figure 4-5 Design of Thermocouples

Principle of Operation of Thermocouples

If the measuring junction is exposed to a temperature other than that obtained at the free ends of the thermocouple (point of connection), a voltage, or thermo-e.m.f., arises between 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.

Extension to a Reference Junction

The thermocouples can be extended from their point of connection to a point of known temperature (reference junction) by means of compensating wires.

These compensating wires consist of the same material as the thermocouple wires. The supply leads are copper wire. You should use external compensation in this case. Make sure these wires are connected with the correct polarity, otherwise there will be considerable measurement errors.

External Compensation

You can compensate for the effects of temperature fluctuations at the reference junction by means of compensating leads, for example by connecting a compensating box.

The compensating box contains a bridge circuit calibrated for a definite reference junction temperature. The reference junction is formed by the connections for the ends of the thermocouple’s compensating leads.

If the actual temperature deviates from the compensating temperature, the temperature-sensitive bridge resistance changes. This results in a positive or negative compensating voltage, which is added to the thermo-e.m.f.

Use compensating boxes with a **reference junction temperature of 0 °C (32 °F)** for analog input modules.

Please note the following:

- The compensating box must have an isolated supply.
- The power supply must have adequate filtering, for example by means of a grounded shielding winding.

Internal Compensation

Bei der internen Kompensation können Sie die Vergleichstelle an den Klemmen der Analogeingabebaugruppe bilden. In diesem Fall müssen Sie die Ausgleichsleitungen bis zur Analogbaugruppe führen. Der interne Temperatursensor erfaßt die Temperatur der Baugruppe und liefert eine Kompensationsspannung.

Note that internal compensation is not as accurate as external compensation!

Using Thermocouples

If you wish to connect thermocouples, you must observe the following:

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

If you employ internal compensation, the internal temperature of the module is used for comparison purposes.

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

Connect the compensating box to the COMP terminals of the module, locating the compensating box at the reference junction of the thermocouples.

The following constraints apply:

- The parameters of a channel group have general validity for all channels of that group (for example, input voltage, integrating time etc.)
- External compensation with the compensating box connected to the COMP terminals of the module can only be implemented for one type of thermocouple. That is, you must use the same type of thermocouple for all channels that are connected to that compensating box.

Abbreviations and Mnemonics

The abbreviations and mnemonics used in Figures 4-6 and 4-7 have the following meanings:

M +: Measuring lead (positive)

M –: Measuring lead (negative)

$COMP_{+}$: Compensating terminal (positive)

$COMP_{-}$: Compensating terminal (negative)

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

M : Ground terminal

L +: Terminal for 24 VDC supply voltage

Choice of Thermocouple Connections

Figures 4-6 and 4-7 show the various methods of connecting thermocouples with and without compensating boxes.

In addition to the following explanations, the remarks in Section 4.2.1 about the connection of sensors to analog inputs apply. In the following figures, the required connecting leads between the M connection of the CPU, M–, M_{ANA} and ground potential which are required due to the potential connection of the analog module (isolated, non-isolated) are not shown. This means that you must bear in mind and implement the remarks comprised in Section 4.2.1.

Thermocouples with Compensating Box

The thermocouples using a compensating box must be of the same type. If the thermocouples connected to the inputs of the module or a group all have the same reference junction, you must provide compensation as shown in Figure 4-6.

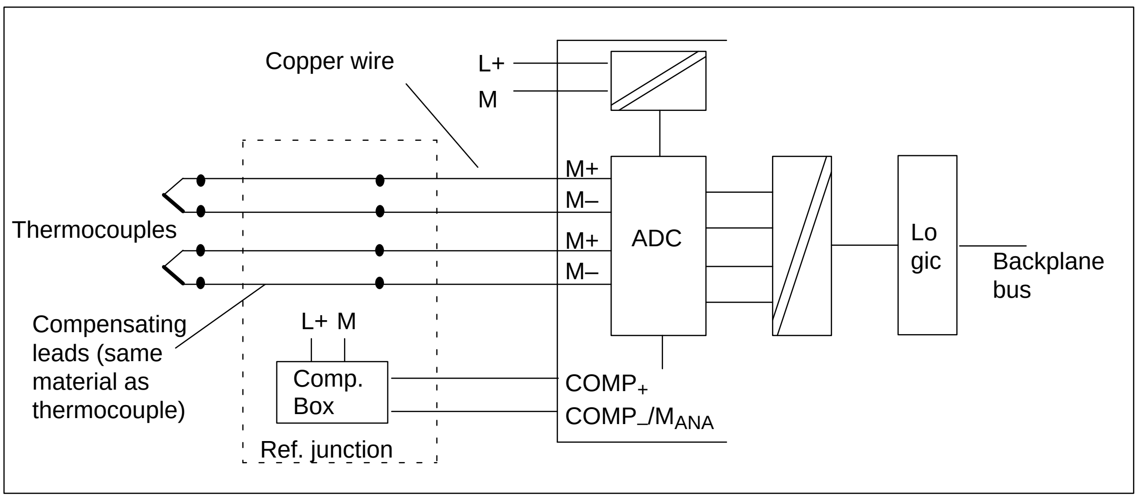


Figure 4-6 Connection of Thermocouples with External Compensating Box to an Isolated Analog Input Module

Thermocouples without Compensating Box

If you connect thermocouples direct to the inputs of the module or via compensating leads, you can use internal temperature compensation. Each channel group can use a thermocouple type supported by the analog module independently of the other channel groups.

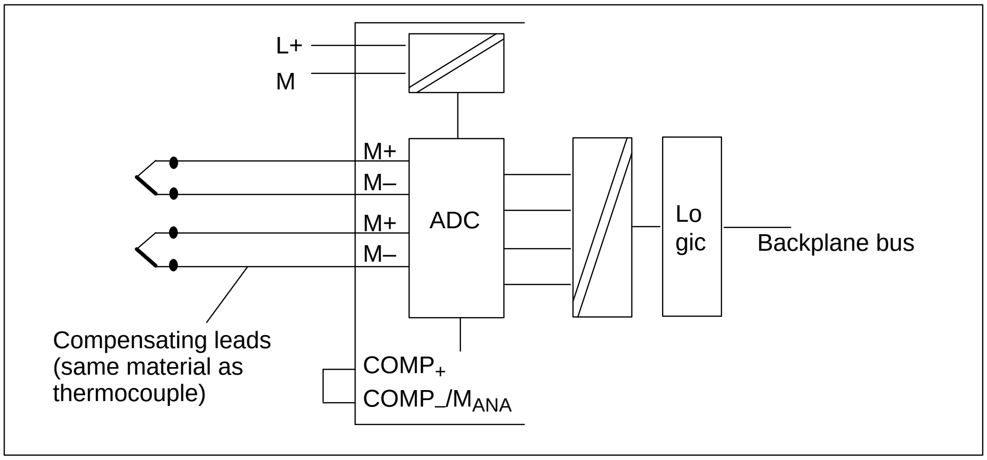


Figure 4-7 Connection of Thermocouples with Internal Compensation to an Isolated Analog Input Module

4.2.3 Connecting Voltage and Current Sensors and Resistance-TypeThermometers

Abbreviations and Mnemonics

The abbreviations and mnemonics used in Figures 4-8 through 4-11 have the following meanings:

- I_{C+}: Constant-current lead (positive)
- I_{C-}: Constant-current lead (negative)
- M +: Measuring lead (positive)
- M –: Measuring lead (negative)
- M_{ANA}: Reference potential of the analog measuring circuit
- M : Ground terminal
- L +: Terminal for 24 VDC supply voltage

In addition to the following explanations, the remarks in Section 4.2.1 about the connection of sensors to analog inputs apply. In the following figures, the required connecting leads between the M connection of the CPU, M–, M_{ANA} and ground potential which are required due to the potential connection of the analog module (isolated, non-isolated) are not shown. This means that you must bear in mind and implement the remarks comprised in Section 4.2.1.

Connecting Voltage Sensors

Figure 4-8 shows you how to connect voltage sensors to an isolated analog input module.

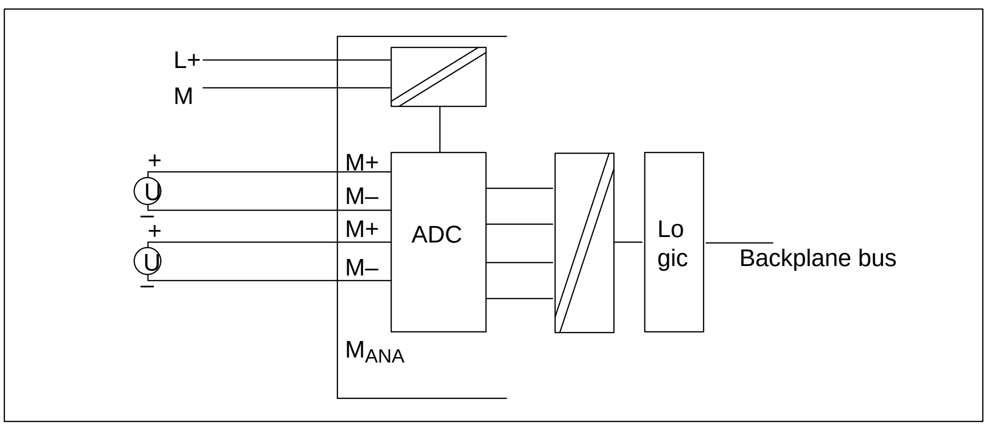


Figure 4-8 Connecting Voltage Sensors to an Isolated Analog Input Module

Connecting Current Sensors as 2-Wire and 4-Wire Transducers

The 2-wire transducer receives its short-circuit-proof power supply via the analog input. This transducer then converts the measured variable into a current. Four-wire transducers have separate power supplies.

Two-wire transducers must be isolated sensors.

Figure 4-9 shows you how to connect current sensors as 2-wire transducers to an isolated analog input module.

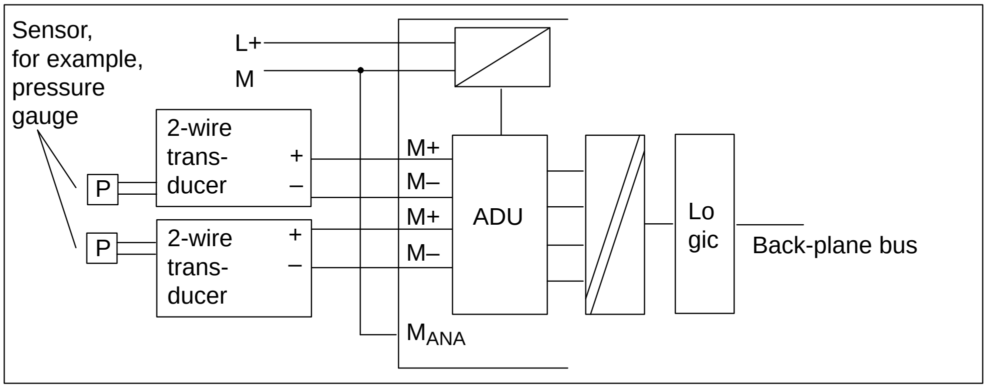


Figure 4-9 Connecting 2-Wire Transducers to an Isolated Analog Input Module

Figure 4-10 shows you how to connect current sensors as 4-wire transducers to an isolated analog input module.

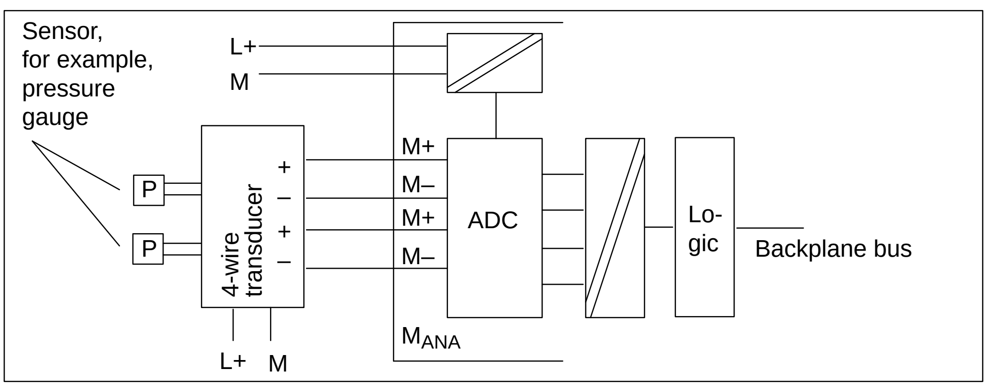


Figure 4-10 Connecting 4-Wire Transducers to an Isolated Analog Input Module

Connecting Resistance-Type Thermometers (e.g. Pt 100) and Resistances

Resistance-type thermometers and resistances are connected in a 4-wire circuit. A constant current is supplied to the resistance-type thermometer or resistance over terminals I_{C+} and I_{C-}. The voltage generated at the resistance-type thermometer or resistance is measured via the M+ and M– terminals. This results in a high measuring accuracy in the 4-wire circuit.

Figure 4-11 shows you how to connect resistance-type thermometers to an isolated analog input module.

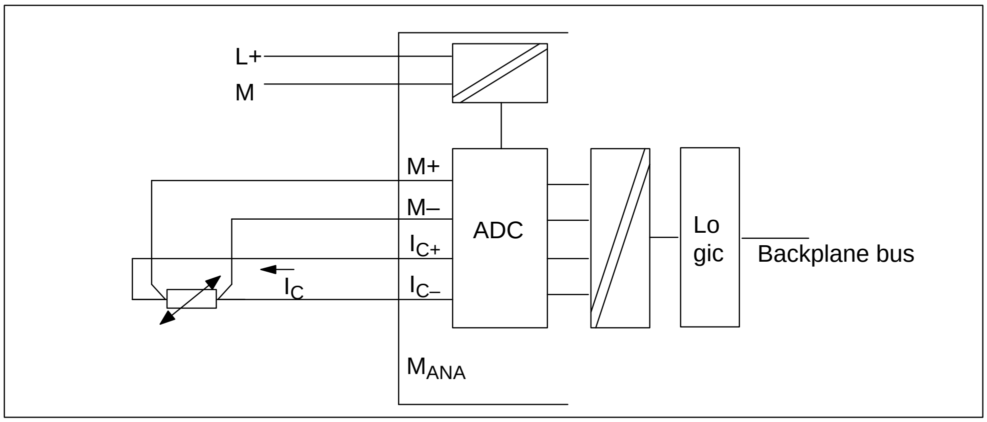


Figure 4-11 Connecting Resistance-Type Thermometers to an Isolated Analog Input Module

In the 2-wire and 3-wire circuit, you must insert jumpers between M+ and I_{C+} and between M– and I_{C-}. This, however, reduces the accuracy of the measuring results.

4.2.4 Connecting Loads/Actuators to Analog Outputs

Introduction

You can use the analog output modules to supply loads/actuators with current and voltage.

Cables for Analog Signals

To reduce electrical interference, you should use twisted-pair shielded cables for the analog signals. The cables Q_V and S+ and M and S–, respectively, are to be twisted together. The shield of the analog signal cables should be grounded at both cable ends. 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. In such a case, you should ground the shield at one end of the cable only.

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 the M terminal of the CPU.

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 the M terminal of the CPU. Make sure that U_{ISO} does not exceed the permissible value. If it is possible that the permissible value is exceeded, establish a connection between the M_{ANA} terminal and the M terminal of the CPU.

Non-Isolated Analog Output Modules

With the non-isolated analog output modules, you must establish a connection between the reference point of the measuring circuit M_{ANA} and the M terminal of the CPU. Therefore, connect the M_{ANA} terminal with the M terminal of the CPU. A potential difference between M_{ANA} and the M terminal of the CPU can lead to a corruption of the analog signal.

Abbreviations and Mnemonics

The abbreviations and mnemonics used in Figures 4-12 to 4-15 have the following meanings:

- Q_I: Analog output current
- Q_V: Analog output voltage
- S +: Detector lead (positive)
- S –: Detector lead (negative)
- M_{ANA}: Reference potential of analog circuit
- R_L: Load/actuator
- L +: Terminal for 24 VDC supply voltage
- M : Ground terminal
- U_{ISO}: Potential difference between M_{ANA} and M terminal of CPU.

Connecting Loads to a Current Output

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

Figure 4-12 shows the principle of connecting loads to a current output of an isolated analog output module.

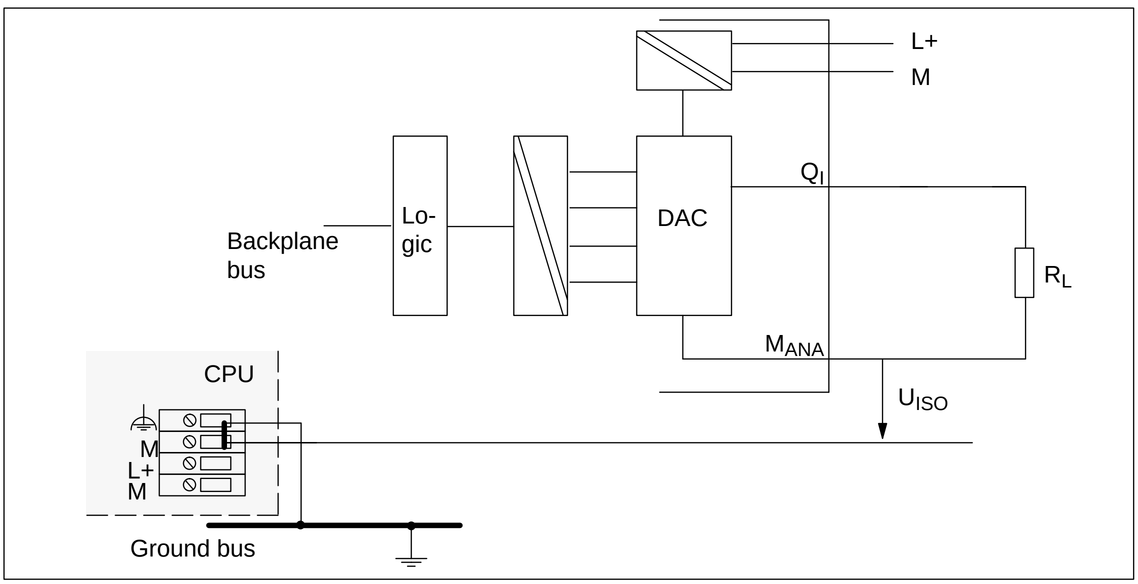


Figure 4-12 Connecting Loads to a Current Output of an Isolated Analog Output Module

Connecting Loads to a Current Output, continued

Figure 4-13 shows the principle of connecting loads to a current output of a non-isolated analog output module.

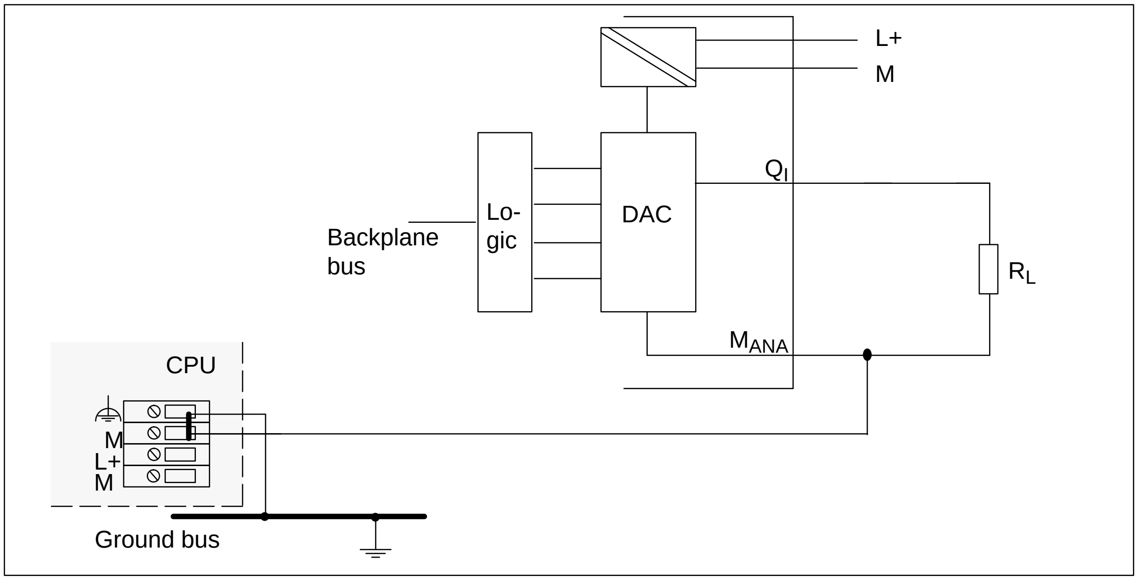


Figure 4-13 Connecting Loads to a Non-Isolated Analog Output Module

Connecting Loads to a Voltage Output

Connecting loads to a voltage output is possible both in a 4-wire and a 2-wire circuit. However, not all analog output modules allow both types of connection.

4-Wire Circuit

A high accuracy at the load can be achieved through the 4-wire circuit. You must therefore connect the sensor leads (S– and S+) directly to the load. The voltage is thus measured and corrected directly at the load. Interferences 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}. However, this potential difference should not exceed the permissible value. If the permissible potential difference is exceeded, the accuracy of the analog signal is impaired.

With a 2-wire circuit, the S+ and S– terminals can be left open. However, you will not achieve the accuracy of a 4-wire circuit.

Figure 4-14 shows you how to connect loads to a voltage output of an isolated analog output module over a 4-wire circuit.

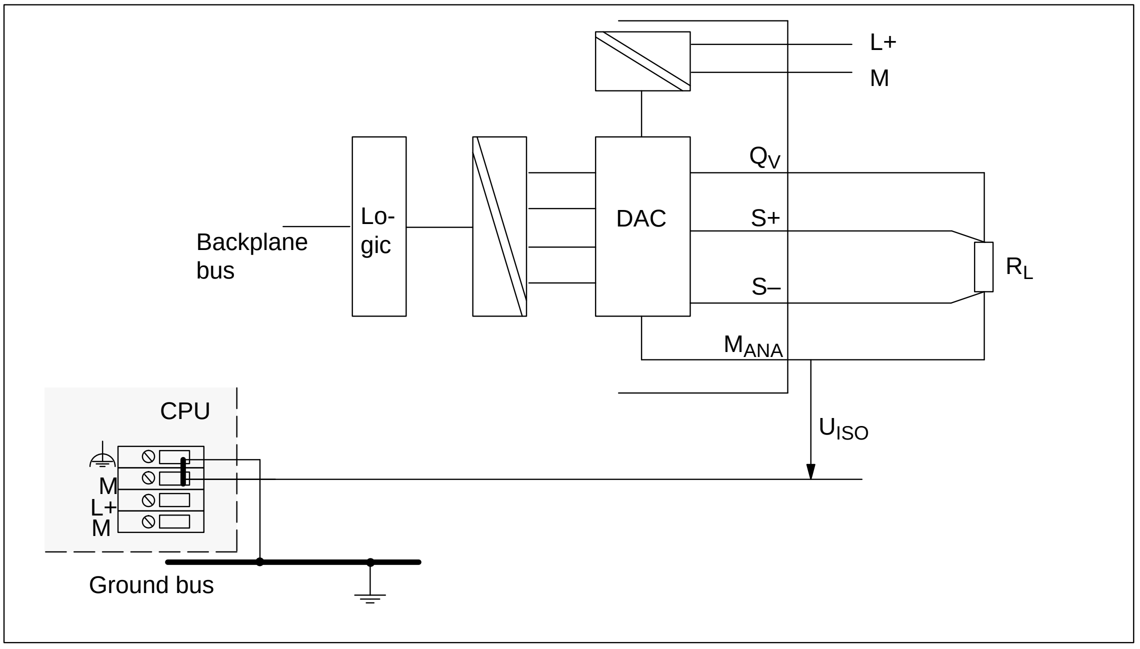


Figure 4-14 Connecting Loads to a Voltage Output of an Isolated Analog Output Module over a 4-Wire Circuit

2-Wire Circuit

Use terminals Q_V and the reference point of the measuring circuit M_{ANA} to connect loads to a voltage output over a 2-wire circuit.

Figure 4-15 shows the principle of connecting loads to a voltage output of a non-isolated analog output module over a 2-wire circuit.

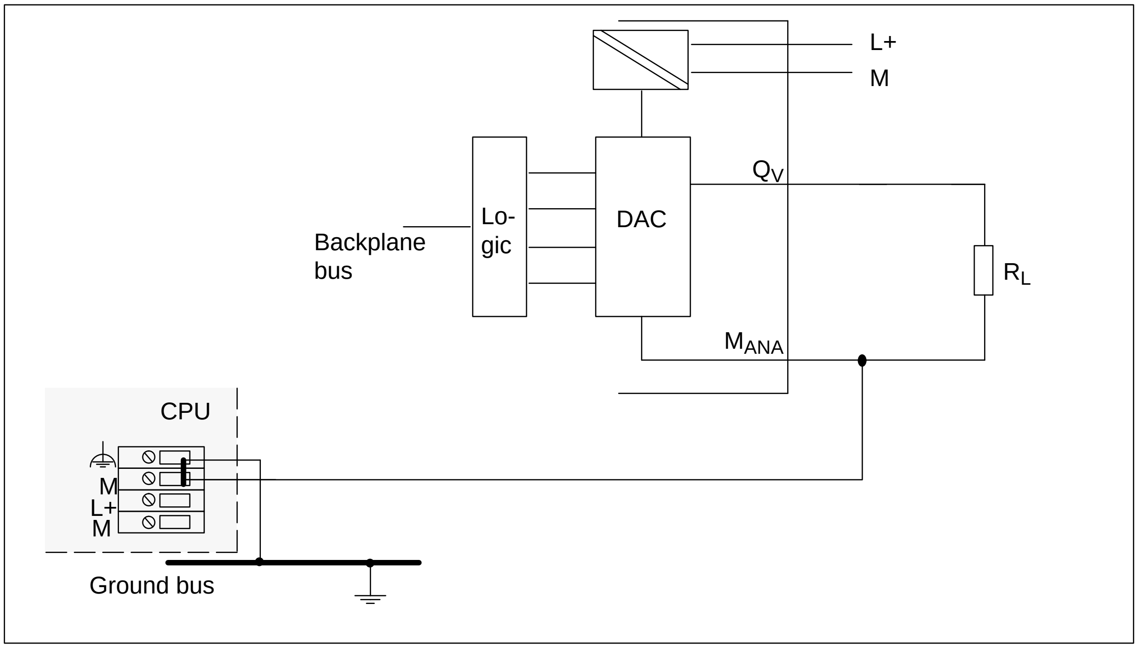


Figure 4-15 Connecting Loads to a Voltage Output of a Non-Isolated Analog Output Module over a 2-Wire Circuit

4.3 Fundamental Principles for the Use of Analog Modules

In this Section

In this section, you will find information on:

- The fundamental terms of analog value processing.
- How to set the measuring ranges of the analog input channels.
- Which diagnostics means the individual analog modules offer.
- How to set the functions of the individual analog modules (using which parameters).
- The behavior of the individual analog modules.

4.3.1 Conversion and Cycle Time of the Analog Input Channels

Introduction

In this section, you will find the definitions and relations of the conversion time and cycle time for the analog input modules.

Conversion Time

The conversion time consists of a basic conversion time and additional processing times of the module for:

- Resistance measurement
- Wire-break monitoring

The basic conversion time depends directly on the conversion method (integrating method, successive approximation) of the analog input channel. In the case of integrating conversion methods, the integration time has a direct influence on the conversion time. The integration time has a direct influence on the resolution. You will find the basic conversion times for the individual analog modules in Section 4.3.4. You set the integration time using *STEP 7* (see Section 4.3.3).

Cycle Time

Analog-to-digital conversion and the transfer of digitized measured values to memory and/or the data bus of the programmable controller is sequential. This means that the individual analog input channel values are converted one after the other. The cycle time, that is 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. When the analog input channels are grouped in channel groups, you must take into account the conversion time channel group by channel group. Two analog input channels of the analog input modules SM 331 form one channel group. You must therefore grade the cycle time in steps of 2. To reduce the cycle time, you should use the parameter assignment in *STEP 7* to deactivate any analog input channels that are not used.

Figure 4-16 illustrates the components of the cycle time for an n-channel analog input module.

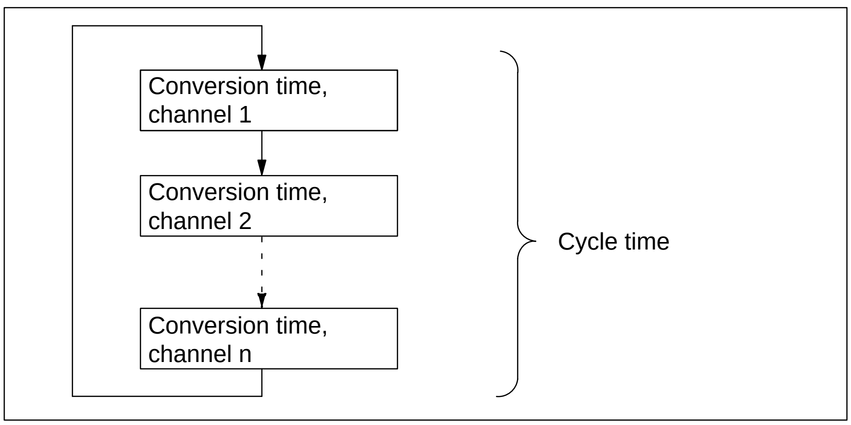


Figure 4-16 Cycle Time of the Analog Input Module

4.3.2 Conversion, Cycle, Setting and Response Times of the Analog Output Channels

Introduction

This section contains the definition and interrelationships of the times relevant for the analog output modules.

Conversion Time

The conversion time of the analog output channels comprises the transfer of the digitized output values from the internal memory and the digital-to-analog conversion.

Cycle Time

Conversion of the analog output channels is sequential. This means that the analog output channel values are converted one after the other.

The cycle time, that is the time elapsing before an analog output value is again converted, is the sum of the conversion times of all activated analog output channels of the analog output module.

Figure 4-17 illustrates the components of the cycle time for an n-channel analog output module.

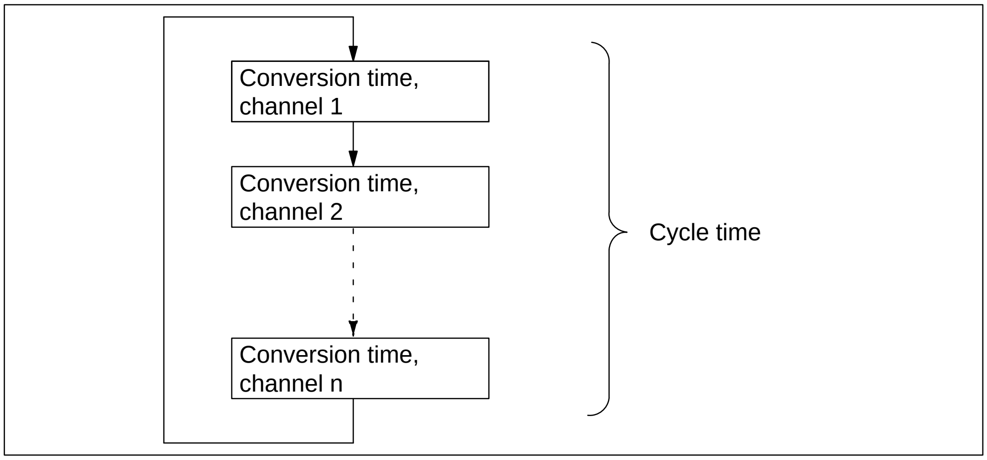


Figure 4-17 Cycle Time of the Analog Output Module

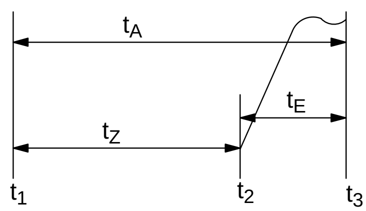
Settling Time

The settling time (t_2 to t_3), that is the time elapsing between the converted value being present and reaching the specified value at the analog output is load-dependent. A distinction is made between resistive, capacitive and inductive loads.

Response Time

The response time (t_1 to t_3), that is the time elapsing between the digital output values being present in the internal memory and reaching the specified value at the analog output is in the worst case the sum of the cycle time and the settling time. You have a worst case situation, if, shortly prior to the transfer of a new output value, the analog channel has been converted and is not converted again until all other channels are converted (cycle time).

Figure 4-18 shows the response time of the analog output channels.



t_A = Response time

t_Z = Cycle time corresponds to n $\times$ conversion time (n = activated channels)

t_E = Settling time

t_1 = New digitized output value is present

t_2 = Output value transfered and converted

t_3 = Specified output value reached

Figure 4-18 Response Time of the Analog Output Channels

4.3.3 Setting the Measuring Method and the Measuring Ranges of the Analog Input Channels

Introduction

You can set the measuring method and the measuring ranges for the analog input channels of the S7-300 analog modules in two different ways:

- Using a measuring range module on the analog module and *STEP 7* (see also the *STEP 7 Documentation*)

  or

- Using the wiring of the analog input channel.

Which of these two methods is used for the individual analog modules depends on the module and is described in detail in the module section.

This section describes how you set the measuring method and the measuring range via a measuring range module.

Setting the Measuring Method and the Measuring Ranges with Measuring Range Modules

If an analog module has a measuring range module, it is supplied with the measuring range module plugged in.

You may have to relocate the measuring range modules to change the measuring method and the measuring range. Make sure that the measuring range modules are on the left-hand side of the analog input module. **Before** installing the analog input module, therefore, check whether the measuring range modules have to be set to another measuring method and measuring range! The assignment of measuring range modules to measuring ranges is described in connection with the particular analog module.

Markings for the Measuring Range Module

When unplugging and plugging in the measuring range module, please note the markings on the analog input module.

Figure 4-19 shows you the position of the measuring range module relative to the marking on the analog input module.

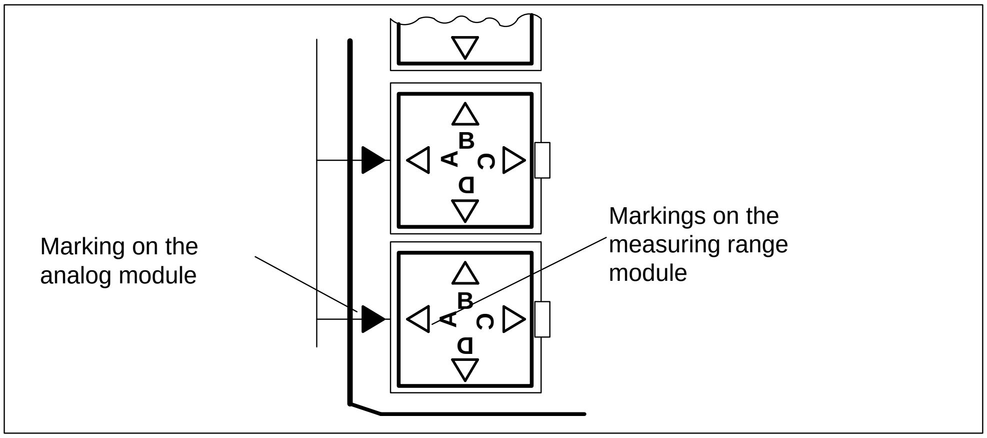


Figure 4-19 Markings for the Measuring Range Module

Resetting the Measuring Range Module

If you have to reset a measuring range module, proceed as follows (example: analog input module SM 331; AI 8 × 12 Bit):

1. Use a screwdriver to ease the measuring range module out of the analog input module with a **single** lift.

   Note: Make sure that you do not insert the screwdriver in the latching window of the measuring range module if you require more than one lift to ease the measuring range module out. You might thus damage its contacts.

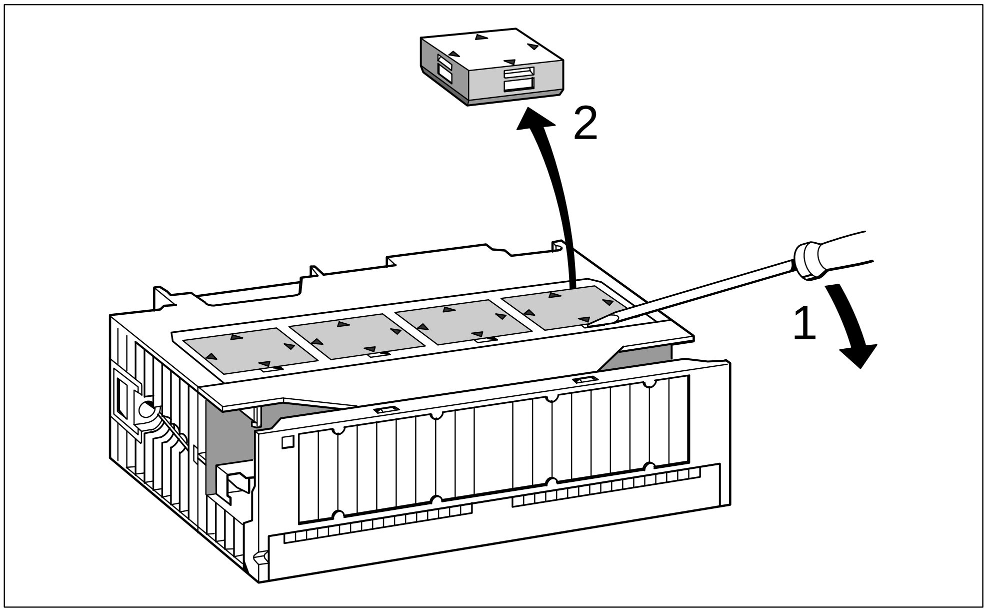


Figure 4-20 Easing a Measuring Range Module out of Analog Input Module SM 331; AI 8 × 12 Bit

2. Insert the measuring range module (correctly positioned) into the analog input module

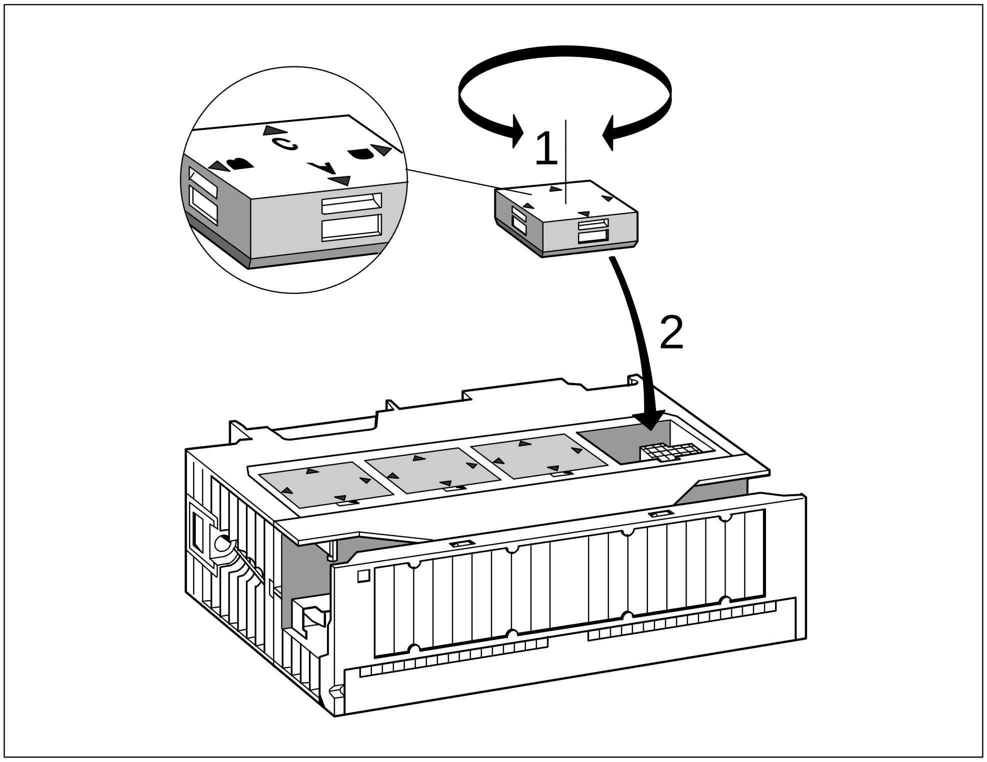


Figure 4-21 Inserting a Measuring Range Module into Analog Input Module SM 331; AI 8 × 12 Bit

Follow the same procedure for all other measuring range modules.

Position of the Measuring Range Modules

The measuring range modules have the following possible positions: “A”, “B”, “C” and “D”.

Which measuring range module positions you must select for the individual types of measurement and measuring ranges is described under the description of the analog module.

The settings for the various types of measurement and measuring ranges are also printed on the analog module.

4.3.4 Parameters of the Analog Modules

Introduction

This section contains a summary of the analog modules and their parameters.

Parameter Assignment

Use *STEP 7* to assign the parameters to the analog modules. You must carry out this setting in the STOP mode of the CPU. On a transition from STOP to RUN mode, the CPU then transfers the parameters to the individual analog modules.

Alternatively, you can also change some of the parameters in the user program with SFC 55. You can find the relevant parameters in Appendix A or in Tables 4-19 and 4-20. The parameters set with STEP 7 in the CPU RUN mode can be transferred to the analog module using SFCs 56 and 57 (see Reference Manual *System and Standard Functions*).

For the two parameter assignment alternatives, we subdivide the parameters into:

- Static parameters and
- Dynamic parameters.

The following table shows the characteristics of the static and dynamic parameters.

Parameter	Settable with	CPU Operating State
Static	*Programming device*	STOP
Dynamic	*Programming device*	STOP
	SFC 55 in the user program	RUN

Programmable Characteristics

You can program the characteristics of the analog modules by means of the following parameters in *STEP 7*:

- For input channels
  - Interrupt enable
  - Limit value interrupt
  - Diagnostics interrupt
  - Measurement
- For output channels
  - Interrupt enable
  - Diagnostics interrupt
  - Substitute values
  - Output

Parameters of the Analog Input Modules

Table 4-19 summarizes the parameters of the analog input modules and shows which paremeters

- are static or dynamic or
- can be set for the modules as a whole or for one group of channels or one channel each.

Table 4-19 Parameters of the Analog Input Modules

Parameter	SM 331; AI 2 × 12 Bit and SM 331; AI 8 × 12 Bit		Para-meter Type	Scope
	Value Range	Default Setting		
Enable • Process interrupt when limit value is exceeded • Diagnostics interrupt	 Yes/no Yes/no	 No No	Dynamic	Module
Trigger for process interrupt • Upper limit value • Lower limit value	 32511 to – 32512 – 32512 to 32511	 –	Dynamic	Channel
Diagnostics • Group diagnostics • With wire-break check	 Yes/no Yes/no	 No No	Static	Channel or channel group
Measurement • Interference frequency suppression	400 Hz; 60 Hz; 50 Hz; 10 Hz	50 Hz	Dynamic	Channel or channel group
• Measurement type	deactivated U Voltage 4DMU Current (4-wire transducer) 2DMU Current (2-wire transducer) R-4L Resistance (4-wire connection) RTD-4L Thermal resistance (linear, 4-wire - connection) TC-I Thermocouple (internal comparison) TC-E Thermocouple (external comparison) TC-LI Thermocouple (linear, internal comparison) TC-LE Thermocouple (linear, external comparison)	U	Dynamic	Channel or channel group
• Measuring range	For the settable measuring ranges of the input channels, please refer to the individual module description.	± 10 V		

Parameters of the Analog Output Modules

Table 4-20 summarizes the parameters of the analog output modules and shows which parameters

- are static or dynamic or
- can be set for the modules as a whole or for one channel each.

Table 4-20 Parameters of the Analog Output Modules

Parameter	SM 332; AO 4 × 12 Bit and SM 332; AO 2 × 12 Bit		Parameter Type	Scope
	Value Range	Default Setting		
Enable • Diagnostics interrupt	Yes/no	No	Dynamic	Module
Diagnostics • Group diagnostics	Yes/no	No	Static	Channel
Response with CPU-STOP	LWH Hold last value ASS Outputs de-energized	–	Dynamic	Channel
Output • Output type	Deactivated Voltage Current	U	Dynamic	Channel
• Output range	For the settable measuring ranges of the output channels, please refer to the individual module description.	+/–10 V	Dynamic	Channel

Parameters of the Analog Input/Output Module SM 334

You cannot parameterize the analog input/output module SM 334; AI 4/AO 2 × 8/8 Bit. The measuring method for this module is set via the wiring (see Section 4.10).

4.3.5 Diagnostics of the Analog Modules

Introduction

This Section contains tables listing the diagnostic messages of the analog modules.

What does Diagnostics Mean?

Use diagnostics to find out if and which errors have occurred on analog processing. When detecting an error, the analog input modules supply signal value "$7FFF_H$", independent of the parameter assignment.

Parameterizing Diagnostics

Use *STEP 7* to set the diagnostics parameters.

Diagnostics Evaluation

For the purpose of diagnostics evaluation, a distinction is made between programmable and non-programmable diagnostics messages. With the programmable diagnostics messages, evaluation is made only if a diagnostics enable has been programmed (in the "group diagnostics" parameter). The non-programmable diagnostics messages are always evaluated, irrespective of the diagnostics enable setting.

Only evaluated diagnostics messages will activate the following functions:

- Group error LED on the analog module lights up,
- Diagnostics message is transferred to CPU,
- Diagnostics interrupt is triggered (only if you have enabled the diagnostics interrupt by parameter).

See also Appendix B and the reference manual *Systems and Standard Functions* for diagnostics evaluation in the user program with SFC.

Diagnostics of the Analog Input Modules

Table 4-21 gives an overview of the diagnostic messages that you can program for the analog input modules. Enabling is executed in the “Diagnostics” parameter block (see Section 4.3.4). The diagnostic information is assigned to the individual channels or to the module as a whole.

Table 4-21 Diagnostic Message of the Analog Input Modules

Diagnostics Message	SM 331; AI 2 × 12 Bit	SM 331 ; AI 8 × 12Bit	Diagnostics Effective for	Configur-able
External auxiliary supply missing	Yes	Yes	Module	No
Configuring/parameter assignment error	Yes	Yes	Channel	Yes
Common-mode error	Yes	Yes		
Wire break	Yes	Yes		
Measuring range underflow	Yes	Yes		
Measuring range overflow	Yes	Yes		

Wire-Break Check

Diagnosis of a wire break is only possible when the wire-break check is activated. You can activate the wire-break check with the corresponding parameter.

Error Causes and Remedies:

The following table shows for the analog input modules the possible error causes by which the diagnostics messages are triggered, and relevant remedies.

Please note that the analog input module must be parameterized accordingly so that the errors for which programmable diagnostics messages are output can be detected.

Table 4-22 Diagnostics Messages of the Analog Input Modules, Possible Error Causes, Remedies

Diagnostics Message	Possible Error Cause	Remedy
External load voltage missing	Load voltage L+ of module missing	Feed supply L+
Configuring/parameter assignment error	Illegal parameters transferred to module	Check measuring range module
		Reassign module parameter
Common-mode error	Potential difference U_{CM} between the inputs (M–) and reference potential of measuring circuit (M_{ANA}) too high	Connect M– with M_{ANA}

Table 4-22 Diagnostics Messages of the Analog Input Modules, Possible Error Causes, Remedies, continued

<table>
<tr><th>Diagnostics Message</th><th>Possible Error Cause</th><th>Remedy</th></tr>
<tr><td rowspan="4">Wire break</td><td>Resistance too high in the sensor connection</td><td>Use different type of sensor or connection, e.g. use conductors with a larger cross-sectional core area</td></tr>
<tr><td>Open circuit between module and sensor</td><td>Close circuit</td></tr>
<tr><td rowspan="2">Channel not connected (open)</td><td>Deactivate channel group (“measure type” parameter</td></tr>
<tr><td>Connect channel</td></tr>
<tr><td>Measuring range underflow</td><td>Input value underflows underrange, error may be caused:
• with measuring range betw. 4 and 20 mA, 1 to 5 V:
– by polarity reversal of sensor connection
– by incorrect measuring range selected
• with other measuring ranges
– by incorrect measuring range selected</td><td>

Check terminals
Configure other measuring range

Configure other measuring range</td></tr>
<tr><td>Measuring range overflow</td><td>Input value overflows overrange</td><td>Configure other measuring range</td></tr>
</table>

Diagnostics of the Analog Output Modules

Table 4-23 gives an overview of the diagnostic messages of the analog output modules. Enabling is executed in the “Diagnostics” parameter block (see Section 4.3.4).

The diagnostics information is assigned to the individual channels or to the module as a whole.

Table 4-23 Diagnostics Message of the Analog Output Modules

<table>
<tr><th>Diagnostics Message</th><th>SM 332; AO 2 × 12 Bit</th><th>SM 332; AO 4 × 12 Bit</th><th>Diagnostics Effective for</th><th>Configur-able</th></tr>
<tr><td>External auxiliary supply missing</td><td>Yes</td><td>Yes</td><td>Module</td><td>No</td></tr>
<tr><td>Configuring/paramet er assignment error</td><td>Yes</td><td>Yes</td><td rowspan="3">Channel</td><td rowspan="3">Yes</td></tr>
<tr><td>M short circuit</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Wire break</td><td>Yes</td><td>Yes</td></tr>
</table>

Error Causes and Remedies:

The following table shows for the analog output modules the possible error causes by which the diagnostics messages are triggered, and the relevant remedies.

Please note that the analog output module must be parameterized accordingly so that the errors for which programmable diagnostics messages are output can be detected.

Table 4-24 Diagnostics Messages of the Analog Output Modules and their Possible Error Causes and Remedies

Diagnostics Message	Possible Error Cause	Remedy
External load voltage missing	Load voltage L+ of module missing	Feed supply L+
Configuring/parameter assignment error	Illegal parameter transferred to module	Reassign module parameter
M short circuit	Overload of output	Eliminate overload
	Short circuit of output QV to M_{ANA}	Eliminate short circuit
Wire break	Actuator resistance too high	Use different type of actuator or connection, e.g. use conductors with a larger cross-sectional core area
	Open circuit between module and actuator	Close circuit
	Channel not used (open)	Deactivate channel group (“output type” parameter)

Reading Out Diagnostics Messages

If you set diagnostics for analog modules, you can read out the detailed diagnostics messages with STEP 7 (see *STEP 7* User Manual).

Diagnostics of the Analog Input/Output Module SM 334

You cannot program diagnostics messages for the analog input/output module SM 334; AI 4/AO 2 × 8/8 Bit.

4.3.6 Analog Module Interrupts

Introduction

In this Section, the interrupt behavior of the analog modules is described.

The following interrupts exist:

- Diagnostics interrupt
- Process interrupt

Configuring Interrupts

Use *STEP 7* to configure the interrupts.

Default Setting

The default setting for interrupts is “disabled”.

Diagnostics Interrupt

If an error (for example, wire break) is detected or eliminated, the module triggers a diagnostics interrupt, provided the interrupt is enabled. The CPU interrupts the execution of the user program or of priority classes with low priority and processes the diagnostics interrupt block (OB 82).

Process Interrupt

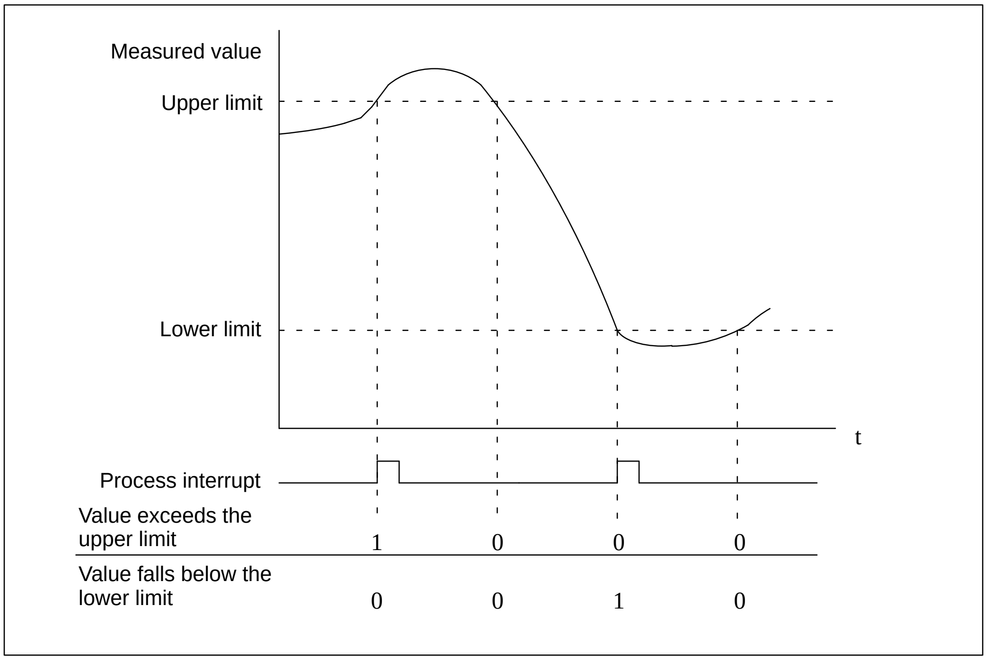
Define a working range by setting parameters for an upper and lower limit value. If the process signal (for example, temperature) leaves this working range, the module triggers a process interrupt, provided the interrupt is enabled. The CPU interrupts the execution of the user program or of priority classes with low priority and processes the process interrupt block (OB 40). The 4 bytes of the additional process interrupt information of OB 40 indicate which channel has exceeded which limit value.

Contents of the 4 bytes of additional information		2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Byte
Analog modules	2 bits per channel for marking the range									
	Value exceeds upper limit in channel	7	6	5	4	3	2	1	0	0
	Value falls below lower limit in channel	7	6	5	4	3	2	1	0	1

Process Interrupt Example

The following figure shows when the analog module triggers a process interrupt:

- If the value exceeds the upper limit
- If the value falls below the lower limit



4.3.7 Behavior of the Analog Modules

Introduction

In this section, you will find information on:

- How the analog input and output values depend on the supply voltage of the analog module and the operating states of the CPU
- The behavior of the analog modules depending on where the analog values lie within the value range
- The influence of errors on the analog modules

Influence of Supply Voltage and Operating Mode

The input and output values of the analog modules depend on the supply voltage of the analog module and on the operating state of the CPU.

Table 4-25 gives an overview of these dependencies.

Table 4-25 Dependencies of the Analog Input/Output Values on the Operating State of the CPU and the Supply Voltage L+

CPU Operating State		Supply Voltage L+ at Analog Module	Input Value of the Analog Input Module	Output Value of the Analog Output Module
POWER ON	RUN	L + present	Process value	CPU values
			$7FFF_H$ until the 1st conversion after switch-on or after configuration of the module has been completed	Until the 1st conversion ... • **after switch-on** has been completed, a signal of 0 mA or 0 V is output. • **after parameter assignment** has been completed, the previous value is output.
		L + missing	Overflow value	0 mA/0 V
POWER ON	STOP	L + present	Process value	Substitute value/last value (0 mA/0 V default)
			$7FFF_H$ until the 1st conversion after switch-on or after parameter assignment of the module has been completed	
		L + missing	Overflow value	0 mA/0 V
POWER OFF	–	L + present	–	0 mA/0 V
		L + missing	–	0 mA/0 V

Failure of the supply voltage of the analog modules is always indicated by the SF-LED on the module and additionally entered in the diagnostics.

Triggering of the diagnostic interrupt depends on the parameter assignment (see Section 4.3.4).

Influence of the Value Range on the Input

The behavior of the analog modules depends on where the input values lie within the value range. Table 4-26 shows this dependency for the analog input values.

Table 4-26 Behavior of the Analog Modules Depending on the Position of the Analog Input Value within the Value Range

Process Value Lies Within	Input Value	SF LED	Diagnostics	Interrupt
Nominal range	Process value	–	–	–
Overrange/ underrange	Process value	–	–	–
Overflow	$7FFF_H$	Flashes[1]	Entered[1]	Diagnostic interrupt[1]
Underflow	8000_H	Flashes[1]	Entered[1]	Diagnostic interrupt[1]
Beyond the programmed limit	Process value	–	–	Process interrupt[1]

1 Depending on the parameter assignment

Influence of the Value Range on the Output

The behavior of the analog modules depends on where the output values lie within the value range. Table 4-27 shows this dependency for the analog output values.

Table 4-27 Behavior of the Analog Modules Depending on the Position of the Analog Output Value within the Value Range

Process Value Lies Within	Output Value	SF LED	Diagnostics	Interrupt
Nominal range	CPU value	–	–	–
Overrange/ underrange	CPU value	–	–	–
Overflow	0 signal	–	–	–
Underflow	0 signal	–	–	–

Influence of Faults/Errors

In the case of analog modules with diagnostics capability and the appropriate parameter assignment (see Section 4.3.4 “Parameters of the Analog Modules”), faults/errors can cause a diagnostic entry and a diagnostic interrupt. Tables 4-19 and 4-21 in Section 4.3.5 list the possible faults/errors.

The SF LED flashes also if external faults/errors occur, independent of the operating state of the CPU (with POWER ON).

4.4 Analog Input Module SM 331; AI 8 × 12 Bit

In this Section

In this section, you will find information on:

- The characteristics of the analog input module SM 331; AI 8 × 12 Bit
- The technical specifications of the analog input module SM 331; AI 8 × 12 Bit

You will also learn:

- How to start up the analog input module SM 331; AI 8 × 12 Bit
- Which measuring ranges the analog input module SM 331; AI 8 × 12 Bit has
- Which parameters can be used to influence the characteristics of the analog input module SM 331; AI 8 × 12 Bit

4.4.1 Characteristic Features and Technical Specifications of the Analog Input Module SM 331; AI 8 × 12 Bit

Order No.

6ES7 331-7KF01-0AB0

Characteristic Features

The analog input module SM 331; AI 8 × 12 Bit has the following characteristic features:

- 8 inputs in 4 channel groups
- Measured-value resolution; settable per group (depending on the integration time set)
  - 9 bits + sign
  - 12 Bit + sign
  - 14 Bit + sign
- Measuring method selectable per channel group:
  - Voltage
  - Current
  - Resistance
  - Temperature
- Arbitrary measuring range selection per channel group
- Programmable diagnostics
- Programmable diagnostic interrupt
- Two channels with limit monitoring
- Programmable limit interrupt
- Galvanic isolation to CPU
- Galvanic isolation to load voltage (**not** for 2-wire transducer)

Resolution

The resolution of the measured value is a direct function of the integration time selected. In other words the longer the integration time for an analog input channel, the more accurate the resolution of the measured value will be (see Technical Specifications of the analog input module and Table 4-3).

Terminal Connection Diagram

Figure 4-22 shows the module view and the block diagram of the SM 331; AI 8 × 12 Bit. The input resistances depend on the measuring range selected (see Technical Specifications). You will find the detailed technical specifications of the analog input module SM 331; AI 8 × 12 Bit on the following page.

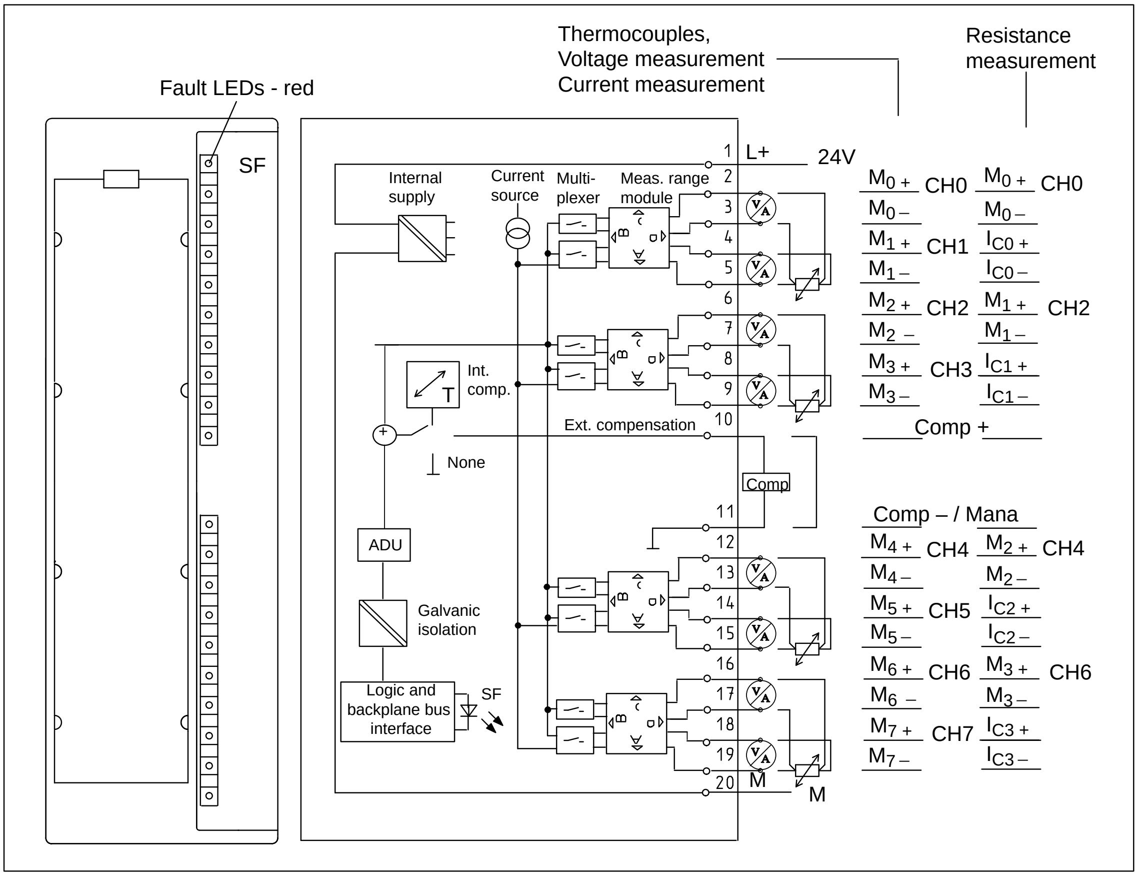


Figure 4-22 Module View and Block Diagram of the Analog Input Module SM 331; AI 8 × 12 Bit

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 250 g (8.75 oz.)
Module-Specific Data	
Number of inputs	8
• with resistance measurement	4
Length of cable (shielded)	max. 200 m (218 yd.)
	max. 50 m (54.5 yd.) at 80 mV and thermocouples
Voltages and Currents	
Rated load voltage L +	24 VDC
• Reverse polarity protection	Yes
Power supplies of the transducers	
• Supply current (for 2 channels each of a channel group):	max: 62 mA
• Short-circuit-proof	Yes
• Constant current for resistance-type sensor	typ. 1.67 mA
Galvanic isolation	
• between channels and backplane bus	Yes
• between channels and load voltage L+	Yes
Possible potential difference	
• between inputs and M_{ANA} (U_{CM})	2.5 VDC
– at signal = 0 V	
– not for 2-wire transducer	
• between M_{ANA} and $M_{internal}$ (U_{ISO})	75 VDC 60 VAC
• Insulation tested with	600 VDC
Current consumption	
• from backplane bus	max. 60 mA
• from load voltage L + (without load)	max. 200 mA
Power losses of the module	typ. 1.3 W

Analog Value Generation				
Measuring principle	Integrating			
Integrations/conversion time/resolution (per channel)				
• Programmable	Yes			
• Integration time in ms	2.5	$16^2/_3$	20	100
• Basic conversion time incl. integr. time in ms	3	17	22	102
Additional conversion time for resistance measurement in ms	1	1	1	1
or				
Additional conversion time for wire-break monitoring in ms	10	10	10	10
or				
Additional conversion time for resistance measurement **and** wire-break monitoring in ms	16	16	16	16
• Possible resolution in bits + sign (incl. overrange)				
unipolar measuring range	9	12	12	14
bipolar measuring range	9+ sign	12+ sign	12+ sign	14+ sign
• Noise suppression for frequency f1 in Hz	400	60	50	10

Noise Suppression and Error Limits	
Noise suppression for F = n × (f1 ± 1 %), (f1 = interference frequency)	
• Common-mode noise (U_{pp} < 2.5 V)	> 70 dB
• Series-mode noise (peak value of noise < nominal value of input range)	> 40 dB
Crosstalk between inputs	> 50 dB

Noise Suppression and Error Limits, continued	
Operational limit (over entire temperature range, referred to input range)	
• 80 mV	± 1 %
• 250 to 1000 mV	± 0.6 %
• 2.5 to 10 V	± 0.8 %
• 3.2 to 20 mA	± 0.7 %
Basic error limit (over entire temperature range, referred to input range)	
• 80 mV	± 0.6 %
• 250 to 1000 mV	± 0.4 %
• 2.5 to 10 V	± 0.6 %
• 3.2 to 20 mA	± 0.5 %
Temperature drift (over entire temperature range, referred to input range)	± 0.005 %/K
Linearity error (referred to input range)	± 0.05 %
Repeatability (in steady state at 25 °C or 77°F, referred to input range)	± 0.05 %
Temperature error of internal compensation	± 1 %
Status, Interrupts, Diagnostics	
Interrupts	
• Limit interrupt	Programmable channels 0 and 2
• Diagnostics interrupt	Programmable
Diagnostics functions	Programmable
• System fault display	Red LED (SF)
• Diagnostics information read-out	Possible
Sensor Selection Data	
Input ranges (rated values)/ input resistance	
• Voltage	± 80 mV; /10 MΩ ± 250 mV; /10 MΩ ± 500 mV; /10 MΩ ± 1000 mV; /10 MΩ ± 2.5 V; /100kΩ ± 5 V; /100kΩ 1 to 5 V; /100kΩ ± 10 V; /100kΩ

Sensor Selection Data, continued	
Input ranges (rated values)/ input resistance	(Continued)
• Current	± .3.2 mA; /25 Ω ± 10 mA; /25 Ω ± 20 mA; /25 Ω 0 to 20 mA; /25 Ω 4 to 20 mA: /25 Ω
• Resistance	150 Ω; /10 MΩ 300 Ω; /10 MΩ 600 Ω; /10 MΩ
• Thermocouples	Type E, N, J, K, L /10 MΩ
• Resistance-type thermometer	Pt 100, Ni 100 /10 MΩ
Permissible input voltage for voltage input (destruction limit)	max. 20 V continuously; 75 V for max. 1 s (duty factor 1:20)
Permissible input current for current input (destruction limit)	40 mA
Connection of sensors	
• for voltage measurement	Possible
• for current measurement as 2-wire transducers as 4-wire transducers	 Possible Possible
• for resistance 2-wire connection 3-wire connection 4-wire connection	 Possible Possible Possible
• Impedance of 2-wire transducer	max. 820 Ω
Characteristic linearization	Programmable
• for thermocouples	• Type E, N, J, K, L
• for resistance-type thermometers	• Pt 100 (standard, climate range) Ni 100 (standard, climate range)
Temperature compensation	Programmable
• Internal temperature compensation	Possible
• External temperature compernsation with compensating box	Possible

4.4.2 Starting Up the Analog Input Module SM 331; AI 8 $\times$ 12 Bit

Parameter Assignment

The analog input module SM 331; AI 8 $\times$ 12 Bit is set

- by means of measuring range modules on the module

  and

- with *STEP 7* (see also the *STEP 7* User Manual) or
- in the user program by means of SFCs (see *STEP 7 System and Standard Functions* Reference Manual).

Default Setting

The analog input module has default settings for the integration time, diagnostics, interrupts, etc. (see Table 4-19).

These default settings apply, if you have not re-initialized the module with *STEP 7*.

Channel Groups

The channels of the analog input module SM 331; AI 8 $\times$ 12 Bit are arranged in groups of two. You can only assign parameters to one channel group at a time.

The analog input module SM 331; AI 8 $\times$ 12 Bit has a measuring range module for each channel group.

Table 4-28 shows which channels of the analog input module SM 331; AI 8 $\times$ 12 Bit are configured as one channel group. You will need the channel group numbers to set the parameters in the user program with SFC (see Fig. A-3 in Appendix A).

Table 4-28 Assignment of the Channels of the Analog Input Module SM 331; AI 8 $\times$ 12 Bit to Channel Groups

Channels ...	... form one Channel Group each
Channel 0	Channel group 0
Channel 1	
Channel 2	Channel group 1
Channel 3	
Channel 4	Channel group 2
Channel 5	
Channel 6	Channel group 3
Channel 7	

Resistance Measurement

If you use the resistance measurement method, there is only one channel per channel group. The “2nd” channel of each group is used for current injection (I_C).

The measured value is obtained by accessing the “1st” channel of the group. The “2nd” channel of the group has the default carry value “$7FFF_H$”.

Unused Input Channels

You must short-circuit unused channels of the analog input module SM 331; AI 8 × 12 Bit and you should connect them to M_{ANA}. In this way, you obtain an optimum interference immunity for the analog input module. Also deactivate the unused channels using *STEP 7* (see Section 4.3.4), in order to reduce the module’s cycle time.

If you do not use the COMP input, you must short-circuit it also.

Since configured inputs can remain unused, because of the channel group generation, you should note the following points for these inputs:

- Measuring range 1 to 5 V: Connect the unused input in parallel with a used input of the same channel group.
- Current measurement, 2-wire transducer: There are two ways to use the channels:
  a) Leave the unused input open and do not enable diagnostics for this channel group. If diagnostics is enabled, the analog module triggers a diagnostics interrupt once and the group fault LED of the analog module flashes.
  b) Connect a 1.5 to 3.3 kΩ resistance to the unused input. You may then enable diagnostics for this channel group.
- Current measurement 4 to 20 mA, 4-wire transducer: Connect the unused input in series with an input of the same channel group.

Special Feature of De-Activated Input Channels

If you de-activate **all** input channels and enable diagnostics when parameterizing the analog input module SM 331; AI 8 × 12 Bit, the analog input module does **not** indicate that the “external auxiliary voltage” is missing.

Measuring Range Modules

Some of the parameters of the analog input module SM 331; AI 8 × 12 Bit can be assigned directly on the module with measuring range modules.

The measuring range modules can be set to the following positions: “A”, “B”, “C” and “D”.

They are set to the “B” position in the factory.

Tables 4-30 to 4-33 in Section 4.4.3. tell you which setting you have to select for which measuring method and measuring range. The settings for the various measuring ranges are also printed on the module.

Default Settings for Measuring Range Module

In the individual measuring range module positions, you can use the following measuring methods and measuring ranges without re-initializing the analog input module SM 331; AI 8 × 12 Bit with *STEP 7*:

Table 4-29 Default Settings of the Analog Input Module SM 331; AI 8 × 12 Bit Using Measuring Range Modules

Measuring Range Module Setting	Measuring Method	Measuring Range
A	Voltage	± 1000 mV
B	Voltage	± 10 V
C	Current, 4-wire transducer	4 to 20 mA
D	Current, 2-wire transducer	4 to 20 mA

These measuring methods and measuring ranges are the default settings on the module. You only have to insert the measuring range module to the required setting (see Section 4.3).

Special Feature of Process Interrupts

You can set process interrupts in *STEP 7* for the 1st and 2nd channel group. Note that a process interrupt is set only for the 1st channel of the channel group, i.e. for channel 0 or channel 2, respectively.

4.4.3 Measuring Methods and Measuring Ranges of the Analog Input Module SM 331; AI 8 $\times$ 12 Bit

Measuring Methods

You can set the following measuring methods on the analog input module SM 331; AI 8 $\times$ 12 Bit:

- Voltage measurement
- Current measurement
- Resistance measurement
- Temperature measurement

Use the *S7 Configuration* STEP 7 tool and the measuring range modules on the analog input module to make the necessary settings (see Section 4.3.4).

Measuring Ranges

Tables 4-30 to 4-33 list the measuring ranges you can use with the analog input module. Use *STEP 7* and the measuring range modules on the analog input module to select the desired measuring ranges (see Section 4.3.4). Tables 4-30 to 4-33 also show the necessary settings of the measuring range modules.

Wire-Break Check

With the measuring range 4 to 20 mA **and**

- **activated** wire-break check, the analog input module enters a wire break in the diagnostics if the current value falls below 3.6 mA. If you have enabled diagnostics interrupt during configuration, the analog input module additionally triggers a diagnostics interrupt.
  If no diagnostics interrupt has been enabled, the illuminated SF display is the only indicator for the wire break and you must evaluate the diagnostics bytes in the user program.
- **non-activated** wire-break check, the analog input module triggers a diagnostics interrupt when the underflow has been reached.

Measuring Ranges for Voltage Measurements

Table 4-30 shows all of the measuring ranges or the sensor type for voltage measurements, as well as the relevant measuring range module settings.

Table 4-30 Measuring Ranges for Voltage Measurement

Measuring Method Selected	Description	Measuring Range (Type of Sensor)	Measuring Range Module Setting
Voltage	You will find the digitized analog values in Section 4.1.2, Tables 4-4 and 4-6 in the voltage measuring range.	+/– 80 mV +/– 250 mV +/– 500 mV +/– 1000 mV	A
		+/– 2,5 V +/– 5 V 1 to 5 V +/– 10 V	B
Thermocouples + internal compensation (thermovoltage measurement)	You will find the digitized analog values in Section 4.1.2, Table 4-4 in the voltage measuring range ± 80 mV.	Typ N [NiCrSi-NiSi] TypeE [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
Thermocouples + external compensation (thermovoltage measurement)	You will find the digitized analog values in Section 4.1.2, Table 4-4 in the voltage measuring range ± 80 mV.	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A

Measuring Ranges for Current Measurement

Table 4-31 lists all of the measuring ranges for current measurement with 2-wire and 4-wire transducers, as well as the relevant measuring range module settings.

Table 4-31 Measuring Ranges for 2-Wire and 4-Wire Transducers

Measuring Method Selected	Description	Measuring Range	Measuring Range Module Setting
2-wire transducers	You will find the digitized analog values in Section 4.1.2, Table 4-6 in the current measuring range.	4 to 20 mA	D
4-wire transducers	You will find the digitized analog values in Section 4.1.2, Table 4-5 and 4-6 in the current measuring range.	+/– 3.2 mA +/– 10 mA 0 to 20 mA 4 to 20 mA +/– 20 mA	C

Measuring Ranges for Resistance Measurements

Table 4-32 lists all of the measuring ranges for resistance measurements and the relevant measuring range module settings.

Table 4-32 Measuring Ranges for Resistance Measurements

Measuring Method Selected	Description	Measuring Range	Measuring Range Module Setting
Resistance, 4-wire connection	You will find the digitized analog values in Section 4.1.2, Table 4-7, under the resistance measuring range.	150 Ohm 300 Ohm 600 Ohm	A

Measuring Ranges for Temperature Measurement

Table 4-33 lists the measuring ranges (or the sensor type) and the measuring range module settings for temperature measurement. The characteristics are linearized:

- for Pt 100 according to DIN IEC 751
- for Ni 100 to IEC DIN 43760
- for thermocouples to DIN 584, type L to DIN 43710.

Table 4-33 Measuring Ranges for Temperature Measurement

Measuring Method Selected	Description	Measuring Range (Type of Sensor)	Measuring Range Module Setting
Thermocouples + linearization, internal compensation (thermal e.m.f. measurement)	The digitized analog values are listed in Section 4.1.2, Tables 4-12 to 4-15, under the temperature range.	Typ e N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
Thermocouples + linearization, external compensation (thermal e.m.f. measurement)	The digitized analog values are listed in Section 4.1.2, Tables 4-12 to 4-15, under the temperature range.	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
Resistance-type thermometer + linearization, 4-wire connection (temperature measurement)	You will find the digitized analog values in Section 4.1.2, Tables 4-8 and 4-9, under the temperature range.	Pt 100 standard range, climate range Ni 100 standard range, climate range	A

4.5 Analog Input Module SM 331; AI 8 $\times$ 16 Bit

Order No.

6ES7 331-7NF00-0AB0

Characteristic Features

The analog input module SM 331; AI 8 $\times$ 16 Bit has the following characteristic features:

- 8 inputs in 4 channel groups
- Measured-value resolution 15 Bit + sign (independent of integration time)
- Fast update mode for individually enabled channel groups 0 or 1
- Measurement mode selectable per channel group:
  - Voltage
  - Current
- Arbitrary measuring range and filter/update rate selection per channel group
- Programmable diagnostics
- Programmable diagnostic interrupt
- Two channels with limit monitoring
- Programmable limit interrupt
- Galvanic isolation to CPU
- Permissible common mode voltage between channels of 50 VDC maximum

Terminal Connection Diagram

Figure 4-23 shows the terminal connection diagram for the analog input module SM 331; AI 8 x 16 Bit. Note that Channel 0 is configured for current and Channel 7 is configured for voltage.

The detailed technical specifications for this analog input module are on the following page.

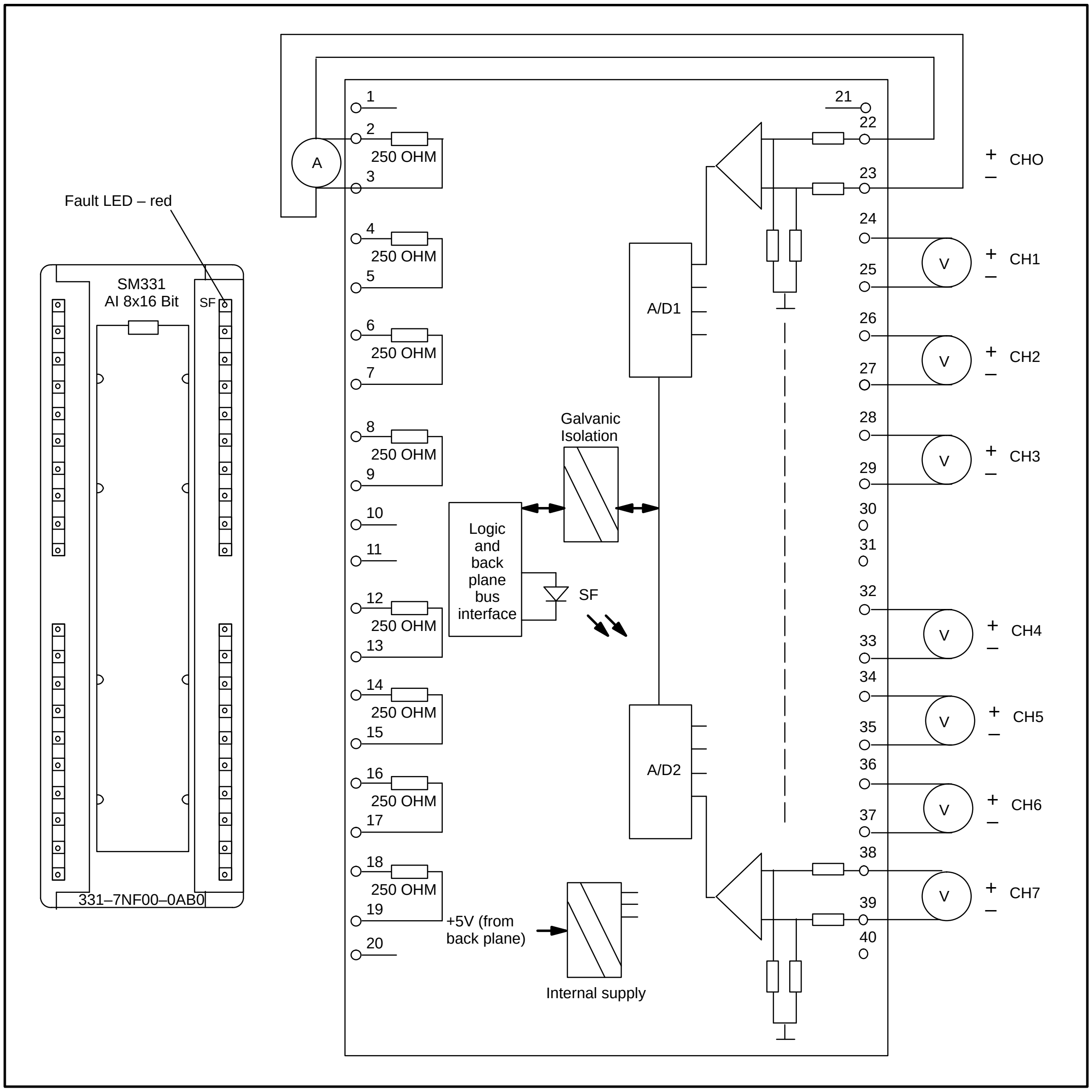


Figure 4-23 Terminal Connection Diagram and Block Diagram of Analog Input Module SM 331; AI 8 x 16 Bit

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 272 g (9.6 oz.)
Module-Specific Data	
Number of inputs	8
Surge protection in accordance with IEC 1000–4–5	External protection device required in the signal lines (150 V/14 mm MOV on each + and – input to chassis ground)
Length of cable (shielded)	max. 200 m (218 yd.)
Voltages and Currents	
Galvanic isolation	
• between channels and back plane bus	Yes, tested at 500 VAC
Permissible common mode voltage	
• between channels	50 VDC, 35 V RMS
• between channel and $M_{internal}$	50 VDC, 35 V RMS
Current consumption	
• from back plane bus	typ. 120 mA max. 130 mA
Power losses of the module	typ. 0.6 W max. 1.4 W (all channels in current mode)

Analog Value Generation				
A/D Conversion Method	Sigma/Delta type			
Integrations/conversion time/resolution (per channel)				
• Programmable	Yes	16.7	20	100
• Filter setting in ms	2.5	16.7	20	100
• Channel integration time (1/fl) in ms	10			
• Module update time, in ms (max.) 8 channels enabled, same filter setting	140	220	260	1220
• Channel update time per active channel group with more than one channel group enabled, or with channel group 2 or 3 only enabled	35	55	65	305
• Channel update time per channel group if only channel group 0 or 1 is enabled	10	16.7	20	100
• Resolution in bits + sign (incl. overrange)				
unipolar measuring range	5	15	15	15
bipolar measuring range	15+ sign	15+ sign	15+ sign	15+ sign
• Noise frequency suppression fl in Hz	100	60	50	10

Noise Suppression and Error Limits	
Interference voltage suppression for F = n × (fl ± 1%),	
(f1 = parameterized interference frequency)	
• Common-mode noise (U_{cm} < 50 V)	> 100 dB
• Series-mode noise (peak value of noise + signal < nominal value of input range)	> 90 dB
Cross-talk between inputs	> 100 dB
Typical error @ 25° C (referred to input range)	
• Voltage	± 0.05%
• Current	± 0.05%
Max. full range error (0 to 60° C, no common mode voltage, referred to input range)	
• Voltage	± 0.1%
• Current	± 0.3%
Max. full range error with DC common mode voltage (0 to 60° C, ± 50 VDC channel to channel, referred to input range)	
• Voltage	± 0.7%
• Current	± 0.9%
Repeatability (Referred to input range)	± 0.025%

Status, Interrupts, Diagnostics		
Interrupts		
• Limit interrupt	Programmable channels 0 and 2	
• Diagnostics interrupt	Programmable	
Diagnostics functions	Programmable	
• System fault display	Red LED (SF)	
• Diagnostics information read-out	Possible	
Sensor Selection Data		
Input ranges (rated values/ input resistance)		
• Voltage	± 5 V	/ 2MΩ
	1 to 5 V	/ 2MΩ
	± 10 V	/ 2MΩ
• Current	0 to 20 mA	/ 250 Ω
	± 20 mA	/ 250 Ω
	4 to 20 mA	/ 250 Ω
Permissible input voltage for voltage input	max. 50 V RMS, continuous	
Destruction limit	120 V RMS common mode or series mode	
Permissible input current for current input (destruction limit)	max. 32 mA, continuous (all points)	

4.5.1 Starting Up the Analog Input Module SM 331; AI 8 × 16 Bit

Parameter Assignment

The analog input module SM 331; AI 8 × 16 Bit is set:

- With STEP 7 (see the *STEP 7 User Manual*) or
- In the user program by means of SFCs (see the *STEP 7 System and Standard Functions Reference Manual)*

Default Setting

The analog input module has default settings for the integration time, diagnostics, interrupts, etc. The default settings are: ±10V measuring mode, 20 ms integration time, no diagnostics, and no interrupts.

Channel Groups

The channels of the analog input module SM 331; AI 8 × 16 Bit are arranged in four groups of two. You must assign the same parameters to both channels in each group.

Table 4-28 shows which channels of the analog input module SM 331; AI 8 × 16 Bit are configured as one channel group. You will need the channel group numbers to set the parameters in the user program with an SFC. See Figure A–3 in Appendix A of the *S7-300 Installation and Hardware Manual* for more information.

Table 4-34 Assignment of Channels of the Analog Input Module SM 331; AI 8 × 16 Bit to Channel Groups

Channels ...	... Form One Channel Group Each
Channel 0	Channel group 0
Channel 1	
Channel 2	Channel group 1
Channel 3	
Channel 4	Channel group 2
Channel 5	
Channel 6	Channel group 3
Channel 7	

Unused Input Channels

Unused channels of the analog input module SM331; AI 8 x 16 Bit should be deactivated using STEP 7 in order to reduce the module's cycle time. See Section 4.3.4 of the *S7-300 Installation and Hardware* manual for more information.

Since configured inputs can remain unused because of the channel group generation, you should make the following preparation for these inputs if diagnostics on the used channels are enabled.

- Measuring range 1 to 5 V: Connect the unused input in parallel with a used input of the same channel group.
- Current measurement 4 to 20 mA: Connect the unused input in series with an input of the same channel group. Ensure that a current sense resistor is connected for each active and unused channel.
- Other ranges: Short the positive to the negative input of the channel.

Current Measurement Mode

Current measurements are made by paralleling a channel's voltage input terminals with its respective current sense resistor. This is accomplished by jumpering the channels input terminals to the adjacent terminals on the field connector. For example, to configure channel 0 for current mode, you must jumper terminal 22 to 2 and terminal 23 to 3.

The channel being configured for current measurements must be paired with the sense resistor connected to the channel's adjacent terminals in order to achieve the specified accuracy.

High Speed Update Mode

The high speed update mode is only available when two channels are enabled on channel group 0 or 1.

The module enters the high speed update mode if either channel group 0 or channel group 1 (not both) is enabled. In the high speed update mode, updates for the two channels in the group occur three times faster than with multiple channel groups enabled. For example, if channels 0 and 1 are enabled with 2.5 ms filtering, data updates for both channels will be available to the PLC every 10 msec. (For other filter settings, the filter setting equals the update rate.)

Special Feature of Process Interrupts

You can set process interrupts in STEP 7 for the first and second channel group. Note that a process interrupt is set only for the first channel of the channel group, that is, for channel 0 or channel 2 respectively.

4.5.2 Measuring Methods and Measuring Ranges of the Analog Input Module SM 331; AI 8 × 16 Bit

Measuring Methods

You can set the following measuring methods on the analog input module SM 331; AI 8 × 16 Bit:

- Voltage measurement
- Current measurement

Use the STEP 7 tool on the analog input module to make the necessary settings. See Section 4.3.4 of the *S7-300 Installation and Hardware Manual* for more information about these settings.

Measuring Ranges

Table 4-35 lists the measuring ranges you can use with the analog input module. Use STEP 7 to select the desired measuring ranges.

Common Mode Voltage

The analog input module SM 331; AI 8 x 16 Bit can make measurements in the presence of AC or DC common mode voltage.

For AC common mode voltages at multiples of the filter frequency setting, the rejection is accomplished by the integration period of the A/D converter and by the common mode rejection of the input amplifiers. For AC common mode voltages < 35 VRMS, the rejection ratio of > 100 dB results in negligible measurement error.

For DC common mode voltages, only the rejection of the input amplifier stage is available to minimize the effect of the common mode voltage. Therefore, some accuracy degradation occurs in proportion to the common mode voltage. The worst case error occurs with 50 VDC between one channel and the other seven channels. The calculated worst case error is 0.7% from 0 to 60 degrees C, and measured error is typically ≤ 0.1% @ 25 degrees C.

Wire-Break Check

The wire-break check is a module software function that is provided for the voltage measuring range 1 to 5 volts and the current range 4 to 20 mA.

With the measuring range 4 to 20 mA (1 to 5 volts) **and**:

- **activated** wire-break check, the analog input module enters a wire break in the diagnostics if the process value falls below 3.6 mA (.9 V). If you have enabled the diagnostic interrupt during configuration, the analog input module additionally triggers a diagnostic interrupt. If no diagnostic interrupt has been enabled, the illuminated SF display is the only indicator for the wire break and you must evaluate the diagnostic bytes in the user program.
- **non-activated** wire-break check, the analog input module triggers a diagnostics interrupt when the underflow limit has been reached.

Measuring Ranges for Voltage and Current Measurement

Table 4-35 shows the voltage and current measuring ranges for the SM331; AI 8 x 16 Bit module.

Table 4-35 Measuring Ranges for Current and Voltage

Measuring Method Selected	Description	Measuring Range
Voltage	You will find the digitized analog values in Section 4.1.2[1], Table 4–4 and Table 4–6 in the voltage measuring range.	± 5 V 1 to 5 V ± 10 V
Current	You will find the digitized analog values in Section 4.1.2[1], Table 4–5 and Table 4–6 in the voltage measuring range	0 to 20 mA ± 20 mA 4 to 20 mA

1 *of the S7-300 Installation and Hardware* manual

Overflow, Underflow, and Process Alarm Limits

Overflow and Underflow diagnostic thresholds for some of the measuring ranges differ from those shown in Section 4.1.2, of the *S7-300 Installation and Hardware Manual.* Numerical methods in the module software for evaluating the process variables prevent values up to 32511 from being reported in some cases. The process input value at which an underflow or overflow diagnostic will be reported depends on the calibration factors for an individual channel and may vary between the minimum limits shown in Table 4-29 and 32511 ($7EFF_H$).

Process alarm limits should not be set at values higher than the minimum potential overflow or underflow threshold limits shown in Table 4-29.

Table 4-36 Minimum Potential Overflow/Underflow Threshold Limits

Range	Minimum Possible Overflow Threshold	Minimum Possible Underflow Threshold
± 10 V	11.368 V 31430 $7AC6_H$	–11.369 V –31433 8537_H
± 5 V	5.684 V 31430 $7AC6_H$	–5.684 V –31430 $853A_H$
1 to 5 V	5.684 V 32376 $7E78_H$	0.296 V –4864 $ED00_H$
0 to 20 mA	22.737 mA 31432 $7AC8_H$	–3.519 mA –4864 $ED00_H$
4 to 20 mA	22.737 mA 32378 $7E7A_H$	1.185 mA –4864 $ED00_H$
± 20 mA	22.737 mA 31432 $7AC8_H$	–22.737 ma –31432 8538_H

4.6 Analog Input Module SM 331; AI 2 × 12 Bit

In this Section

In this section, you will find information on:

- The characteristics of the analog input module SM 331; AI 2 × 12 Bit
- The technical specifications of the analog input module SM 331; AI 2 × 12 Bit

You will also learn:

- How to start up the analog input module SM 331; AI 2 × 12 Bit
- Which measuring ranges the analog input module SM 331; AI 2 × 12 Bit has
- Which parameters can be used to influence the characteristics of the analog input module SM 331; AI 2 × 12 Bit

4.6.1 Characteristic Features and Technical Specifications of the Analog Input Module SM 331; AI 2 × 12 Bit

Order No.

6ES7 331-7KB01-0AB0

Characteristic Features

The analog input module SM 331; AI 2 × 12 Bit has the following characteristic features:

- Two inputs in one channel group
- Measured-value resolution (depending on the integration time set)
  - 9 bits + sign
  - 12 bits + sign
  - 14 bits + sign
- Measuring method selectable per channel group:
  - Voltage
  - Current
  - Resistance
  - Temperature
- Arbitrary measuring range selection per channel group
- Programmable diagnostics
- Programmable diagnostic interrupt
- One channel with limit monitoring
- Programmable limit interrupt
- Galvanic isolation to CPU
- Galvanic isolation to load voltage (**not** for 2-wire transducer)

Resolution

The resolution of the measured value is a direct function of the integration time selected. In other words the longer the integration time for an analog input channel, the more accurate the resolution of the measured value will be (see technical specifications of analog input module and Table 4-3).

Terminal Connection Diagram

Figure 4-24 shows the terminal connection diagram and the block diagram of the analog input module SM 331; AI 2 × 12 Bit. The input resistances depend on the measuring range selected (see Technical Specifications). You will find the detailed technical specifications of the analog input module SM 331; AI 2 × 12 Bit on the following page.

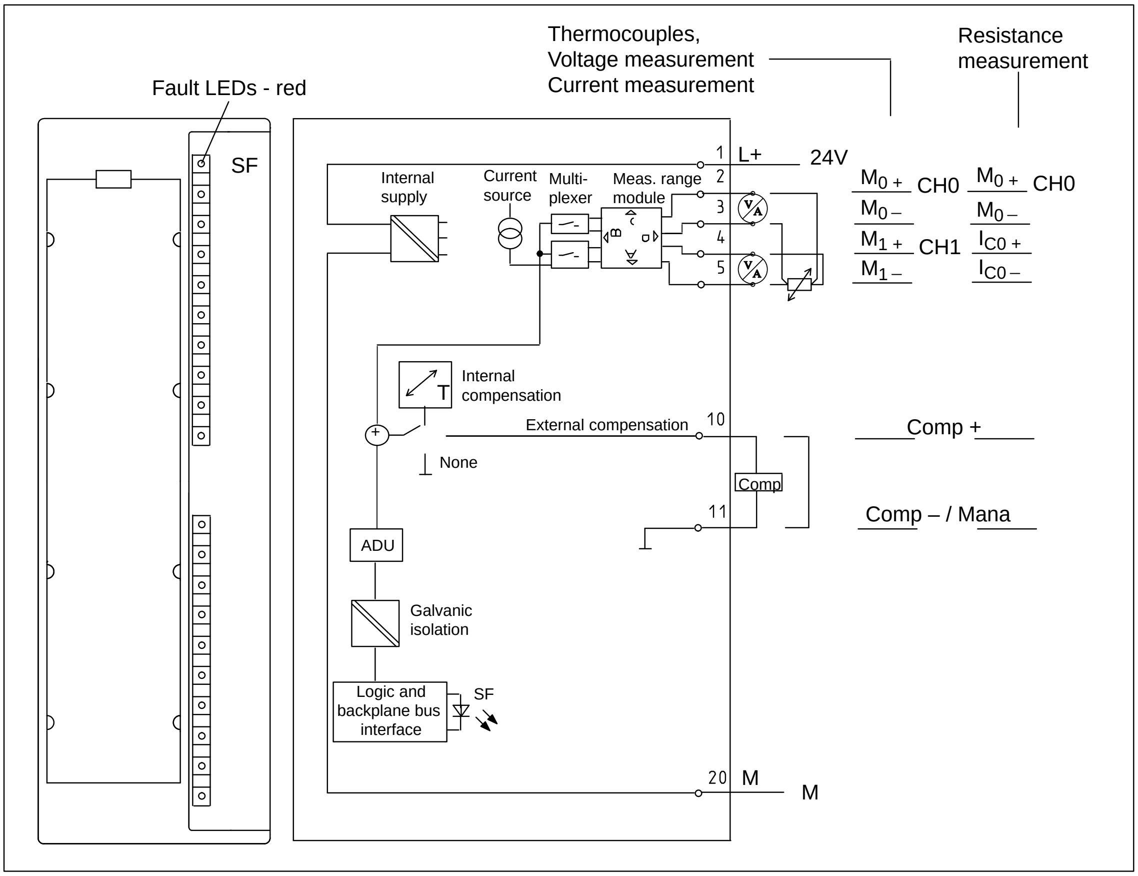


Figure 4-24 Module View and Block Diagram of the Analog Input Module SM 331; AI 2 × 12 Bit

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 250 g (8.75 oz.)
Module-Specific Data	
Number of inputs	2
• with resistance-type sensor	1
Length of cable (shielded)	max. 200 m (218 yd.)
	max. 50 m (54.5 yd.) at 80 mV and thermocouples
Voltages, Currents, Potentials	
Rated load voltage L+	24 VDC
• Reverse polarity protection	Yes
Power supplies of the transducers	
• Supply current (for 2 channels each of a channel group):	max: 62 mA
• Short-circuit-proof	Yes
• Constant current for resistance-type sensor	typ. 1.67 mA
Galvanic isolation	
• between channels and backplane bus	Yes
• between channels and load voltage L+	Yes
Permissible potential difference	
• between inputs and M_{ANA} (U_{CM})	2.5 VDC
– at signal = 0 V	
– not for 2-wire transducer	
• between M_{ANA} and $M_{internal}$ (U_{ISO})	75 VDC 60 VAC
• Insulation tested with	600 VDC
Current consumption	
• from backplane bus	max. 60 mA
• from load voltage L+ (without load)	max. 80 mA
Power losses of the module	typ. 1.3 W

Analog Value Generation				
Measuring principle	Integrating			
Integration/conversion time/resolution (per channel)				
• Programmable	Yes			
• Integration time in ms	2.5	$16^2/_3$	20	100
• Basic conversion time incl. integr. time in ms	3	17	22	102
Additional conversion time for resistance measurement in ms	1	1	1	1
Additional conversion time for wire-break monitoring in ms	10	10	10	10
or				
Additional conversion time for resistance measurement **and** wire-break monitoring in ms	16	16	16	16
• Possible resolution in bits + sign (incl. overrange)				
Unipolar meas. range	9	12	12	14
Bipolar measuring range	9+ sign	12+ sign	12+ sign	14+ sign
• Noise suppression for frequency f1 in Hz	400	60	50	10

Noise Suppression and Error Limits	
Noise suppression for F=n × (f1 ± 1 %), (f1=interference frequency)	
• Common-mode noise (U_{pp} < 2.5 V)	> 70 dB
• Series-mode noise (peak value of noise < nominal value of input range)	> 40 dB
Crosstalk between inputs	> 50 dB
Operational limit (over entire temperature range, referred to input range)	
• 80 mV	± 1 %
• 250 to 1000 mV	± 0.6 %
• 2.5 to 10 V	± 0.8 %
• 3.2 to 20 mA	± 0.7 %

Noise Suppression and Error Limits, continued		
Basic error (operational limit at 25 °C or 77 °F, referred to input range)		
• 80 mV	± 0.6 %	
• 250 to 1000 mV	± 0.4 %	
• 2.5 to 10 V	± 0.6 %	
• 3.2 to 20 mA	± 0.5 %	
Temperature drift (referred to input range)	± 0.005 %/K	
Linearity error (referred to input range)	± 0.05 %	
Repeatability (in steady state at 25 °C or 77 °F, referred to input range)	± 0.05 %	
Temperature drift (referred to internal compensation)	± 1 %	
Status, Interrupts, Diagnostics		
Interrupts		
• Limit interrupt	Programmable channel 0	
• Diagnostics interrupt	Programmable	
Diagnostics functions	Programmable	
• System fault display on module	Red LED (SF)	
• Diagnostics information Read-out	Possible	
Sensor Selection Data		
Input ranges (nominal values)/ input resistance		
• Voltage	± 80 mV;	/10 MΩ
	± 250 mV;	/10 MΩ
	± 500 mV;	/10 MΩ
	±1000 mV;	/10 MΩ
	± 2.5 V;	/100kΩ
	± 5 V;	/100kΩ
	1 to 5 V;	/100kΩ
	± 10 V;	/100kΩ
• Current	± 3.2 mA;	/25 Ω
	± 10 mA;	/25 Ω
	± 20 mA;	/25 Ω
	0 to 20 mA;	/25 Ω
	4 to 20 mA:	/25 Ω

Sensor Selection Data, continued		
• Resistance	150 Ω;	/10 MΩ
	300 Ω;	/10 MΩ
	600 Ω;	/10 MΩ
• Thermocouples	Types E, N, J, K,L	/10 MΩ
• Resistance-type thermometer	Pt 100, Ni 100	/10 MΩ
Permissible input voltage for voltage input (destruction limit)	max. 20 V continuously; 75 V for max. 1 s (duty factor 1:20)	
Permissible input current for current input (destruction limit)	40 mA	
Connection of sensors		
• for voltage measurement	Possible	
• for current measurement		
as 2-wire transducers	Possible	
as 4-wire transducers	Possible	
• for resistance measurement		
2-wire connection	Possible	
3-wire connection	Possible	
4-wire connection	Possible	
• Impedance of 2-wire transducer	max. 820 Ω	
Characteristic linearization	Programmable	
• for thermocouples	• Types E, N, J, K, L	
• for resistance-type thermometers	• Pt 100 (standard, climate range) Ni 100 (standard, climate range)	
Temperature compensation	Programmable	
• Internal temperature compensation	Possible	
• External temperature compensation with compensating box	Possible	
• External temperature compensation with Pt 100	Not possible	

4.6.2 Starting Up the Analog Input Module SM 331; AI 2 × 12 Bit

Parameter Assignment

You make the necessary settings of the analog input module SM 331; AI 2 × 12 Bit

- by means of measuring range module on the module

  and

- with *STEP 7* (see also the *STEP 7* User Manual) or
- in the user program by means of SFCs (see *STEP 7 System and Standard Functions* Reference Manual).

Default Settings

The analog input module has default settings for the integration time, diagnostics, interrupts, etc. (see Table 4-19).

These default settings apply, if you have not re-initialized the module with *STEP 7*.

Channel Groups

The two channels of the analog input module SM 331; AI 2 × 12 Bit are combined to a channel group. You can thus assign channel group parameters only to the two channels.

The analog input module SM 331; AI 2 × 12 Bit has a measuring range module for this channel group.

Resistance Measurement

If you use the resistance measurement method, the analog input module has only one channel. The “2nd” channel is used for current injection (I_C).

The measured value is obtained by accessing the “1st” channel. The “2nd” channel has the default carry value “$7FFF_H$”.

Unused Input Channels

You must short-circuit unused channels of the analog input module SM 331; AI 2 × 12 Bit and you should connect them to M_{ANA}. In this way, you obtain an optimum interference immunity for the analog input module. Also deactivate the unused channels using *STEP 7* (see Section 4.3.4), in order to reduce the module's cycle time.

If you do not use the COMP input, you must short-circuit it also.

Since configured inputs can remain unused, because of the channel group generation, you should note the following points for these inputs:

- Measuring range 1 to 5 V: Connect the unused input in parallel with a used input of the same channel group.
- Current measurement, 2-wire transducer:

  There are two ways to use the channels:

a) Leave the unused input open and do not enable diagnostics for this channel group. If diagnostics is enabled, the analog module triggers a diagnostics interrupt once and the group fault LED of the analog module flashes.

b) Provide a 1.5 to 3.3 kΩ resistor on unused input. You may then enable diagnostics for this channel group.

- Current measurement 4 to 20 mA, 4-wire transducer: Connect the unused input in series with an input of the same channel group.

Measuring Range Module

Some of the parameters of the analog input module SM 331; AI 2 × 12 Bit can be assigned directly on the module with a measuring range module. The analog input module is supplied with the measuring range module plugged in.

The measuring range modules can be set to the following positions: “A”, “B”, “C” and “D”.

They are set to the “B” position in the factory.

Tables 4-38 to 4-41 in Section 4.6.3 tell you which setting you have to select for which measuring method and measuring range. The settings for the various measuring ranges are also printed on the module.

Default Settings for Measuring Range Module

In the individual measuring range module positions, you can use the following measuring methods and measuring ranges without re-initializing the analog input module SM 331; AI 2 × 12 Bit with *STEP 7*:

Table 4-37 Default Settings of the Analog Input Module SM 331; AI 2 × 12 Bit Using Measuring Range Module

Measuring Range Module Setting	Measuring Method	Measuring Range
A	Voltage	± 1000 mV
B	Voltage	± 10 V
C	Current, 4-wire transducer	4 to 20 mA
D	Current, 2-wire transducer	4 to 20 mA

These measuring methods and measuring ranges are the default settings on the module. You only have to insert the measuring range module to the required setting (see Section 4.3).

Special Feature of Process Interrupts

You can set a process interrupt in *STEP 7* for the channel group. Note, however, that the process interrupt is set only for the 1st channel of the channel group, i.e. for channel 0.

4.6.3 Measuring Methods and Measuring Ranges of the Analog Input Module SM 331; AI 2 × 12 Bit

Measuring Methods

You can set the following measuring methods on the analog input module SM 331; AI 2 × 12 Bit:

- Voltage measurement
- Current measurement
- Resistance measurement
- Temperature measurement

Use *STEP 7* and the measuring range module on the analog input module to make the necessary settings (see Section 4.3.4).

Measuring Ranges

Tables 4-38 to 4-41 list the measuring ranges you can use with the analog input module. Use *STEP 7* and the measuring range modules on the analog input module to select the desired measuring ranges (see Section 4.3.4). Tables 4-38 to 4-41 also show the necessary settings of the measuring range module.

Wire-Break Check

With the measuring range 4 to 20 mA **and**

- **activated** wire-break check, the analog input module enters a wire break in the diagnostics if the current value falls below 3.6 mA. If you have enabled diagnostics interrupt during configuration, the analog input module additionally triggers a diagnostics interrupt.
  If no diagnostics interrupt has been enabled, the illuminated SF display is the only indicator for the wire break and you must evaluate the diagnostics bytes in the user program.
- **non-activated** wire-break check, the analog input module triggers a diagnostics interrupt when the underflow has been reached.

Measuring Ranges for Voltage Measurements

Table 4-38 shows all of the measuring ranges or the sensor type for voltage measurements, as well as the relevant measuring range module settings.

Table 4-38 Measuring Ranges for Voltage Measurement

Measuring Method Selected	Description	Measuring Range (Type of Sensor)	Measuring Range Module Setting
Voltage	You will find the digitized analog values in Section 4.1.2, Tables 4-4 and 4-6 in the voltage measuring range.	+/– 80 mV +/– 250 mV +/– 500 mV +/– 1000 mV	A
		+/– 2,5 V +/– 5 V 1 to 5 V +/– 10 V	B
Thermocouples + internal compensation (thermovoltage measurement)	You will find the digitized analog values in Section 4.1.2, Table 4-4 in the voltage measuring range ± 80 mV.	Typ N [NiCrSi-NiSi] TypeE [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
Thermocouples + external compensation (thermovoltage measurement)	You will find the digitized analog values in Section 4.1.2, Table 4-4 in the voltage measuring range ± 80 mV.	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A

Measuring Ranges for Current Measurement

Table 4-39 lists all of the measuring ranges for current measurement with 2-wire and 4-wire transducers, as well as the relevant measuring range module settings.

Table 4-39 Measuring Ranges for 2-Wire and 4-Wire Transducers

Measuring Method Selected	Description	Measuring Range	Measuring Range Module Setting
2-wire transducers	You will find the digitzed analog values in Section 4.1.2, Tables 4-5 and 4-6 in the current measuring range.	4 to 20 mA	D
4-wire transducers	You will find the digitzed analog values in Section 4.1.2, Tables 4-5 and 4-6 in the current measuring range.	+/– 3.2 mA +/– 10 mA 0 to 20 mA 4 to 20 mA +/– 20 mA	C

Measuring Ranges for Resistance Measurements

Table 4-40 lists all of the measuring ranges for resistance measurements and the relevant measuring range module settings.

Table 4-40 Measuring Ranges for Resistance Measurements

Measuring Method Selected	Description	Measuring Range	Measuring Range Module Setting
Resistance, 4-wire connection	You will find the digitized analog values in Section 4.1.2, Table 4-7, under the resistance measuring range.	150 Ohm 300 Ohm 600 Ohm	A

Measuring Ranges for Temperature Measurement

Table 4-41 lists the measuring ranges (or the sensor type) and the measuring range module settings for temperature measurement. The characteristics are linearized:

- for Pt 100 according to DIN IEC 751
- for Ni 100 to DIN 43760
- for thermocouples to DIN 548, type L to DIN 43710.

Table 4-41 Measuring Ranges for Temperature Measurement

Measuring Method Selected	Description	Measuring Range (Type of Sensor)	Measuring Range Module Setting
Thermocouples + linearization, internal compensation (temperature measurement)	The digitized analog values are listed in Section 4.1.2, Tables 4-12 to 4-15, under the temperature range.	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
Thermocouples + linearization, external compensation (temperature measurement)	The digitized analog values are listed in Section 4.1.2, Tables 4-12 to 4-15, under the temperature range.	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
Resistance-type thermometer + linearization, 4-wire connection (temperature)	You will find the digitized analog values in Section 4.1.2, Table 4-8 and 4-10, under the temperature range.	Pt 100 standard range climate range Ni 100 standard range climate range	A

4.7 Analog Output Module SM 332; AO 4 × 12 Bit

In this Section

In this section, you will find:

- The characteristic features of the analog output module SM 332; AO 4 × 12 Bit
- The technical specifications of the analog output module SM 332; AO 4 × 12 Bit

You will learn:

- How to start up the analog output module SM 332; AO 4 × 12 Bit
- Which output ranges you can use with the analog output module SM 332; AO 4 × 12 Bit
- The parameters with which you can influence the characteristic features of the analog output module SM 332; AO 4 × 12 Bit

4.7.1 Characteristic Features and Technical Specifications of the Analog Output Module SM 332; AO 4 × 12 Bit

Order No.

6ES7 332-5HD01-0AB0

Characteristic Features

The analog output module SM 332; AO 4 × 12 Bit has the following characteristic features:

- 4 outputs in 4 channel groups
- The individual output channels can be programmed as
  - voltage outputs
  - current outputs
- Resolution 12 bits
- Programmable diagnostics
- Programmable diagnostics interrupt
- Porgrammable substitute value output
- Galvanic isolation to CPU and load voltage

Note

When switching on and off the rated load voltage (L+), wrong intermediate values can be present at the output for approx. 10 ms.

Terminal Connection Diagram

Figure 4-25 shows the module view and the block diagram of the analog output module SM 332; AO 4 × 12 Bit. You will find the detailed technical specifications of the analog output module on the following pages.

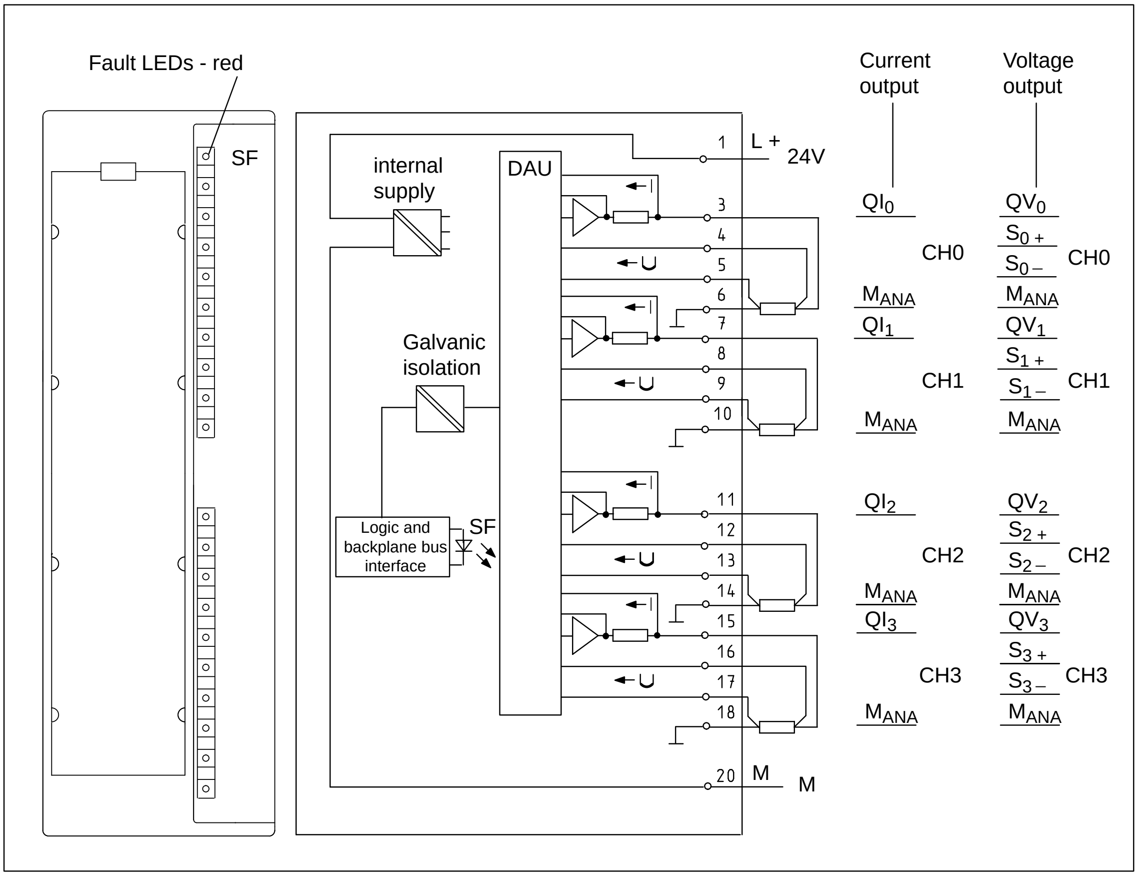


Figure 4-25 Module View and Block Diagram of the Analog Output Module SM 332; AO 4 × 12 Bit

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 220 g (7.7 oz.)
Module-Specific Data	
Number of outputs	4
Length of cable (shielded)	max. 200 m (218 yd.)
Voltages, Currents, Potentials	
Rated load voltage L+	24 VDC
• Reverse polarity protection	No
Galvanic isolation	
• between channels and backplane bus	Yes
• between channels and load voltage L+	Yes
Permissible potential difference	
• between S– and M_{ANA} (UCM)	3 VDC
• between M_{ANA} and the $M_{internal}$ (U_{ISO})	75 VDC 60 VAC
• Insulation tested with	600 VDC
Current drawn	
• from backplane bus	max. 60 mA
• from load voltage L+ (without load)	max. 240 mA
Power losses of the module	typ. 3 W
Analog Value Generation	
Resolution (incl. overrange)	
• ±10 V; ±20 mA; 4 to 20 mA; 1 to 5 V	11 bits + sign
• 0 to 10 V; 0 to 20 mA	12 bits
Conversion time per channel	max. 0.8 ms
Setting time	
• for resistive load	0.1 ms
• for capacitive load	3.3 ms
• for inductive load	0.5 ms
Injection of substitute values	Yes, programmable

Noise Suppression and Error Limits	
Crosstalk between outputs	> 40 dB
Operational limit (in the total temperature range, referred to output range)	
• Voltage output	± 0.5 %
• Current output	± 0.6 %
Basic error (operational limit at 25 °C, referred to output range)	
• Voltage output	± 0.2 %
• Current output	± 0.3 %
Temperature drift (referred to output range)	± 0.02 %/K
Linearity error (referred to output range)	± 0.05 %
Repeatability (in steady state at 25 °C, referred to output range)	± 0.05 %
Output ripple; range 0 to 50 kHz (referred to output range)	± 0.05 %
Status, Interrupts, Diagnostics	
Interrupts	
• Diagnostics interrupt	Programmable
Diagnostics functions	Programmable
• System fault display on module	Red LED (SF)
• Diagnostics information read-out	Possible

Actuator Selection Data	
Output ranges (nominal values)	
• Voltage	$\pm$ 10 V 0 to 10 V 1 to 5 V
• Current	$\pm$ 20 mA 0 to 20 mA 4 to 20 mA
Impedance (in the nominal output range)	
• with voltage outputs	min. 1 k Ω
– capacitive load	max. 1 μF
• with current outputs	max. 500 Ω
– at U_{CM} < 1 V	max. 600 Ω
– inductive load	max. 10 mH
Voltage output	
• Short-circuit protection	Yes
• Short-circuit current	max. 25 mA
Current output	
• Open-circuit voltage	max. 18 V
Destruction limit for voltages/currents connected from outside	
• Voltage at outputs to M_{ANA}	max 18 V continuously; 75 V for max. 1 s (duty factor 1:20)
• Current	max. DC 50 mA
Connection of actuators	
• Voltage output 2-wire connection 4-wire connection (measuring leads)	 Possible Possible
• Current output 2-wire connection	 Possible

4.7.2 Starting Up the Analog Output Module SM 332; AO 4 × 12 Bit

Parameter Assignment

The functions of the analog output module SM 332; AO 4 × 12 Bit are set as follows:

- with *STEP 7* (also see *STEP 7* User Manual) or
- in the user program by means of SFCs (see *STEP7 System and Standard Functions* Reference Manual).

Note

If you modify output ranges when the analog output module SM 332; AO 4 × 12 Bit is in operation, intermediate values may appear at the output!

Default Settings

The analog output module has default settings for the type of output, diagnostics, interrupts, etc. (see Table 4-20).

These default settings are valid, if you have not re-initialized the module with *STEP 7* .

Parameter Assignment

You can configure each output channel of the SM 332; AO 4 × 12 Bit individually.

Advantage: You can assign individual parameters for each output channel.

When you set the parameters with SFCs in the user program, the parameters are assigned to channel groups. Each output channel of the analog output module SM 332; AO 4 × 12 Bit is then assigned to one channel group, i.e. output channel 0 = channel group 0 (see Fig. A-4 in Appendix A).

Unused Output Channels

To make sure that unused output channels of the analog output module *SM* 332; AO 4 × 12 Bit are dead, you must deactivate them and leave them open. Deactivate an output channel using the “Output” parameter block when programming with *STEP 7* (see Section 4.3.4).

4.7.3 Output Ranges of the Analog Output Module SM 332; AO 4 × 12 Bit

Analog Outputs

You can use the outputs as:

- Voltage outputs
- Current outputs

Set the outputs group-wise, using *STEP 7* for programming the output type.

Output Ranges

Set the various output ranges for the voltage and/or current outputs with *STEP 7*.

Table 4-42 lists all the possible output ranges of the analog output module SM 332; AO 4 × 12 Bit.

Table 4-42 Output Ranges of the Analog Output Module SM 332; AO 4 × 12 Bit

Selected Type of Output	Description	Output Range
Voltage	You will find the digital analog values in Section 4.1.3 in the voltage output range	1 to 5 V 0 to 10 V ± 10 V
Current	You will find the digital analog values in Section 4.1.3 in the current output range	0 to 20 mA 4 to 20 mA ± 20 mA

Default Setting

The default settings of the module are output type “voltage” and output range “± 10 V”. You can use this output type with this output range without changing the parameters of the SM 332; AO 4 × 12 Bit with *STEP 7*.

Wire-Break Check

The analog output module SM 332; AO 4 × 12 Bit carries out a wire-break check only for current outputs.

Short-Circuit Check

The analog output module SM 332; AO 4 × 12 Bit carries out a short-circuit check only for voltage outputs.

Substitute Values

You can configure the SM 332; AO 4 × 12 Bit for the CPU operating mode STOP as follows: Output Substitute Values (default: 0 mA/0 V) or Hold Last Value.

For the output ranges 4 to 20 mA and 1 to 5 V you must set the substitute value $E500_H$ in order for the output to remain de-energized (see Tables 4-17 and 4-18).

4.8 Analog Output Module SM 332; AO 2 × 12 Bit

In this Section

In this section, you will find:

- The characteristic features of the analog output module SM 332; AO 2 × 12 Bit
- The technical specifications of the analog output module SM 332; AO 2 × 12 Bit

You will learn:

- How to start up the analog output module SM 332; AO 2 × 12 Bit
- Which output ranges you can use with the analog output module SM 332; AO 2 × 12 Bit
- The parameters with which you can influence the characteristic features of the analog output module SM 332; AO 2 × 12 Bit

4.8.1 Characteristic Features and Technical Specifications of the Analog Output Module SM 332; AO 2 × 12 Bit

Order No.

6ES7 332-5HB01-0AB0

Characteristic Features

The analog output module SM 332; AO 2 × 12 Bit has the following characteristic features:

- 2 output in 2 channels groups
- The individual output channels can be programmed as
  - voltage outputs
  - current outputs
- Resolution 12 bits
- Programmable diagnostics
- Programmable diagnostics interrupt
- Programmable substitute value output
- Galvanic isolation to CPU and load voltage

Note

When switching on and off the rated load voltage (L+), wrong intermediate values can be present at the output for approx. 10 ms.

Terminal Connection Diagram

Figure 4-26 shows the module view and the block diagram of the analog output module SM 332; AO 2 × 12 Bit. You will find the detailed technical specifications of the analog output module on the following pages.

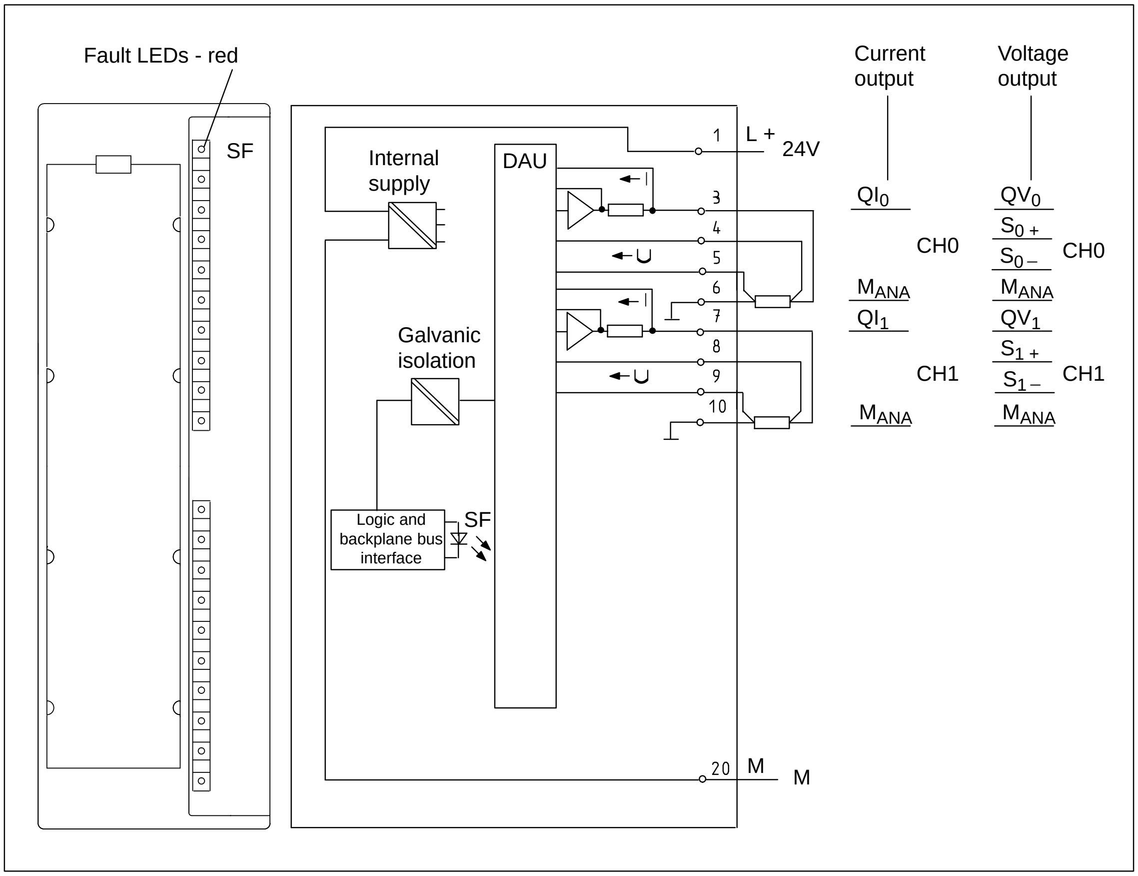


Figure 4-26 Module View and Block Diagram of the Analog Output Module SM 332; AO 2 × 12 Bit

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 220 g (7.7 oz.)
Module-Specific Data	
Number of outputs	2
Length of cable (shielded)	max. 200 m (218 yd.)
Voltages, Currents, Potentials	
Rated load voltage L+	24 VDC
• Reverse polarity protection	Yes
Galvanic isolation	
• between channels and backplane bus	Yes
• between channels and load voltage L+	Yes
Permiss. potential difference	
• between S– and M_{ANA} (U_{CM})	3 VDC
• between M_{ANA} and the $M_{internal}$ (U_{ISO})	75 VDC 60 VAC
• Isolation tested with	600 VDC
Current drawn	
• from backplane	max. 60 mA
• from load voltage L+ (without load)	max. 135 mA
Power losses of the module	typ. 3 W
Analog Value Generation	
Resolution (incl. overrange)	
• ±10 V; ±20 mA; 4 to 20 mA; 1 to 5 V	11 bits + sign
• 0 to 10 V; 0 to 20 mA	12 bits
Conversion time per channel	max. 0.8 ms
Setting time	
• for resistive load	0.1 ms
• for capacitive load	3.3 ms
• for inductive load	0.5 ms
Injection of substitute values	Yes, programmable

Noise Suppression and Error Limits	
Crosstalk between outputs	> 40 dB
Operational limit (in the total temperature range, referred to output range)	
• Voltage output	± 0.5 %
• Current output	± 0.6 %
Basic error (operational limit at 25 °C, referred to output range)	
• Voltage output	± 0.2 %
• Current output	± 0.3 %
Temperature drift (referred to output range)	± 0.02 %/K
Linearity error (referred to output range)	± 0.05 %
Repeatability (in steady state at 25 °C, referred to output range)	± 0.05 %
Output ripple; range 0 to 50 kHz (referred to output range)	± 0.05 %
Status, Interrupts, Diagnostics	
Interrupts	
• Diagnostics alarm	Programmable
Diagnostics functions	Programmable
• System fault display on module	Red LED (SF)
• Diagnostics information read-out	Possible

Actuator Selection Data	
Output ranges (nominal values)	
• Voltage	± 10 V 0 to 10 V 1 to 5 V
• Current	± 20 mA 0 to 20 mA 4 to 20 mA
Impedance (in nominal output range)	
• with voltage outputs	min. 1 k Ω
– capacitive load	max. 1 μF
• with current outputs	max. 500 Ω
– at U_{CM} < 1 V	max. 600 Ω
– inductive load	max. 10 mH
Voltage output	
• Short-circuit protection	Yes
• Short-circuit current	max. 25 mA
Current output	
• Open-circuit voltage	max. 18 V
Destruction limit for voltages/currents connected from outside	
• Voltage at outputs to M_{ANA}	max 18 V continuously; 75 V for max. 1 s (duty factor 1:20)
• Current	max. DC 50 mA
Connection of actuators	
• Voltage output 2-wire connection 4-wire connection (measuring leads)	 Possible Possible
• Current output 2-wire connection	 Possible

4.8.2 Starting Up the Analog Output Module SM 332; AO 2 × 12 Bit

Parameter Assignment

The functions of the analog output module SM 332; AO 2 × 12 Bit are set as follows:

- with *STEP 7* (see aso *STEP 7* User Manual) or
- in the user program by means of SFCs (see *STEP 7 System and Standard Functions* Reference Manual).

Note

If you modify output ranges when the analog output module SM 332; AO 2 × 12 Bit is in operation, intermediate values may appear at the output!

Default Settings

The analog output module has default settings for the type of output, diagnostics, interrupts, etc. (see Table 4-20).

These default settings are valid, if you have not re-initialized the module with *STEP 7*

Parameter Assignment

You can configure each output channel of the SM 332; AO 2 × 12 Bit individually.

Advantage: You can assign individual parameters for each output channel.

When you configure with SFCs in the user program, the parameters are assigned to channel groups. Each output channel of the analog output module SM 332; AO 2 × 12 Bit is then assigned to one channel group, i.e. output channel 0 = channel group 0 (see Fig. A-3 in Appendix A).

Unused Output Channels

To make sure that unused output channels of the analog output module SM 332; AO 2 × 12 Bit are dead, you must deactivate them and leave them open. Deactivate an output channel using the “Output” parameter block of *STEP 7* (see Section 4.3.4).

4.8.3 Output Ranges of the Analog Output Module SM 332; AO 2 × 12 Bit

Analog Outputs

You can use the outputs as:

- Voltage outputs
- Current outputs

You make the output settings channel-group-wise, using *STEP 7*.

Output Ranges

Set the various output ranges for the voltage and/or current outputs with *STEP 7*.

Table 4-43 lists all the possible output ranges of the analog output module SM 332; AO 2 × 12 Bit.

Table 4-43 Output Ranges of the Analog Output Module SM 332; AO 2 × 12 Bit

Selected Type of Output	Description	Output Range
Voltage	You will find the digital analog values in Section 4.1.3 in the voltage output range	1 to 5 V 0 to 10 V ± 10 V
Current	You will find the digital analog values in Section 4.1.3 in the current output range	0 to 20 mA 4 to 20 mA ± 20 mA

Default Setting

The default settings of the module are output type “voltage” and output range “± 10 V”. You can use this output type with this output range without changing the parameters of the SM 332; AO 2 × 12 Bit with *STEP 7*.

Wire-Break Check

The analog output module SM 332; AO 2 × 12 Bit carries out a wire-break check only for current outputs.

Short-Circuit Check

The analog output module SM 332; AO 2 × 12 Bit carries out a short-circuit check only for voltage outputs.

Substitute Values

You can parameterize the SM 332; AO 2 × 12 Bit for the CPU operating mode STOP as follows: Output Substitute Values (default: 0 mA/0 V) or Hold Last Value.

For the output ranges 4 to 20 mA and 1 to 5 V you must set the substitute value $E500_H$ in order for the output to remain de-energized (see Tables 4-17 and 4-18).

4.9 Analog Output Module SM 332; AO 4 × 16 Bit

Order No.

6ES7 332-7ND00-0AB0

Characteristic Features

The analog output module SM 332; AO 4 × 16 Bit has the following characteristic features:

- 4 outputs in 4 channel groups
- The individual output channels can be programmed as:
  - Voltage outputs
  - Current outputs
- Resolution of 16 bits
- Programmable diagnostics
- Programmable diagnostics interrupt
- Programmable substitute value output
- Galvanic isolation to CPU and analog output channel
- Galvanic isolation analog output channel-to-channel
- Galvanic isolation analog output and L+, M
- Galvanic isolation CPU and L+, M

Terminal Connection Diagram

Figure 4-27 shows the block diagram of the analog output module SM 332; AO 4 x 16 Bit.

The detailed technical specifications for this analog output module are on the following pages.

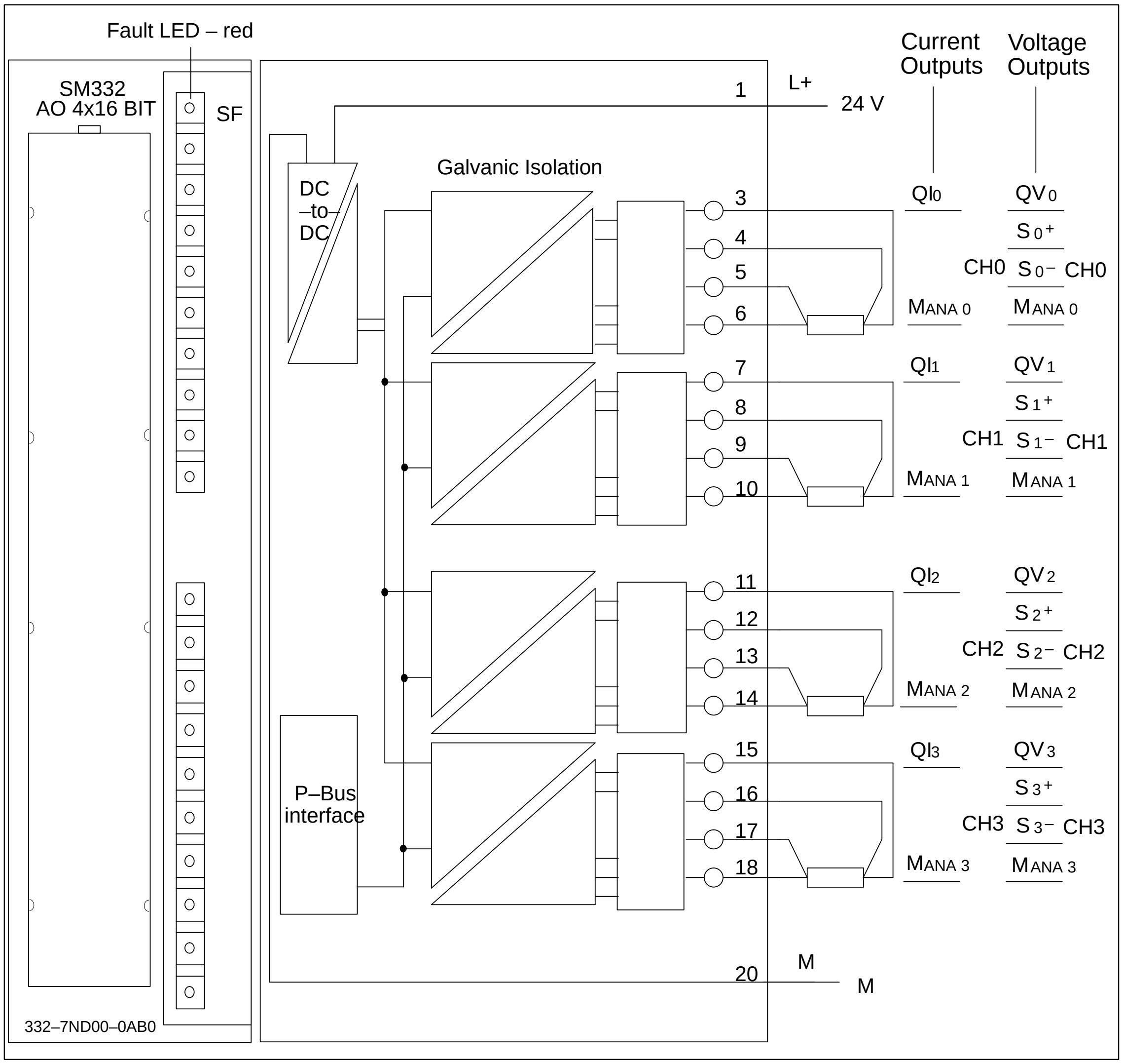


Figure 4-27 Block Diagram of Analog Output Module SM 332; AO 4 x 16 Bit

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 220 g (7.7 oz.)
Module-Specific Data	
Number of outputs	4
Length of cable (shielded)	max. 200 m (218 yd.)
Voltages, Currents, and Potentials	
Rated load voltage L +	24 VDC
• Reverse Polarity protection	Yes
Galvanic isolation	
• between channels and backplane bus	Yes
• between channels and load voltage L+	Yes
• between output channel-to-channel	Yes
• backplane bus and L+	Yes
Permissible potential difference	
• channel to backplane	200 VDC / 120 VAC
• channel to L+, M	200 VDC / 120 VAC
• between channels	200 VDC / 120 VAC
• backplane to L+, M	200 VDC / 120 VAC
Isolation tested with	
• channel to backplane	1500 VAC
• channel to L+, M	1500 VAC
• between channels	1500 VAC
• backplane to L+, M	1500 VAC
Current drawn	
• from backplane bus	max. 60 mA
• from load voltage L+ (without load)	max. 240 mA
Power losses of the module	typ. 3 W

Analog Value Generation	
Resolution (incl. Overrange)	15 bits + sign
• 1 to 5 V	13 bits
• 4 to 20 mA	14 bits
Conversion time 1 to 4 channels	max. 1.5 ms
Settling time	
• for resistive load	0.2 ms
• for capacitive load	1.0 ms
• for inductive load	0.2 ms
Substitute values	Yes, configurable
Noise Suppression and Error Limits	
Crosstalk between outputs	> 100 dB
Operational limit (over entire temperature range, referred to output range)	
• Voltage outputs	max. ± 0.12% typ. ± 0.04%
• Current outputs	max. ± 0.18% typ. ± 0.05%
Basic error (operational limit at 25° C, referred to output range)	
• Voltage outputs	± 0.01%
• Current outputs	± 0.01%
Temperature drift (referred to output range)	± 0.001% / K 10 ppm / K
Linearity error (referred to output range)	± 0.004%
Repeatability (in steady state at 25° C, referred to output range)	± 0.002 %
Output ripple; range 0 to 50 Khz (referred to output range)	± 0.05 %

Status, Interrupts, Diagnostics	
Interrupts	
• Diagnostic interrupt	Programmable
• Diagnostic functions	Programmable
• System fault display on module	Red LED (SF)
• Diagnostic information readout	Possible
Actuator Selection Data	
Output ranges (nominal values)	
• Voltage	± 10 V 0 to 10 V 1 to 5 V
• Current	± 20 mA 0 to 20 mA 4 to 20 mA
Load impedance (in the nominal output range)	
• With voltage outputs – capacitive load	min. 1K Ω max. 1µ F
• With current outputs – inductive load	max. 500 Ω max. 1 mH
Voltage output	
• Short circuit protection	Yes
• Short circuit current	40 mA, nominal
Current output	
• Open circuit voltage	max. 18 V
Connection of actuators	
• Voltage output 4-wire connection (measuring leads)	Possible
• Current output 2-wire connection	Possible

4.9.1 Starting Up the Analog Output Module SM 332; AO 4 × 16 Bit

Parameter Assignment

The functions of the analog output module SM 332; AO 4 × 16 Bit are set:

- with STEP 7 (see the *STEP 7 User Manual*) or
- in the user program by means of SFCs (see the *STEP 7 System and Standard Functions* Reference Manual)

Note

If you modify output ranges when the analog output module SM 332; AO 4 X 16 Bit is in operation, intermediate values may appear at the output.

You can configure each output channel of the SM 332; AO 4 x 16 Bit individually.

Advantage: you can assign individual parameters for each output channel.

When you set the parameters with SFCs in the user program, the parameters are assigned to channel groups. Each output channel of the analog output module SM 332; AO 4 x 16 Bit is then assigned to one channel group, i.e., output channel 0 = channel group 0.

Default Setting

The default settings of the module are diagnostic interrupt disabled: group diagnostics disabled; output type: voltage; output range: ± 10 V; and reaction to CPU STOP: outputs without voltage or current. You can use this output type with this output range without changing the parameters of the SM 332; AO 4 x 16 Bit with STEP 7.

Unused Output Channels

Unused output channels of the analog output module SM 332; AO 4 x 16 Bit should be deactivated by using the Output parameter block when programming with STEP 7 and field wiring terminals should be empty.

4.9.2 Output Ranges of the Analog Output Module SM 332; AO 4 × 16 Bit

Analog Outputs

You can use the outputs as:

- Voltage outputs
- Current outputs

Set the outputs as groups, using STEP 7 for programming the output type.

Output Ranges

Set the various output ranges for the voltage and/or current outputs with STEP 7.

Table 4-35 lists the possible output ranges of the analog output module SM 332; AO 4 x 16 Bit.

Table 4-44 Ranges for Current and Voltage Outputs

Selected Type of Output	Description	Output Range
Voltage	You will find the digital analog values in Table 4–17[1], in the voltage output range.	1 to 5 V 0 to 10 V ± 10 V
Current	You will find the digital analog values in Table 4–18[1], in the current output range.	0 to 20 mA 4 to 20 mA ± 20 mA

1 of the *S7-300 Installation and Hardware* manual

Reaction to CPU STOP

You can configure the SM 332; AO 4 x 16 Bit for the CPU operating mode STOP as follows: Outputs Without Voltage or Current (OWVC), Retain Last Value (RLV), or Switch to Substitute Value (SSV).

Substitute Values

Substitute values, expressed as a current (mA) or voltage (V), must be within the nominal range of the channel configuration.

4.10 Analog Input/Output Module SM 334; AI 4/AO 2 × 8/8 Bit

In this Section

In this section you will get to know:

- The characteristic features of the analog input/output module SM 334; AI 4/AO 2 × 8/8 Bit
- The technical specifications of the analog input/output module SM 334; AI 4/AO 2 × 8/8 Bit

You will learn:

- How to start up the analog input/output module SM 334; AI 4/AO 2 × 8/8 Bit
- Which measuring and output ranges the analog input/output module SM 334; AI 4/AO 2 × 8/8 Bit has

4.10.1 Characteristic Features and Technical Specifications of the Analog Input/Output Module SM 334; AI 4/AO 2 × 8/8 Bit

Order No.

6ES7 334-0CE01-0AA0

Characteristic Features

The analog input/output module SM 334: AI 4/AO 2 × 8/8 Bit has the following characteristic features:

- Four input and two output channels
- Resolution 8 bits
- Measuring range of 0 to 10 V or 0 to 20 mA
- Output range of 0 to 10 V or 0 to 20 mA
- Both voltage and current output options
- Non-isolated to CPU
- Galvanic isolation to load voltage

Special Feature: Measuring Range and Output Range Selection

You cannot assign parameters to the SM 334 analog input/output module with four 8-bit analog input channels and two 8-bit analog output channels. Select the measuring range of the input channels and the output range of the output channels via the wiring (see Figure 4-28).

Terminal Connection Diagram

Figure 4-28 shows the module view and the block diagram for the analog input/output module SM 334; AI4/AO2 × 8/8 Bit. You will find the detailed technical specifications of the analog input/output module on the following page.

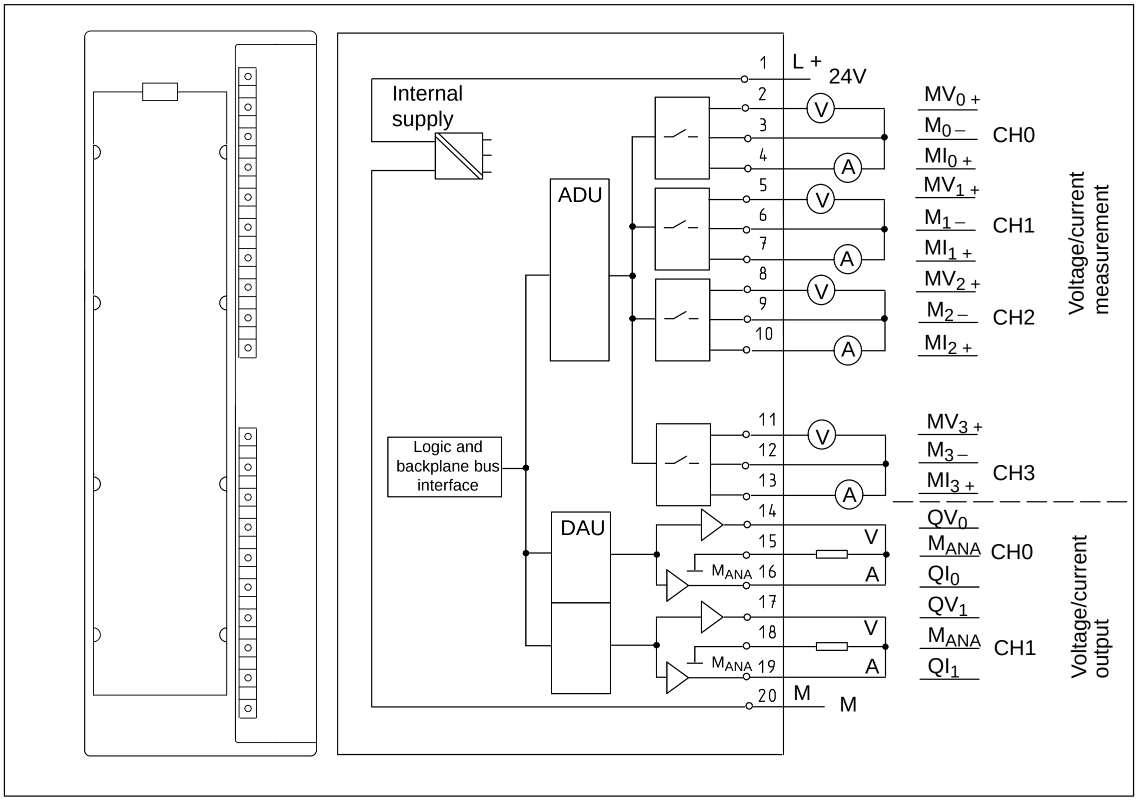


Figure 4-28 Module View and Block Diagram of the Analog Input/Output Module SM 334; AI 4/AO 2 × 8/8 Bit

Important Information on Connecting the Module

The SM 334; AI4/AO2 x 8/8 Bit analog input/output module is a **non-isolated module.**

Note when connecting the SM 334 that the ***analog ground (M_{ANA}), which is terminal 15 or 18, is connected to the ground (M) of the CPU or IM interface module***. Use a wire with a minimum cross-section of 1 mm^2 for this.

If there is no ground connection between M_{ANA} and M, the module switches off. Inputs are read with $7FFF_H$; outputs return a value of 0.

If the module is run without a ground connection for some time, it may be destroyed.

Note also that ***the supply voltage for the CPU or IM interface module must not be connected incorrectly***. Reverse polarity causes the destruction of the module because M_{ANA} is subjected to an impermissibly high potential (+24V).

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 285 g (9.98 oz.)
Module-Specific Data	
Number of inputs	4
Number of outputs	2
Cable length, shielded	max. 200 m (218 yd.)
Voltages, Currents, Potentials	
Rated load voltage L+	24 VDC
Galvanic isolation	No
Permiss. potential difference	
• between the inputs and M_{ANA} (U_{CM})	1 VDC
Current drawn	
• from the backplane bus	max. 55 mA
• from load voltage L+ (without load)	max. 110 mA
Module power losses	typ. 2.6 W
Status, Interrupts, Diagnostics	
Interrupts	No
Diagnostic functions	No
Analog Value Generation for the Inputs	
Measuring principle	Successive approximation
Resolution (incl. overrange)	8 bits
Conversion time (all channels)	5 ms

Interference Suppression, Error Limits for the Inputs	
Interference suppression for f = n × (f1 ± 1 %)	
(f1 = interference frequency)	
• Common-mode interference (U_{pp} < 1 V)	> 60 dB
Crosstalk between the inputs	> 50 dB
Operational limit	
(in the total temperature range, referred to the input range)	
• Voltage input	± 0.9 %
• Current input	± 0.8 %
Basic error limit (operational limit at 25 °C or 77 F, referred to the input range)	
• Voltage input	± 0.7 %
• Current input	± 0.6 %
Temperature error (referred to input range)	± 0.005 %/K
Linearity error (referred to the input range)	± 0,05 %
Repeat accuracy (in the steady state at 25 °C / 77 F, referred to the input range)	± 0.05 %

Sensor Selection Data	
Input ranges (rated values) / input resistance	
• Voltage	0 to10 V/100 k Ω
• Current	0 to 20 mA/50 Ω
Permissible input voltage (destruction limit)	max. 20 V continuously; 75 V for max. 1 s (duty factor 1:20)
Permissible input current for current input (destruction limit)	40 mA
Connection of signal sensors	
• for voltage measurement	Possible
• for current measurement	
as 2-wire transducer	Not possible
as 4-wire transducer	Possible
Analog Value Generation for the Outputs	
Resolution	8 bits
Conversion time (all channels)	5 ms
Settling time	
• for resistive load	0.3 ms
• for capacitive load	3.0 ms
• for inductive load	0.3 ms
Injection of substitute values	No
Interference Suppress., Error Limits for the Outputs	
Crosstalk between the outputs	> 40 dB
Operational limit (in the total temperature range, referred to the output range)	
• Voltage output	±0.6 %
• Current output	±1.0 %
Basic error (operational limit at 25 °C or 77 F, referred to the output range)	
• Voltage output	±0.5 %
• Current output	±0.5 %
Temperature error (referred to the output range)	± 0.02 %/K
Linearity error (referred to the output range)	± 0.05 %
Repeat accuracy (in the steady state at 25 °C / 77 °F, referred to the output range)	± 0.05 %
Output ripple (bandwidth referred to the output range)	± 0.05 %
Actuator Selection Data	
Output ranges (rated values)	
• Voltage	0 to10 V
• Current	0 to20 mA
Impedance (in nominal output range)	
• with voltage outputs	min. 5 kΩ
– with capacitive load	max. 1 μF
• with current outputs	max. 300 Ω
– with capacitive load	max. 1 mH
Voltage output	
• Short-circuit protection	Yes
• Short-circuit current	max. 11 mA
Current output	
• No-load voltage	max. 15 V
Destruction limit for voltages/currents connected from outside	
• Voltage at outputs to M_{ANA}	max 15 V continuously;
• Current	max. DC 50 mA
Connection of actuators	
• for voltage output 2-wire connection 4-wire connection (measuring line)	 Possible Not possible
• for current output 2-wire connection	Possible

4.10.2 Starting Up the Analog Input/Output Module SM 334; AI 4/AO 2 × 8/8 Bit

Electrical Design

You **must** connect one of the chassis ground terminals (M_{ANA}) of the analog input/output module SM 334; AI 4/AO 2 × 8/8 Bit to the chassis ground terminal of the CPU (see Figure 4-28). Use a cable with a cross-section conductor of at least 1 mm^2 for this purpose.

Unused Channels

You must short-circuit unused input channels and you should connect them to M_{ANA}. You thus obtain optimum interference protection for your analog module.

Unused output channels must be left open.

4.10.3 Measurement Method and Type of Output of the Analog Input/Output Module SM 334; AI 4/AO 2 × 8/8 Bit

Selecting the Measurement Method and the Type of Output

Select the measuring method of an input channel (voltage, current) by wiring the input channel appropriately.

Select the type of output of an output channel (voltage, current) by wiring the output channel appropriately.

The analog input/output module SM 332; AI 4/AO 2 × 8/8 Bit cannot be programmed.

Addressing

The module's inputs and outputs are addressed starting at the module start address.

The address of a channel is obtained from the module start address and an address offset.

Input Addresses

The following addresses apply to the inputs:

Channel	Address
0	Module start address
1	Module start address + 2 bytes address offset
2	Module start address + 4 bytes address offset
3	Module start address + 6 bytes address offset

Output Addresses

The following channel addresses apply to the module outputs:

Channel	Address
0	Module start address
1	Module start address + 2 bytes address offset

Measuring Ranges for the SM 334

The analog input/output module SM 334; AI 4/AO 2 $\times$ 8/8 Bit has the measuring ranges 0 to 10 V and 0 to 20 mA. In contrast to other analog modules, however, the analog input/output module SM 334 has a lower resolution and no negative measuring ranges. Observe this, when reading Tables 4-5 and 4-6.

Output Ranges for the SM 334

The analog input/output module SM 334; AI 4/AO 2 $\times$ 8/8 Bit has the measuring ranges 0 to 10 V and 0 to 20 mA. In contrast to other analog modules, however, the analog input/output module SM 334 has a lower resolution and the analog outputs have no negative measuring ranges. Please remember this when reading Tables 4-17 and 4-18.

4.11 Analog Input/Output Module SM 334; AI 4/AO 2 × 12 Bit

Order No.

6ES7 334–0KE00–0AB0

Characteristic Features

The SM 334 has the following characteristic features:

- 4 inputs in two groups
- 2 outputs (voltage outputs)
- Measured value resolution of 12 bits + sign
- Type of measurement selectable
  - Voltage
  - Resistance
  - Temperature
- Isolated from CPU
- Isolated from load voltage

Note

Below the rated load voltage range, incorrect intermediate values occur at the output when the rated load voltage supply is switched on/off.

Terminal Connection Diagram

Figure 4-29 shows the module view and the block diagram for the SM 334. You will find the detailed technical specifications of the SM 334 on the following pages.

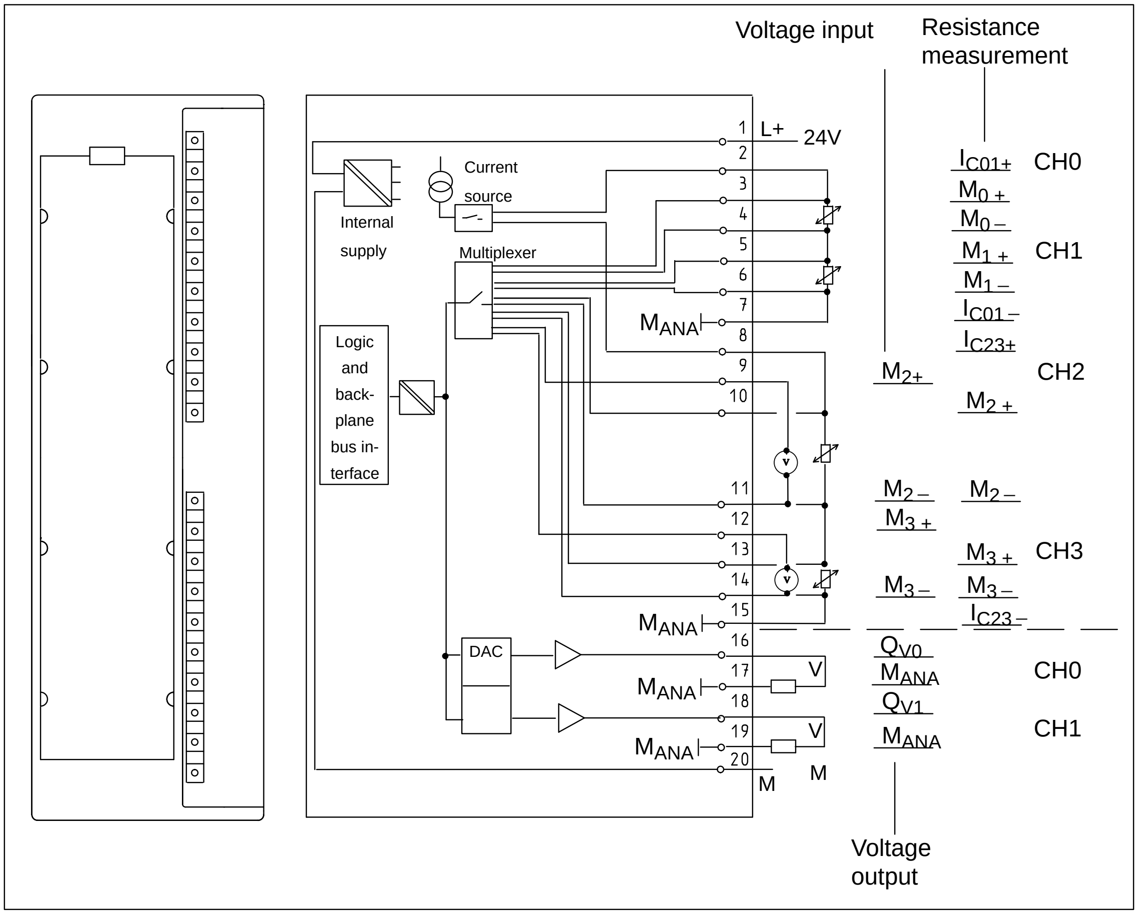


Figure 4-29 Module View and Block Diagram of the SM 334

Dimensions and Weight	
Dimensions W × H × D (mm)	40 × 125 × 120 (1.56 x 4.88 x 4.68 in.)
Weight	Approx. 200 g
Module-Specific Data	
Number of inputs	4
Number of outputs	2
Cable length, shielded	Max. 100 m
Voltages, Currents, Potential	
Rated load voltage L +	24 V DC
• Polarity protection	Yes
Power supply to the transducers	
• Short-circuit-proof	Yes
• Constant current	
– Resistance measurement	Typ. 400 μA
Galvanic isolation	
• Between channels and backplane bus	Yes
• Between channels and load voltage L+	Yes
Permiss. potential difference	
• Between the inputs and M_{ANA} (U_{CM})	1 V
• Between M_{ANA} and $M_{internal}$-(U_{ISO})	75 V DC 60 V AC
Current drawn	
• From the backplane bus	Max. 60 mA
• From load voltage L + (without load)	Max. 80 mA
Module power losses	Typ. 2 W

Status, Interrupts, Diagnostics		
Interrupts	No	
Diagnostic functions	No	
Analog Value Generation for the Inputs		
Measuring principle	Integrating	
Integration/conversion time (per channel)		
• Configurable	Yes	
• Integration time in ms	$16^2/_3$	20
• Basic conversion time incl. integration time in ms	72	85
Additional conversion time for temperature measurement in ms	72	85
• Resolution in bits (incl. overcontrol range)	12	12
unipolar measuring range	12+	12+
bipolar measuring range	Sign	Sign
• Interference suppression for interference frequency f1 in Hz	60	50

Interference Suppression, Error Limits for the Inputs	
Interference suppression for f = n × (f1 ± 1 %)	
(f1 = interference frequency)	
• Common-mode interference (U_{SS} < 1 V)	> 38 dB
• Series-mode interference (peak value of interference < rated value of input range)	> 36 dB
Crosstalk between the inputs	> 88 dB
Operational limit	
(in the total temperature range, referred to the input range)	
• Pt 100	± 0.7 %
• 0 to 10 V	± 0.7 %
• 10 k Ω	± 3.0 %
Basic error limit (operational limit at 25 °C, referred to the input range)	
• Pt 100	± 0.5 %
• 0 to 10 V	± 0.5 %
• 10 k Ω	± 2.0 %
Temperature error (referred to the input range)	± 0.01 %/K
Linearity error (referred to the input range)	± 0.05 %
Repeat accuracy (in the steady state at 25 °C, referred to the input range)	± 0.05 %

Sensor Selection Data		
Input ranges (rated values)/input resistance		
• Resistance thermometer	Pt 100	10 M Ω
• Resistance	10 kΩ	10 M Ω
• Voltage	0 to 10 V	100 K Ω
Permissible input voltage (destruction limit)	Max. 20 V continuously; 75 V for max. 1 s (duty factor 1:20)	
Connection of signal sensors		
• For voltage measurement	Possible	
• For resistance measurement		
with 2-wire connection	Possible	
with 3-wire connection	Possible	
with 4-wire connection	Possible	
Characteristic linearization	Yes	
• Thermal resistance	Pt 100 (climate range)	

Analog Value Generation for the Outputs	
Resolution (incl. overcontrol range)	12 bits
Cycle time (all output channels)	85 ms
Settling time	
• for resistive load	0.8 ms
• for capacitive load	0.8 ms
Injection of substitute values	No
Interference Suppression, Error Limits for the Outputs	
Crosstalk between the outputs	> 88 dB
Operational limit (in the total temperature range, referred to the output range)	± 1.0 %
Basic error limit (operational error limit at 25°C, referred to the output range)	± 0.85 %
Temperature error (referred to the output range)	± 0.01 %/K
Linearity error (referred to the output range)	± 0.01 %
Repeat accuracy (in the steady state at 25°C, referred to the output range)	± 0.01 %
Output ripple; bandwidth 0 to 50 kHz (referred to the output range)	± 0.1 %

Actuator Selection Data	
Output range (rated value)	0 to 10 V
Impedance (in rated output range)	
• with voltage outputs	Min. 2.5 kΩ
– with capacitive load	Max. 1.0 μF
Voltage output	
• Short-circuit protection	Yes
• Short-circuit current	Max. 10 mA
Destruction limit for voltages/currents connected from outside	
• Voltage at outputs to M_{ANA}	Max 15 V continuously
Connection of actuators	
2-wire connection	Possible
4-wire connection (measuring line)	Not possible

4.11.1 Starting Up the SM 334

STEP 7 **V 4.0**

Analog input/output module SM 334 AI4/AO2 × 12Bit is only contained in the module catalog of *STEP 7* V 4.0 and higher.

Configuration

You set the prescribed function parameters of the SM 334:

- with *STEP 7* before start-up (see User Manual *STEP 7* or the online help in *STEP 7*).
- in the user program with SFCs (see Reference Manual *STEP 7 System and Standard Functions*).

Default Settings

The SM 334 has the following default settings:

- for the analog inputs: Pt 100 climate range
- for the analog outputs: 0 to 10 V

Wiring Versions

You can wire the channels of the SM 334 for the following combinations:

Channels 0 and 1	• 2 × Pt 100 • 2 × resistance
Channels 2 and 3	• 2 × voltage • 2 × resistance • 2 × Pt 100 • 1 × Pt 100, 1 × voltage • 1 × resistance, 1 × voltage

Unused Input Channels

You must short-circuit unused channels of the SM 334 and connect them to M_{ANA}. You thus obtain optimum interference protection for your analog module. You should also deactivate unused channels during configuration with *STEP 7* (see Section 4.3.4 in the *Module Specifications* Reference Manual), in order to reduce the cycle time of the module.

Unused Output Channels

To ensure that unused output channels of the SM 334 are voltage-free, you must deactivate them and leave them open. You deactivate an output channel during configuration with *STEP 7* in the “Output” parameter block (see Section 4.3.4 in the *Module Specifications* Reference Manual).

4.11.2 Analog Value Representation

Analog Values

The digitized analog value is the same for input and output values with the same rated range.

The analog values are represented in two’s complement.

Table 4-1 shows the analog value representation of the analog modules:

Table 4-45 Analog Value Representation

Resolution	Analog Value															
Bit number	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Significance of the bits	S.	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}

Analog Value

Table 4-46 contains the analog value representation for the measuring ranges 10 kΩ and 0 to 10 V.

Table 4-46 Representation of the Digitized Measured Value for Measuring Ranges 10 kΩ and 0 to 10 V

Measuring Range		Units		Range
10 kΩ	**0 to 10 V**	**Decimal**	**Hexadecimal**	
> 11.7589	> 11.7589	32767	$7FFF_H$	Overflow
11.7589 : 10.0004	11.7589 : 10.0004	32511 : 27649	$7EFF_H$: $6C01_H$	Overcontrol range
10.0000 : 7.50000 : 0	10.0000 : 7.50000 : 0	27648 : 20736 : 0	$6C00_H$: 5100_H : 0	Rated range
Negative value not possible	Not possible	–	–	Undercontrol range
–	–	–	–	Underflow

Climate Temperature Range, Pt 100

Table 4-47 contains the representation of the digitized measured value for the climate temperature range of the Pt 100 sensor.

Table 4-47 Representation of the Digitized Measured Value for the Climate Temperature Range, Pt 100

Climate Temperature Range Pt 100 130 °C	Decimal	Hexadecimal	Range
> 155.00	32767	$7FFF_H$	Overflow
155.00 : 130.01	15500 : 13001	$3C8C_H$: $32C9_H$	Overcontrol range
130.00 : –120.00	13000 : –12000	$32C8_H$: $D120_H$	Rated range

Table 4-47 Representation of the Digitized Measured Value for the Climate Temperature Range, Pt 100

Climate Temperature Range Pt 100 130 °C	Decimal	Hexadecimal	Range
–120.01 : –145.00	–12001 : –14500	$D11F_H$: $C75C_H$	Undercontrol range
<– 145.00	–32768	8000_H	Underflow

Analog Value

Table 4-48 contains the representation of the 0 to 10 V output range.

Table 4-48 Representation of the analog output range from 0 to 10 V

Output Range 0 to 10 V	Units		Range
	Decimal	Hexadecimal	
0	>32511	$>7EFF_H$	Overflow
11.7589 : 10.0004	32511 : 27649	$7EFF_H$: $6C01_H$	Overcontrol range
10.0000 : 0	27648 : 0	$6C00_H$: 0_H	Rated range
0	–	–	Undercontrol range

4.11.3 Parameters

Structure of Record 1

Figure 4-30 shows you the structure of record 1 of the parameters for SM 334.

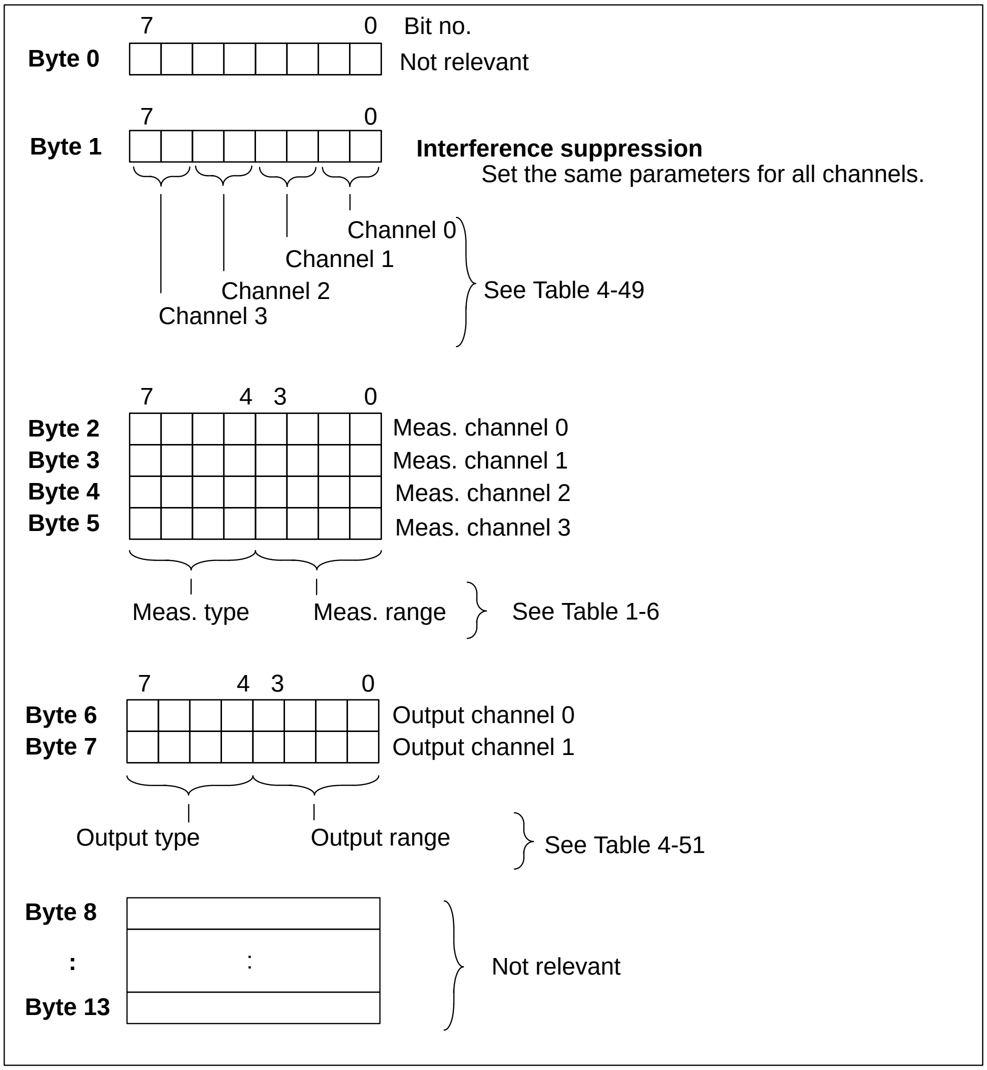


Figure 4-30 Record 1 of the SM 334 parameters

Interference Suppression

Table 4-49 contains the codes for the various frequencies which you enter in byte 1 of record 1 (see Figure 4-30). You must count the resulting integration time separately for each channel!

Note

You must set the same interference suppression for all channels of the SM 334.

Table 4-49 Codes for Interference Suppression

Interference Suppression Frequency	Integration Time	Code
60 Hz	16.7 ms	2#01
50 Hz	20 ms	2#10

Type of Measurement and Measuring Ranges

Table 4-50 contains the measuring ranges of the SM 334 analog input/output module. The table shows the codes for the type of measurement and for the corresponding measuring range. You must enter these codes in bytes 2 to 5 of record 1, according to the desired measuring range (see Figure 4-30).

Table 4-50 Codes for the Measuring Ranges of the Analog Inputs

Type of Measurement	Code (Bits 4 to 7)	Measuring Range	Code (Bits 0 to 3)
Deactivated	2#0000	Deactivated	2#0000
Voltage	2#0001	0 to 10 V	2#1000
Resistance 4-wire connection	2#0100	10 kΩ	2#1001
Thermal resistance + lin earization 4-wire connection	2#1000	Pt 100 climate	2#0000

Note

The simultaneous connection of the PT 100 and a resistance to channels 0 and 1, or to channels 2 and 3, is not permitted.

Reason: common current source for both channels.

Output Type and Output Ranges

Table 4-51 contains the output ranges of the SM 334 analog input/output module. The table shows the codes for the output type and for the corresponding output range. You must enter these codes in bytes 6 and 7 of record 1, according to the desired output range (see Figure 4-30).

Table 4-51 Codes for the Output Ranges

Output Type	Code (Bits 4 to 7)	Output Range	Code (Bits 0 to 3)
Deactivated	2#0000	Deactivated	2#0000
Voltage	2#0001	0 to 10 V	2#1000

Other Signal Modules 5

Other Signal Modules?

In addition to the digital and analog modules further signal modules are available :

- a simulator module for simulating inputs and outputs and
- a dummy module for reserving an installation slot.
- an SM 338 POS input module to register the SSI encoder values

In this chapter, you will find the technical specifications for these signal modules and a description of their function.

Contents

The following signal modules are described in this chapter:

5.1 Simulator Module SM 374; IN/OUT 16

Order No.

6ES7 374-2XH01-0AA0

Characteristics

The simulator module SM 374; IN/OUT 16 has the following salient features:

- Simulation of
  - 16 input points or
  - 16 output points or
  - 8 input points and 8 output points (with the same start addresses each!)
- The function can be set using screwdriver

Note

Do not actuate the switch for setting the mode when the CPU is in the RUN mode!

- Status LED for simulating inputs and outputs

What to Note when Assigning Parameters

The SM 374; IN/OUT 16 is not listed in the module catalog of *STEP 7* . That is, *STEP 7* does not recognize the order number of the simulator module. This means that you must “simulate” the relevant operating mode of the simulator module when configuring the desired function:

- If you wish to use the SM 374 with 16 inputs, enter the order number of a digital input module with 16 inputs.

  Example: 6ES7 321-1BH01-0AA00
- If you require an SM 374 with 16 outputs, enter the order number of a digital output module with 16 outputs.

  Example: 6ES7 322-1BH01-0AA00
- If you wish to use the SM 374 with eight inputs and eight outputs, enter the order number of a digital input module with eight inputs.

  Example: 6ES7 323-1BH00-0AA0

Front View

Figure 5-1 shows you the front view of the simulator module SM 374; IN/OUT (without front door). You will find the simulator module's detailed specifications under Figure 5-1.

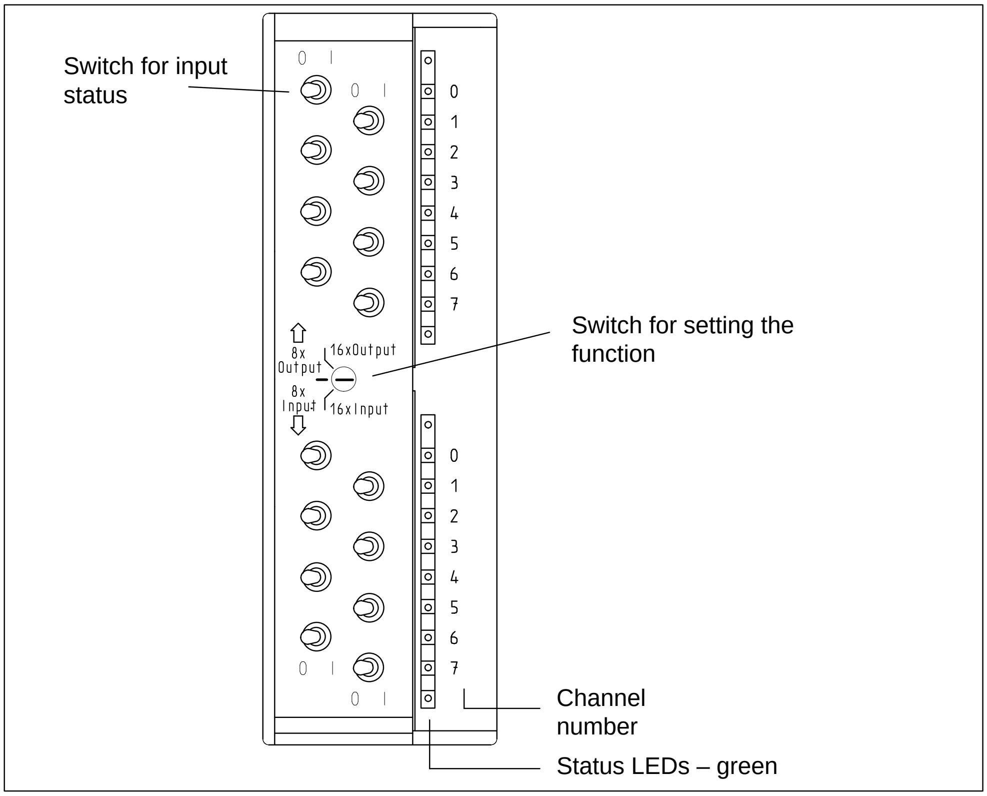


Figure 5-1 Front View of Simulator Module SM 374; IN/OUT 16

Technical Specifications

The following table lists the technical specifications of the simulator module SM 374; IN/OUT 16.

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 110 mm (1.56 × 4.88 × 4.29 in.)
Weight	approx. 190 g (6.65 oz.)
Module-Specific Data	
Simulation either of	16 input points 16 output points 8 input and output points

Voltages, Currents, Potentials	
Current drawn from backplane bus	max. 80 mA
Module power losses	typ. 0.35 W
Status, Interrupts, Diagnostics	
Status display	Yes, green LED per channel
Interrupts	No
Diagnostic functions	No

5.2 Dummy Module DM 370

Order No.

6ES7 370-0AA01-0AA0

Characteristics

The dummy module DM 370 reserves a slot for non-configured digital modules and interface modules. If you replace the dummy module by another S7-300 module, the mechanical configuration and the address assignment of the overall configuration are retained.

Special Features

The dummy module can be used as a placeholder for:

- Interface modules (without reserving address space)
- Non-configured digital modules (reserving address space)
- Modules occupying 2 slots.
  In this case, you must plug in two dummy modules with the dummy module in slot “x” reserving the address space and the dummy module in slot “x + 1” reserving no address space (see also Table 5-1). Note: No more than 8 modules (SM/FM/CP) may be plugged into a module rack. For example, if you reserve a slot for a module of 80 mm width using 2 dummy modules, you can plug in only 6 other modules (SM/FM/CP).

Configuration with STEP 7

Use *STEP 7* to configure the dummy module only if you are using the module to reserve the slot for a parameterized signal module. If the module is to reserve the slot for an interface module, you need not configure the module with *STEP 7* .

Configuration for ET 200M

If you use the dummy module DM 370 in an ET 200M setup with active bus modules, you must configure an input or output address range of 0 bytes for the dummy module (see also Table 5-1).

Front and Rear View of the Dummy Module

Figure 5-2 shows the front and rear view of the dummy module DM 370 and the position of the address assignment switch.

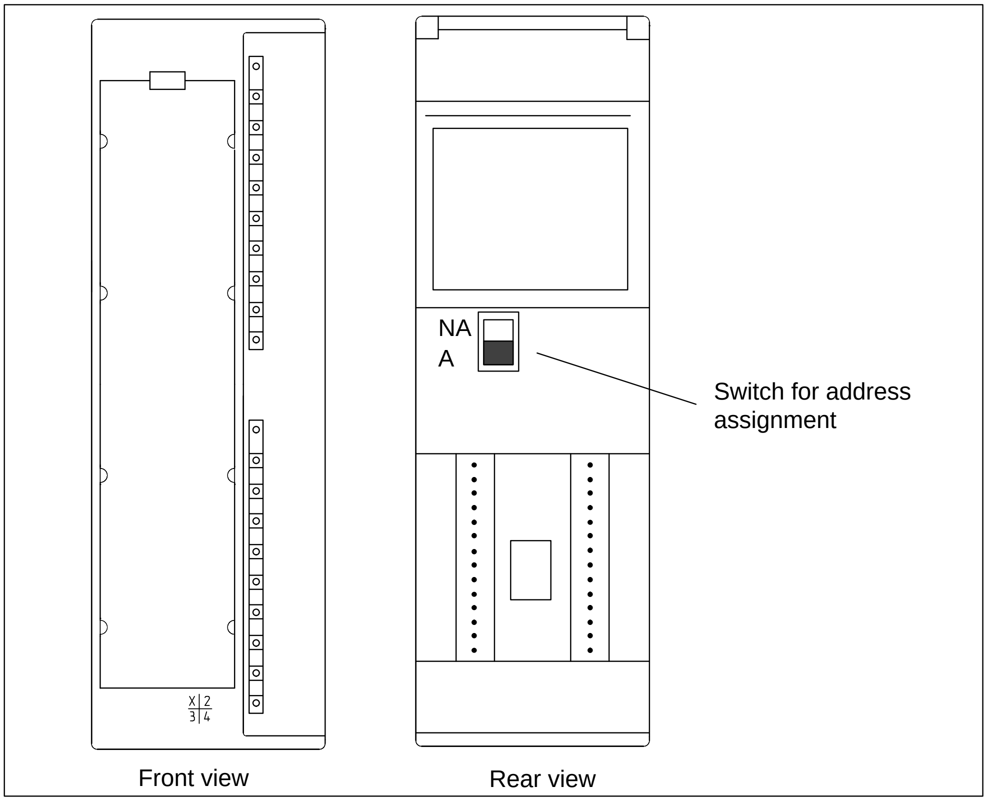
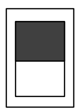
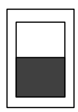


Figure 5-2   Front and Rear View of the Dummy Module DM 370 and Position of the Address Assignment Switch

Switch Position

Table 5-1 shows the meaning of the switch positions on the rear of the dummy module DM 370.

Table 5-1 Meaning of the Switch Positions of the Dummy Module DM 370

Switch Position	Meaning	Use in an ET 200M Setup with Active Bus Modules (Pull and Plug)
NA A 	Dummy module reserves the slot for an interface module (NA = No Address, that is no address space reserved)	No
NA A 	Dummy module reserves the slot for a signal module (A = Address, that is address space reserved)	Dummy module reserves the slot for a signal module. If you use the dummy module for an “empty slot”, you must configure the “empty slot” with 0 bytes input/output addresses.

Technical Specifications

The following table lists the technical specifications for the dummy module DM 370.

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120
Weight	approx. 180 g
Voltages, Currents, Potentials	
Current drawn from backplane bus	approx. 5 mA
Power loss	typ. 0.03 W

5.3 SM 338 POS Input Module

Order Number

6ES7 338-4BC00-0AB0

Characteristics

The SM 338 POS input module is characterized by the following features:

- The SM 338 POS input module is an interface between up to three absolute position encoders (SSIs) and the CPU of SIMATIC S7.
- You edit the encoder values obtained by the SM 338 in your STEP 7 program.
- You can respond directly in your process to encoder values in moving systems.

How the SM 338 POS Input Module Works

The SM 338 POS input module makes available the SSI position encoder status in the process input range to the CPU. It is also possible to freeze the SSI position encoder statuses via two module-specific digital inputs. This freeze function makes it possible to provide a solution for other time-critical position detection applications.

Supported Encoder Types

The following encoder types are supported:

- The absolute position encoder (SSI) with 13 bits
- The absolute position encoder (SSI) with 21 bits
- The absolute position encoder (SSI) with 25 bits

Data Formats

The data formats supported are gray code and binary code.

Parameterization

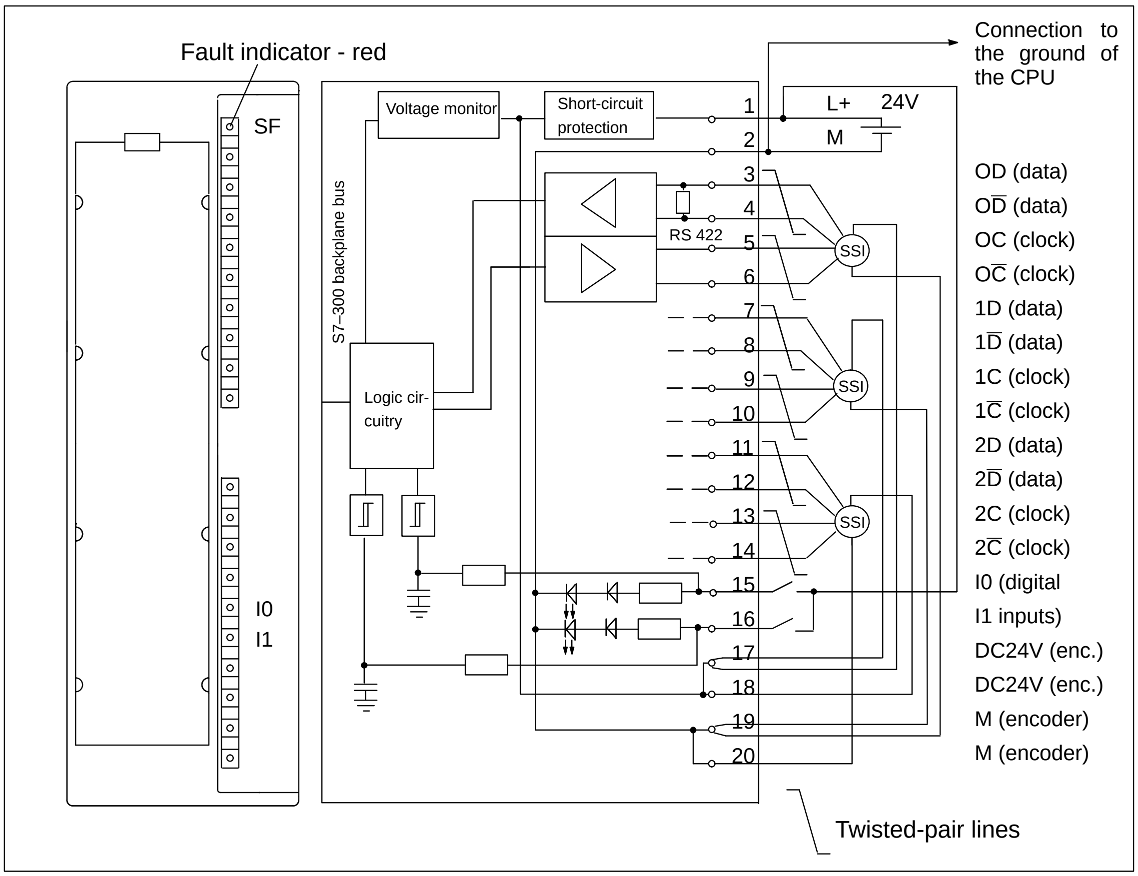
You parameterize the SM 338 with HWConfig in STEP 7 (as of Version 4.1).

5.3.1 Connection Diagram

Wiring Rules

- The ground of the encoder supply must be connected to the ground of the CPU (non-isolated). In other words, pin 2 (M) of the SM 338 must be connected to the ground of the CPU with low impedance.
- The encoder lines (pins 3 to 14) must be shielded, twisted-pair cables. The shield must be supported at both ends. To support the shield at the SM 338, use the shield supporting element (order number 6ES7 390-5AA00-0AA0).
- If you exceed the maximum output current (900 mA) of the encoder supply, you must connect an external power supply.

Connection Diagram

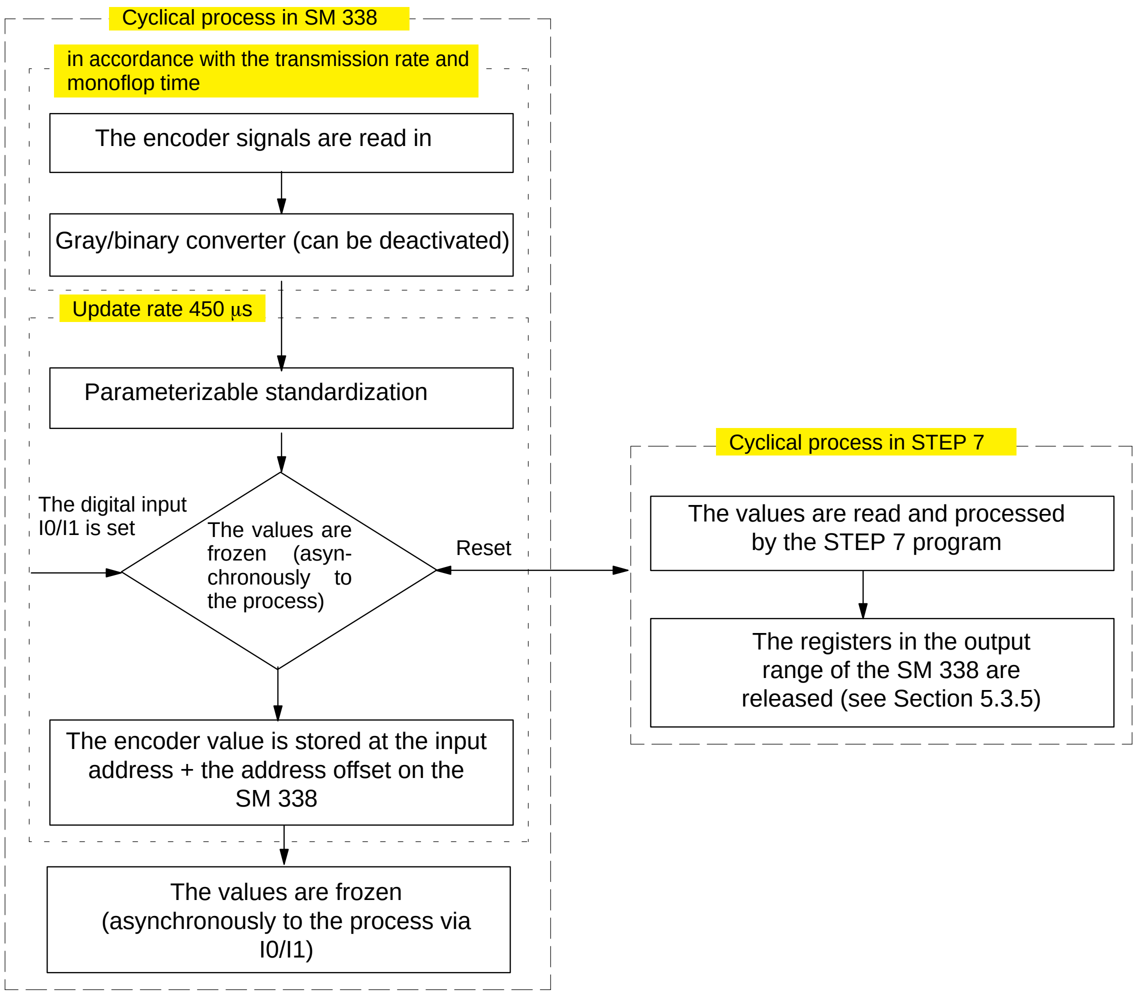


5.3.2 How the SM 338 Works

The SM 338 captures the signals of up to three connected encoders cyclically.

The principle is illustrated here using the example of an encoder input. A 25-bit encoder may be connected to the input, for example.

The following steps are relevant:



Standardization

Standardization allows you to choose whether:

- trailing, irrelevant bits remain in the encoder value; or
- these bits are excluded.

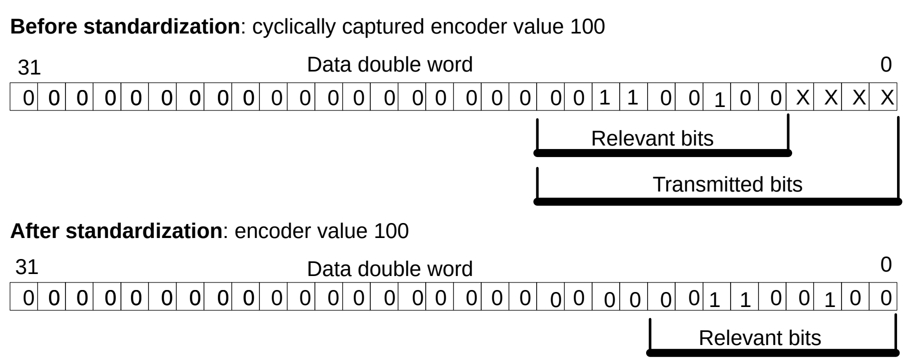
Note

If you are using an absolute position encoder that transmits additional information in the trailing bits (see the manufacturer's information) and you want to evaluate this information, you must take this into account at standardization by specifying the positions. You will find more information in the online help system and Section 5.3.4.

Example: Standardization

You are using a single-turn encoder with 2^9 steps = 512 steps per revolution (resolution/360°) with the following parameterization:

- Encoder type: 13-bit
- Standardization: 4 positions



Result: Bits 0 to 3 (4 positions marked "x") are excluded

5.3.3 Freeze Function

The freeze function ”freezes” the module’s current encoder values. A frozen encoder value is indicated by bit 31 being set (output range). The encoder value is retained until the freeze function is terminated. The evaluation of the encoder values can thus be event-dependent.

Prerequisite for Using the Freeze Function

The freeze function must be enabled and linked to the I0 and/or I1 digital inputs.

During parameterization you specify which I0/I1 digital inputs freeze the encoder values.

With one digital input you can freeze one, two or three encoder values.

Terminating the Freeze State

The freeze state must be terminated separately for each encoder input. When the user program acknowledges the transfer of the encoder value, bit 31 is deleted and the encoder values are updated again.

You write the acknowledgment in the output address of the module with a set acknowledgment bit by directly accessing the SM 338 (T PAB “xyz”).

Freezing is possible again as soon as you have deleted the acknowledgment bit in the module’s output address.

Example: Accessing Encoder Values

You want to read and evaluate the value of the encoder at the encoder inputs. The initial module address is 256.

STL			Explanation
L	PED	256	The encoder value in the address area for encoder input 0 is read.
T	MD	100	The encoder value is stored in the memory double word.
U	M	100.7	The freeze status is determined and stored
=	M	99.0	for subsequent acknowledgment.
L	PED	260	The encoder value in the address area for encoder input 1 is read.
T	MD	104	The encoder value is stored in the memory double word.
U	M	104.7	The freeze status is determined and stored
=	M	99.1	for subsequent acknowledgment.
L	PED	264	The encoder value in the address area for encoder input 2 is read.
T	MD	108	The encoder value is stored in the memory double word.
U	M	108.7	The freeze status is determined and stored
=	M	99.2	for subsequent acknowledgment.
L	MB	99	The freeze status is loaded and
T	PAB	256	acknowledged (SM 338: output address 256)

Afterwards you can further process the encoder values from the bit memory address area MD 100, MD 104 and MD 108.

The encoder value is in bits 0 to 30 of the memory double word.

5.3.4 Parameterization

You parameterize the SM 338 with HWConfig in STEP 7 (as of Version 4.1). Reparameterization using the user program is not possible.

Parameters of the SM 338

You enter the following parameters in STEP 7. Note also the information in the online help system.

Parameter *(per channel)*	**Values**	**Note**
Diagnostic Interrupt	Yes; **No**[2]	
Absolute Encoder (SSI)	None; **13-bit**[2]; 21-bit; 25-bit	None means the encoder input is disabled.
Code Type	**Gray**; Binary	
Transmission Rate	**125 kHz**[2]; 250 kHz; 500 kHz; 1 MHz	Note that the transmission rate and monoflop time affect the accuracy and currency of the encoder values.
Monoflop Time [1]	16 µs; 32 µs; 48 µs; **64 µs**[2]	See the technical specifications of the manufacturer.
Standardization	**0**[2] to 12 Positions	
Enable Freeze	**Off**[2]; I0; I1	Off: The encoder value cannot be frozen. I0; I1: You specify the digital input whose positive edge is to ”freeze” the value at the respective encoder input 0,1 or 2. You can also ”freeze” all the encoder values with one digital input.

1 The monoflop time is the length of time between 2 SSI frames. The parameterized monoflop time must be greater than the monoflop time of the absolute encoder (see the technical specifications of the manufacturer). You have to add the time 2 × (1/transmission rate) to the specified values.

2 Default setting for all 3 encoder inputs.

5.3.5 Data Handling

The values of the encoders are stored in the data area as of the initial module address. They can be read from there using the command (L PED “xyz”).

Data Areas for the Encoder Values

The inputs and outputs of the module are both addressed as of the initial module address.

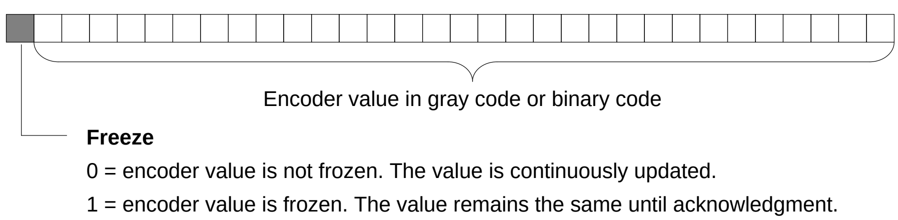
You determine the input address and output address during configuration of the SM 338. Read about this in the online help system.

Input Addresses

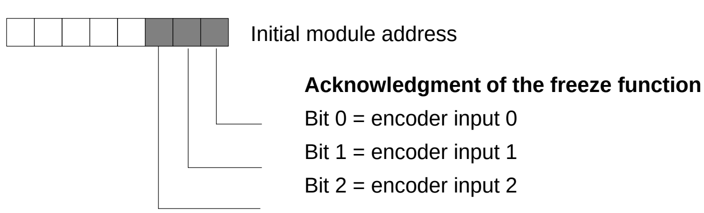
Encoder Input	Input Address (from Configuration) + Address Offset
0	“Initial module address”
1	“Initial module address” + 4 bytes address offset
2	“Initial module address” + 8 bytes address offset

Structure of the Data Double Word

The data double word is structured as follows at each encoder input:



Output Address



5.3.6 Diagnostic Messages of the SM 338

In the event of a diagnostic interrupt, the SM 338 makes information available to the user in the diagnostic area. The area is subdivided into diagnostic data part 1 (module diagnosis, bytes 0 to 3) and part 2 (channel diagnosis, bytes 4 to 15). The diagnostic messages are generated even when you have not enabled diagnostics.

The module diagnosis is available after a diagnostic interrupt in the CPU (interrupt OB, OB 82). The channel diagnostic information must be read using the SFC 51 ”RDSYSST” with SZL_ID :=W#16#B3. See the *System and Standard Functions* Reference Manual.

All the relevant bytes and bits are listed in the tables below.

Group Error LED (SF)

The group error LED (red) comes on:

- When there is a problem with a module
- At start-up during the self-test of the SM 338 (for a short time)

Module Diagnosis

Byte	Bit	Meaning	Explanation
0	0	Module problem	The bit is always set when a malfunction occurs.
	1	Internal malfunction	An internal malfunction or internal channel malfunction has occurred.
	2	External malfunction	An external malfunction or external channel malfunction has occurred.
	3	Channel malfunction	An internal or external channel malfunction has occurred.
	4	External auxiliary supply missing	Cause: missing connection, undervoltage, ground wire break Effect: diagnostic interrupt, no cyclical capture, encoder malfunction Remedy: Ensure the 24V connection is correct.
	6	Module not parameterized.	Parameterize the module.
	7	Parameterization error	Check the parameterization.
1	0 to 3	Module category: 5_H	
	4	Channel information	This bit is always set.
2	3	Watchdog	Internal time monitoring is activated.

Channel Diagnosis (Diagnosis of the Encoder Inputs)

<table>
<tr><th>Byte</th><th>Bit</th><th>Meaning</th><th>Explanation</th></tr>
<tr><td>4</td><td>—</td><td>Channel type</td><td>The SM 338 is of the type SM POS-INPUT: $79_{H.}$</td></tr>
<tr><td>5</td><td>—</td><td>Length of the diagnostic information</td><td>The length of the diagnostic information is 8 diagnostic bits per channel.</td></tr>
<tr><td>6</td><td>—</td><td>Number of channels</td><td>Number of subsequent channels of the same type: 3</td></tr>
<tr><td rowspan="3">7</td><td>0</td><td rowspan="3">Channel malfunction</td><td>Channel 0</td></tr>
<tr><td>1</td><td>Channel 1</td></tr>
<tr><td>2</td><td>Channel 2</td></tr>
<tr><td rowspan="2">8</td><td>0</td><td rowspan="2">POS-INPUT 0 individual error</td><td>POS-INPUT configuration or parameterization error (internal channel malfunction)</td></tr>
<tr><td>1</td><td>POS-INPUT encoder malfunction (external channel malfunction)
Cause: wire break of the encoder cable, encoder cable not connected, encoder defective, interference
Effect: diagnostic message
Remedy: Check the connected encoder.</td></tr>
<tr><td rowspan="2">9</td><td>0</td><td rowspan="2">POS-INPUT 1 individual error</td><td rowspan="2">See byte 8.</td></tr>
<tr><td>1</td></tr>
<tr><td rowspan="2">10</td><td>0</td><td rowspan="2">POS-INPUT 2 individual error</td><td rowspan="2">See byte 8.</td></tr>
<tr><td>1</td></tr>
</table>

5.3.7 Technical Specifications

Dimensions and Weight	
Dimensions W x H x D (mm)	40 × 125 × 120
Weight	Approx. 235 g
Voltages, Currents, Potentials	
Rated load voltage L+	DC 24V
• Range	20.4 ... 28.8V
• Reversed polarity protection	No
Optical isolation	No, only from shield
Permissible potential difference	
• Between input (M terminal) and centralized ground point of the CPU	DC 1V
Encoder supply	
• Output voltage	L+ –0.8V
• Output current	Max. 900 mA short circuit-proof
Power input	
• From backplane bus	Max. 160 mA
• From load voltage L+ (without load)	Max. 10 mA
Power loss of the module	Typically 3W
Encoder Inputs POS-INPUT 0 to 2	
Position detection	Absolute
Data transmission rate and line length with absolute encoders (shielded)	• 125 kHz max. 320 m • 250 kHz max. 160 m • 500 kHz max. 60 m • 1 MHz max. 20 m
Digital Inputs I0, I1	
Optical isolation	No, only from shield
Input voltage	0 signal: –3V ... 5V 1 signal: 11V ... 30.2V
Input current	0 signal: ≤ 2 mA (closed-circuit current) 1 signal: 9 mA (typically)
Input delay	0 > 1: max. 300 µs 1 > 0: max. 300 µs
Maximum repetition frequency	1 kHz
Connection of a two-wire BERO type 2	Possible
Shielded line length	600 m
Unshielded line length	32 m

Status, Interrupts, Diagnostics			
Interrupts			
• Diagnostic interrupt	Parameterizable		
Status indication for digital inputs	LED (green)		
Group error	LED (red)		
Unsharpness of the Measured Value			
Minimum unsharpness[1]	Frame time + 130 µs		
Maximum unsharpness[1]	(2 × frame time) + monoflop time + 600 µs		
Frame time of the encoders	13-bit	21-bit	25-bit
• 125 kHz	112 µs	176 µs	208 µs
• 250 kHz	56 µs	88 µs	104 µs
• 500 kHz	28 µs	44 µs	52 µs
• 1 MHz	14 µs	22 µs	26 µs
Monoflop time[2]	16 µs, 32 µs, 48 µs, 64 µs		
Update rate	Evaluation of the frame every 450 µs		

1 Age of the encoder values determined by the method of transmission and the processing

2 Encoder with a monoflop time greater than 64 µs cannot be used with the SM 338. You have to add the time 2 × (1/transmission rate) to the specified values.

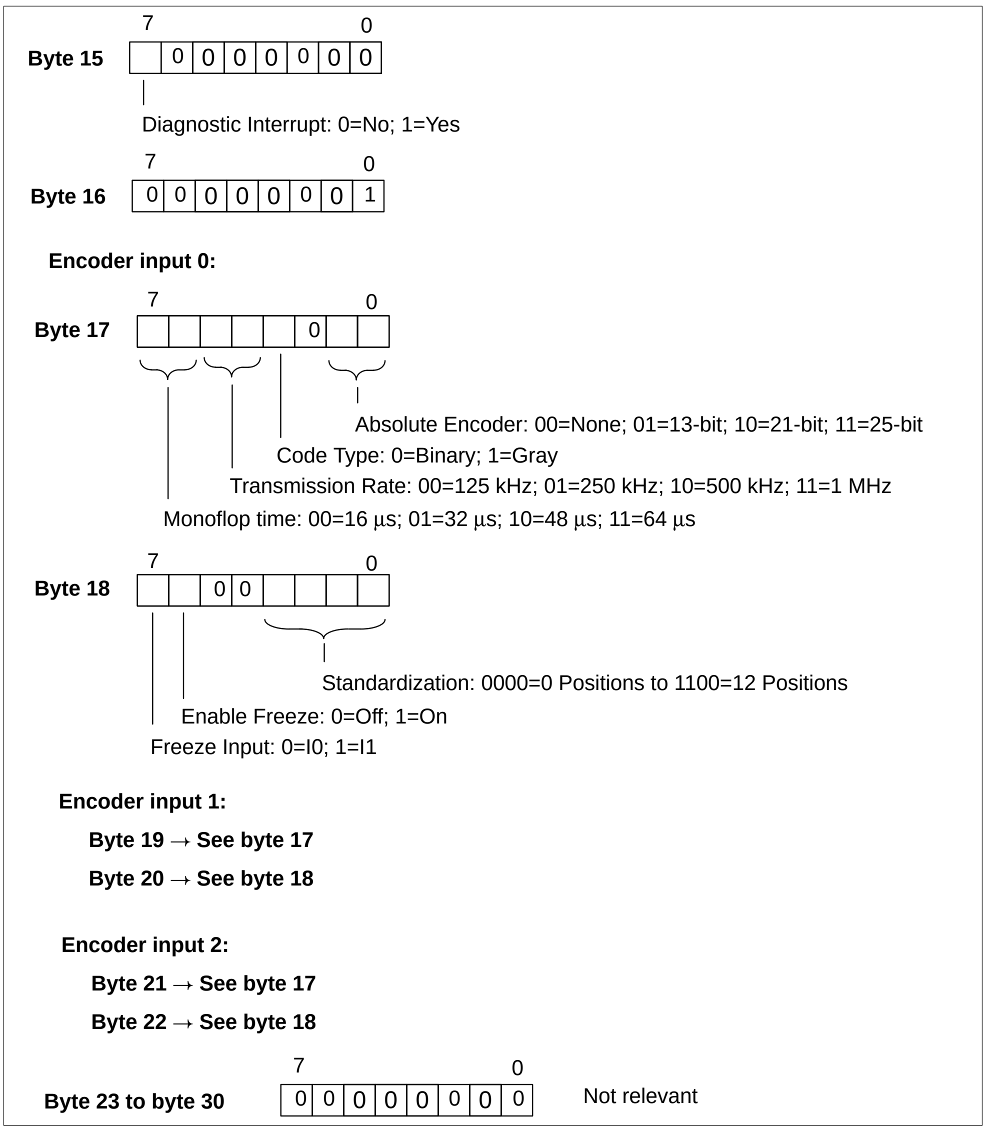
5.3.8 Configuration and Parameter Assignment Frame

Identifier for the Configuration Frame

Order Number: 6ES7...	Byte 0	Byte 1	Byte 2	Byte 4	Byte 5
338-4BC00-0AB0	C2	8F	00	05	CD

Structure of Data Record 0 for the Parameter Assignment Frame

The parameters of the SM 338 in data record 0 are shown below:



Interface Modules 6

Interface Modules

In this chapter you will find the technical specifications and characteristic features of the interface modules for the S7-300.

Contents

The following interface modules are described in this chapter:

6.1 Interface Module IM 360

Order No.

6ES7 360-3AA01-0AA0

Characteristics

The interface module IM 360 has the following characteristic features:

- Interface for rack 0 of the S7-300
- Data transfer from IM 360 to IM 361 over the connecting cable 368
- Maximum distance between IM 360 and IM 361 is 10 m (32.8 ft.)

Status and Fault LEDs

The interface module IM 360 has the following status and fault LEDs.

LED	Meaning	Explanation
SF	Group error/fault	The LED lights up if • the connecting cable is missing. • IM 361 is switched off.

Front View

Figure 6-1 shows the front view of the interface module IM 360.

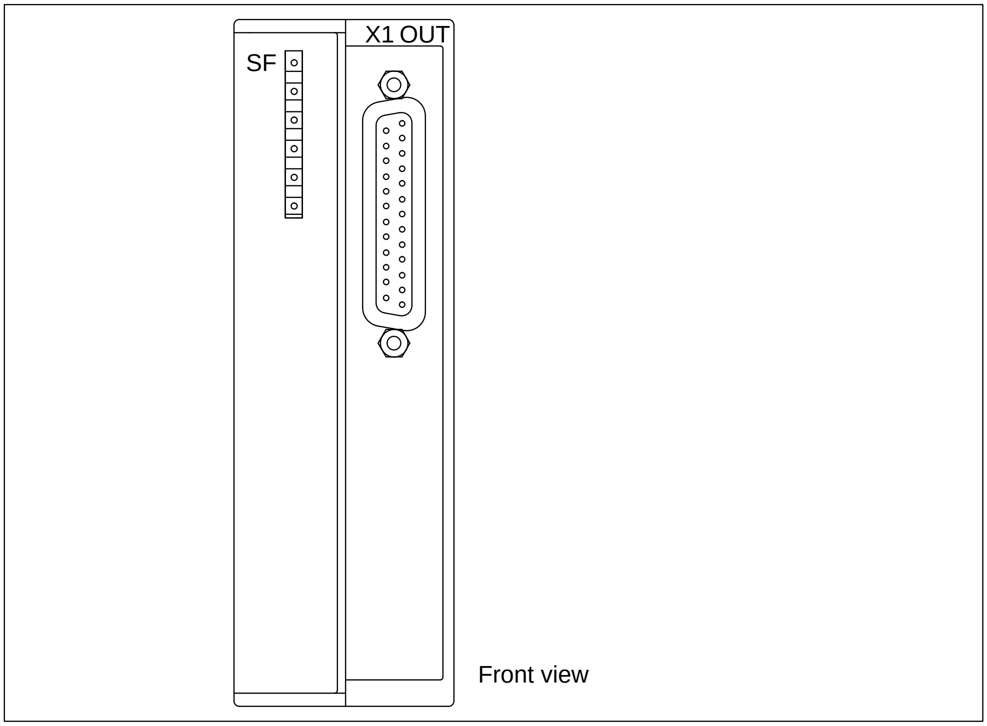


Figure 6-1 Front View of the Interface Module IM 360

Technical Specifications

The following overview lists the technical specifications for the interface module IM 360.

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120 mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 250 g
Module-Specific Data	
Cable length	
• Maximum length to next IM	10 m (32.8 ft.)
Current drawn	
• from backplane bus	350 mA
Power loss	typ. 2 W
Status and fault LEDs	Yes

6.2 Interface Module IM 361

Order No.

6ES7 361 3CA01-0AA0

Characteristics

The interface module IM 361 has the following characteristic features:

- 24 VDC power supply
- Interface for racks 1 to 3 of the S7-300
- Current output via the S7-300 backplane bus max. 0.8 A
- Data transfer from the IM 360 to the IM 361 or from the IM 361 to the IM 361 via connecting cable 368
- Maximum distance between IM 360 and IM 361 is 10 m (32.8 ft.)
- Maximum distance between IM 361 and IM 361 is 10 m (32.8 ft.)

Status and Fault LEDs

The interface module IM 361 has the following status and fault LEDs.

LED	Meaning	Explanation
SF	Group error/fault	The LED flashes, if • the connecting cable is missing • the series-connected IM 361 is switched off • the CPU is in the POWER OFF state
5 VDC	5 VDC supply for the S7-300 backplane bus	–

Front View

Figure 6-2 shows the front view of the interface module IM 361.

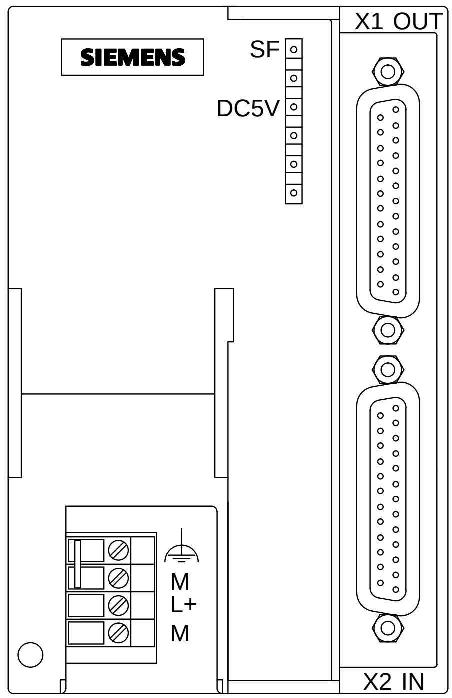


Figure 6-2 Front View of the Interface Module IM 361

Technical Specifications

The following overview lists the technical specifications for the interface module IM 361.

Dimensions and Weight	
Dimensions W × H × D	80 × 125 × 120 mm (3.12 × 4.88 × 4.68 in.)
Weight	505 g (17.68 oz.)
Module-Specific Data	
Cable length	
• Maximum length to next IM	10 m (32.8 ft.)
Current drawn	
• from 24 VDC	0.5 A
Power loss	typ. 5 W
Current output	
• to backplane bus	0.8 A
Status and fault LEDs	Yes

6.3 Interface Module IM 365

Order No.

6ES7 365-0BA01-0AA0

Characteristics

The interface module IM 365 has the following characteristic features:

- Pre-assembled pair of modules for rack 0 and rack 1
- Total power supply of 1.2 A, of which up to 0.8 A can be used per rack.
- Connecting cable with a length of 1 m (3.28 ft.) already permanently connected
- Install only signal modules in rack 1
- IM 365 does **not** route the communication bus to subrack 1

Front View

Figure 6-3 shows the front view of the interface module IM 365.

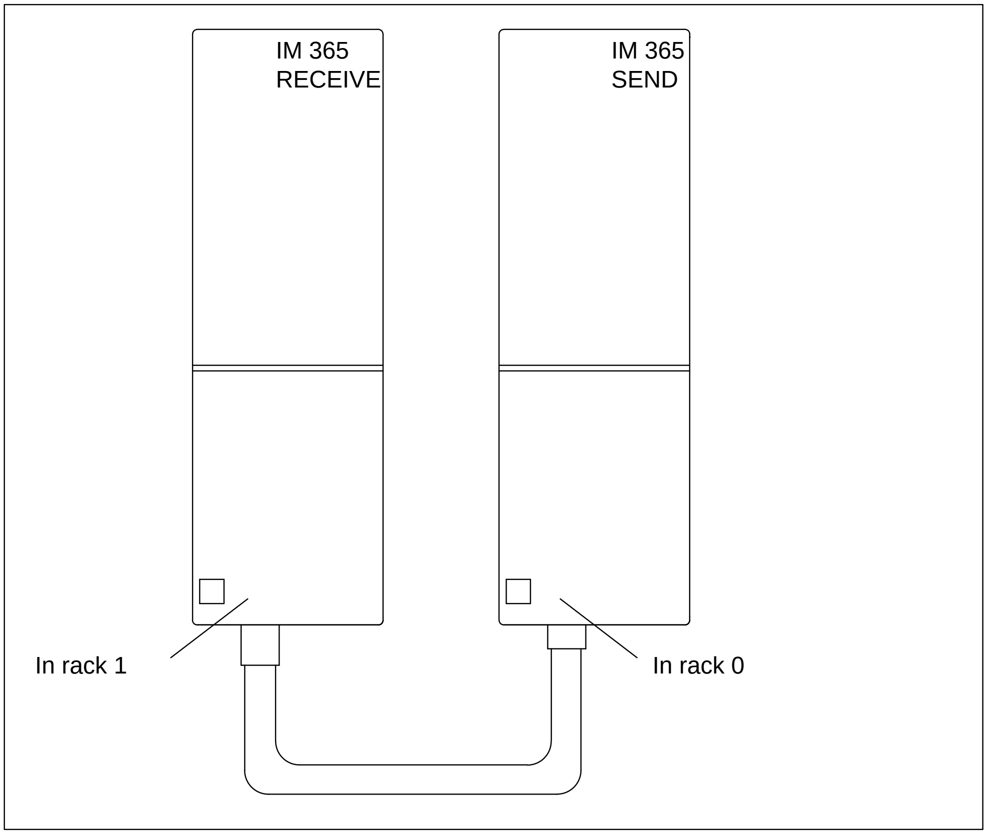


Figure 6-3 Front View of the Interface Module IM 365

Technical Specifications

The following overview lists the technical specifications for the interface module IM 365.

Dimensions and Weight	
Dimensions W × H × D (mm) per rack	40 × 125 × 120
Total weight	580 g (20.3 oz.)
Module-Specific Data	
Cable length	
• Maximum length to next IM	1 m (3.28 ft.)
Current drawn	
• from backplane bus	100 mA
Power loss	typ. 0.5 W
Current output	max. 1.2 A
• per rack	0.8 A
Status and fault LEDs	No

7 RS 485 Repeater

In this Chapter

In this chapter, you will find a detailed description of the RS 485 repeater.

Included in the description are:

- The purpose of the RS 485 repeater
- The maximum cable lengths possible between two RS 485 repeaters
- The functions of the individual operating elements and terminals
- Information about grounded and non-grounded operation
- Technical specifications and the block diagram

Further Information

You will find further information on the RS 485 repeater in the manuals *Hardware and Installation* in the Chapter “Configuring of an MPI or PROFIBUS-DP network”.

Contents

This chapter includes the following sections on the RS 485 repeater:

7.1 Application and Properties

Order No.

6ES7 972-0AA00-0XA0

What is an RS 485 Repeater?

The RS 485 repeater amplifies data signals on bus lines and interconnects bus segments.

Application of the RS 485 Repeater

You need an RS 485 repeater if:

- more than 32 nodes are connected to the bus
- bus segments are to be operated non-grounded on the bus, or
- the maximum cable length of a segment is exceeded.

Table 7-1 Maximum Cable Length of a Segment

Baud Rate	Max. Cable Length of a Segment (in m)
9.6 to 187.5 kbaud	1000
500 kbaud	400
1.5 Mbaud	200
3 to 12 Mbaud	100

Rules

If you configure the bus with RS 485 repeaters:

- Up to 9 RS 485 repeaters can be connected in series.
- The maximum cable length between two nodes must not exceed the values in Table 7-2.

Table 7-2 Maximum Cable Length between Two RS 485 Repeaters

Baud Rate	Max. Cable Length between 2 Nodes with RS 485 Repeaters (in m) (6ES7 972-0AA00-0XA0)
9.6 to 187.5 kbaud	10000
500 kbaud	4000

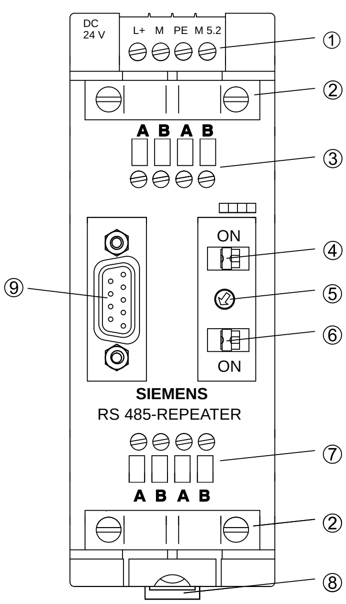
Table 7-2 Maximum Cable Length between Two RS 485 Repeaters

Baud Rate	Max. Cable Length between 2 Nodes with RS 485 Repeaters (in m) (6ES7 972-0AA00-0XA0)
1.5 Mbaud	2000
3 to 12 Mbaud	1000

Design of the RS 485 Repeater

Table 7-3 shows the RS 485 repeater:

Table 7-3 Description and Functions of the RS 485 Repeater (Order Number 6ES7 972-0AA00-0XA0)

Repeater Design	No.	Function
	①	Connection for the RS 485 repeater power supply (pin “M5.2” is the ground reference, if you want to measure the voltage difference between terminals “A2” and “B2”).
	②	Shield clamp for the strain relief and grounding of the bus cable of bus segment 1 or bus segment 2
	③	Terminals for the bus cable of bus segment 1
	④	Terminating resistance for bus segment 1
	⑤	Switch for baud rate. The various positions have the following meaning: 0: bus segments separated from each other 5: 500 kbaud 1: 9.6 kbaud 6: 1.5 Mbaud 2: 19.2 kbaud 7: 3 Mbaud 3: 93.75 kbaud 8: 6 Mbaud 4: 187.5 kbaud 9: 12 Mbaud
	⑥	Terminating resistance for bus segment 2
	⑦	Terminals for the bus cable of bus segment 2
	⑧	Slide for mounting and removing the RS 485 repeater on the standard rail
	⑨	Interface for programming device/OP in bus segment 1

Grounded or Ungrounded

The RS 485 repeater is

- grounded, if all other nodes in the segment are also operated with a grounded potential
- ungrounded, if all other nodes in the segment are operated with an ungrounded potential

---

Note

The bus segment 1 is grounded if you connect a programming device to the PG/OP socket of the RS 485 repeater. Ground connection is effected since the MPI in the programming device is grounded and the PG/OP socket is connected internally with bus segment 1 in the RS 485 repeater.

Grounded Operation of the RS 485 Repeater

You must not remove the jumper at the top side of the RS 485 repeater if you wish to operate the RS 485 repeater in a grounded configuration.

Galvanic Isolation between Bus Segments

Bus segment 1 and bus segment 2 are galvanically isolated from each other. The PG/OP interface is connected internally to the port for bus segment 1. Figure 7-1 shows the front panel of the RS 485 repeater.

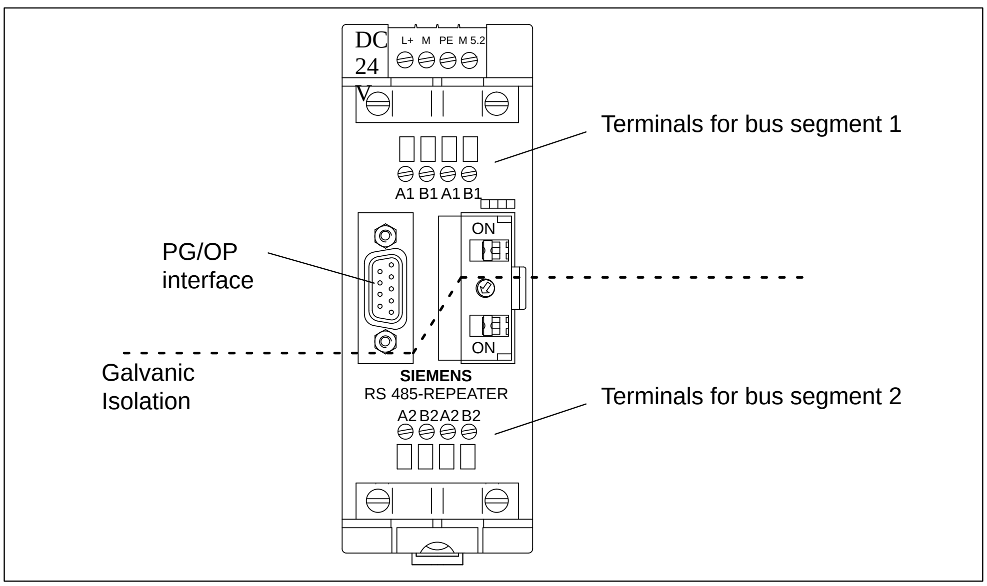


Figure 7-1 RS 485 Repeater

Amplification of the Bus Signals

The amplification of the bus signals takes place between the port for bus segment 1 or the PG/OP interface and the port for bus segment 2.

7.2 Technical Specifications

Technical Specifications

Table 7-4 shows the technical specifications of the RS 485 repeater:

Table 7-4 Technical Specifications of the RS 485 Repeater

Technical Specifications	
Power supply • Rated voltage • Ripple	 24 VDC 18 VDC to 30 VDC
Current consumption at rated voltage • without node at PG/OP socket • Node at PG/OP socket (5 V/90 mA) • Node at PG/OP socket (24 V/100 mA)	 100 mA 130 mA 200 mA
Galvanic isolation	Yes, 500 VAC
Connection of fiber optic cables	Yes, via repeater adapters
Redundancy operation	No
Baud rate	9.6 Kbaud to 12 Mbaud
Degree of protection	IP 20
Dimensions W × H × D	45 × 128 × 67 mm (1.8 x 5 x 2.6 in.)
Weight (incl. packing)	350 g (12.3 oz.)

Note

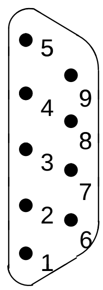
For harsh industrial environments, a special RS 485 repeater with degree of protection IP 65 is available; a special RS 485 repeater is also available for redundancy operation.

A detailed description of these RS 485 repeaters is contained in the *SINEC L2/L2FO Network Manual*.

Pin Assignment of the Sub D Connector (PG/OP Socket)

The 9-pin sub D connector has the following pin assignment:

Table 7-5 Pin Assignment of the 9-Pin Sub D Connector (PG/OP Socket)

View	Pin No.	Signal Name	Designation
	1	–	–
	2	M24V	Ground 24 V
	3	RxD/TxD-P	Data line B
	4	RTS	Request To Send
	5	M5V2	Data reference potential (from station)
	6	P5V2	Supply plus (from station)
	7	P24V	24 V
	8	RxD/TxD-N	Data line A
	9	–	–

Block Diagram

Figure 7-2 shows the block diagram of the RS 485 repeater:

- Bus segment 1 and bus segment 2 are galvanically isolated from each other.
- Bus segment 2 and the PG/OP socket are galvanically isolated from each other.
- Signals are amplified
  - between bus segment 1 and bus segment 2
  - between PG/OP socket and bus segment 2

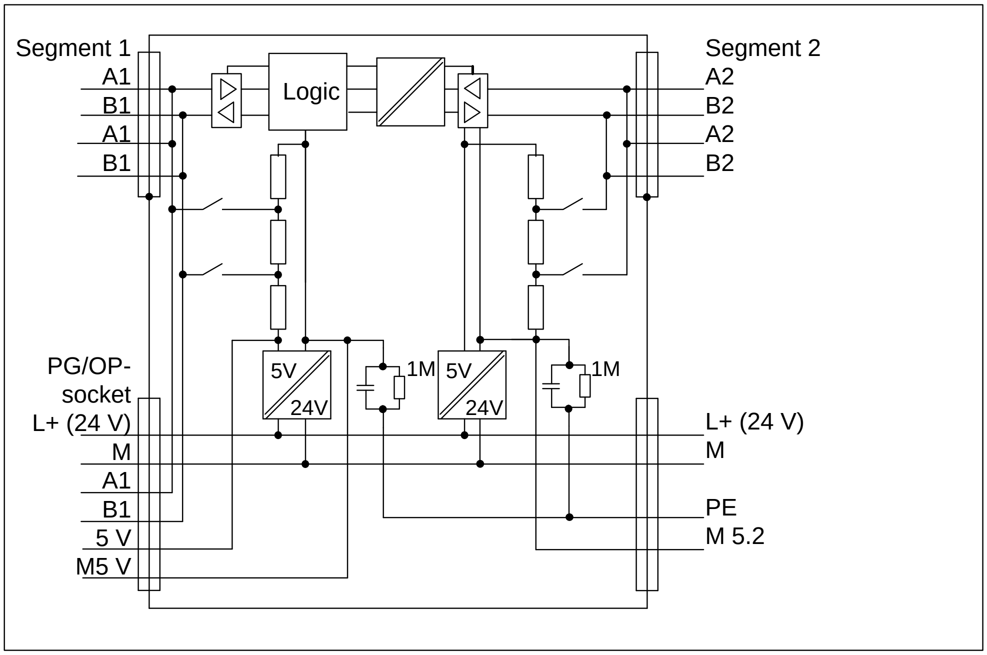


Figure 7-2 Block Diagram of the RS 485 Repeater

SIMATIC TOP connect 8

Introduction

SIMATIC TOP connect is the name of components used for wiring digital modules.

This type of wiring is an elegant alternative to the conventional way of wiring the actuators and sensors directly at the front connector.

Contents

In this Chapter the following is described referring to SIMATIC TOP connect:

Application

When using SIMATIC TOP connect, you wire actuators and sensors “locally” to one or more terminal blocks. A connecting cable (round-sheath ribbon cable) establishes the connection to the digital module.

Advantages

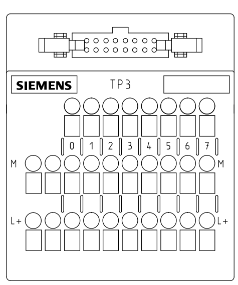
Wiring the digital modules using SIMATIC TOP connect has the following advantages:

- Easy plug-on connection of front connector module, connecting cable and terminal
- Fast, low-cost wiring (the use of central terminal blocks is no longer necessary)
- The power supply for the digital module can be wired either to the front connector or to the terminal block
- Multiple terminals for M– and L+ connection
- Wiring errors are drastically reduced and the cabinet wiring is clearly arranged
- Each component can be replaced separately
- Cable length can be configured without cuttings

8.1 Application Areas and Components of SIMATIC TOP Connect

Application Areas

SIMATIC TOP connect is used for wiring the following digital modules:

With SIMATIC TOP connect ...	... You can Wire the Following Digital Modules
 	SM 321; DI 32 × 24 VDC SM 321; DI 16 × 24 VDC SM 321; DI 16 × 24 VDC; source input
	SM 322; DO 32 × 24 VDC/0.5 A SM 322; DO 16 × 24 VDC/0.5 A SM 322; DO 8 × 24 VDC/0.5 A; with diagnostics interrupt SM 322; DO 8 × 24 VDC/2 A
	SM 323; DI 16/DO 16 × 24 VDC/0.5 A SM 323; DI 8/DO 8 × 24 VDC/0.5 A

SIMATIC TOP Connect and its Components

A SIMATIC TOP connect always consists of a front connector module with a flat ribbon connection À and one or more terminal blocks Â. The front connector and the terminal block are linked via a connecting cable Á. This cable may be up to 30 m long.

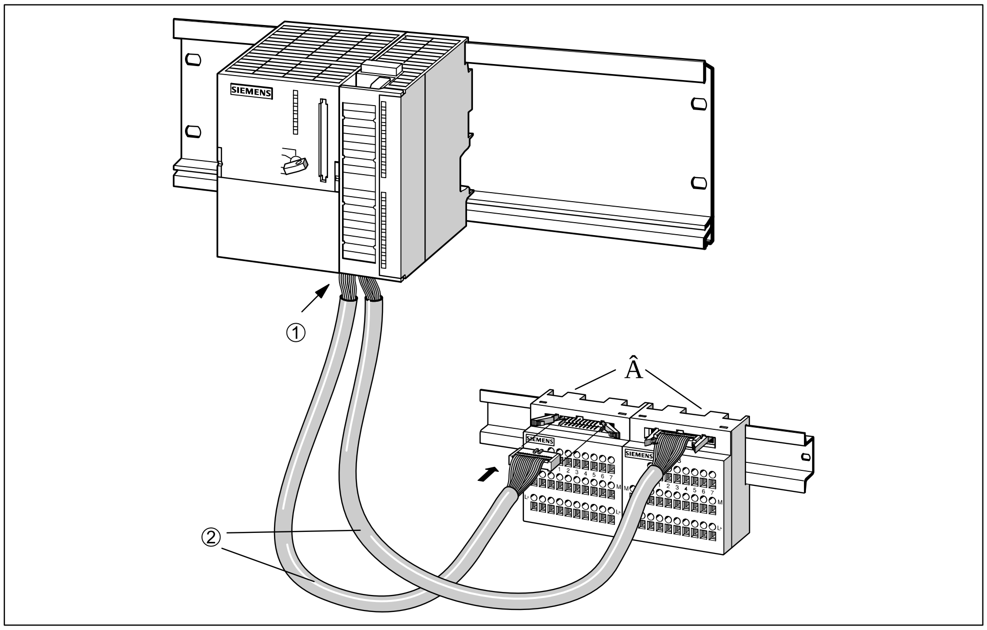


Figure 8-1 SIMATIC TOP connect

Components

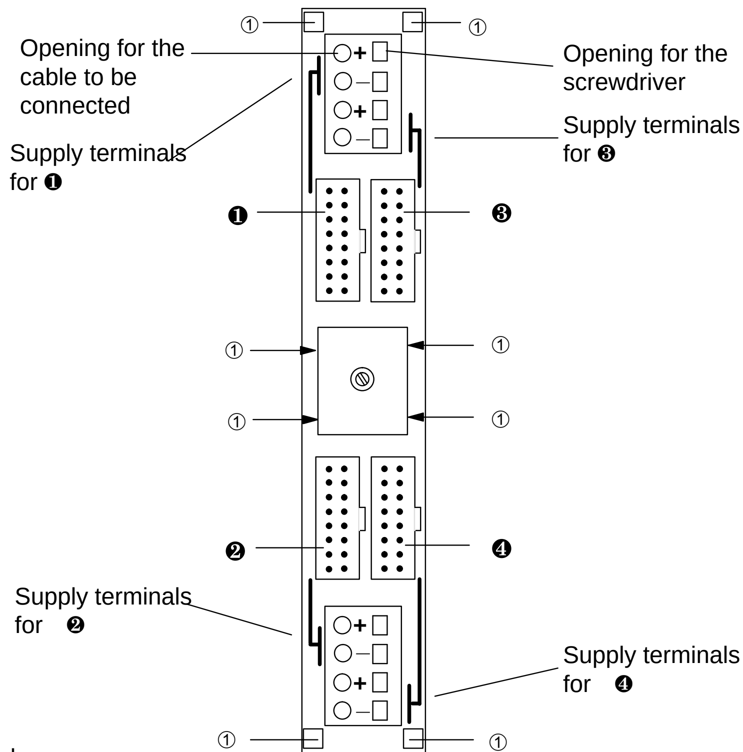
Table 8-1 lists all components of SIMATIC TOP connect.

Table 8-1 Components of SIMATIC TOP connect

Components			Order number
Terminal block	... for 1-conductor connection	spring-loaded screw-type	6ES7 924-0AA00-0AB0 6ES7 924-0AA00-0AA0
	... for 1-conductor connection (10 items)	spring-loaded screw-type	6ES7 924-0AA00-1AB0 ES7 924-0AA00-1AA0
	... for 3-conductor initiators	spring-loaded screw-type	6ES7 924-0CA00-0AB0 6ES7 924-0CA00-0AA0
	... for 3-conductor initiators (10 items)	spring-loaded screw-type	6ES7 924-0CA00-1AB0 6ES7 924-0CA00-1AA0
	... for 2A modules	spring-loaded screw-type	6ES7 924-0BB00-0AB0 6ES7 924-0BB00-0AA0
	... for 2A modules (10 items)	spring-loaded screw-type	6ES7 924-0BB00-1AB0 6ES7 924-0BB00-1AA0
Front connector	for 32-channel modules (see Figure 8-2)	Power supply via: spring-loaded	 6ES7 921 3AA20-0AA0
	for 16-channel modules	Power supply via: spring-loaded screw-type	 6ES7 921-3AA00-0AA0 6ES7 921-3AB00-0AA0
	for 16-channel 2A modules	Power supply via: spring-loaded screw-type	 6ES7 921-3AC00-0AA0 6ES7 921-3AD00-0AA0
Connector, 8 items (crimped)			6ES7 921-3BE10-0AA0
Round-sheath ribbon cables	unshielded	30 m 60 m	6ES7 923-0CD00-0AA0 6ES7 923-0CG00-0AA0
	shielded	30 m 60 m	6ES7 923-0CD00-0BA0 6ES7 923-0CG00-0BA0
Crimping tool for connectors 16-pin			6ES7 928-0AA00-0AA0

Front Connector for 32-Channel Modules

Figure 8-2 shows the front view of the front connector for 32-channel modules. The terminals for the supply voltage are spring-loaded (see also Section 8.4). Table 8-2 indicates the assignment of the flat ribbon cable terminals to the channels of the signal modules via the address assignment.



Legend:

① Openings for strain relief

❶ to ❹: flat ribbon cable terminals; address assignment see Table 8-2

Figure 8-2 Front Connector for 32-Channel Module

Table 8-2 Assignment of the Round-Sheath Ribbon Cable Terminals to the Address Bytes of the 32-Channel Modules

Flat Ribbon Terminal (Assignment See Figure 8-2)	Address Assignment for		
	Digital Input Module	**Digital Output Module**	**Digital Input/Output Module**
❶	IB x	QB x	IB x
❷	IB (x+1)	QB (x+1)	IB (x+1)
❸	IB (x+2)	QB (x+2)	QB x
❹	IB (x+3)	QB (x+3)	QB (x+1)

Selection Table

The following selection table shows to which SIMATIC TOP connect components the digital modules can be wired. Please observe the Notes for Connection in Section 8.7.

Table 8-3 Selection Table for SIMATIC TOP Connect Components

Digital Modules	Terminal Block			Front Connector	
	for 1-conductor connection	for 3-conductor connection	for 2A modules	for SM: 16 or 32 channels	for 2A modules
SM 321; DI16 × 24 VDC	X	X		X	
SM 321; DI16 × 24 VDC; source input	X	X		X	
SM 322; DO32 × 24 VDC/0.5 V	X	X	–	X	–
SM 322; DO16 × DC VDC/0.5 V	X	X		X	
SM 322; DO8 × 24 VDC/0.5 V; with diagnostics interrupt	X	X		X	
SM 322; DO8 × 24 VDC/2 A			X		X
SM 323; DI 16/DO16 × 24 VDC/ 0.5 A	X	X	–	X	–
SM 323; DI 8/DO 8 × 24 VDC/0.5 A	X	X		X	

8.2 Terminal Assignments for Wiring the Terminal Block

Introduction

The terminal assignments are described in this section.

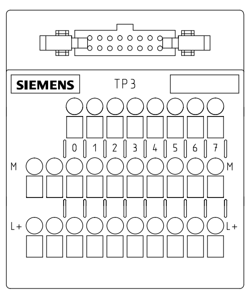
Terminal Assignment of Digital Modules

The description of the bit address is printed in the top tier of the terminal block.

Terminal Block for 3-Conductor Initiators

Table 8-4 shows the terminal assignments of the 3-conductor initiators.

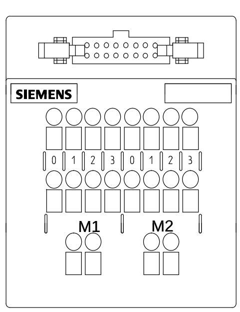
Table 8-4 Terminal Assignments of the Terminal Block for 3-Conductor Initiators

Front View of Terminal Block	Assignments of the Terminals
	Top tier: Terminal 0 through 7: Inputs/outputs x.0 to x.7
	Middle tier: All terminals: M potential
	Bottom tier: All terminals: L + potential

Terminal Block for 2A Modules

Table 8-5 shows the terminal assignments of 2A modules.

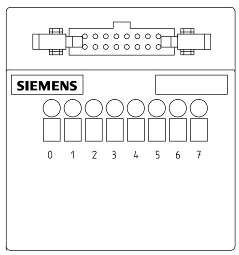
Table 8-5 Terminal Assignments of the Terminal Block for 2A Modules

Front View of Terminal Block	Assignments of the Terminals (left)	Assignments of the Terminals (right)
	Top tier: Terminal 0 through 3: Outputs x.0 to x.3	Top tier, right: Terminal 0 through 3: Outputs x.4 to x.7
	Middle tier: Terminal 0 through 3: M1 potential for x.0 to x.3	Middle tier, right: Terminal 0 through 3: M2 potential for x.4 to x.7
	Bottom tier: 2 terminals connection for M1	Bottom tier: 2 terminals connection for M2

Terminal Block for 1-Conductor Connection

Table 8-6 shows the terminal assignments of the terminal block for 1-conductor connection.

Table 8-6 Terminal Assignments of the Terminal Block for 1-Conductor Connection

Front View of Terminal Block	Assignment of the Terminals
	Top tier: Terminal 0 through 7: Inputs/outputs x.0 to x.7

8.3 Wiring Rules for the Terminal Block and the Front Connector

Rules for Wiring

The following table tells you which rules you have to observe when wiring the terminal blocks and the front connectors (power supply).

Rules for ...	Terminal Block		Front Connector SIMATIC TOP connect	
	Spring-loaded Connection	Screw-type Connection	Connection for Potential Supply	
			Up to 4 Terminals	Up to 8 Terminals
Conductor cross-sectional areas:				
Solid conductors	No		No	No
Stranded conductors				
• without end ferrules	0.25 to 1.5 mm^2		0.25 to 1.5 mm^2	0.25 to 0.75 mm^2
• with end ferrules	0.25 to 1.5 mm^2		0.25 to 1.5 mm^2	0.25 to 0.75 mm^2
Number of conductors per connection	1 or combination of 2 conductors up to 1.5 mm^2 (sum) in a common end ferrule			
Max. diameter of conductor insulation	∅ 3.1 mm		∅ 3.1 mm	∅ 2.0 mm
Length of insulation to be stripped				
• without insulation collar	11 mm		6 mm	
• with insulation collar	11 mm		–	
End ferrules toDIN 46228				
• without insulation collar	Model A; up to 12 mm long	Model A; up to 12 mm long	Model A; 5 to 7 mm long	
• with insulation collar			–	
– 0.25 to 1.0 mm^2	Model E; up to 12 mm long	Model E; up to 12 mm long		
– 1.5 mm^2	Model E; 12 mm long	Model E; 18 mm long		
Blade width of screwdriver	3.5 mm (cylindrical model)			
Tightening torque for connecting the conductors (not for spring-loaded conductors)	–	0.4 to 0.7 Nm		

8.4 Screw-Type Connections or Spring-Loaded Connections

Screw-Type or Spring-Loaded Connections

You can choose between two methods for connecting the signal lines to the terminal block and the power cables to the terminal block or front connector:

- Screw-type connection or
- Spring-loaded connection

Wiring with Spring-Loaded Connections

Wiring with spring-loaded connection enables fast and easy connection of the signal lines and power cables.

You connect the cables as follows to the spring-loaded contacts (see Figure 8-3):

1. Use a screwdriver to press the spring-loaded contact in the rectangular opening down and hold it pressed in this position (see Figure 8-4).
2. Insert the wire Á into the round opening of the relevant spring-loaded contact.
3. Release the pressure of the screwdriver Â on the spring-loaded contact. The wire is gripped in position by the spring-loaded contact.

Caution

The spring-loaded contact will be damaged, if you insert the screwdriver into the opening for the cable.

Make sure that you insert the screwdriver only into the rectangular opening of the terminal block.

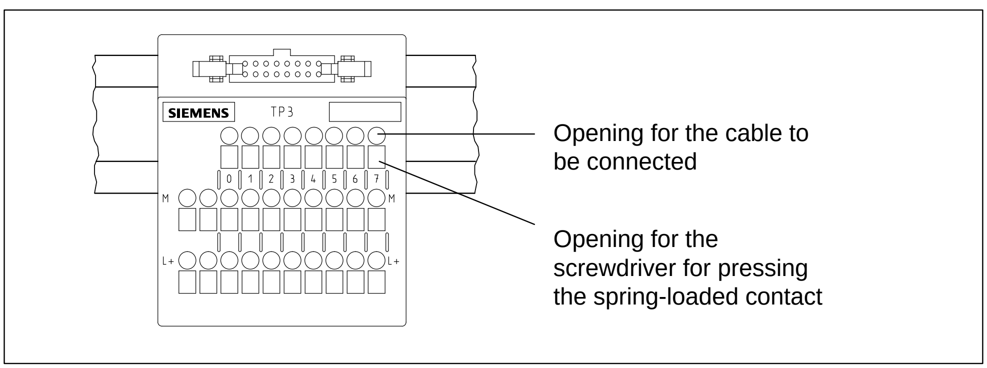


Figure 8-3 Terminal Block with Spring-Loaded Connections

Principle of Spring-Loaded Connections

Figure 8-4 shows the principle of spring-loaded connections.

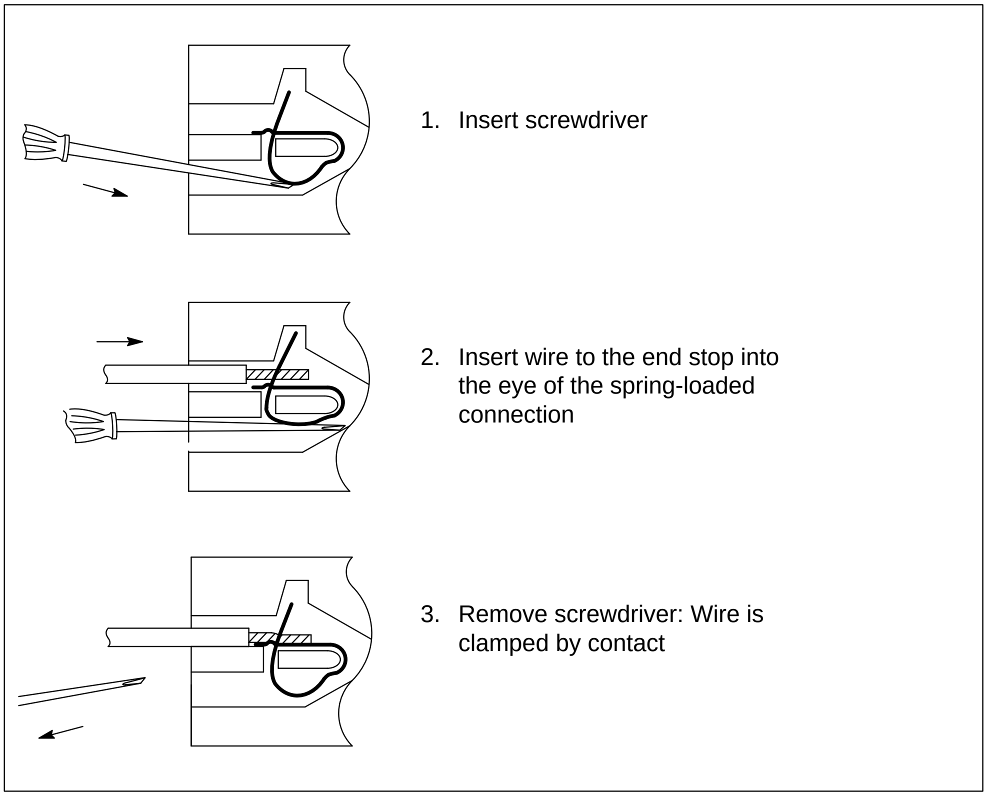


Figure 8-4 Principle of Spring-Loaded Connections

8.5 Preparing the Connecting Cables

Introduction

In this section, we will show you how you can preassemble the connecting cable yourself. The maximum distance between the SIMATIC S7 and the terminal blocks can be 30 m.

Tools Required

A crimping tool is required to connect the connector to the round-sheath ribbon cable.

Connecting Cable End to the Connector

Preassemble the connecting cable as follows:

1. Cut the round-sheath ribbon cable to the length required and remove part of the cable sheath at both ends. The length of the cable sheath to be removed is indicated in the following table.

Cable End to ...	Cable Sheath to be Removed	
Front Connector:	20-pin	40-pin
... upper socket of front connector	110 mm	115 mm
... lower socket of front connector	70 mm	75 mm
... socket of terminal block	40 mm	

2. Thread the round-sheath ribbon cable into the 16-pin connector. The positions of the details marked must be strictly observed (see Figure 8-5).

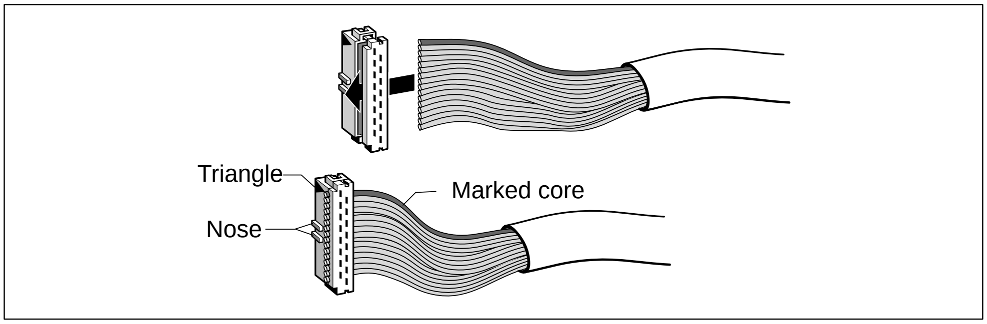


Figure 8-5 Threading the Round-Sheath Ribbon Cable into the Connector

3. Press the end of the cable into the connector using the crimping tool.
4. Secure the strain relief assembly at the connector of the terminal block.

Securing Strain-Relief Assembly

A strain-relief assembly only needs to be attached to the plug-in connector of the terminal block. Proceed as follows: Lay the round-sheath ribbon cable back over the connector after pressing in. You can then slide the enclosed strain-relief assembly over the round-sheath ribbon cable and engage it at the plug-in connector.

8.6 Wiring the Front Connector and the Terminal Block

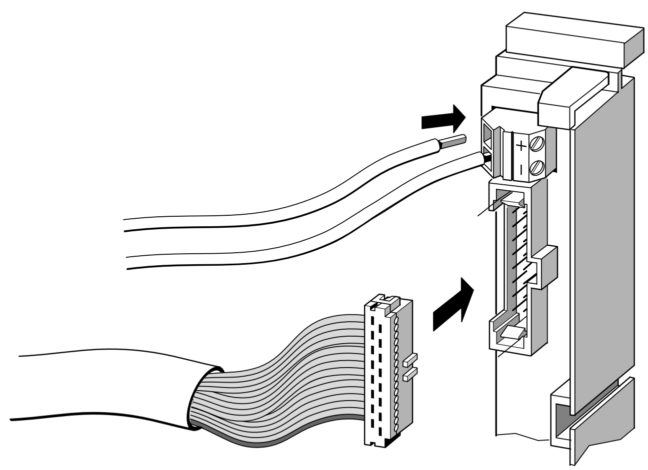
Introduction

In the following section, you will learn how to wire the connecting cable and the power supply at the front connector and at the terminal block.

Connecting the Cable to the Front Connector

Wire the front connector as follows (see also Section 8.3).

Table 8-7 Wiring the Front Connector

Step	8/16-Channel Digital Modules	32-Channel Digital Modules
1.	Open the front door.	
2.	Bring the front connector into the wiring position.	
3.	If required, connect the cables for the power supply of the digital module.	
		Observe the assignment of the supply terminals to the flat ribbon terminals (see Figure 8-2).
4.	Plug the round-sheath ribbon cable into the front connector. 	
5.	Twist the round-sheath ribbon cable downwards by 90 ° and then by a complete turn if possible.	
6.	–	Thread a strain relief assembly into the middle of the front connector. This strain relief serves to fix the round-sheath ribbon cable into the tight cable space of the module.
7.	Thread the strain relief assembly into the front connector.	

Attaching the Connecting Cable to the Terminal Block

1. Attach the terminal block to a 35 mm standard rail in accordance with EN 50 022.
2. Plug the connecting cable into the terminal block (see Figure 8-6).

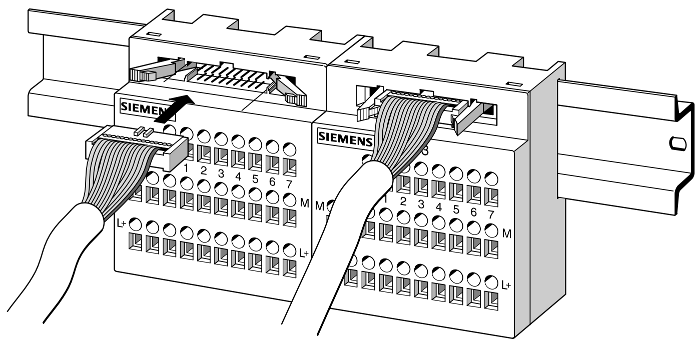


Figure 8-6 Plugging the Connecting Cable into the Terminal Block

8.7 Wiring Digital Modules with SIMATIC TOP Connect

Wiring

Three terminal blocks are available for wiring the SIMATIC S7 digital modules with SIMATIC TOP connect. The following notes for connection must be observed for wiring. The connection notes depend on the SIMATIC TOP connect components used. Table 8-3 in Seciton 8.1 will help you with the selection of components.

Connection Notes

Table 8-8 lists the connection notes for SIMATIC TOP connect with the terminal block for 1-conductor initiators.

Table 8-8 Connection Notes for SIMATIC TOP Connect for 1-Conductor Initiators

Digital Modules	Connection Notes				
	Power supply ...			add. jumper required for power supply	Descr. on terminal block not in line with descr. on SM
	at front connector only	add. ground conn. at terminal block	at front connector or terminal block		
SM 321; DI 32 × 24 VDC	X	–	–	–	–
SM 321; DI 16 × 24 VDC	X	–	–	–	–
SM 321; DI 16 × 24 VDC; source input	X	–	–	–	–
SM 322; DO 32 × 24 VDC/0.5 A	X	–	–	–	–
SM 322; DO 16 × 24 VDC/0.5 A	X	–	–	–	–
SM 322; DO 16 × 24 VDC/0.5 A; with diagnostics interrupt	X	–	–	–	X
SM 323; DI 16/DO 16 × DC 24 V/0.5 A	X	–	–	–	–
SM 323; DI 8/DO 8 × 24 VDC/0.5 A	X	–	–	–	–

Connection to Terminal Block for 1-Conductor Initiators

In Tables 8-3 and 8-8 you will find the digital modules that can be connected with the terminal block for 1-conductor initiators.

When connecting the supply voltage, note the following: The supply voltage is generally connected to the front connector (see description of the relevant digital ouput module). In the example in Figure 8-7 you must connect L+ at the positive connection of the **upper** terminal and M at the negative connection of the **lower** terminal.

Note

With the digital output module SM 322; DO 8 × 24 VDC/0.5 A; with diagnostics interrupt, the description on the terminal block does not match the description on the digital output group.

Figure 8-7 shows the wiring principle and the connection to the supply voltage:

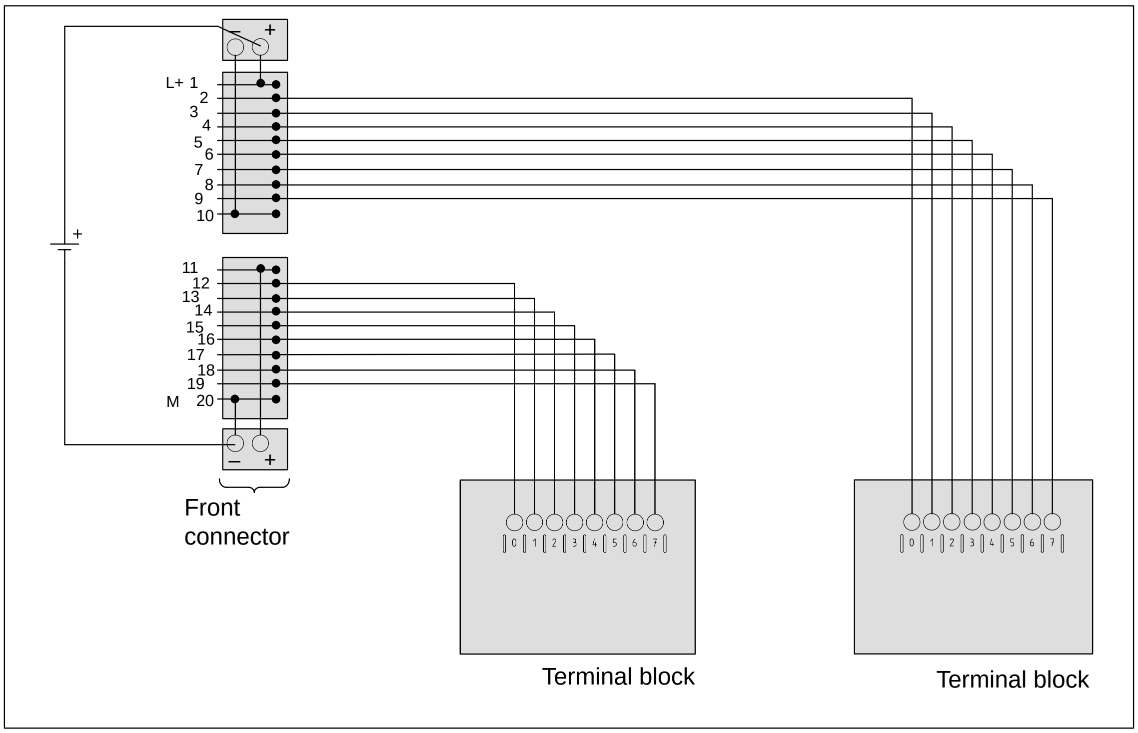


Figure 8-7 Wiring of a Digital Module with Terminal Block for 1-Conductor Initiators

3-Conductor Initiators

The connection notes for SIMATIC TOP connect with the terminal block for 3-conductor initiators are listed in Table 8-9.

Table 8-9 Connection Notes for SIMATIC TOP Connect for 3-Conductor Initiators

Digital Modules	Connection Notes				
	Power supply ...			add. jumper required for power supply	Descr. on terminal block not in line with descr. on SM
	at front connector only	add. ground conn. at terminal block	at front connector or terminal block		
SM 321; DI 32 × 24 VDC	–	–	X	X	–
SM 321; DI 16 × 24 VDC	–	–	X	X	–
SM 321; DI 16 × 24 VDC; source input	–	–	X	X	–
SM 322; DO 32 × 24 VDC/0.5 A	–	–	X	–	–
SM 322; DO 16 × 24 VDC/0.5 A	–	–	X	–	–
SM 322; DO 16 × 24 VDC/0.5 A; with diagnostics interrupt	–	–	X	X	X
SM 323; DI 16/DO 16 × 24 VDC/0.5 A	–	–	X	–	–
SM 323; DI 8/DO 8 × 24 VDC/0.5 A	–	–	X	–	–

Connection to Terminal Block for 3-Conductor Initiators

Tables 8-3 and 8-9 list the digital modules which can be wired to the terminal block for 3-conductor initiators.

For some digital modules, two jumpers are usually required for connecting the power supply. You can wire the jumpers either in the front connector or in the terminal block. In the front connector, you must connect the two positive and the two negative connections. The same applies if you wire the jumpers at the terminal block.

Note

With the digital output module SM 322; DO 8 × 24 VDC/0.5 A; with diagnostics interrupt, the description on the terminal block does not match the description on the digital output group.

Figure 8-8 shows the wiring principle and the connection of the power supply.

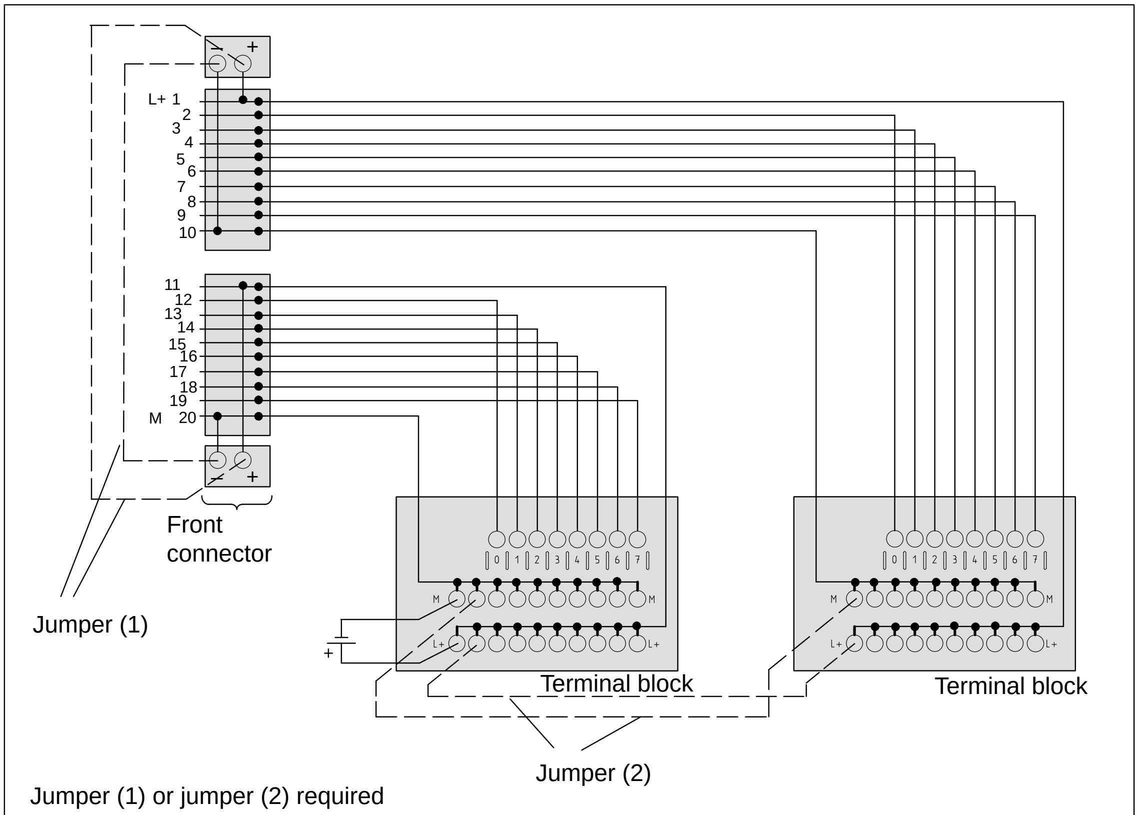


Figure 8-8 Wiring a Digital Module with Terminal Block for 3-Conductor Initiators

2A Modules

Table 8-10 lists the connection notes for SIMATIC TOP connect with the terminal block for the 2A modules. Note that you will also need the front connector for the 2A modules!

Table 8-10 Connection Notes for SIMATIC TOP Connect for 2A Modules

Digital Modules	Connection Notes				
	Power supply ...			Add. jumper required for power supply	Descr. on terminal block not in line with descr. on SM
	at front connector only	add. ground conn. at terminal block	at front connector or terminal block		
SM 322; DO 16 × 24 VDC/2 A	X	X	–	–	–

Connection to Terminal Block for 2A Module

You can use the terminal block for 2A modules to wire the SM 322; 8 × DO 24VDC/2A. Please observe the following when connecting the power supply:

- You must connect the power supply to both potential terminals on the front connector with separate cables.
- In addition to the round-sheath ribbon cable, you must provide each terminal block with a line for M1 or M2. Connect M1 or M2 via a separate line with the front connector and the terminal block. You can jumper the potential of M1 and M2 yourself.

Figure 8-9 shows the principle of wiring and the connection of the power supply:

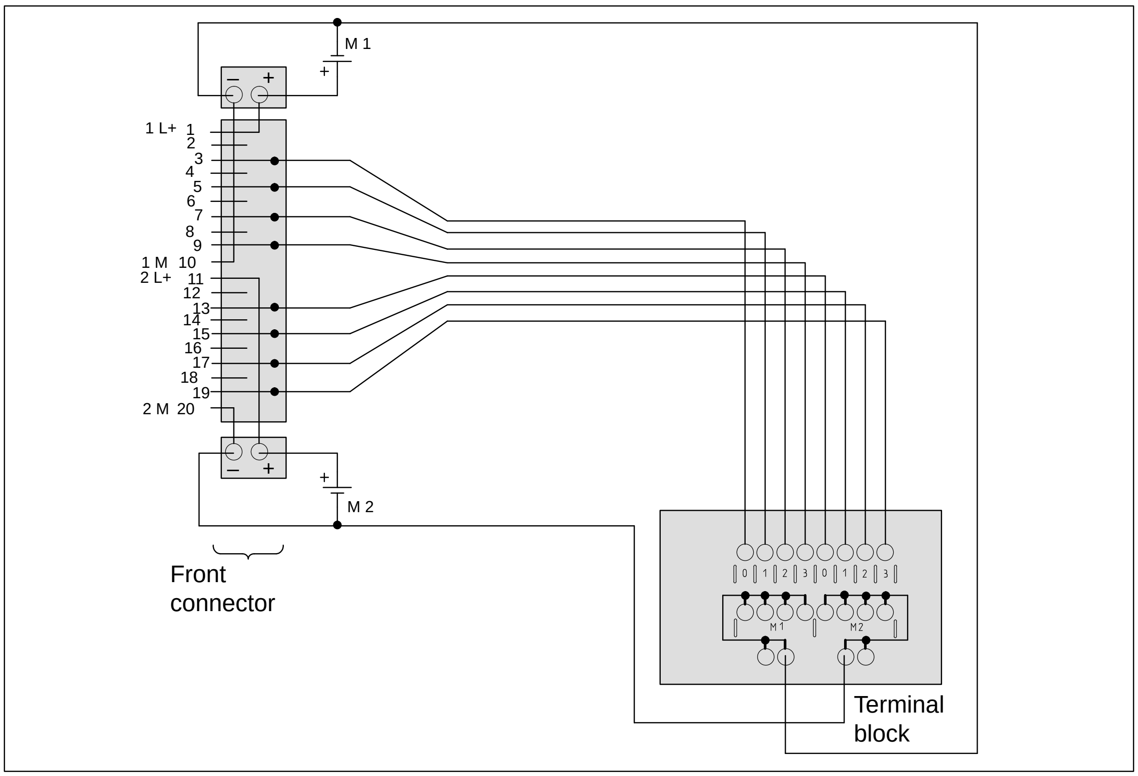


Figure 8-9 Wiring with Terminal Block for 2A Module

SIMATIC TOP connect TPA

9

Einleitung

SIMATIC TOP connect TPA are components for wiring analog modules.

They offer an elegant alternative to the conventional way of wiring the actuators and sensors directly at the front connector.

Contents

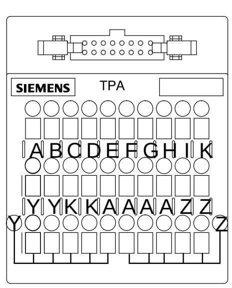
This description contains all information necessary to wire S7-300 analog modules with SIMATIC TOP connect TPA.

Additional information concerning the following topics can be found in Chapter 8.

- Setting up an S7–300 with SIMATIC TOP connect
- Wiring rules
- Principles of wiring with spring-loaded connections.

Application

SIMATIC TOP connect TPA enables wiring of the following analog modules:

With SIMATIC TOP connect ...	... You Can Wire the Following Analog Modules
	SM 331; AI 2 × 12 Bit SM 331; AI 8 × 12 Bit SM 332; AO 4 × 12 Bit SM 332; AO2 × 12 Bit SM 334; AI 4/AO 2 × 8/8 Bit SM 334; AI 4/AO 2 × 12 Bit

Components

Table 9-1 lists the components for SIMATIC TOP connect TPA

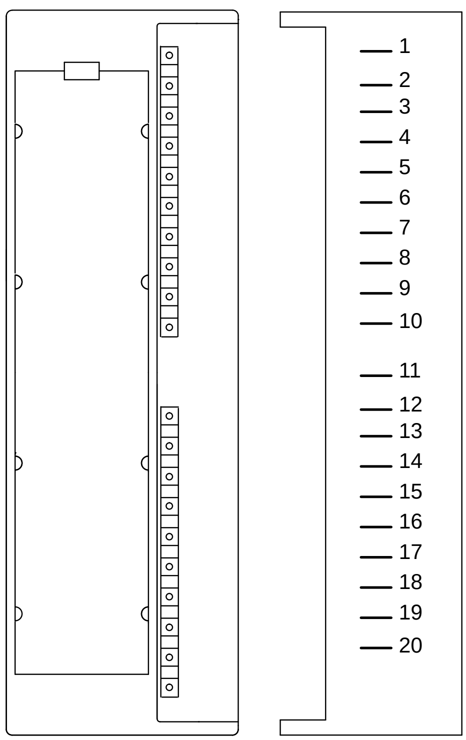
Table 9-1 Components for SIMATIC TOP connect TPA

Components for TPA			Order Number
Terminal block	Quantity: 1	Spring-loaded terminals	6ES7 924-0CC00-0AB0
		Screw-type terminals	6ES7 924-0CC00-0AA0
	Quantity: 10	Spring-loaded terminals	6ES7 924-0CC00-1AB0
		Screw-type terminals	6ES7 924-0CC00-1AA0
Front connector		Voltage supply via:	
		Spring-loaded terminals	6ES7 921-3AF00-0AA0
		Screw-type terminals	6ES7 921-3AG00-0AA0
8 connectors (insulation displacement wiring method)			6ES7 921-3BE10-0AA0
Shielding plate for terminal block; quantity: 4			6ES7 928-1BA00-0AA0
Terminal element for:			
2 cables, each with a shield diameter of 2 to 6 mm			6ES7 390-5AB00-0AA0
1 cable with a shield diameter of 3 to 8 mm			6ES7 390-5BA00-0AA0
1 cable with a shield diameter of 4 to 13 mm			6ES7 390-5CA00-0AA0
Round-sheath ribbon cable, shielded, ∅ 8 mm		30 m	6ES7 923-0CD00-0BA0
		60 m	6ES7 923-0CG00-0BA0
Crimping tool for 16-pin connector			6ES7 928-0AA00-0AA0

Terminal Assignments

On the TPA terminal block, the terminals are identified by letters. This simplifies the allocation of the terminals on the analog module to the terminals on the terminal block.

Figure 9-1 shows the allocation of the terminals on the analog module to those on the terminal block.



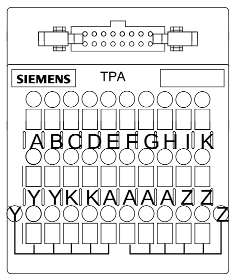
Terminal number on module	Terminal assignments for TPA terminal block	
	Terminal block 1	Terminal block 2
1	Y	Y
2	B	
3	C	
4	D	
5	E	
6	F	
7	G	
8	H	
9	I	
10	K	K
11	A	A
12		B
13		C
14		D
15		E
16		F
17		G
18		H
19		I
20	Z	Z

Figure 9-1 Allocation of Terminals on Analog Module to Terminals on TPA

Multiplier Terminal

The lower row of terminals on the terminal block consists of 2 x 5 multiplier terminals (see Table 9-2)

Table 9-2 Multiplier Terminals for TPA

<table>
<tr><th>Terminal Assignments</th><th>Description</th></tr>
<tr><td rowspan="2">
</td><td>Terminals Z and Y can be used for multiplying arbitrary potentials and signals.</td></tr>
<tr><td>Terminals that have the same letters are electrically linked to one another, except terminals Z and Z and Y and Y .</td></tr>
</table>

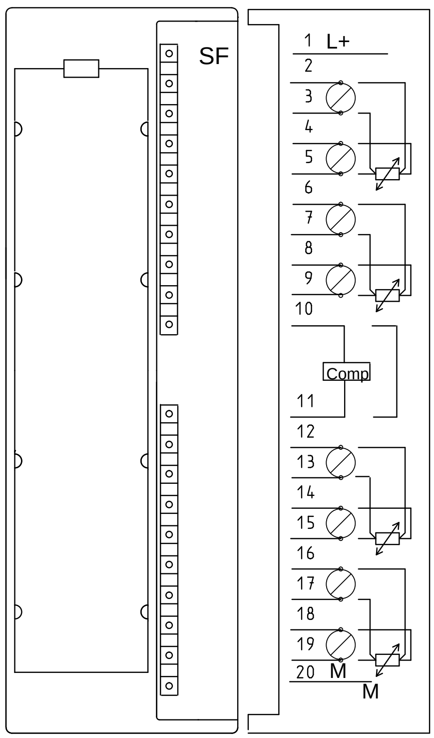
Load Voltage Supply

The front connector provides separate pins for load voltage L+ and M. This allows you to connect the analog module’s load voltage supply via the front connector.

The front connector and the terminal block may be up to 30 meters apart.

Connection Example

Figure 9-2 shows a sample connection for the SM 321 analog input module SM 321; AI 8 × 12 Bit in “resistance test” mode.



Resistance test	Wiring with TPA: Terminal number on module	Terminal block 1	Terminal block 2
L +	1	Y	Y
M_{0+} CH0	2	B	
M_{0-}	3	C	
I_{C0+}	4	D	
I_{C0-}	5	E	
M_{1+} CH2	6	F	
M_{1-}	7	G	
I_{C1+}	8	H	
I_{C1-}	9	I	
Comp +	10	K	K
Comp – / Mana	11	A	A
M_{2+} CH4	12		B
M_{2-}	13		C
I_{C2+}	14		D
I_{C2-}	15		E
M_{3+} CH6	16		F
M_{3-}	17		G
I_{C3+}	18		H
I_{C3-}	19		I
M	20	Z	Z

Figure 9-2 Connection Example

Allocation of Front Connector to Terminal Block

The **upper socket** of the front connector is the connection for **terminal block 1** and the **lower socket** is the connection for **terminal block 2**.

Shield Connection

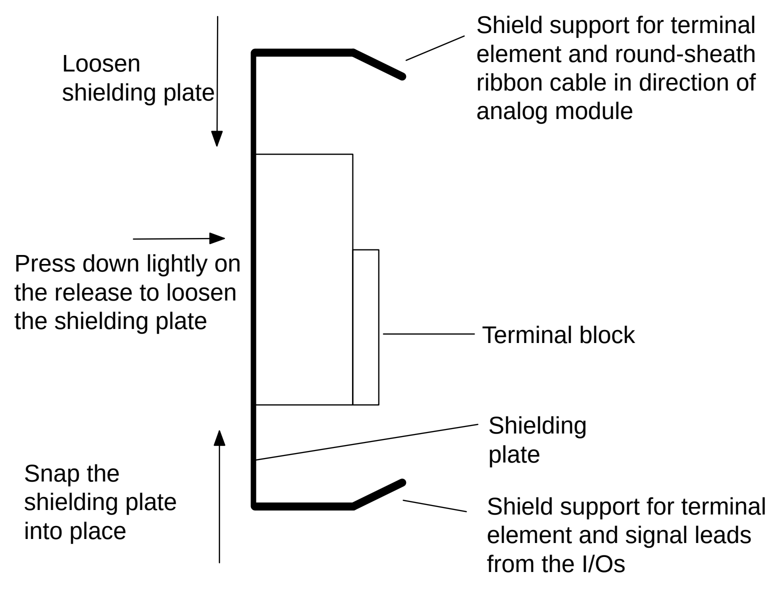
The screen for the shielded signal leads can be connected to ground

- via a shield support on the analog module and
- via the shielding plate on the terminal block.

The shield for the signal leads can be placed directly on the terminal block. To do so, afix a shielding plate to the terminal block prior to installation. Figure 9-3 shows that the shielding plate is at the rear of the terminal block, thus providing a connection to the grounded mounting rail. Connect the shield for the signal leads to the shielding plate via the terminal elements.

This method of shield connection is described in Chapter 6 of the manual entitled *S7–300 Hardware and Installation* as well as in Chapter 5 of the manual entitled *ET 200M Distributed I/O Device*.

Figure 9-3 shows a schematic sketch of the terminal block with shielding plate.



Snap the shielding plate into place at the rear of the terminal block.

Figure 9-3 TPA Terminal Block with Shielding Plate

Parameter Sets for Signal Modules

A

In this Appendix

This appendix briefly describes how to assign the parameters for signal modules in the *STEP 7* user program. You can assign the parameters for the signal modules in the user program instead of, or as well as, with the proogramming device in *STEP 7*.

This appendix also contains the structure of the parameters for the various classes of signal modules.

Reference Literature

In the *System and Standard Functions* Reference Manual, you will find a comprehensive description of how to assign the parameters for signal modules in the user program, as well as a description of the SFCs used.

In M7-300:

You can also use the M7-API to assign the parameters in the user program for M7-300 CPUs or FMs (see the Manuals for *M7-300/400 System Software*).

Contents

This appendix contains the parameter sets for the following classes of signal modules on the S7-300:

A.1 How to Assign the Parameters for Signal Modules in the User Program

Parameter Assignment in the User Program

You have already set the parameters for the S7-300 modules using *STEP 7*. You can use an SFC in the user program to change the module parameters. You can also use an SFC in the user program to transfer the parameters from the CPU to the addressed signal module.

Parameters Stored in Data Records

The parameters for the signal modules are stored in two data records: records 0 and 1.

Modifiable Parameters

You can change the parameters of record 1 and pass them to the signal module using SFC 55. The parameters set on the CPU are not changed when you do this! You cannot change the S7-300 parameters of record 0 in the user program.

In the following sections, we show you an overview of the parameters which are stored in records 0 and 1 for each module class.

SFCs for Parameter Assignment

The following SFCs are available for assigning the parameters for the signal modules in the user program:

SFC No.	Identifier	Application
55	WR_PARM	Transfer modifiable parameters (record 1) to addressed signal module.
56	WR_DPARM	Transfer parameters (record 0 **or** 1) from the CPU to the addressed signal module.
57	PARM_MOD	Transfer all parameters (records 0 **and** 1) from the CPU to the addressed signal module.

Description of the Parameters

The following sections contain **all** the modifiable parameters for the various module classes.

The parameters for the configurable signal modules are described:

- in this reference manual
- in the on-line help of *STEP 7*

The data sheets of the individual signal modules describe which parameters can be set for each signal module.

A.2 Parameters of the Digital Input Modules

Parameters

Table A-1 contains all the parameters which you can set for digital input modules. The comparison shows:

- which parameters you can change with *STEP 7* and
- which parameters you can change with SFC 55 “WR_PARM”.

The parameters which you set with *STEP 7* can also be transferred to the module with SFCs 56 and 57.

Table A-1 Parameters of the Digital Input Modules

Parameter	**Data Record No.**	**Configurable with ...**	
		... SFC 55	**... Programming Device**
Input delay	0	No	Yes
Diagnostics		No	Yes
Process interrupt enable	1	**Yes**	Yes
Diagnostics interrupt enable		**Yes**	Yes
Process interrupt on positive edge		**Yes**	Yes
Process interrupt on negative edge		**Yes**	Yes

Note

Before you can enable the diagnostics interrupt in record 1 in the user program, you must first enable the diagnostics in record 0 with *STEP 7*.

Structure of Data Record 1

Figure A-1 shows the structure of data record 1 for the parameters of the digital input modules.

You activate a parameter by setting the corresponding bit to “1”.

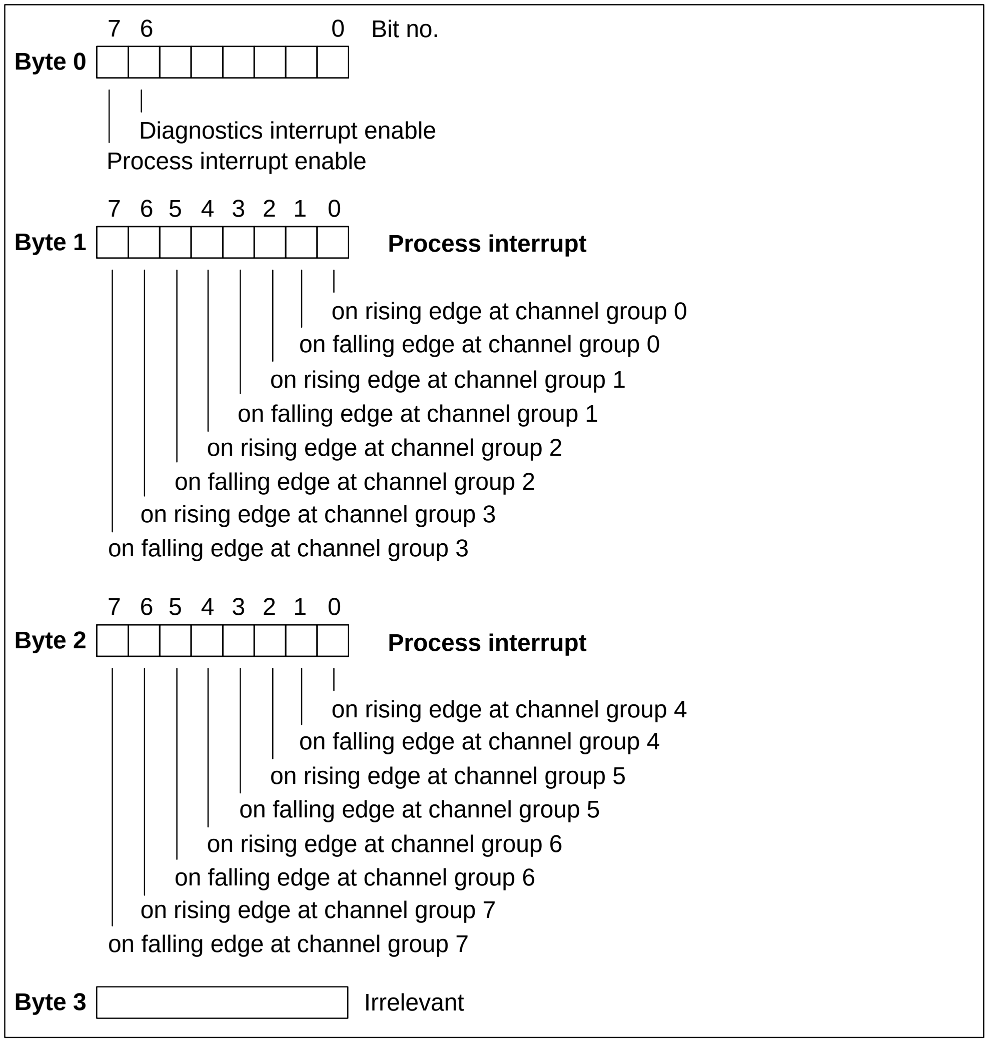


Figure A-1 Data Record 1 for Parameters of the Digital Input Modules

A.3 Parameters of the Digital Output Modules

Parameters

Table A-2 contains all the parameters which you can set for digital output modules. The comparison shows:

- which parameters you can change with *STEP 7* and
- which parameters you can change with SFC 55 “WR_PARM”.

The parameters which you set with *STEP 7* can also be transferred to the module with SFCs 56 and 57.

Table A-2 Parameters of the Digital Output Modules

Parameter	**Data Record No.**	**Configurable with ...**	
		... SFC 55	**... Programming Device**
Group diagnostics	0	No	Yes
Diagnostics interrupt enable	1	**Yes**	Yes
Substitute value enable		**Yes**	Yes
Hold last value		**Yes**	Yes
Substitute value		**Yes**	Yes

Note

Before you can enable the diagnostics interrupt in record 1 in the user program, you must first enable the diagnostics in record 0 with *STEP 7*!

You should only activate one of the parameters “substitute value output” and “hold last value” at a time.

Structure of Data Record 1

Figure A-2 shows the structure of data record 1 for the parameters of the digital output modules.

You activate a parameter by setting the corresponding bit in byte 0 to "1".

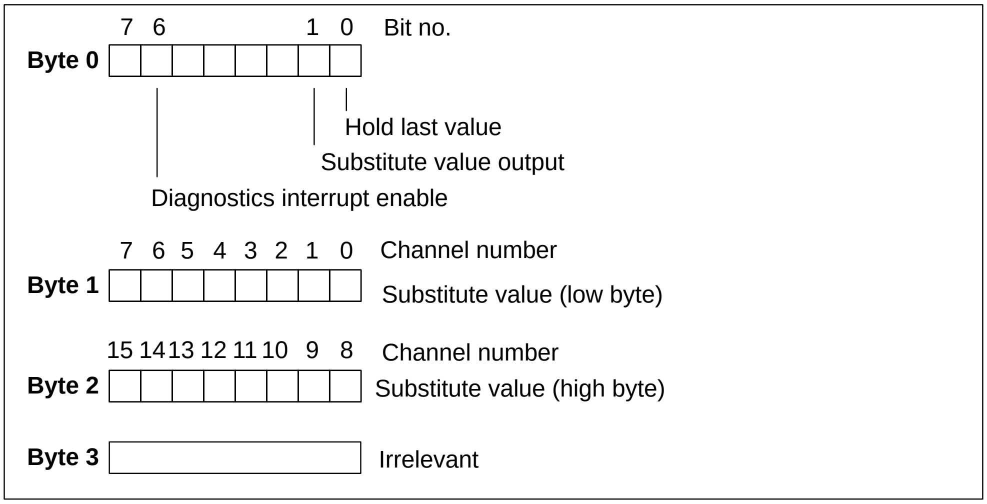


Figure A-2 Data Record 1 for Parameters of the Digital Output Modules

A.4 Parameters of the Analog Input Modules

Parameters

Table A-3 contains all the parameters which you can set for analog input modules. The comparison shows:

- which parameters you can change with *STEP 7* and
- which parameters you can change with SFC 55 “WR_PARM”.

The parameters which you set with *STEP 7* can also be transferred to the module with SFCs 56 and 57.

Table A-3 Parameters of the Analog Input Modules

Parameter	Data Record No.	Configurable with ...	
		... SFC 55	**... Programming Device**
Diagnostics: : Group diagnostics	0	No	Yes
Diagnostics:with wire-break check		No	Yes
Limit value interrupt enable	1	**Yes**	Yes
Diagnostics interrupt enable		**Yes**	Yes
Interference frequency suppression	1	**Yes**	Yes
Measurement type		**Yes**	Yes
Measurement range		**Yes**	Yes
Upper limit value		**Yes**	Yes
Lower limit value		**Yes**	Yes

Note

Before you can enable the diagnostics interrupt in record 1 in the user program, you must first enable the diagnostics in record 0 with *STEP 7*.

Structure of Data Record 1

Figure A-3 shows the structure of data record 1 for the parameters of the digital output modules.

You activate a parameter by setting the corresponding bit in byte 0 to “1”.

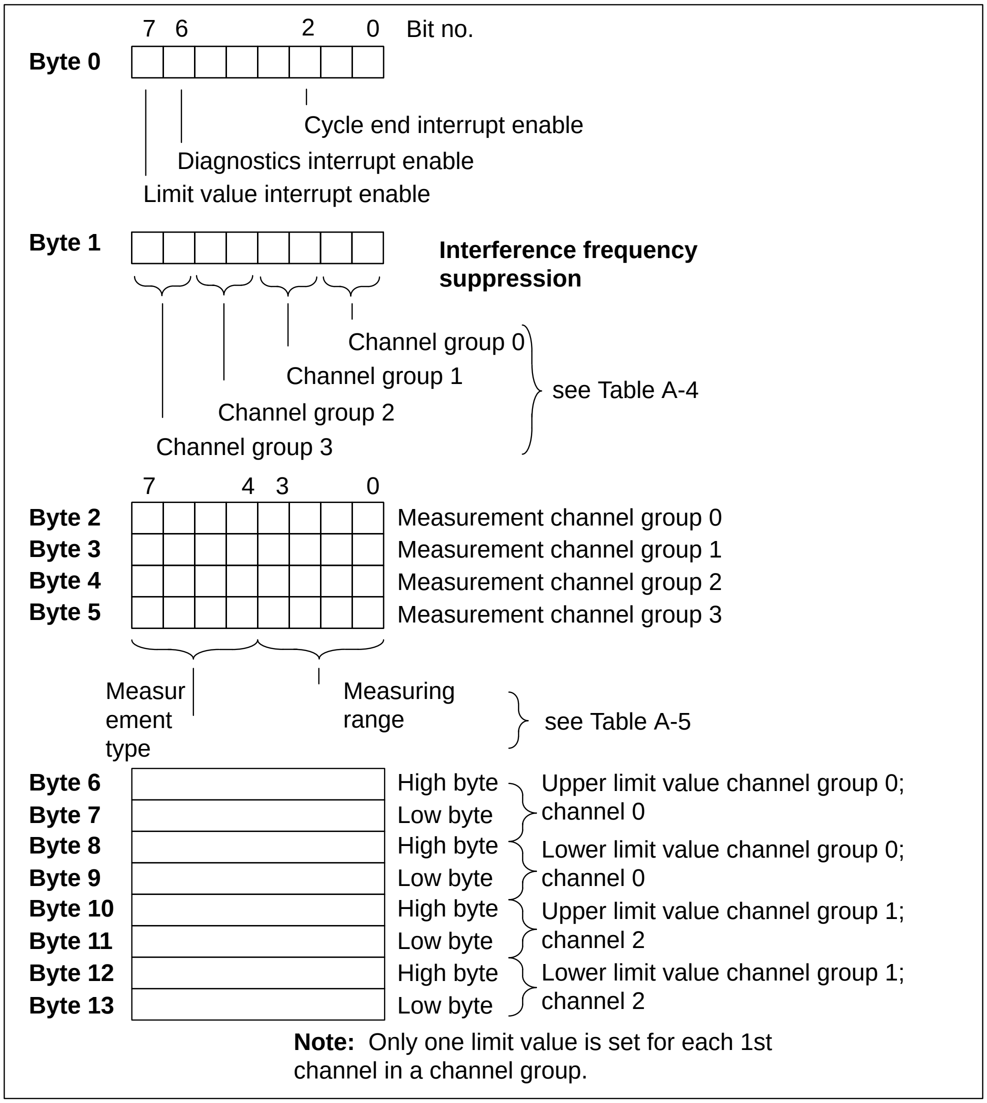


Figure A-3 Data Record 1 for Parameters of the Analog Input Modules

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Note

The representation of the limit values matches the analog value representation (see Chapter 4). Please observe the range limits when setting the limit values.

Interference Frequency Suppression

Table A-4 contains the codes for the various frequencies which you enter in byte 1 of data record 1 (see Figure A-3). The integration time must be calculated per channel!

Table A-4 Codes for the Interference Frequency Suppression of the Analog Input Modules

Interference Frequency Suppression	Reset Time	Code
400 Hz	2.5 ms	2#00
60 Hz	16.7 ms	2#01
50 Hz	20 ms	2#10
10 Hz	100 ms	2#11

Measurement Type and Measuring Ranges

Table A-5 contains all the measuring ranges for the analog input modules. The table also shows the codes for the measurement types and the measuring range. You must enter these codes, according to the measuring range desired, in bytes 2 to 5 of data record 1 (see Figure A-3).

Note

Please note that a measuring range module may need to be reconnected, depending on the measuring range (see Chapter 4)!

Table A-5 Codes for the Measuring Ranges of the Analog Input Modules

Measurement Type	Code	Measuring Range	Code
Deactivated	2#0000	Deactivated	2#0000
Voltage	2#0001	± 80 mV	2#0001
		± 250 mV	2#0010
		± 500 mV	2#0011
		± 1 V	2#0100
		± 2.5 V	2#0101
		± 5 V	2#0110
		1 to 5 V	2#0111
		± 10 V	2#1001
		± 25 mV	2#1010
		± 50 mV	2#1011

Table A-5 Codes for the Measuring Ranges of the Analog Input Modules, continued

Measurement Type	Code	Measuring Range	Code
4-wire transducer	2#0010	± 3.2 mA	2#0000
		± 10 mA	2#0001
		0 to 20 mA	2#0010
		4 to 20 mA	2#0011
		± 20 mA	2#0100
		± 5 mA	2#0101
2-wire transducer	2#0011	4 to 20 mA	2#0011
Resistor 4-wire connection	2#0100	150 Ω	2#0010
		300 Ω	2#0100
		600 Ω	2#0110
Resistor 4-wire connection; 100 Ω compensation	2#0110	52 to 148 Ω	2#0001
		250 Ω	2#0011
		400 Ω	2#0101
		700 Ω	2#0111
Resistance-type thermometer + line arization 4-wire connection	2#1000	Pt 100 climate	2#0000
		Ni 100 climate	2#0001
		Pt 100 standard range	2#0010
		Pt 200 standard range	2#0011
		Pt 500 standard range	2#0100
		Pt 1000 standard range	2#0101
		Ni 1000 standard range	2#0110
		Pt 200 climate	2#0111
		Pt 500 climate	2#1000
		Pt 1000 climate	2#1001
		Ni 1000 climate	2#1001
		Ni 100 standard range	2#1011
Thermocouples internal comparison	2#1010	Type B [PtRh – PtRh]	2#0000
		Type N [NiCrSi – NiSi]	2#0001
		Type E [NiCr – CuNi]	2#0010
Thermocouples external comparison	2#1011	Type R [PtRh –Pt]	2#0011
		Type S [PtRh –Pt]	2#0100
Thermocouples + linearization internal comparison	2#1101	Type J [Fe – CuNi IEC]	2#0101
		Type L [Fe – CuNi]	2#0110
		Type T [Cu – CuNi]	2#0111
		Type K [NiCr – Ni]	2#1000
Thermocouples + linearization external comparison	2#1110	Type U [Cu – CuNi]	2#1001

A.5 Parameters of the Analog Output Modules

Parameters

Table A-6 contains all the parameters which you can set for analog output modules. The comparison shows:

- which parameters you can change with *STEP 7* and
- which parameters you can change with SFC 55 “WR_PARM”.

The parameters which you set with *STEP 7* can also be transferred to the module with SFCs 56 and 57.

Table A-6 Parameters of the Analog Output Modules

Parameter	**Data Record No.**	**Configurable with ...**	
		... SFC 55	**... Programming Device**
Diagnostics: group diagnostics	0	No	Yes
Diagnostics interrupt enable	1	**Yes**	Yes
Behavior on CPU STOP		**Yes**	Yes
Output: type		**Yes**	Yes
Output: range		**Yes**	Yes
Substitute value		**Yes**	Yes

Note

Before you can enable the diagnostics interrupt in record 1 in the user program, you must first enable the diagnostics in record 0 with *STEP 7*.

Structure of Data Record 1

Figure A-4 shows the structure of data record 1 for the parameters of the analog output modules.

You activate the diagnostics interrupt enable by setting the corresponding bit in byte 0 to “1”.

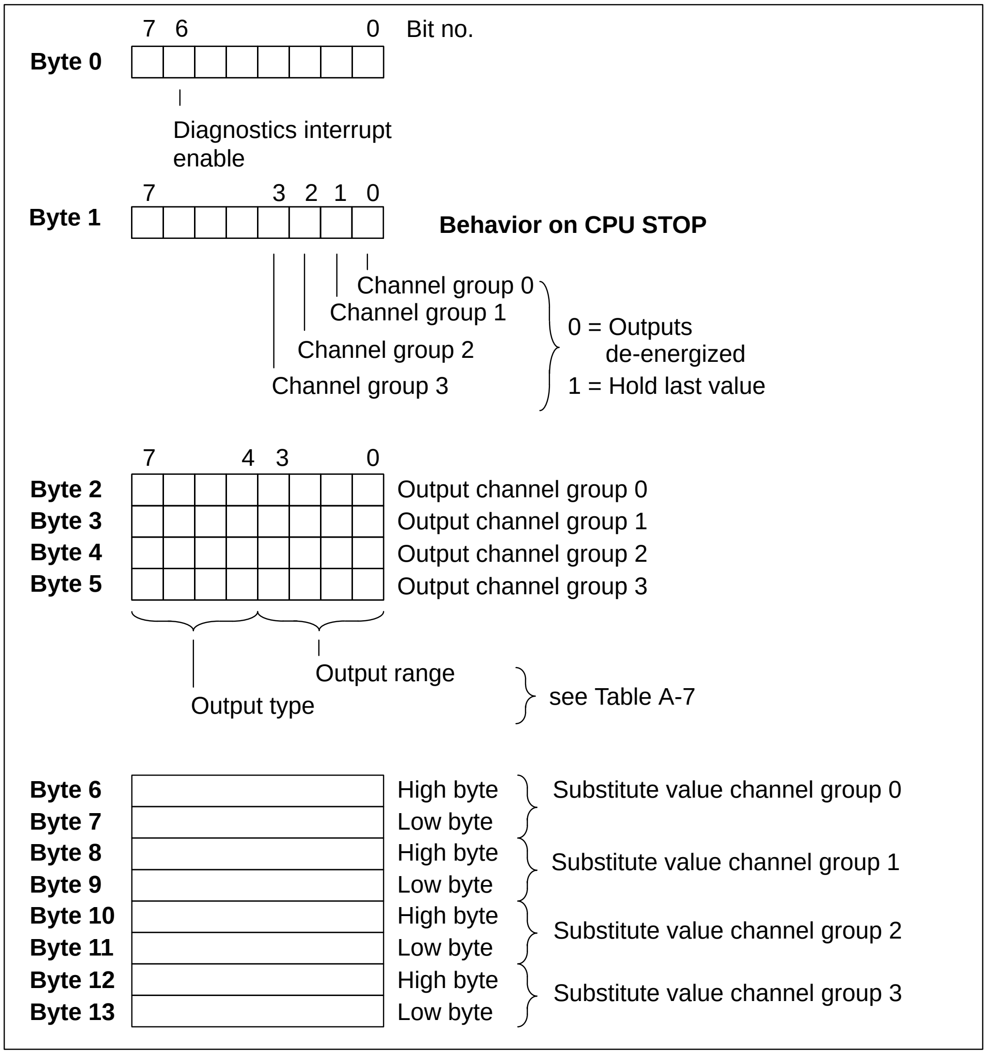


Figure A-4 Data Record 1 for Parameters of the Analog Output Module

Notes on Substitute Values

Please observe the following notes when you set substitute values for the analog outputs:

- For the output ranges 4 to 20 mA and 1 to 5 V you must set the substitute value $E500_H$ so that the output remains de-energized (see Tables 4-17 and 4-18 in Chapter 4).
- The representation of the substitute values corresponds to the representation of the analog values (see Chapter 4). You should observe the relevant range limits when setting the substitute values.

Output Type and Output Ranges

Table A-7 contains all output ranges for the analog output modules. Also shown in the table are the codes for the output type and the output range. You must enter these codes, according to the measuring range desired, in bytes 2 to 5 of data record 1 (see Figure A-4).

Table A-7 Codes for the Output Ranges of the Analog Output Modules

Output Type	Code	Output Range	Code
Deactivated	2#0000	Deactivated	2#0000
Voltage	2#0001	1 to 5 V	2#0111
		0 to 10 V	2#1000
		± 10 V	2#1001
Current	2#0010	0 to 20 mA	2#0010
		4 to 20 mA	2#0011
		± 20 mA	2#0100

Diagnostics Data of the Signal Modules

B

In this Appendix

This appendix describes the configuration of the diagnostics data in the system data. You must be familiar with this configuration if you want to evaluate the diagnostics data of the signal module in the STEP 7 user program.

Further References

The reference manual *System and Standard Functions* includes an extensive description of the evaluation principle for the diagnostics data of signal modules in the user program, in addition to a description of the SFCs that can be used for this purpose.

Data Records 0 and 1 of the System Data

The diagnostics data of a module can be up to 16 bytes long and are located in data records 0 and 1 of the system data area:

- Data record 0 contains 4 bytes of diagnostics data describing the current status of an S7-300.
- Data record 1 contains
  - the 4 bytes of diagnostics data of an S7-300 that are also located in data record 0 **and**
  - up to 12 bytes of module-specific diagnostics data.

Configuration and Contents of Diagnostics Data

The configuration and the contents of the individual bytes of the diagnostics data are described below.

The following general rule applies: If an error occurs, the corresponding bit is set to “1”.

Bytes 0 and 1

Figure B-1 shows the contents of bytes 0 and 1 of the diagnostics data.

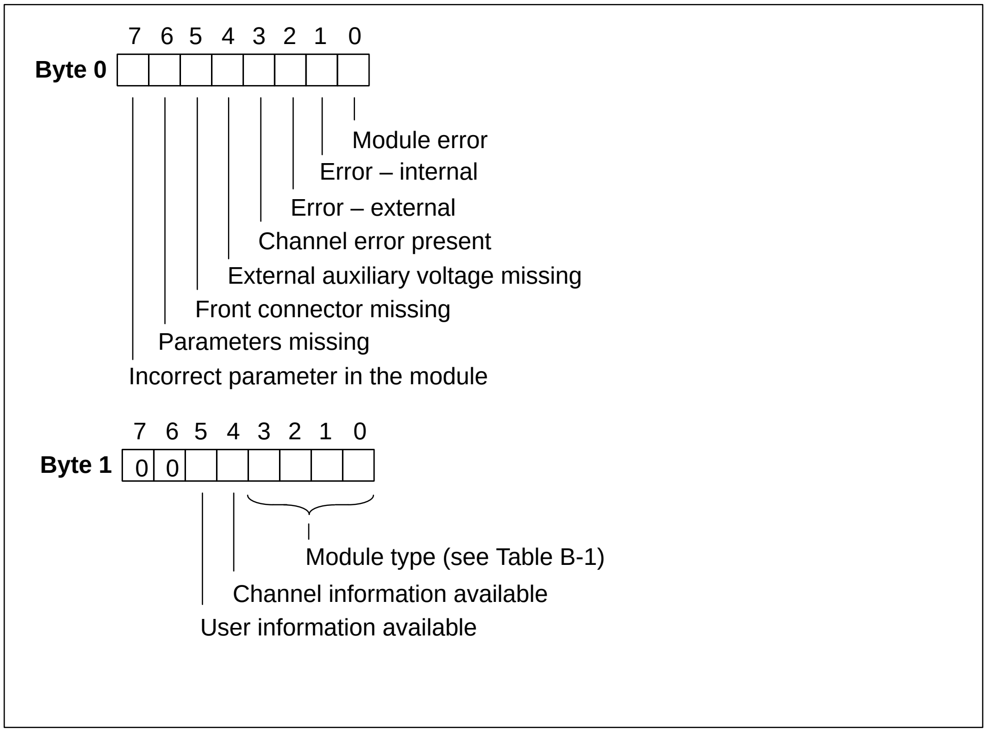


Figure B-1 Bytes 0 and 1 of the Diagnostics Data

Module Types

Table B-1 lists the codes of the module types (bits 0 to 3 in byte 1).

Table B-1 Codes of the Module Types

Code	Module Type
0101	Analog module
0110	CPU
1000	Function module
1100	CP
1111	Digital module

Bytes 2 and 3

Figure B-2 shows the contents of bytes 2 and 3 of the diagnostics data.

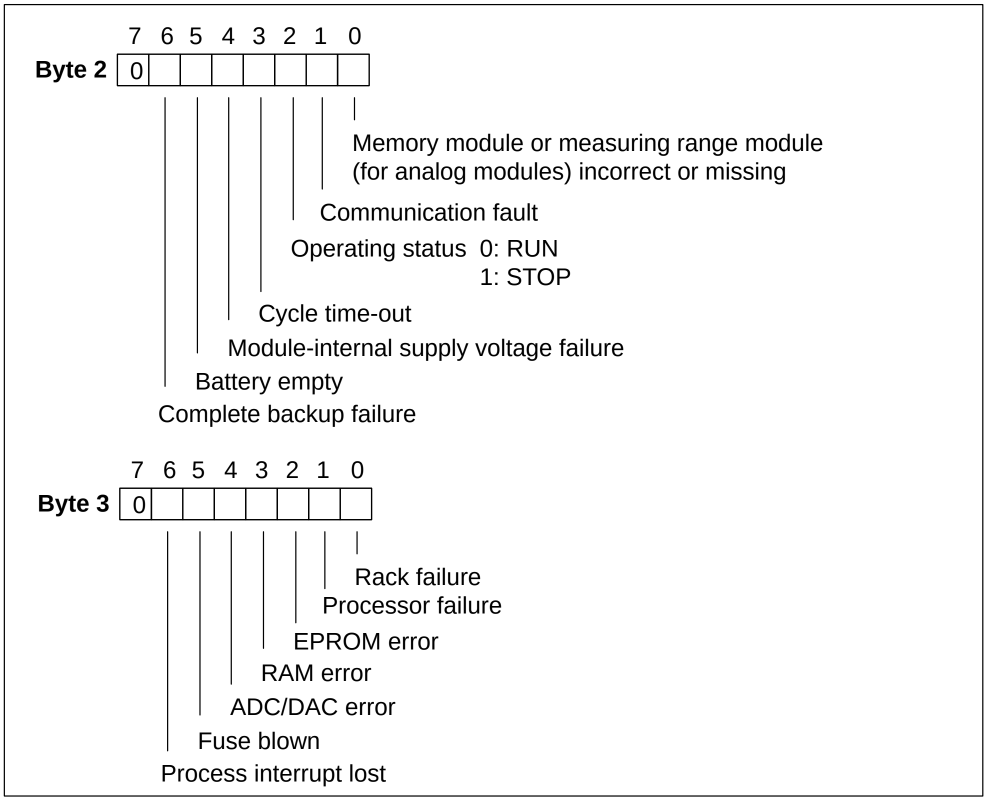


Figure B-2 Bytes 2 and 3 of the Diagnostics Data

Bytes 4 to 7

Figure B-3 shows the contents of bytes 4 to 7 of the diagnostics data.

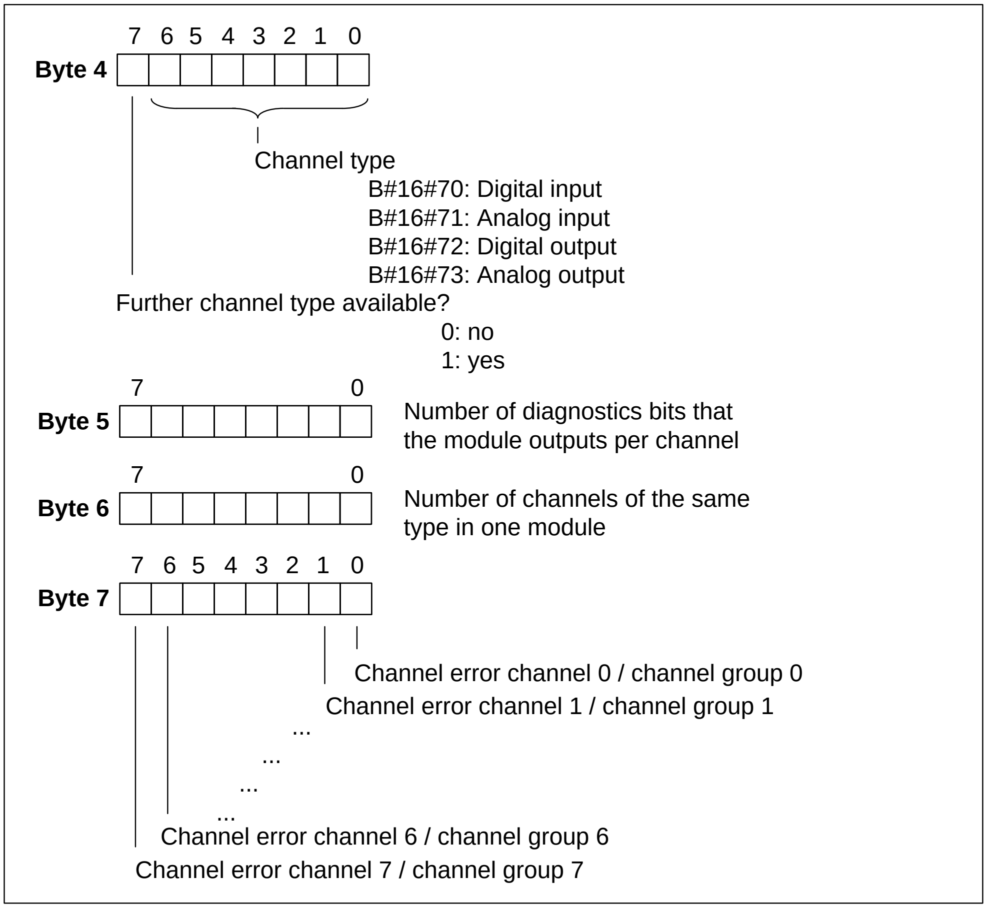


Figure B-3 Bytes 4 to 7 of the Diagnostics Data

Byte 7 and Higher: Channel-Specific Error

Bytes 7 to 15 of data record 1 contain the channel-specific errors (see Figures B-4 to B-7).

Analog Input Channel

Figure B-4 shows the bit assignment of the diagnostics byte for an analog input channel of the SM 331 analog input modules (see Sections 4.4 and 4.6). Section 4.3.5 includes a description of possible error causes and appropriate remedies.

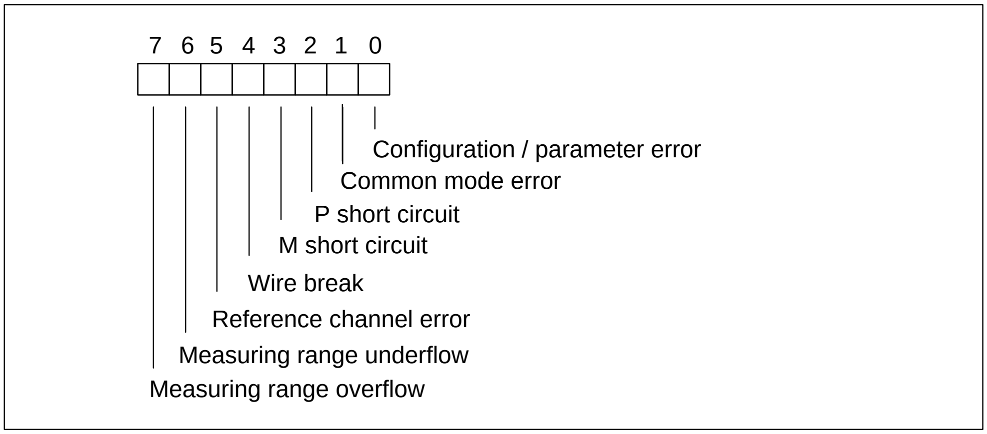


Figure B-4 Diagnostics Byte for an Analog Input Channel of an SM 331 Analog Input Module

Analog Output Channel

Figure B-5 shows the bit assignment of the diagnostics byte for an analog output channel of the SM 332 analog output modules (see Sections 4.7 and 4.8). Section 4.3.5 includes a description of possible error causes and appropriate remedies.

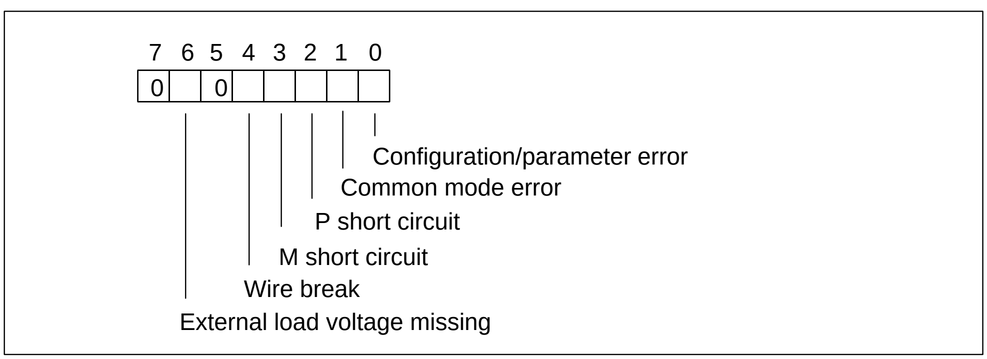


Figure B-5 Diagnostics Byte for an Analog Output Channel of an SM 332 Analog Output Module

Digital Input Channel

Figure B-6 shows the bit assignment of the diagnostics byte for a digital input channel of the digital input module SM 321; DI 16 × 24VDC; with process and diagnostics interrupt (see Section 3.1.3). This section also includes a description of possible error causes and appropriate remedies.

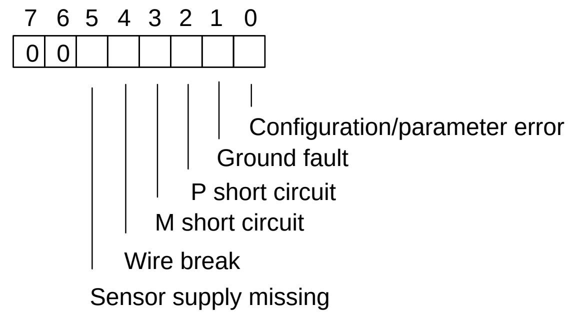


Figure B-6 Diagnostics Byte for a Digital Input Channel of the Digital Input Module SM 321; DI 16 × 24 VDC

Digital Output Channel

Figure B-7 shows the bit assignment of the diagnostics byte for a digital output channel of the digital output module SM 322; DO 8 24VDC/0.5A; with diagnostics alarm (see Section 3.2.3). This section also includes a description of possible error causes and appropriate remedies.

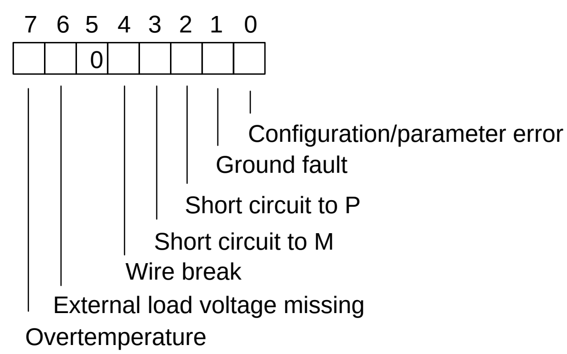


Figure B-7 Diagnostics Byte for a Digital Output Channel

Dimension Drawings

C

Introduction

In this appendix, you will find the dimension drawings for the most important components of an S7-300. The specifications in these dimension drawings are required for dimensioning the S7-300 configuration. The dimensions of an S7-300 configuration must be taken into account when installing an S7-300 in cabinets, switchgear rooms, etc. This appendix does not contain any dimension drawings of the CPUs of the S7-300 or M7-300 or of the IM 153-1. These dimension drawings are contained in the relevant manuals.

Contents

In this appendix, you will find the dimension drawings of the following S7-300 components.

C.1 Dimension Drawings of the Rails

483 mm Standard Rail

Figure C-1 shows the dimension drawing of the 483 mm standard rail.

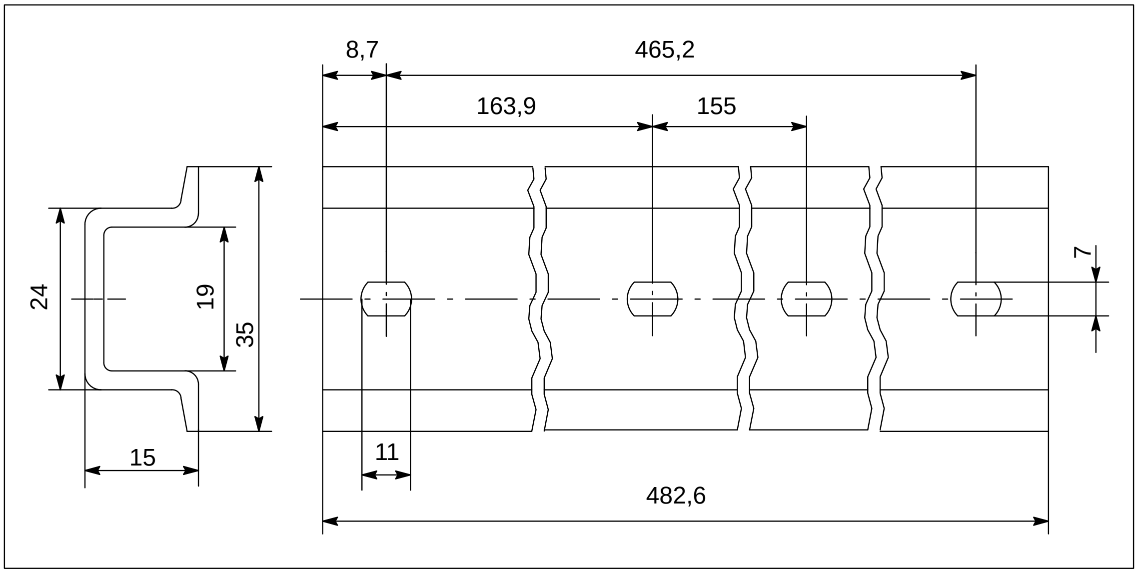


Figure C-1 Dimension Drawing of the 483 mm Standard Rail

530 mm Standard Rail

Figure C-2 shows the dimension drawing of the 530 mm standard rail.

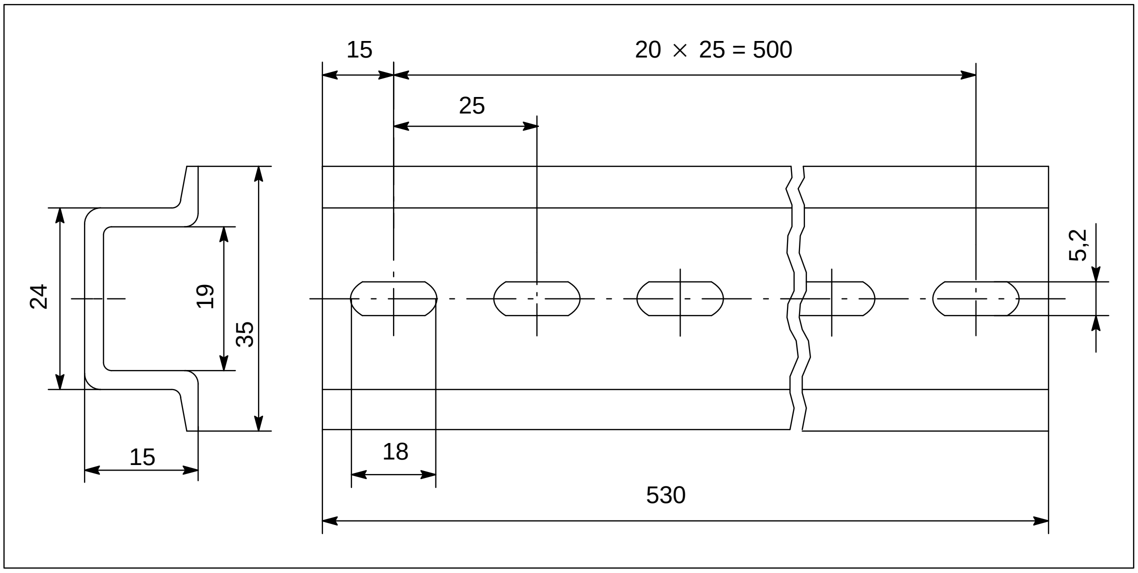


Figure C-2 Dimension Drawing of the 530 mm Standard Rail

830 mm Standard Rail

Figure C-3 shows the dimension drawing of the 830 mm standard rail.

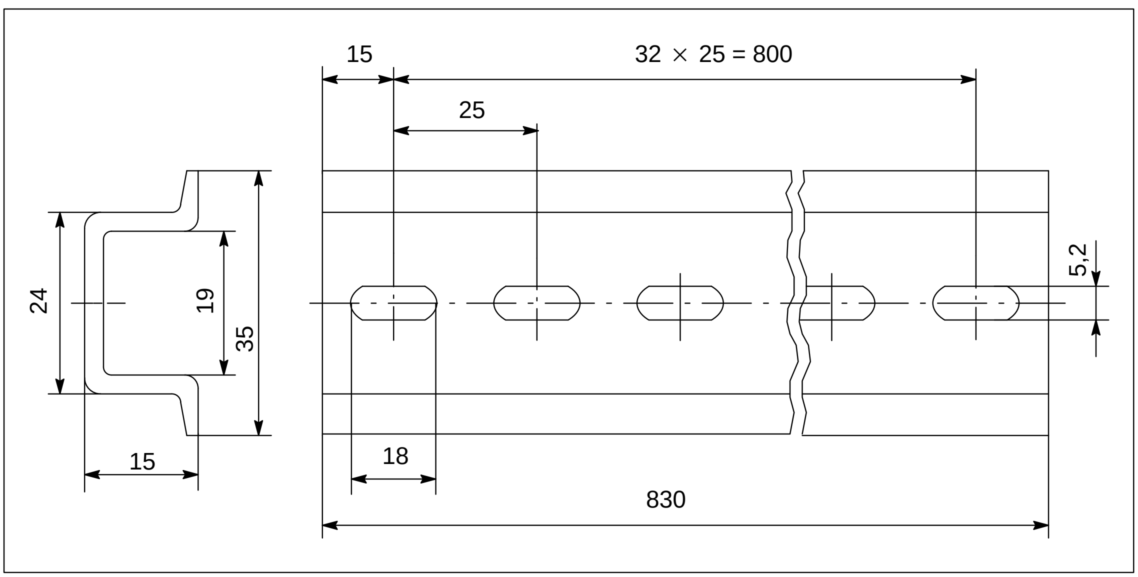


Figure C-3 Dimension Drawing of the 830 mm Standard Rail

2000 mm Standard Rail

Figure C-4 shows the dimension drawing of the 2000 mm standard rail.

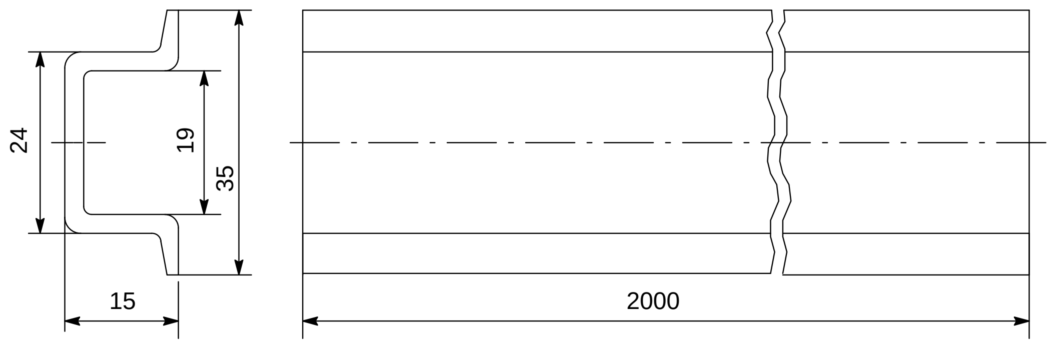


Figure C-4 Dimension Drawing of the 2000 mm Standard Rail

160 mm Rail

Figure C-5 shows the dimension drawing of the 160 mm rail.

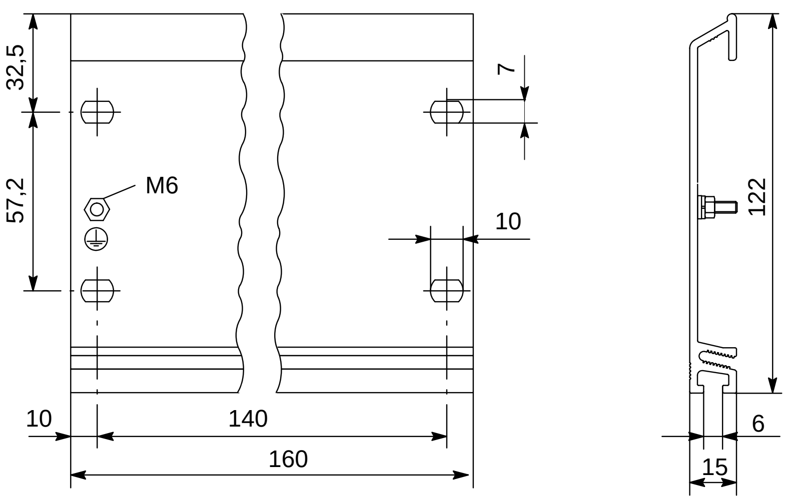


Figure C-5 Dimension Drawing of the Rail with 160 mm Standard Width

482.6 mm Rail

Figure C-6 shows the dimension drawing of the 482.6 mm rail.

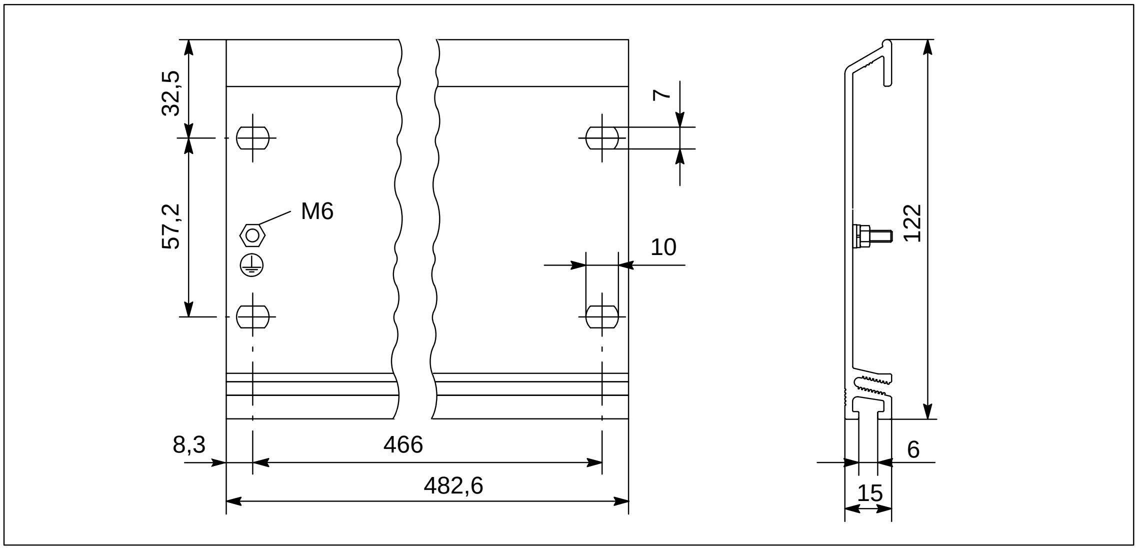


Figure C-6 Dimension Drawing of the Rail with 482.6 mm Standard Width

530 mm Rail

Figure C-7 shows the dimension drawing of the 530 mm rail.

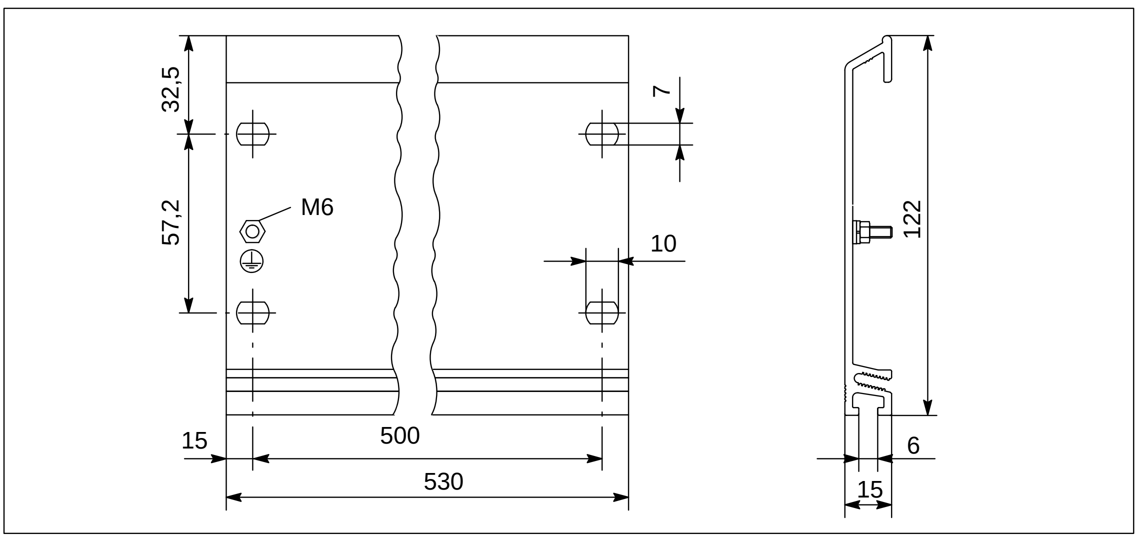


Figure C-7 Dimension Drawing of the Rail with 530 mm Standard Width

830 mm Rail

Figure C-8 shows the dimension drawing of the 830 mm rail.

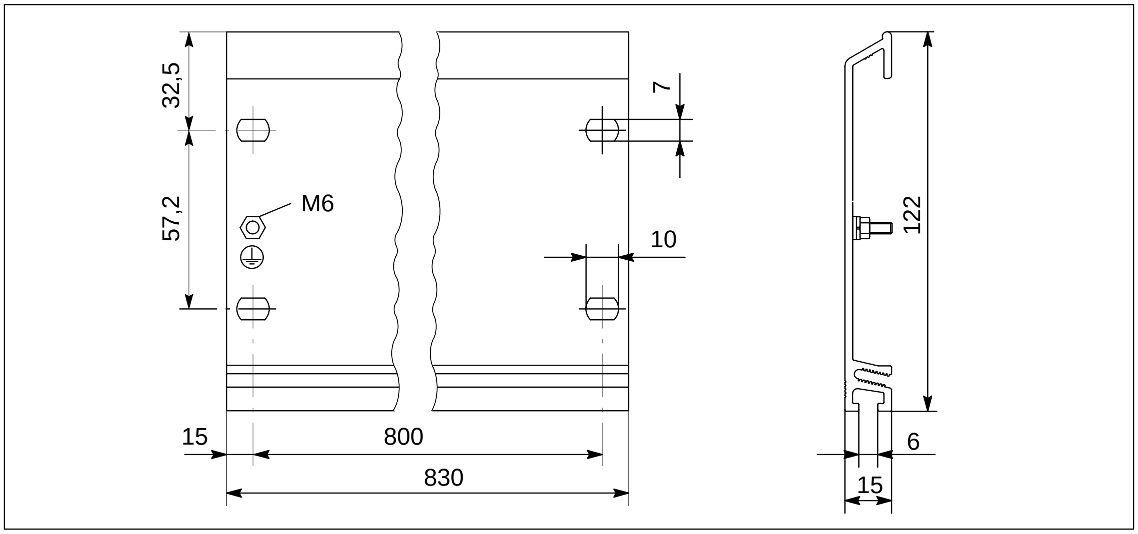


Figure C-8 Dimension Drawing of the Rail with 830 mm Standard Width

2000 mm Rail

Figure C-9 shows the dimension drawing of the 2000 mm rail.

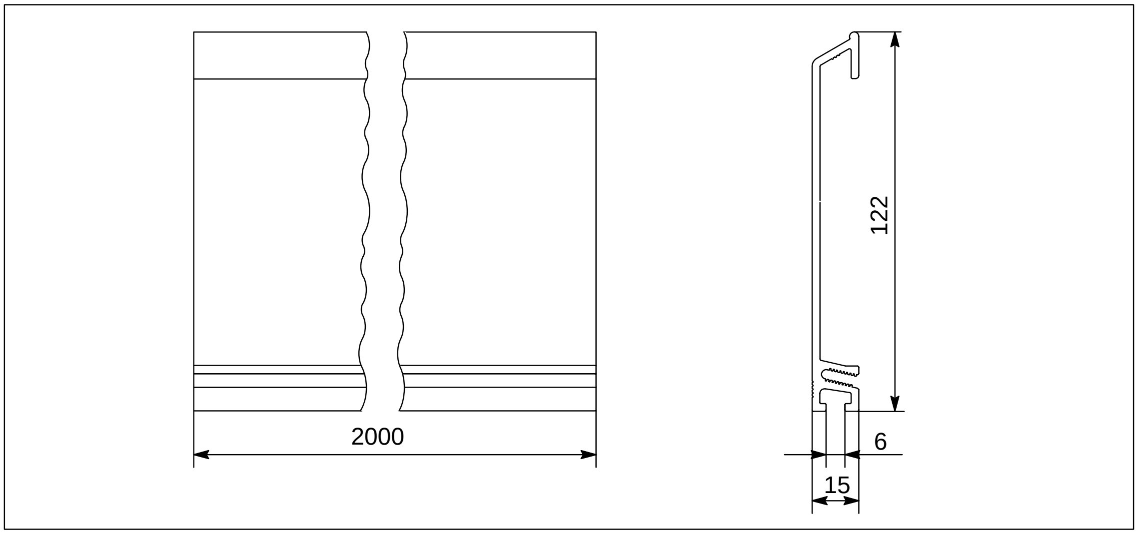


Figure C-9 Dimension Drawing of the 2000 mm Rail

Rail for “Insert and Remove” Function

Figure C-10 shows the dimension drawing of the rail for the “Insert and Remove” function with active bus module, S7-300 module and explosion-proof partition. The rail is 482.6 mm or 530 mm long.

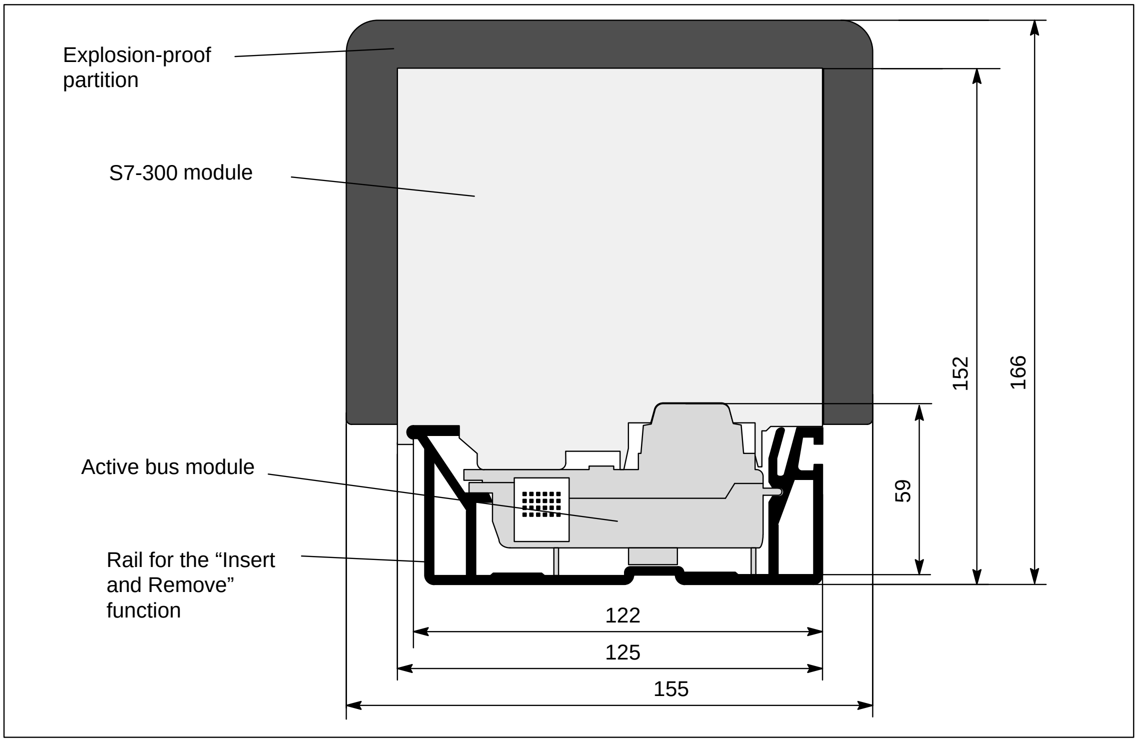
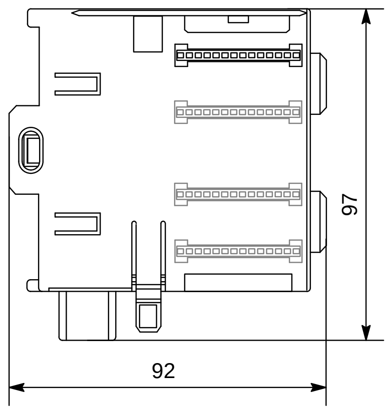


Figure C-10 Complete Dimension Drawing of a Rail for “Insert and Remove” Function with Active Bus Module, S7-300 Module and Explosion-proof Partition

Bus Modules (Expansion Buses)

Figure C-11 shows the dimension drawing of the active bus module for the “Insert and Remove” function.



Bus module
BM PS/IM (...7HA)
BM IM/IM (...7HD)
BM 2 × 40 (...7HB)
BM 1 × 80 (...7HC)

Figure C-11 Dimension Drawing of the Active Bus Modules

C.2 Dimension Drawings of the Power Supply Modules

PS 307; 2 A

Figure C-12 shows the dimension drawing of the PS 307; 2 A power supply module.

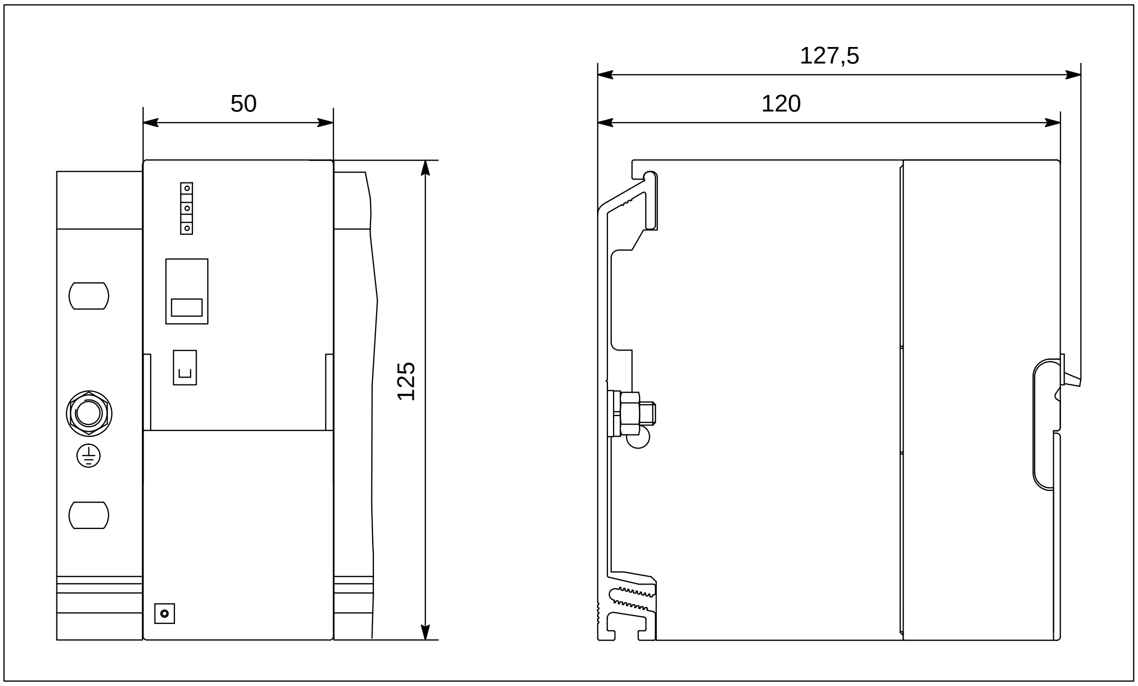


Figure C-12 Power Supply Module PS 307; 2 A

PS 307; 5A

Figure C-13 shows the dimension drawing of the PS 307; 5 A power supply module.

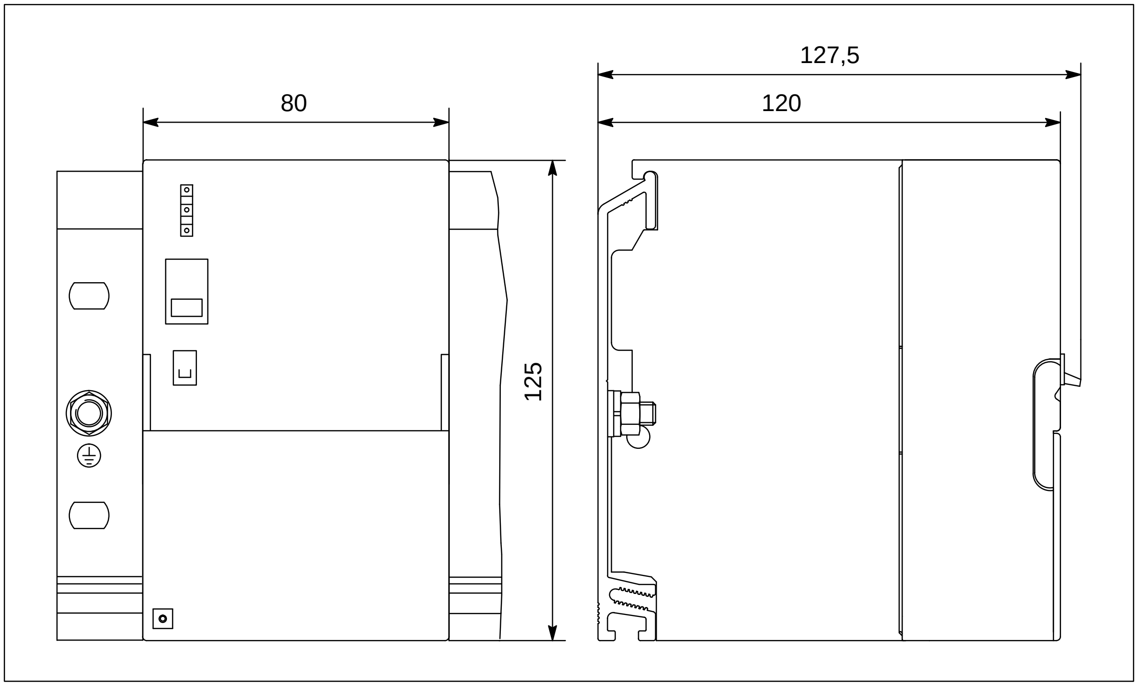


Figure C-13   Power Supply Module PS 307; 5 A

PS 307; 10 A

Figure C-14 shows the dimension drawing of the PS 307; 10 A power supply module.

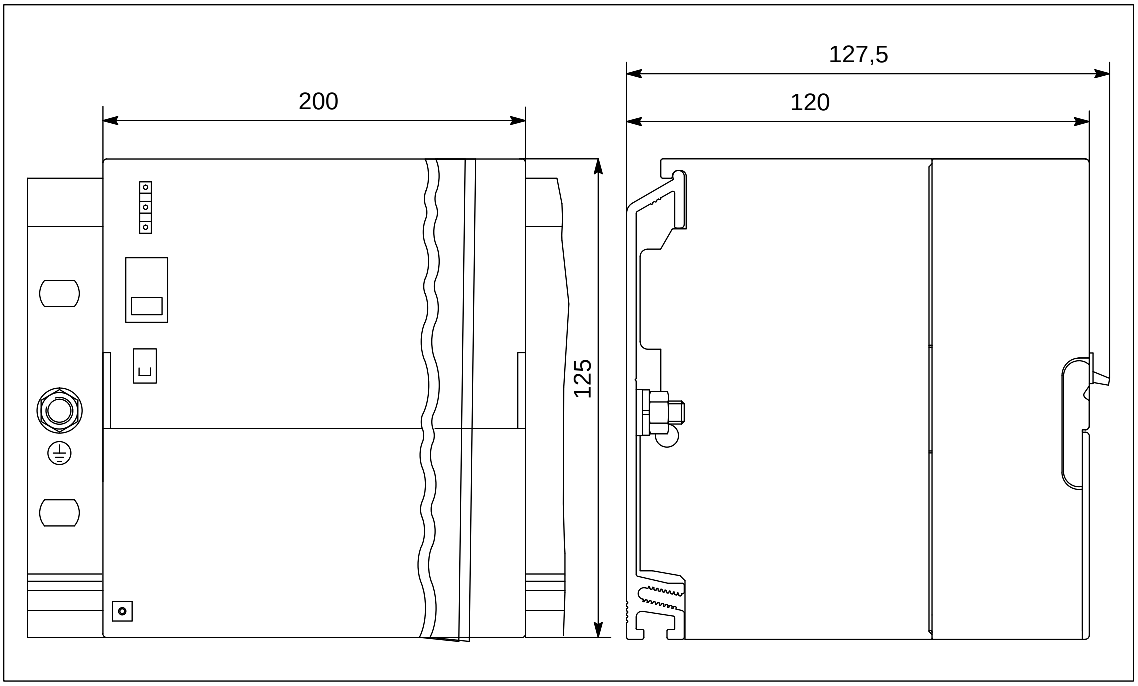


Figure C-14   Power Supply Module PS 307; 10 A

PS 307; 5 A with CPUs 313/314/315/315-2 DP

Figures C-15 and C-16 show the dimension drawings of the configuration of a power supply module PS 307; 5 A with the CPUs 313/314/315/315-2 DP. Observe the dimensions that result from the use of the power connector for wiring the PS 307; 5 A with the CPU.

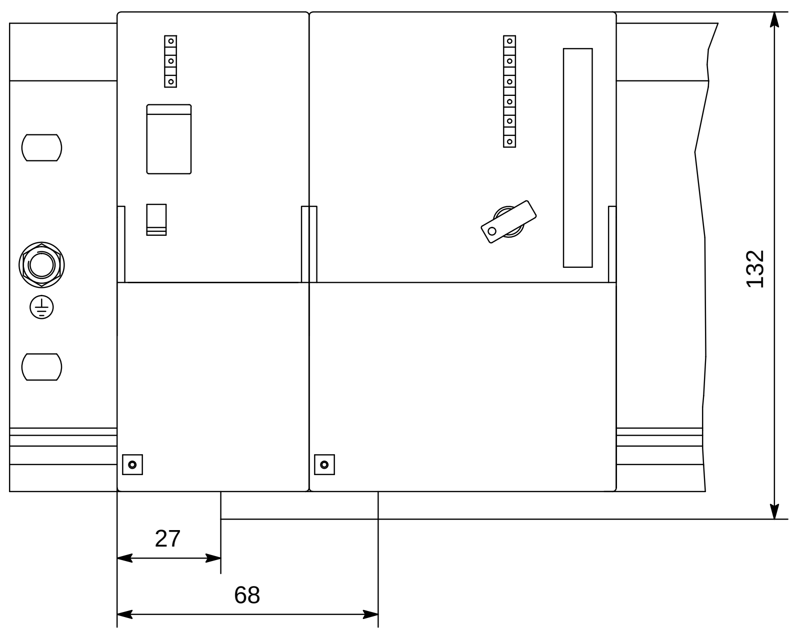


Figure C-15 Dimension Drawing of the Power Supply Module PS 307; 5 A with CPUs 313/314/315/315-2 DP. Front View

PS 307; 5 A with CPUs 313/314/315/315-2 DP

Figure C-16 shows the dimension drawing of the power supply module PS 307; 5 A with the CPUs 313/314/315/315-2 DP in the side view.

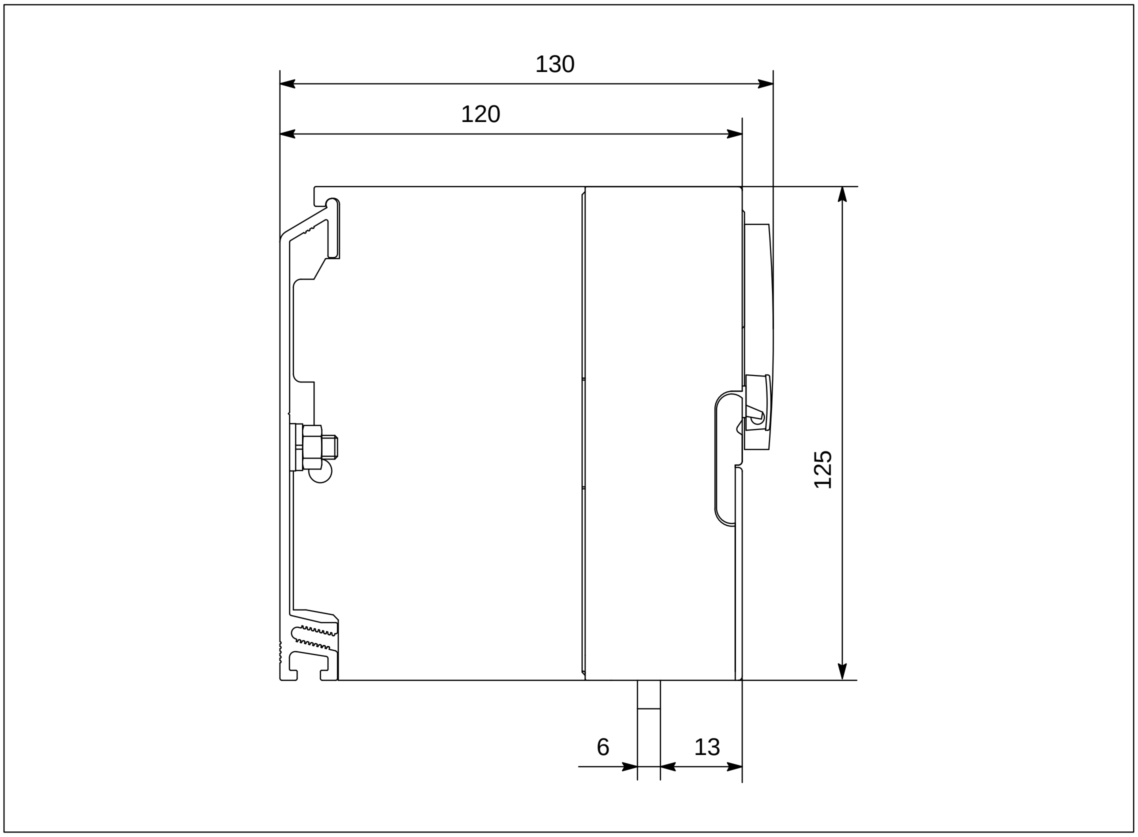


Figure C-16 Dimension Drawing of the Power Supply Module PS 307; 5 A with CPUs 313/314/315/315-2 DP. Side View

C.3 Dimension Drawings of the Interface Modules

IM 360

Figure C-17 shows the dimension drawing of the interface module IM 360.

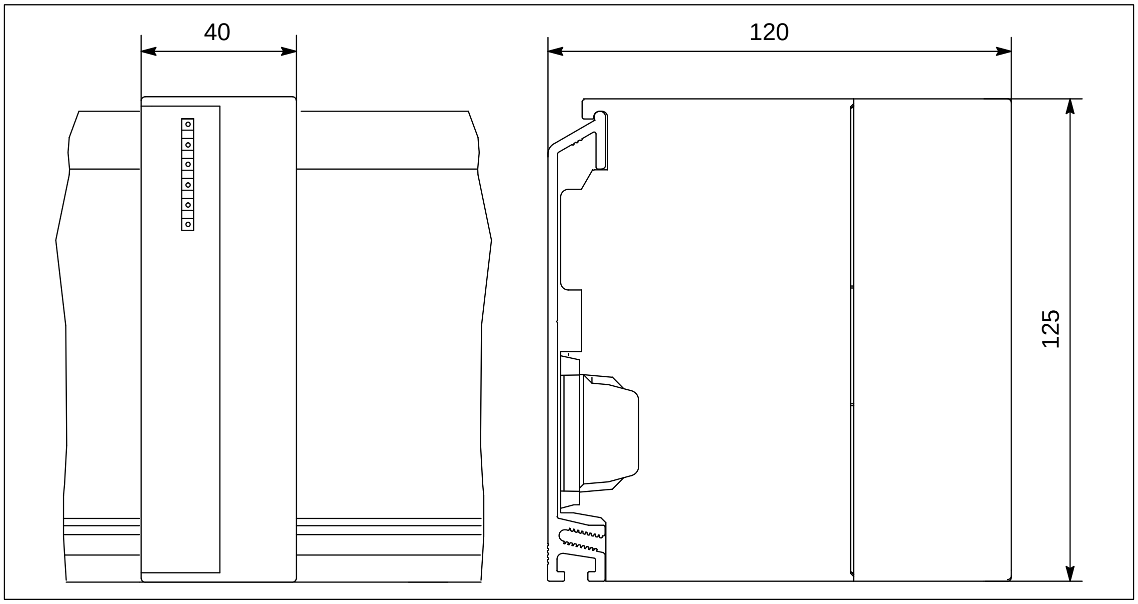


Figure C-17 Interface Module IM 360

IM 361

Figure C-18 shows the dimension drawing of the interface module IM 361.

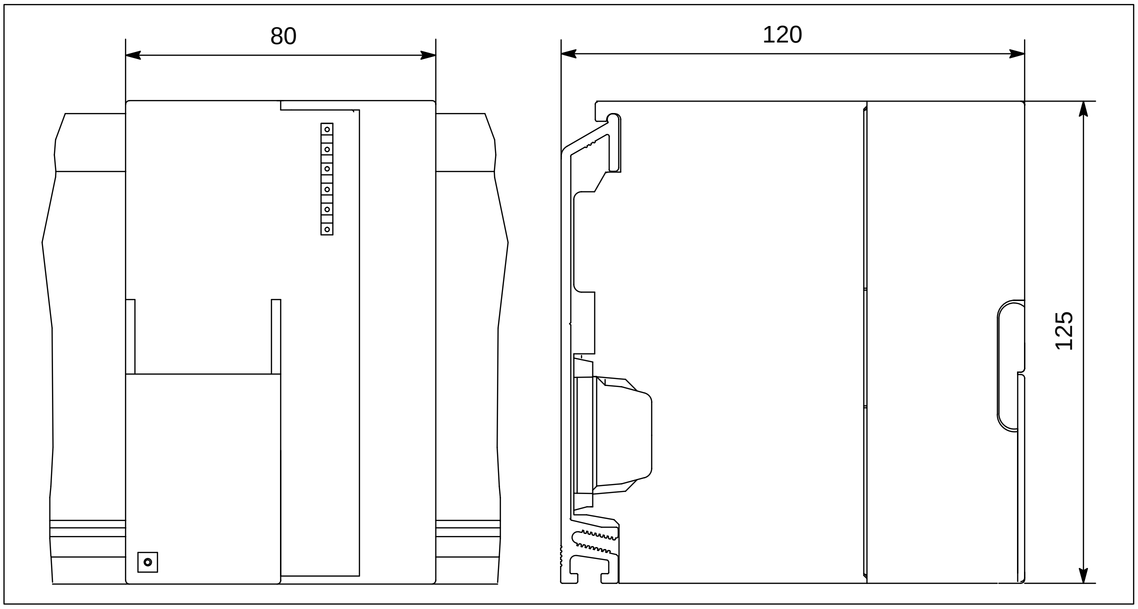


Figure C-18   Interface Module IM 361

IM 365

Figure C-19 shows the dimension drawing of the interface module IM 365.

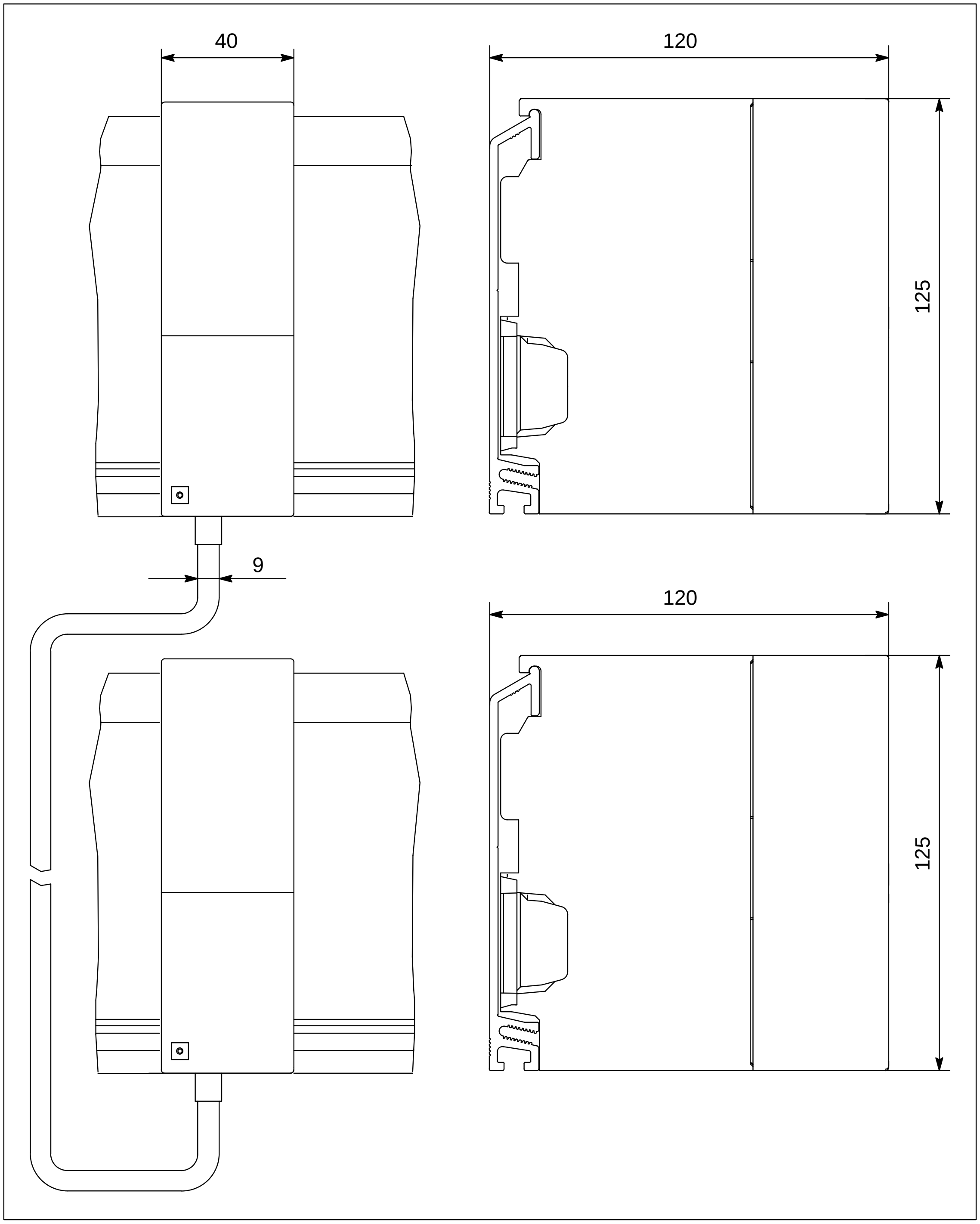


Figure C-19 Interface Module IM 365

C.4 Dimension Drawings of the Signal Modules

Signal Module

Figure C-20 shows the dimension drawing of the signal module. A signal module might look slightly different than the example below. The dimensions however are always the same.

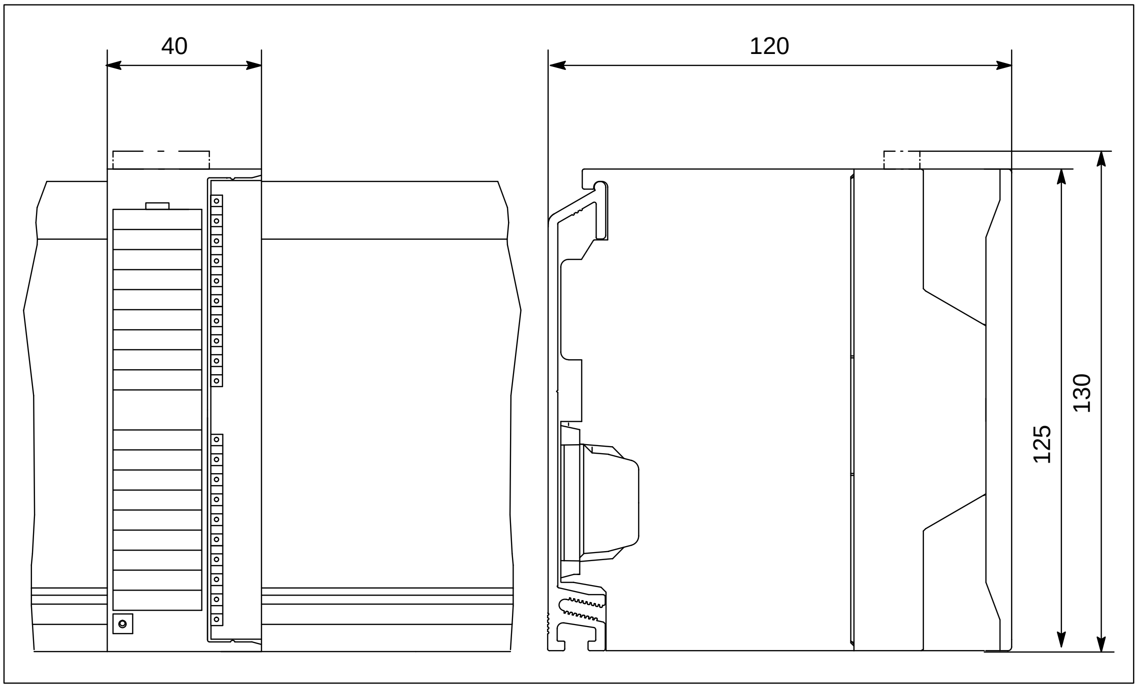


Figure C-20 Signal Module

C.5 Dimension Drawings for Accessories

Shield Connecting Element

Figure C-21 shows the dimension drawing of the shield connecting element in connection with two signal modules.

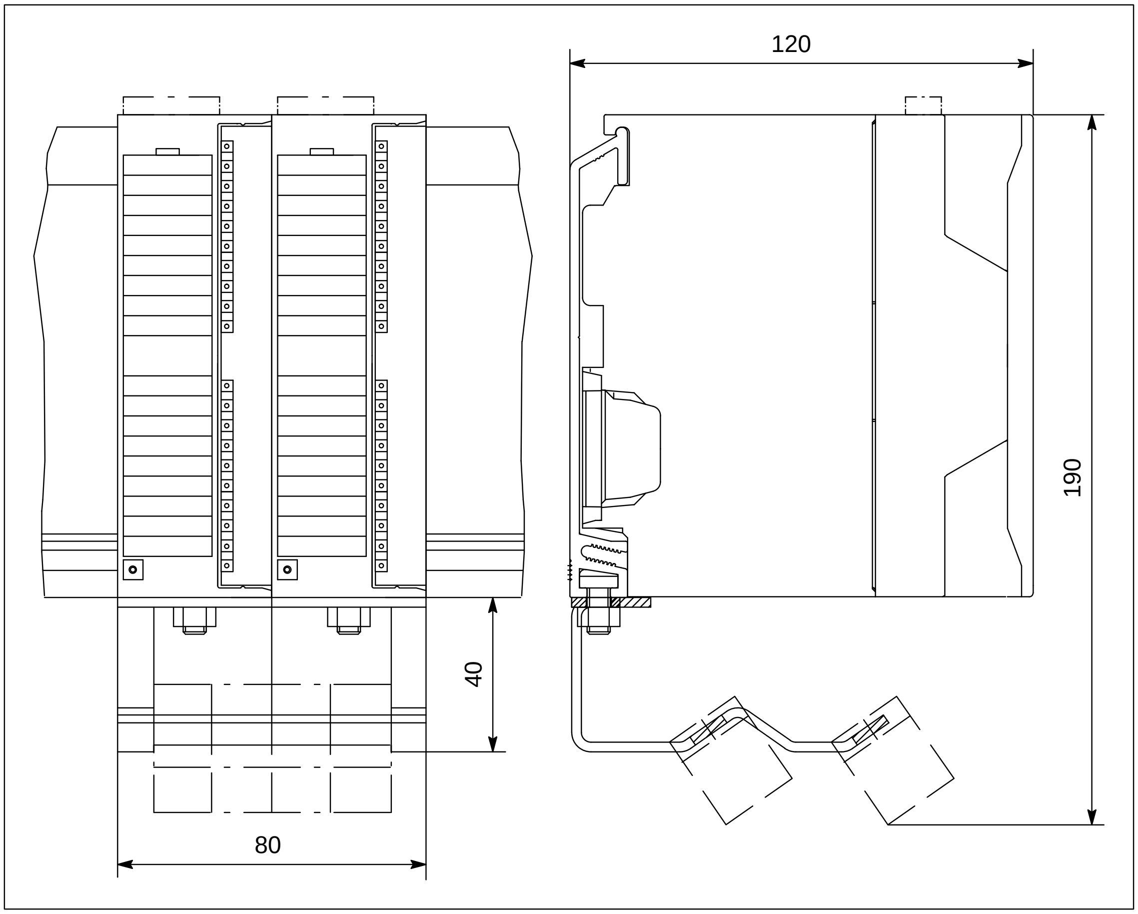


Figure C-21 2 Signal Modules with Shield Connecting Element

SIMATIC TOP Connect, 3-Tier

Figure C-22 shows the dimension drawing of the 3-tier SIMATIC TOP connect.

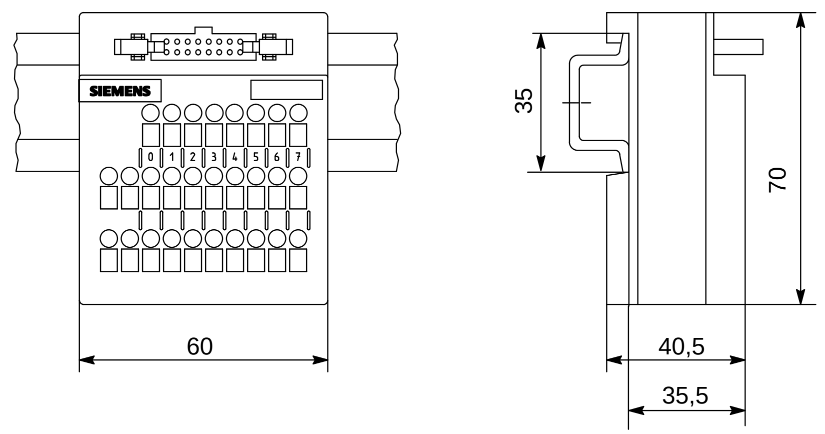


Figure C-22 SIMATIC TOP Connect, 3-Tier

SIMATIC TOP Connect, 2-Tier

Figure C-23 shows the dimension drawing of the 2-tier SIMATIC TOP connect.

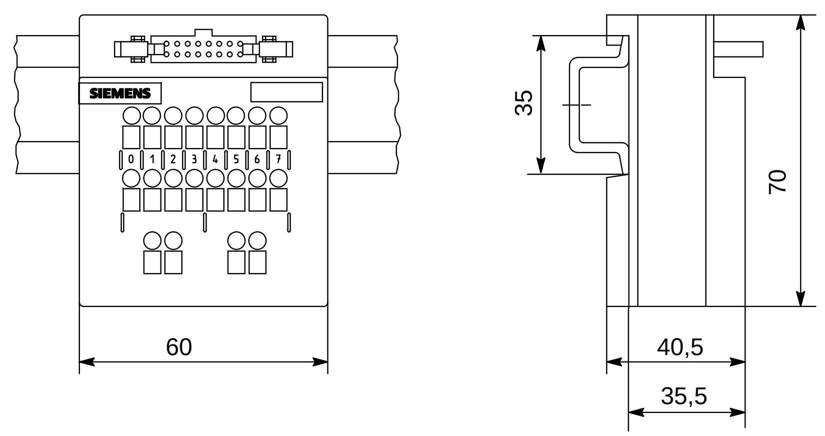


Figure C-23 SIMATIC TOP Connect, 2-Tier

SIMATIC TOP Connect, 1-Tier

Figure C-24 shows the dimension drawing of the 1-tier SIMATIC TOP connect.

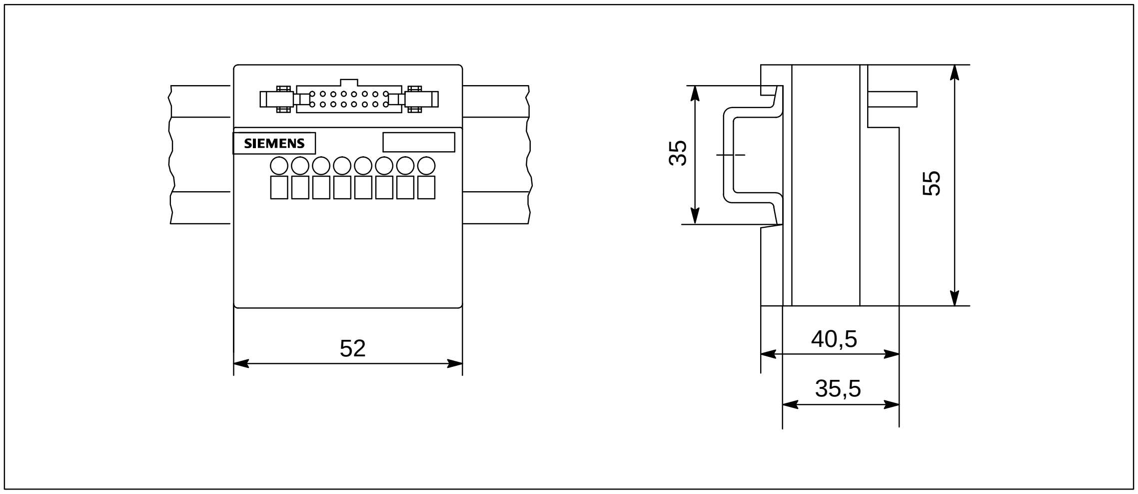


Figure C-24 SIMATIC TOP Connect, 1-Tier

RS 485 Repeater on Standard Rail

Figure C-25 shows the dimension drawing of the RS 485 repeater on the standard rail.

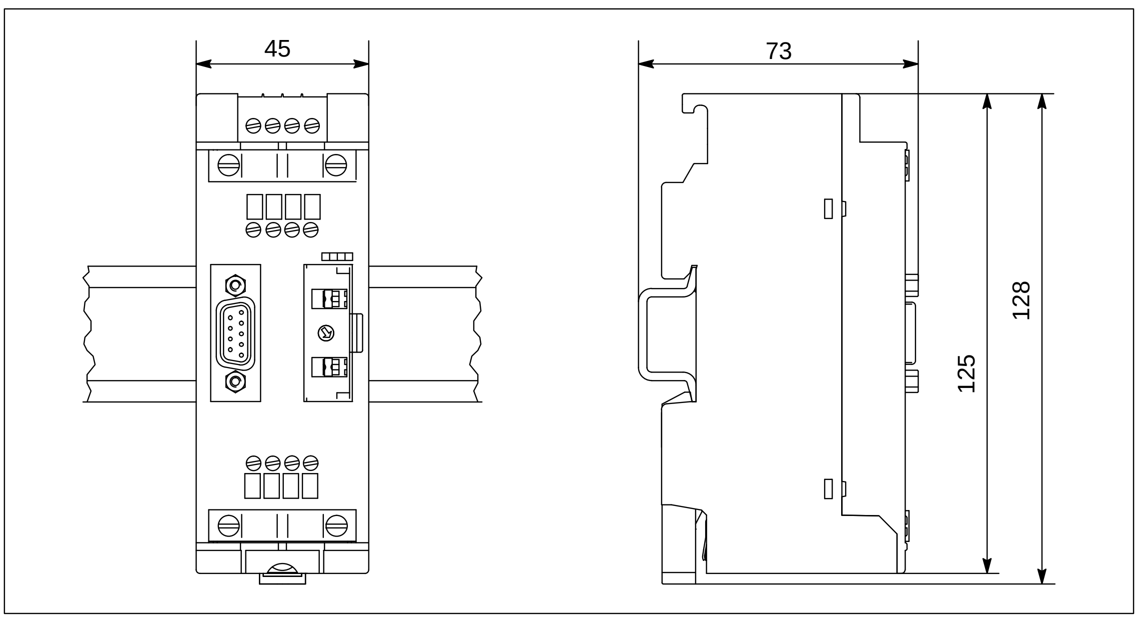


Figure C-25 RS 485 Repeater on Standard Rail

RS 485 Repeater on S7-300 Rail

Figure C-26 shows the dimension drawing of the RS 485 repeater on the S7-300 rail.

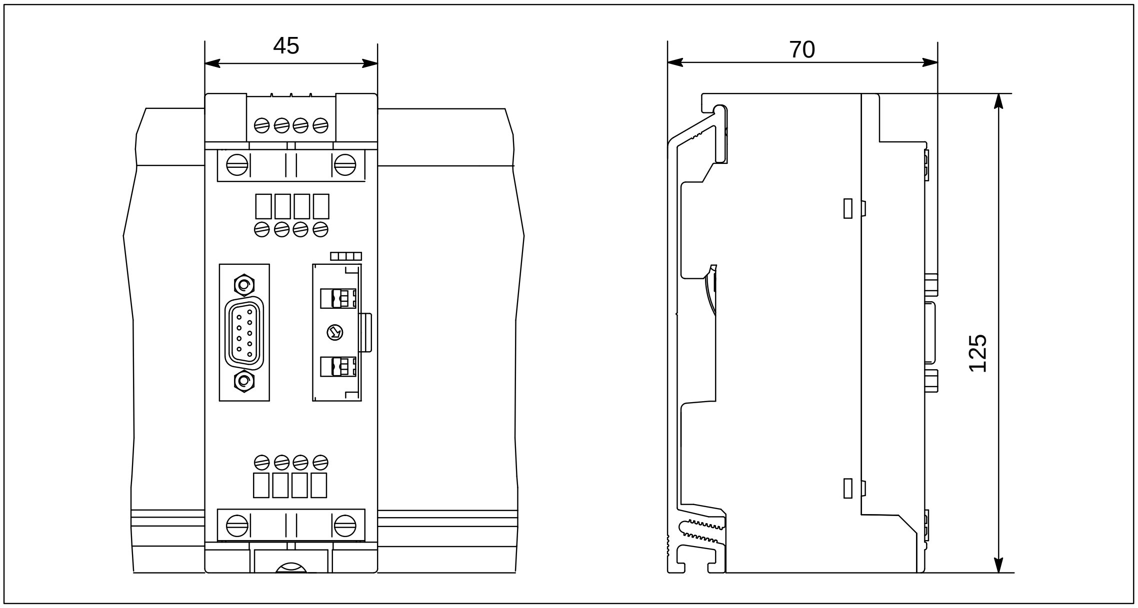


Figure C-26   RS 485 Repeater on S7-300 Rail

Spare Parts and Accessories for S7-300 Modules

D

Spare Parts

Table D-1 lists all the parts you can order separately or later for S7-300 programmable controllers.

Table D-1 Accessories and Spare Parts

S7-300 Parts	Order No.
Bus connector	6ES7 390-0AA00-0AA0
Power connector between power supply unit and CPU	6ES7 390-7BA00-0AA0
Labeling strip (Qty 10) • for 8/16-channel modules • for 32-channel modules	 6ES7 392-2XX00-0AA0 6ES7 392-2XX10-0AA0
Slot numbering label	6ES7 912-0AA00-0AA0
Front connector 20-pin • Screw-type connection • Spring-loaded connection	 6ES7 392-1AJ00-0AA0 6ES7 392-1BJ00-0AA0
Front connector 40-pin • Screw-type connection	 6ES7 392-1AM00-0AA0
Front connector for 2 flat ribbon terminals • Screw-type connection • Spring-loaded connection	 6ES7 921-3AB00-0AA0 6ES7 921-3AA00-0AA0
Front connector for 4 flat ribbon terminals • Spring-loaded connection	 6ES7 921-3AA20-0AA0
SIMATIC TOP connect, 1-tier, with • Screw-type connection • Spring-loaded connection	 6ES7 924-0AA00-0AA0 6ES7 924-0AA00-0AB0
SIMATIC TOP connect, 2-tier, with • Screw-type connection • Spring-loaded connection	 6ES7 924-0BB00-0AA0 6ES7 924-0BB00-0AB0

Table D-1 Accessories and Spare Parts, continued

S7-300 Parts	Order No.
SIMATIC TOP connect, 3-tier, with • Screw-type connection • Spring-loaded connection	 6ES7 924-0CA00-0AA0 6ES7 924-0CA00-0AB0
Round-sheath ribbon cable (16-pin) • Unshielded 30 m (98.4 ft.) • Unshielded 60 m (196.8 ft.) • Shielded 30 m (98.4 ft.) • Shielded 60 m (196.8 ft.)	 6ES7 923-0CD00-0AA0 6ES7 923-0CG00-0AA0 6ES7 923-0CD00-0BA0 6ES7 923-0CG00-0BA0
Plug-in connectors, 16-pin, set of 8 (insulation displacement connectors)	6ES7 921-3BE10-0AA0
Shield connecting element	6ES7 390-5AA00-0AA0
Shield connection terminals for • 2 cables with a shield diameter of 2 to 6 mm each • 1 cable with a shield diameter of 3 to 8 mm • 1 cable with a shield diameter of 4 to 13 mm	 6ES7 390-5AB00-0AA0 6ES7 390-5BA00-0AA0 6ES7 390-5CA00-0AA0
Measuring range module for analog modules	6ES7 974-0AA00-0AA0
Fuse set for 120/230 VAC digital output modules (contains 10 fuses and 2 fuse holders)	6ES7 973-1HD00-0AA0

Guidelines for Handling Electrostatic Sensitive Devices (ESD)

E

Introduction

In this appendix, we explain

- what is meant by “electrostatic sensitive devices”
- the precautions you must observe when handling and working with electrostatic sensitive devices.

Contents

This chapter contains the following sections on electrostatic sensitive devices:

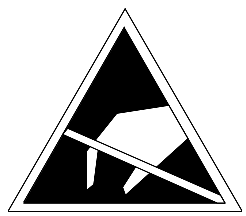
E.1 What is ESD?

Definition

All electronic modules are equipped with large-scale integrated ICs or components. Due to their design, these electronic elements are very sensitive to overvoltages and thus to any electrostatic discharge.

These **E**lectrostatic **S**ensitive **D**evices are commonly referred to by the abbreviation **ESD**.

Electrostatic sensitive devices are labelled with the following symbol:



Caution

Electrostatic sensitive devices are subject to voltages that are far below the voltage values that can still be perceived by human beings. These voltages are present if you touch a component or the electrical connections of a module without previously being electrostatically discharged. In most cases, the damage caused by an overvoltage is not immediately noticeable and results in total damage only after a prolonged period of operation.

E.2 Electrostatic Charging of Persons

Charging

Every person with a non-conductive connection to the electrical potential of its surroundings can be charged electrostatically.

Figure E-1 shows you the maximum values for electrostatic voltages which can build up on a person coming into contact with the materials indicated in the figure. These values are in conformity with the specifications of IEC 801-2.

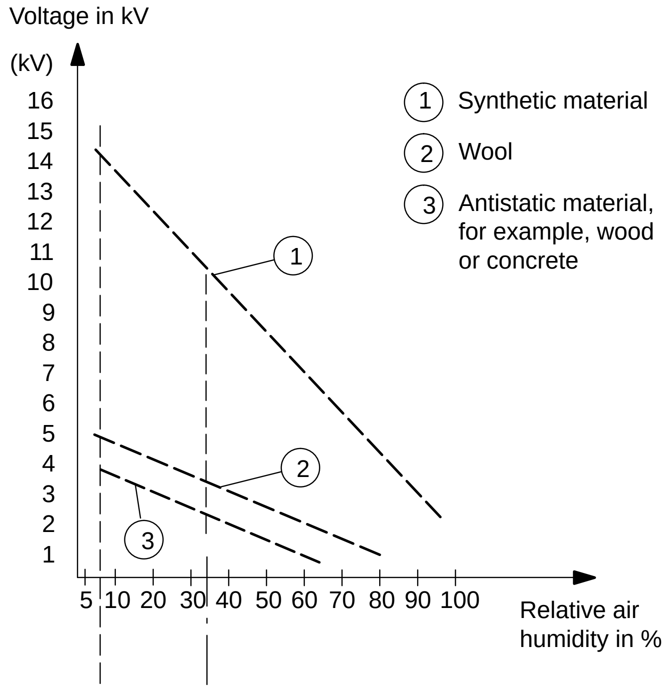


Figure E-1 Electrostatic Voltages which can Build up on a Person

E.3 General Protective Measures Against Electrostatic Discharge Damage

Ensure Sufficient Grounding

Make sure that the personnel, working surfaces and packaging are sufficiently grounded when handling electrostatic sensitive devices. You thus avoid electrostatic charging.

Avoid Direct Contact

You should touch electrostatic sensitive devices only if it is unavoidable (for example, during maintenance work). Hold modules without touching the pins of components or printed conductors. In this way, the discharged energy cannot affect the sensitive devices.

If you have to carry out measurements on a module, you must discharge your body before you start the measurement by touching grounded metallic parts. Use grounded measuring devices only.

List of Abbreviations

F

Abbreviation	Description
ADC	Analog-digital converter
AI	Analog input
AO	Analog output
CPU	Central processing unit of programmable controller
DAC	Digital-analog converter
DB	Data block
DI	Digital input
DO	Digital output
EMC	Electromagnetic compatibility
ESD	Electrostatic sensitive device
FB	Function block
IM	Interface module
IP	Intelligent I/O
LS	Leading sign
M	Ground connection
MPI	Multiple point interface
OB	Organization block
OP	Operator panel
PG	Programming device
PLC	Programmable controller
PS	Power supply
SFC	System function

Glossary

Analog Module

Analog modules convert analog process variables (for example, temperature) into digital values that can be processed in the CPU or they convert digital values into analog manipulated variables.

Chassis Ground

The chassis ground comprises all interconnected inactive parts of an apparatus, which even in case of a fault cannot take dangerous touch voltages.

CPU

Central processing unit of the S7 programmable controller with control and arithmetic unit, memory, operating system and interface for programming device.

Data Block

Data blocks (DB) are data areas in the user program, which contain user data. Global data blocks can be accessed by all code blocks and instance data blocks are assigned to a specific FB call.

Diagnostics

→ System Diagnostics

Diagnostics Buffer

The diagnostics buffer is a backed up memory area in the CPU where diagnostic events are stored in the order they occur.

Diagnostics Interrupt

Modules with diagnostics capability signal system errors to the → CPU by means of diagnostic interrupts.

Equipotential Bonding

An electrical connection (equipotential bonding conductor) that ties the exposed conductive parts of an item of electrical equipment and extraneous conductive parts to the same, or approximately the same, potential in order to prevent disturbing or dangerous voltages between these parts.

Error Display

Error display is one of the possible responses of the operating system to a → Run Time Error. The other possible responses include: → Error Response in the user program, STOP mode of the CPU.

Error Handling via OB

When the operating system detects an error (for example, STEP 7 access error), it calls the specific organization block (error OB) for this error, where the further response of the CPU can be specified.

Functional Grounding

Grounding whose only purpose is to ensure the intended function of the electrical equipment concerned. Functional grounding short-circuits any noise that might otherwise have a detrimental effect on the equipment.

Ground

The conductive mass of the ground whose potential can be assumed to be zero at any point.
In the vicinity of ground electrodes, the ground may have a potential other than zero. The term ”reference ground” is often used in this situation.

Ground (verb)

To ground means connecting an electrically conductive part via a grounding system to ground (one or several electrically conductive parts that have good contact with the soil).

Hardware Interrupt

Interrupt-triggering modules trigger a hardware interrupt in the case of a certain event in the process. The hardware interrupt is signalled to the CPU. In accordance with the priority of this interrupt, the corresponding → Organization Block is then executed.

Interrupt

The → Operating System of the CPU has 10 different priority classes which control execution of the user program. These priority classes include interrupts, as for example, process interrupts. When an interrupt occurs, the operating system automatically calls a corresponding organization block where the user can program the reaction desired (for example, in an FB).

Interrupt, Diagnostics

→ Diagnostics Interrupt

Interrupt, Hardware

→ Hardware Interrupt

Isolated

In the case of isolated input/output modules, the reference potentials of the control and load circuits are galvanically isolated from each other, for example, by optocouplers, relay contacts or transformers. The input/output circuits can be connected to a common potential.

Measuring Range Module

Measuring range modules are plugged onto the analog input module for adaptation to various measuring ranges.

Module Parameters

Module parameters are used to set the module reactions. A difference is made between static and dynamic module parameters.

Non-Isolated

In the case of non-isolated input/output modules, the reference potentials of the control and load circuits are electrically connected to each other.

Operating Mode

The SIMATIC S7 programmable controllers have the following operating modes: STOP, → RESTART, RUN.

Parameters

1. Variable of a STEP 7 code block
2. Variable for setting the module reaction (one or several per module). Each module is supplied with a basic setting that can be changed by means of *STEP7*. Parameters can be → Dynamic or → Static.

Parameters, Dynamic

In contrast to static parameters, dynamic parameters of modules can be changed during running operation by calling an SFC in the user program, for example, limit values of an analog signal input module.

Parameters, Static

In contrast to dynamic parameters, static parameters of modules cannot be changed by means of the user program, but only via *STEP7*, for example, input delay of a digital signal input module.

PG

→ Programming Device

PLC

→ Programmable Controller

Programmable Controller

Programmable controllers (PLCs) are electronic control devices whose functions are stored in the controller in the form of a program. The configuration and wiring of a PLC therefore do not depend on the actual functions of the control. Programmable controllers and computers have similar structures: they consist of a CPU (central processing unit) with memory, input/output modules and an internal bus system. The I/O and programming language are tailored to the requirements of open-loop control technology.

Programming Device

Programming devices are principally personal computers that are industry-standard, compact and transportable. They are characterized by a special hardware and software for SIMATIC programmable controllers.

Reference Ground

→ Ground

Reference Potential

The potential on which the voltages of the various circuits are based and according to which they are measured.

RESTART

On transition from the STOP to the RUN mode, the PLC goes through the RESTART mode.
It can be triggered using the → Mode Selector or after a power on or through operator intervention on the programming device. With the S7-300, a → Complete Restart is carried out.

S7-300 Backplane Bus

The S7-300 backplane bus is a serial data bus the modules use to communicate with each other and from which they draw the power they require. The connection between the modules is implemented via bus connectors.

SFC

→ System Function

Signal Module

Signal modules (SMs) are the interface between the process and the programmable controller. Signal modules comprise digital input and output modules (input/output module, digital) and analog input and output modules (input/output module, analog).

STEP 7

Programming language for generating user programs for SIMATIC S7 programmable controllers.

Substitute Value

Substitute values are values which are output to the process in the case of faulty signal output modules or which are used in the user program instead of a process variable in the case of faulty signal input modules. The substitute values can be specified in advance by the user (for example, maintain old value).

System Diagnostics

System diagnostics comprises the recognition, evaluation and signalling of errors which occur within the programmable controller. Examples of such errors include: Program errors or module failures. System errors can be indicated via LEDs or via the STEP 7 tool *S7 Information*.

System Function

A system function (SFC) is a → Function integrated in the operating system of the CPU, which can be called in the STEP 7 user program if required.

Total Current

Sum of currents of all output channels of a digital output module.

Ungrounded

Without galvanic connection to ground

User Program

With SIMATIC; a difference is made between the → Operating System of the CPU and user programs. The latter are generated by means of the → STEP 7 programming software in the possible programming languages (Ladder Logic and Statement List) and are stored in code blocks. Data is stored in data blocks.

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