SIEMENS

SIMATIC S7

Supplement to Manual

C79000-Z7076-C412-05

S7-400, M7-400 Programmable Controllers

This Supplement contains **additional information** about the products. It is a separate component and should be considered **more up-to-date** than the information in the manuals and catalogs if uncertainties arise.

Disclaimer of Liability

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

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Technical data subject to change.

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Progress
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Contents

1 Connecting the Central Rack (CR) and the Expansion Rack (ER)

EXTF LED on the IM 461-x

In the case of an expansion rack connected to a central rack via an IM 460-3/IM 461-3 (remote link), the EXTF LED on the receive IM 461-3 lights up when the CR is switched off.

In the case of an ER connected to a CR via an IM 460-0/IM 461-0 or IM 460-1/IM 461-1 (local link), the EXTF LED on the receive IM does not light up when the CR is switched off.

Interference Suppression Measures

In order to conform to the requirements of the EC Directive 89/336/EEC "Electromagnetic Compatibility" (CE mark), you should take the following measures when connecting central racks and expansion racks:

- Remote connection of expansion rack to a central rack with mounting rack UR via IM 460-0/IM 461-0:

  Attach a ferrule (split ferrite core) close to each connector on the IM cable

A suitable split ferrite core is that of the type SFC 10 by Thora, Winn 6, D-91567 Herrieden, Germany Tel. +49 9825 4755 or a comparable product.

Figure 1 shows an IM cable with a ferrule (split ferrite core).

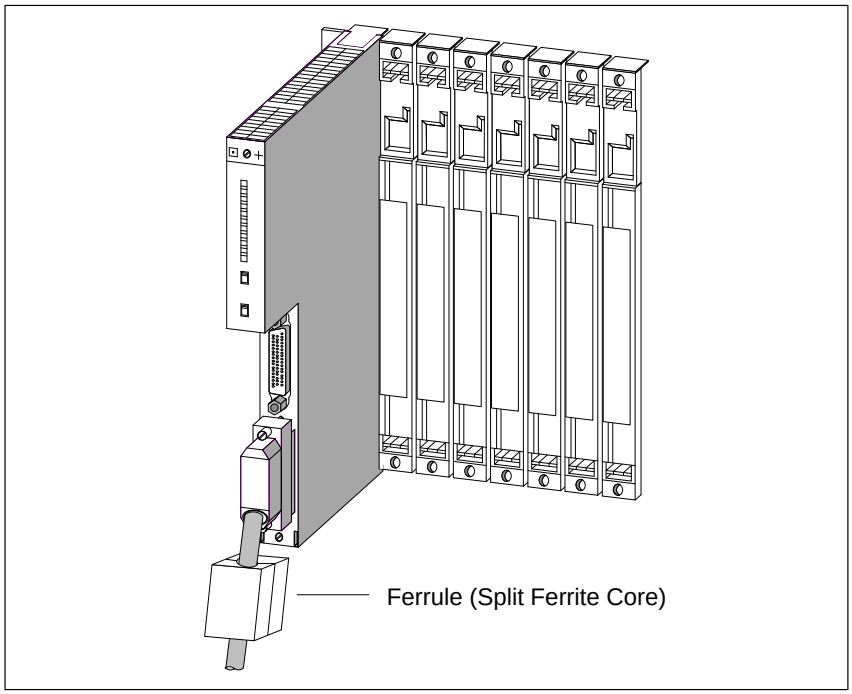


Figure 1 IM Cable with Ferrule (Split Ferrite Core)

2 Special Features of STEP 7 Programming with CPUs 41x

Starting a Timer

If there is an instruction for starting a timer programmed in the user program, there must be a BCD number at this point in the program sequence in accumulator 1. This also applies if the timer is not started.

Setting a Counter

If there is an instruction for setting a counter programmed in the user program, there must be a BCD number at this point in the program sequence in accumulator 1. This also applies if the counter is not set.

SLD and SRD Instructions

If parameters 64, 96, 128, 160, 192, or, 224 are transferred to the SRD or SLD instructions in accumulator 2-L-L with the CPUs 41x, status word bit CC1 is set.

RND- and RND + Instructions

If a value in the range 0 to 0.25 is present as a floating-point number, the instruction RND+ supplies the result “0” instead of “1.”
If a value in the range 0 to -0.25 is present as a floating-point number, the instruction RND- supplies the result “0” instead of “-1.”

Writing Bit Instructions

In the case of a fault, writing bit instructions register a read error instead of a write error. This applies to the following:

- Area length errors
- Area errors
- I/O access errors

Configuring DP Stations

You should not configure more than 16 slots per DP station.

Access to DP Slaves

A DP station ist connected to an S7-400 via an external DP interface module CP 443-5 Extended.

If you use word access to access a DP slave with one byte of user data (instructions L PIW, T PQW), the I/O access error organization block (OB122) is not called. After executing the instruction L PIW, B#16#00 is stored in accumulator 1 instead of the non-existent peripheral byte.

If you use double word access to access a DP slave with three bytes of user data (instructions L PID, T PQD), the I/O access error organization block (OB122) is not called. After executing the instruction L PID, B#16#00 is stored in accumulator 1 instead of the non-existent peripheral byte.

Single Step

With the STEP 7 function “single step mode,” the CPU requires more time than the execution time for the instruction. As a result of the scan cycle time monitoring, it is possible that the CPU may go into STOP mode because the cycle time was exceeded. You can avoid this by calling the SFC43 “RE_TRIGR” in the time error organization block (OB80).

Breakpoints

If you have set a breakpoint at a jump instruction or a block end instruction and the CPU has reached this instruction, neither the function “execute next statement” nor the function “execute call” can be executed. Instead the error message “D063: Resource error: the trigger event is occupied” is displayed.

If you have set a breakpoint at a UC or CC instruction and the CPU has reached this instruction, the function “execute call” cannot be executed. Instead the error message “D063: Resource error: the trigger event is occupied” is displayed.

Remedy: Delete the current breakpoint or move it to the previous command line.

Multiple Instances and Communication SFBs

CPU	Order Number
CPU 412-1	6ES7412-1XF00-0AB0
CPU 413-1	6ES7413-1XG00-0AB0
CPU 413-2 DP	6ES7413-2XG00-0AB0
CPU 414-1	6ES7414-1XG00-0AB0
CPU 414-2 DP	6ES7414-2XG00-0AB0
CPU 416-1	6ES7416-1XJ00-0AB0

The following restrictions relating to instance data from communication SFBs for configured connections within multiple instance data blocks apply for the CPUs listed in the above table:

- The function block (FB) numbers 8, 9, 12 to 15, 19 to 23, and 33 to 37 are not permitted
- You must not declare the instance data from communication SFBs for configured connections as arrays
- If you declare variables of the data types ARRAY, STRUCT, or STRING for input, output, and in/out parameters, these must end at an even memory address (WORD alignment). You can check this by opening the respective data block with the Program Editor
- You must not declare one-dimensional arrays of the data type BOOL and multi-dimensional arrays

- You must not declare input parameters of the data type POINTER and in/out parameters of the data type POINTER, DATE_AND_TIME, ARRAY, STRUCT, and STRING. Remedy: you can transfer the respective data via IN and OUT parameters or by means of ANY pointers
- The last variable of each input, output, and in/out variable must not be of the data type BOOL
- If you declare one or more arrays in a function block, the nesting depth is increased by one

If you do not observe these restrictions, the instance data for the respective communication SFB for configured connections are not processed. 12 is entered in the output parameter STATUS.

3 Special Features of Communication

Communication from PG/OP to Module without MPI

If one of the programming devices or operator panels connected to a multipoint interface (MPI) communicates with an S7-400 module which does not have an MPI connection (for example, SINEC CPs, FM 456 etc.), this module can be reached via the CPU to whose MPI the programming device or operator panel is connected. In this case, the CPU simply acts as an intermediary for the transfer. This type of connection between a programming device or operator panel and a module only communicating via the communication bus occupies two connection resources in the CPU.

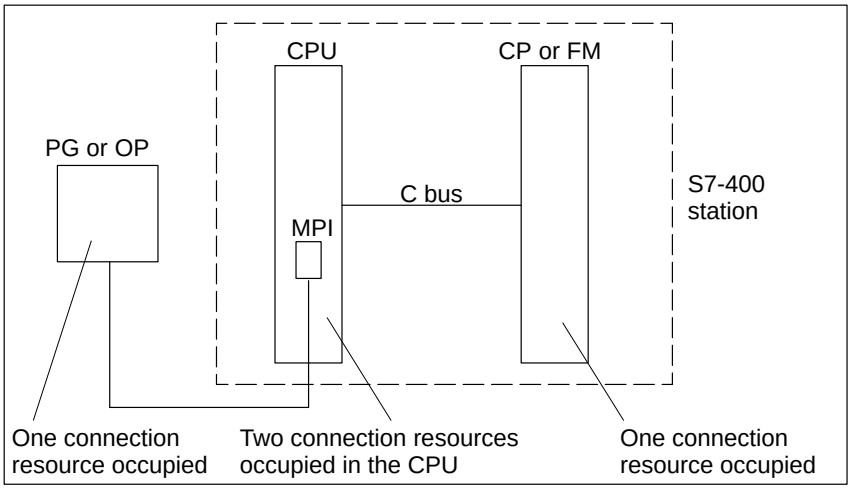


Figure 2 Communication between Programming Device/Operator Panel and a Module without MPI

Communication SFBs for Configured Connections

CPU	Order Number
CPU 412-1	6ES7412-1XF00-0AB0
CPU 413-1	6ES7413-1XG00-0AB0
CPU 413-2 DP	6ES7413-2XG00-0AB0

The following maximum user data lengths apply for the CPUs listed in the table above:

SFB	User Data Length in Bytes
USEND/URCV	200
GET	210
PUT	164

4 Behavior of S7-400 Signal Modules After Parameter Assignment

Parameter Assignment of S7-400 Signal Modules

S7-400 signal modules can be assigned parameters via the operating system of the CPU or via an SFC call from your program.
Parameters are assigned from the operating system of the CPU in the following cases:

- At restart (both cold restart and restart)
- After plugging a module into a configured slot
- After a rack or a station comes back online in the case of distributed I/O

S7-400 Input Modules

After assigning parameters to an S7-400 input module, the data read by your program from the module are not immediately valid. You can only evaluate these when bit 2 (“operating status”) in byte 2 of diagnostics data set 0 has the value 0 (“RUN”).

For this reason, all S7-400 input modules which can be assigned parameters make the diagnostics data set 0 available. You can read out diagnostics data set 0 with SFC51 “RDSYSST” (input parameter SZL_ID W#16#00B1) or with SFC59 “RD_REC”.

S7-400 Output Modules

After assigning parameters to an S7-400 output module, it is possible that the output data you have written to the module are not transferred immediately to the outputs.
From the time that bit 2 (“operating status”) in byte 2 of diagnostics data set 0 takes the value 0 (“RUN”), the module transfers the output data to the output terminals.

For this reason, diagnostics data set 0 is available with all S7-400 output modules which can be assigned parameters. You can read out diagnostics data set 0 with SFC51 “RDSYSST” (input parameter SZL_ID W#16#00B1) or with SFC59 “RD_REC.”

5 Analog Input Module SM 431: AI 8 x RTD x 16 Bit (6ES7 431-7KF10-0AB0)

Order Number

6ES7 431-7KF10-0AB0

Characteristics

The SM 431 (AI 8 x RTD x 16 bit) is an analog input module with the following characteristics:

- 8 differential inputs for resistance thermometers (RTD)
- Resistance thermometer (RTD) can have parameters assigned
- Linearization of the RTD characteristic curves
- Resolution 16 bits
- 25 ms update rate for 8 channels
- Galvanically isolated (programmable controller-to-field), 1500 VAC
- Permissible common-mode voltage 120 VAC
- Diagnostics capability
- Hardware interrupt capability, especially suitable for processed requiring close monitoring
- No external power requirements

Note

This analog module does not use the measuring range modules desribed in the *S7-400, M7-400 Programmable Controllers, Module Specifications* Reference Manual. The upper and lower limit values and the overflow ranges are different from the ranges shown in Section 6.

Connection Diagram

Figure 3 shows the connection diagram for the analog input module SM 431 (AI 8 x RTD x 16 bit).

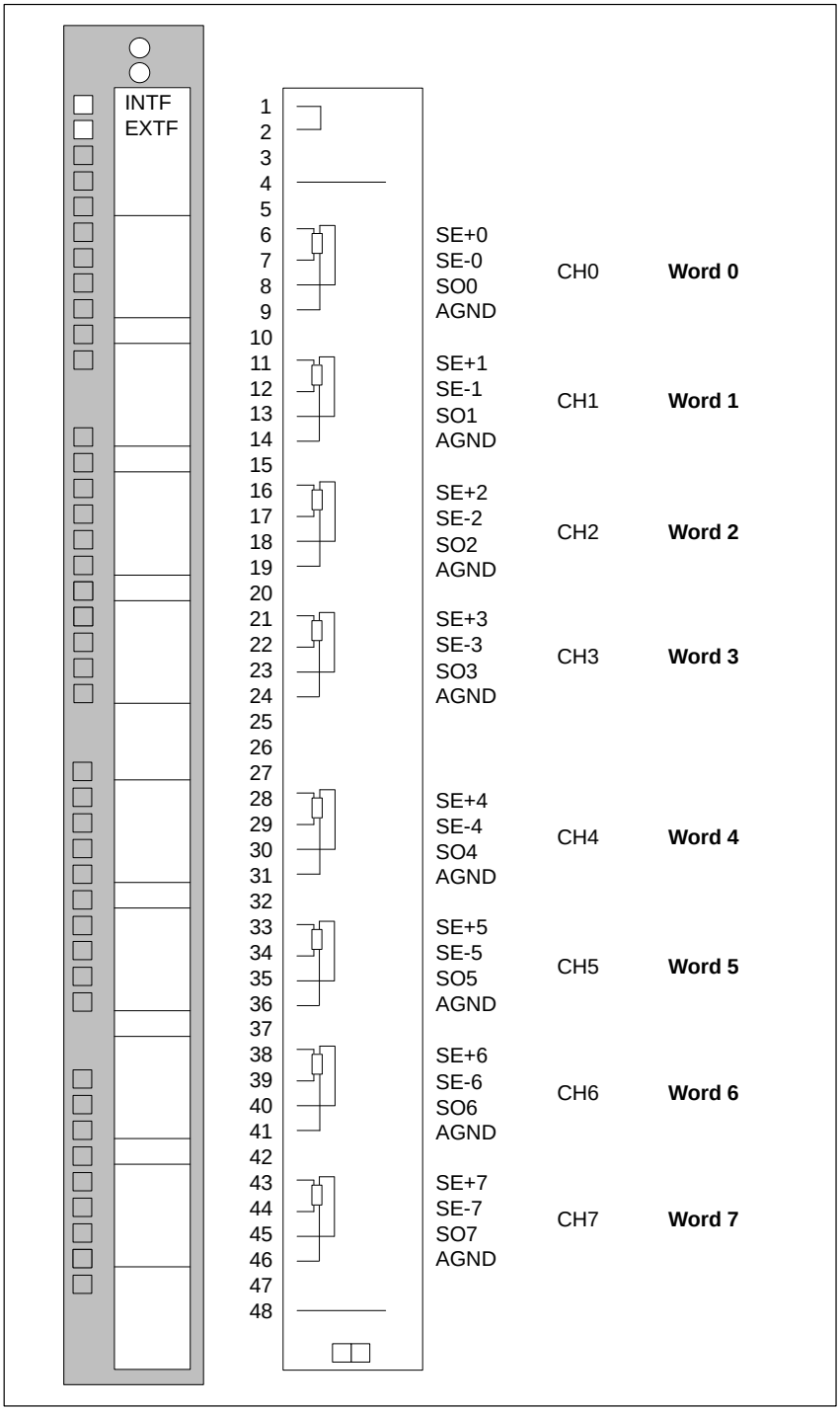


Figure 3 Connection Diagram of the Analog Input Module SM 431 (AI 8 x RTD x 16 Bit)

Circuit Block Diagram

Figure 4 shows the circuit block diagram of the analog input module SM 431 (AI 8 x RTD x 16 bit).

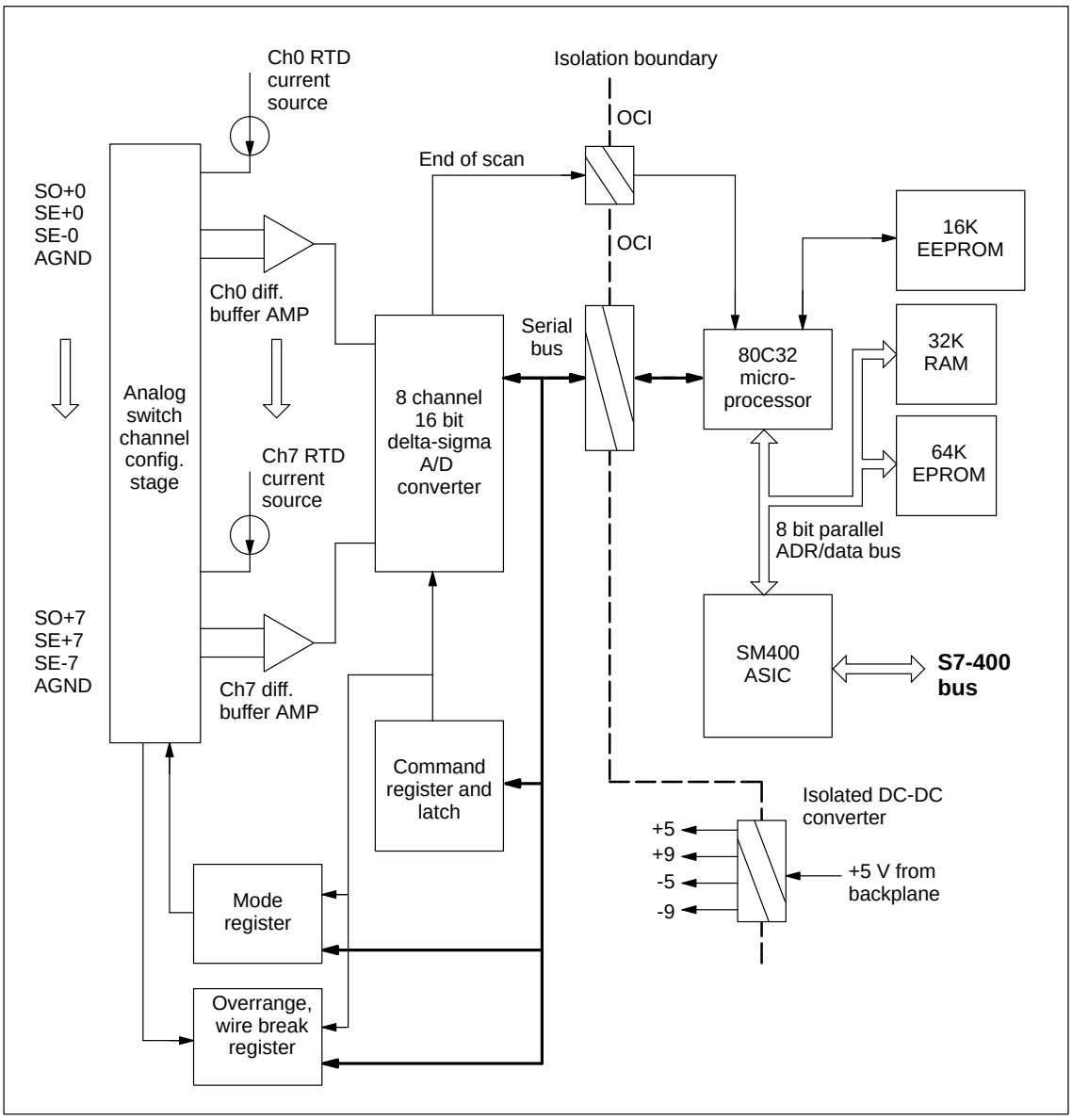


Figure 4 Circuit Block Diagram of the Analog Input Module SM 431 (AI 8 x RTD x 16 Bit)

Static Parameters

Table 1-1 shows the static parameters used by the analog input module SM 431 (AI 8 x RTD x 16 bit).

Table 1-1 Static Parameters of the SM 431 (AI 8 x RTD x 16 Bit)

Parameter	Value Range
Destination CPU for interrupts	1 to 4
The following settings can be made channel-by-channel:	
Measuring range deactivated	Yes/No
RTD with linearization, 3-wire connection	Pt 100 standard range Pt 200 standard range Pt 500 standard range Pt 1000 standard range Ni 100 standard range Ni 1000 standard range
RTD with linearization, 4-wire connection	Pt 100 standard range Pt 200 standard range Pt 500 standard range Pt 1000 standard range Ni 100 standard range Ni 1000 standard range
Temperature coefficient of RTD sensors	Platinum (Pt) 0.00385 Ω/Ω/°C 0.003916 Ω/Ω/°C 0.003902 Ω/Ω/°C 0.003920 Ω/Ω/°C Nickel (Ni) 0.00618 Ω/Ω/°C 0.00672 Ω/Ω/°C
Wire break check Underflow check Overflow check	Yes/No Yes/No Yes/No
Smoothing	None Weak Medium Strong
The following settings can be made only to all channels:	
Interference frequency suppression	None 60 Hz 50 Hz
Temperature format	Degrees C Degrees F

Dynamic Parameters

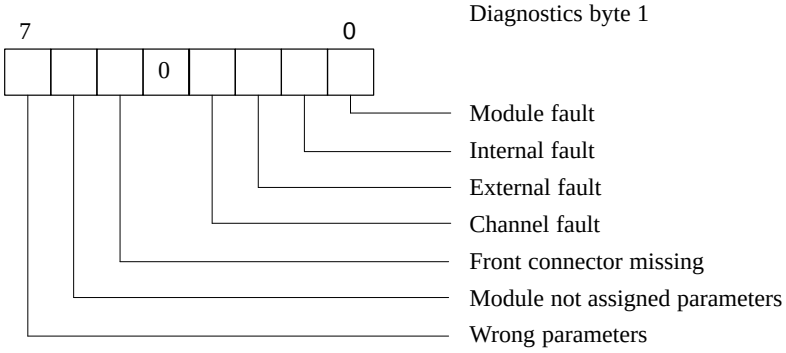
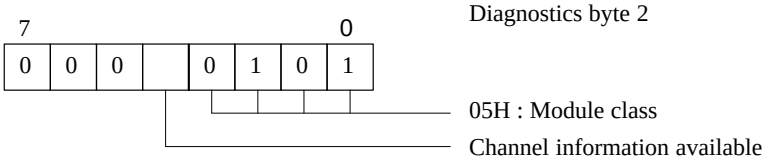
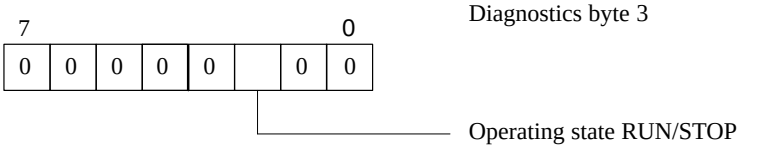
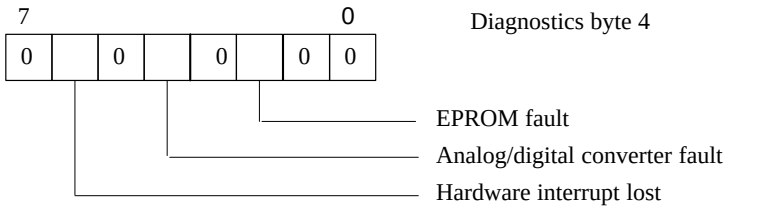
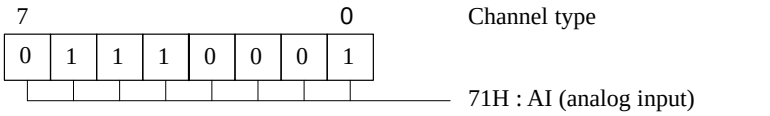
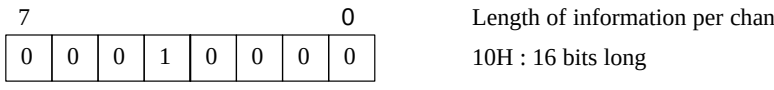
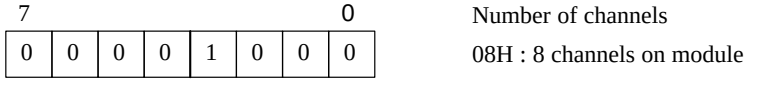
Table 1-2 shows the dynamic parameters used by the analog input module SM 431 (AI 8 x RTD x 16 bit).

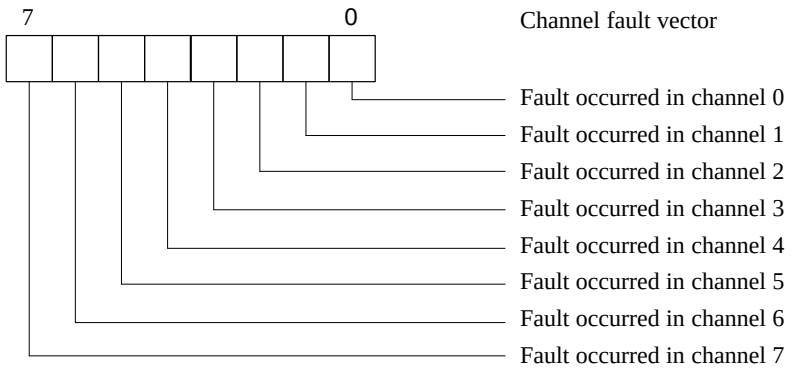
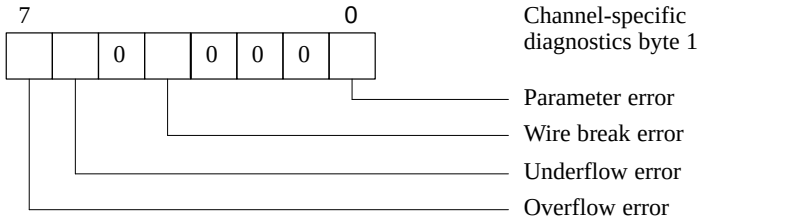
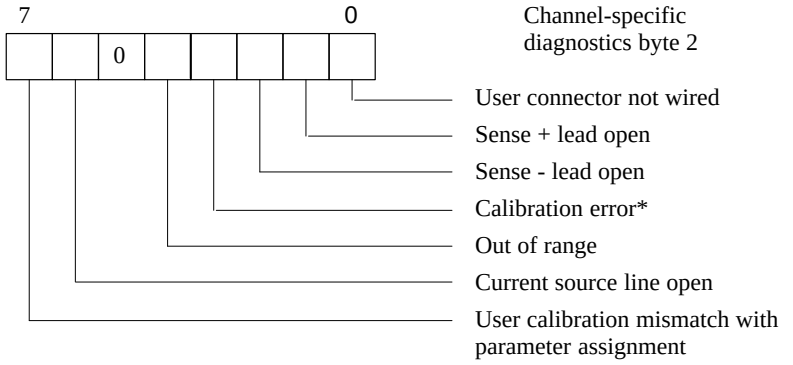
Table 1-2 Dynamic Parameters of the SM 431 (AI 8 x RTD x 16 Bit)

Parameter	Value Range
Hardware interrupt enable	Yes/No
Diagnostic interrupt enable	Yes/No
The following settings can be made channel-by-channel:*	
Upper hardware interrupt limit value range	-32768 to 32767
Lower hardware interrupt limit value range	-32768 to 32767
* Hardware interrupt settings must be within the rated temperature range of the set sensor type.	

Diagnostic Functions

The SM 431 (AI 8 x RTD x 16 bit) uses the following options for carrying out diagnostics:

Address	Meaning	Location
0	Diagnostics byte 1  	DS0/DS1
1	Diagnostics byte 2  	DS0/DS1
2	Diagnostics byte 3  	DS0/DS1
3	Diagnostics byte 4  	DS0/DS1
4	Channel type  	DS1
5	Length of information per channel  	DS1
6	Number of channels  	DS1

Address	Meaning	Location
7		DS1
8, 10 to 22		DS1
9, 11 to 23	 *This module performs a run-time calibration on each channel every 2 to 6 minutes, depending on the number of channels programmed. If there is a wiring error present on a set channel during the calibration cycle, this bit will be set. After the wiring error is corrected, the bit remains set until the next calibration (up to 6 minutes). You can also reset the bit by placing the PLC in STOP mode and then back to RUN mode.	DS1

0 = default value 0; the module does not process this diagnostics function

1 = default value 1; the module uses constants

❑ = no default; the module uses variables, value 1 corresponds to a fault

Smoothing Filter

Smoothing can be set to four different levels for each channel. The smoothing filter function is implemented in the module by providing a rolling average of the number of readings determined by the smoothing level parameter you assign for each channel. The number of samples used in the rolling average for a given smoothing level is shown below.

None	1
Weak	2
Medium	16
Strong	32

Step Response

The amount of smoothing assigned to a given channel determines the step response for that channel. Figure 5 shows the response to a step of 50° C for a 100-ohm 0° C RTD using weak, medium, and strong smoothing.

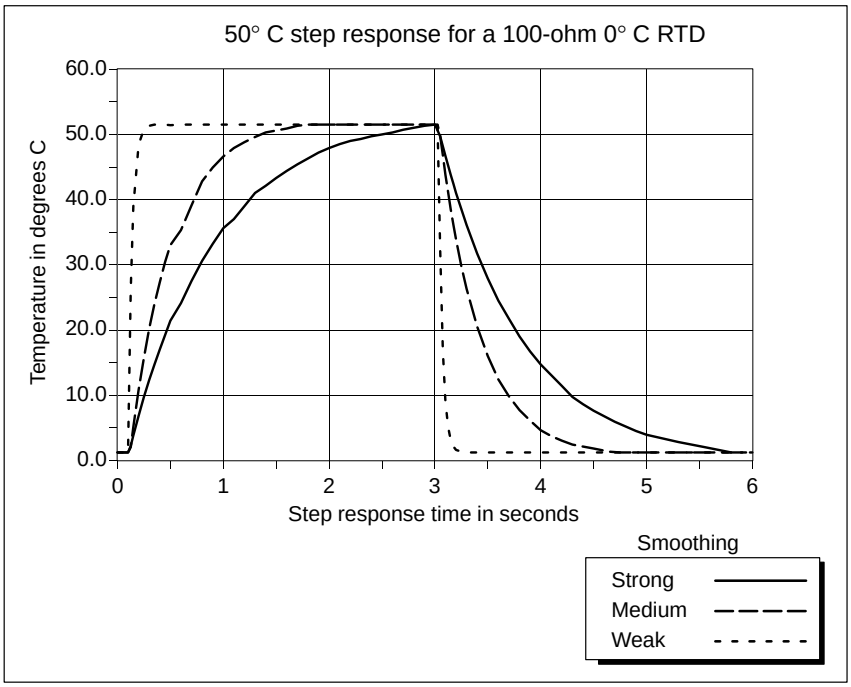


Figure 5 Step Response for Weak, Medium, and Strong Smoothing

Parameter Errors

The module has diagnostics capability. Parameter errors are indicated via diagnostics information:

- Module fault
- Internal fault
- Wrong parameters
- Module not assigned parameters

If the fault can be assigned to specific channels, the following diagnostics information is indicated:

- Module fault
- Internal fault
- Channel fault
- Wrong parameters
- Channel information available
- Channel fault vector
- Channel parameter error
- Calibration mismatch with parameter assignment

Dynamic Parameters (Data Set 1)

The parameter “Upper limit value” of the channel n must be greater than the parameter “Lower limit value” of the channel n.

Technical Specifications

The technical specifications of the SM 431 (AI 8 x RTD x 16 bit) are listed below.

Dimensions, Cable Length and Weight	
Dimensions W × H × D (mm)	25 × 290 × 210
Weight	approx. 650 g
Module-Specific Data	
Number of RTD inputs	8
Overvoltage protection in acc. with IEC 1000-4-5	External protection device required in the signal lines
Cable length, shielded	200 m
Voltages, Currents, Potentials	
Galvanic isolation between bus, analog inputs, and chassis ground	Yes, 3 mm clearance
Test voltage	
• Between bus and analog input section	1500 VAC
• Between bus and chassis ground	500 VAC
• Between analog input section and chassis ground	1500 VAC
Common-mode test voltage	
• Inputs to each other	None
• Between input and common grounding point (input voltage 0 V)	120 VAC
Constant current for resistance sensor	1.0 mA per channel
Current consumption from S7-400 bus (5 VDC)	max. 650 mA typ. 450 mA
Interference Suppression, Error Limits	
Interference voltage suppression for f = n × (f1 ± 1%), (f1 = set interference frequency)	
• Common-mode interference (V_{CM} < 120V)	> 100 dB
• Common-mode interference (peak value of interference < nominal value of the input range)	> 50 dB
Cross-talk attenuation between the inputs	
• At 50 Hz	70 dB
• At 60 Hz	70 dB

Accuracy and Repeatability		
Basic accuracy	typ. 25° C	max. 25 °C
• 100 Ω Pt.	± 0.1° C	± 0.5° C
• 200 Ω Pt.	± 0.1° C	± 0.3° C
• 500 Ω Pt.	± 0.1° C	± 0.2° C
• 1000 Ω Pt.	± 0.1° C	± 0.2° C
Full range accuracy (0 to 60° C)	Basic accuracy 25° C ± 30 ppm/° C	
Repeatability (full temperature range)	3-wire mode	4-wire mode
• 100 Ω Pt.	± 0.4° C	± 0.2° C
• 200 Ω Pt.	± 0.2° C	± 0.1° C
• 500 Ω Pt.	± 0.1° C	± 0.1° C
• 1000 Ω Pt.	± 0.1° C	± 0.1° C
Status, Interrupts, Diagnostics		
Interrupts		
• Limit value interrupts	Yes, can be set	
• Diagnostics interrupts	Yes, can be set	
Diagnostics functions	Yes, can be set	
• Fault indicators on the module		
for internal faults	Yes, red LED (upper)	
for external faults	Yes, red LED (lower)	
• Diagnostics information read out via data sets	Yes	
Data for Selecting a Sensor		
RTDs	Pt 100, 0.00385 in acc. with DIN IEC 751 Ni 100, 0.00618 in acc. with DIN 43760 Pt 200, Pt 500, Pt 1000 Ni 1000	
Resolution in degrees (all sensor types)	0.1 (°C or °F)	

Rated Temperature Range	
Pt 100	-200° C to 850° C
Pt 200	-200° C to 850° C
Pt 500 (α = 0.00385)	-200° C to 830° C
Pt 500 (α = 0.003916)	-200° C to 810° C
Pt 500 (α = 0.003902)	-200° C to 800° C
Pt 500 (α = 0.00392)	-200° C to 800° C
Pt 1000	-200° C to 240° C
Ni 100 (α = 0.00618)	-60° C to 250° C
Ni 100 (α = 0.00672)	-75° C to 275° C
Ni 1000 (α = 0.00618)	-60° C to 140° C
Ni 1000 (α = 0.00672)	-75° C to 130° C
Smoothing of the measured values	Yes, can be set in 4 levels by means of digital filtering
Smoothing level	Time constant
None	1 * cycle time
Weak	2 * cycle time
Medium	16 * cycle time
Strong	32 * cycle time

Analog Value Generation	
Analog/digital conversion method	Sigma/Delta type (pipeline)
Interference frequency suppression f1	60 Hz, 50 Hz
Conversion time/resolution	
• Update time (8 channels, 50 Hz rejection enabled)	< 25.0 ms
• Update time (1 channel, no line noise rejection)	< 8.0 ms
Time required for run-time calibration with no new data updates (not deselectable)	
• 4-wire mode	max. 120 ms, occurring every 2 to 6 minutes, depending on the number of channels programmed
• 3-wire mode (includes 3-wire correction measurement)	max. 200 ms, occurring every 2 to 6 minutes, depending on the number of channels programmed
Time required for wire break check with no new data updates (not deselectable)	max. 100 ms, occurring every 1 to 4 seconds, depending on the number of channels programmed
Resolution (including overrange)	16 bits

Resistance Thermometer Temperature Ranges

Figure 6 shows the temperature ranges (in °C) for each resistance thermometer (RTD) sensor type of the analog input module SM 431 (AI 8 x RTD x 16 bit).

System Word		Temperature Range									
		Pt 100,	Pt 500				Pt 1000	Ni 100		Ni 1000	
Decimal	Hex.	Pt 200	0.00385	0.003916	0.003902	0.00392		0.00618	0.00672	0.00618	0.00672
32767	7FFF										
						Overflow					
9350	2486	935.0									
9130	23AA		913.0								
8910	22CE			891.0							
8800	2260				880.0	880.0					
8500	2134	850.0									
8300	206C		830.0								
8100	1FA4			810.0							
8000	1F40				800.0	800.0					
3000	BB8								300.0		
2750	ABE							275.0	275.0		
2640	A50						264.0				
2500	9C4							250.0			
2400	960						240.0				
1550	60E									155.0	
1430	596										143.0
1400	578									140.0	
1300	514										130.0
1	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1	FFFF	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
-600	FDA8							-60.0		-60.0	
-660	FDC6							-66.0		-66.0	
-750	FD12								-75.0		-75.0
-830	FCC2								-83.0		-83.0
-2000	F830	-200.0	-200.0	-200.0	-200.0	-200.0	-200.0				
-2200	F768	-220.0	-220.0	-220.0	-220.0	-220.0	-220.0				
						Underflow					
-32768	8000										
Standard: 1 digit = 0.1° C											

Nominal range
Overrange/underrange
Overflow/underflow

Figure 6 Temperature Ranges for RTD Sensors

6 Analog Input Module SM 431: AI 8 x 16 Bit (6ES7 431-7KF00-0AB0)

Order Number 6ES7 431-7KF00-0AB0

Characteristics The SM 431 (AI 8 x 16 bit) is an analog input module with the following characteristics:

- 8 isolated differential analog inputs
- Input range for voltage
- Input range for thermocouple
- Input range for 4-wire transducer
- Can have parameters assigned for voltage, current, and thermocouple
- Linearization of the thermocouple characteristic curves
- Isolated bus to analog inputs
- Diagnostics capability
- Hardware interrupt capability, especially suitable for processes requiring close monitoring
- Permissible common-mode voltage 120 VAC
- Internal current sense resistor (connector jumper)
- Field connector (6ES7 431-7KF00-6AA0) with internal reference temperature (shipped with module)
- Analog-to-digital conversion resolution 24 bits (including sign)
- Analog value resolution 16 bits (including sign)
- No external power requirements

Note

This analog module does not use the measuring range modules desribed in the *S7-400, M7-400 Programmable Controllers, Module Specifications* Reference Manual. The upper and lower limit values and the overflow ranges are different from the ranges shown in Section 6.

Connection Diagram

Figure 7 shows the connection diagram for the analog input module SM 431 (AI 8 x 16 bit).

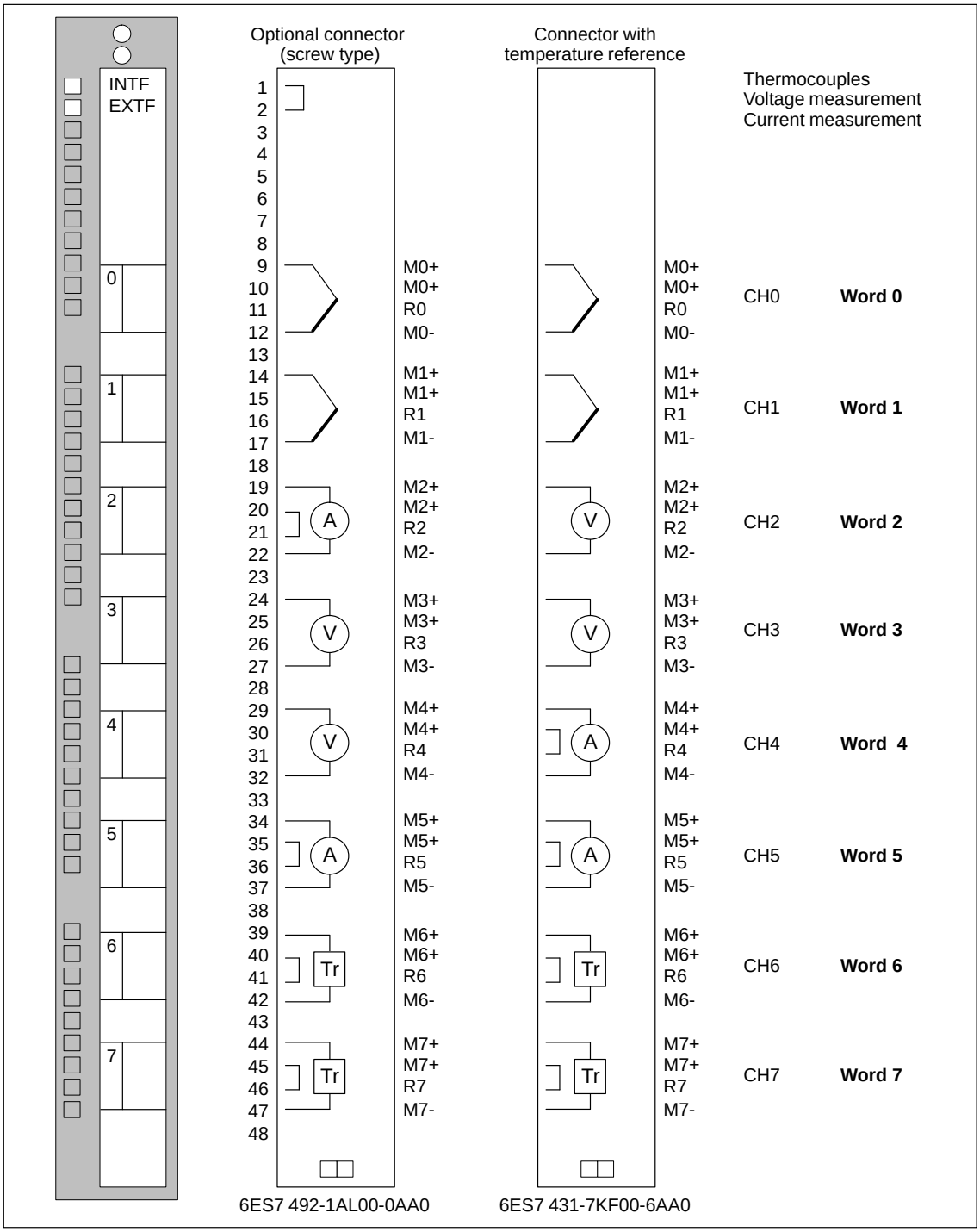


Figure 7 Connection Diagram of the Analog Input Module SM 431 (AI 8 x 16 Bit)

Circuit Block Diagram

Figure 8 shows the circuit block diagram of the analog input module SM 431 (AI 8 x 16 bit).

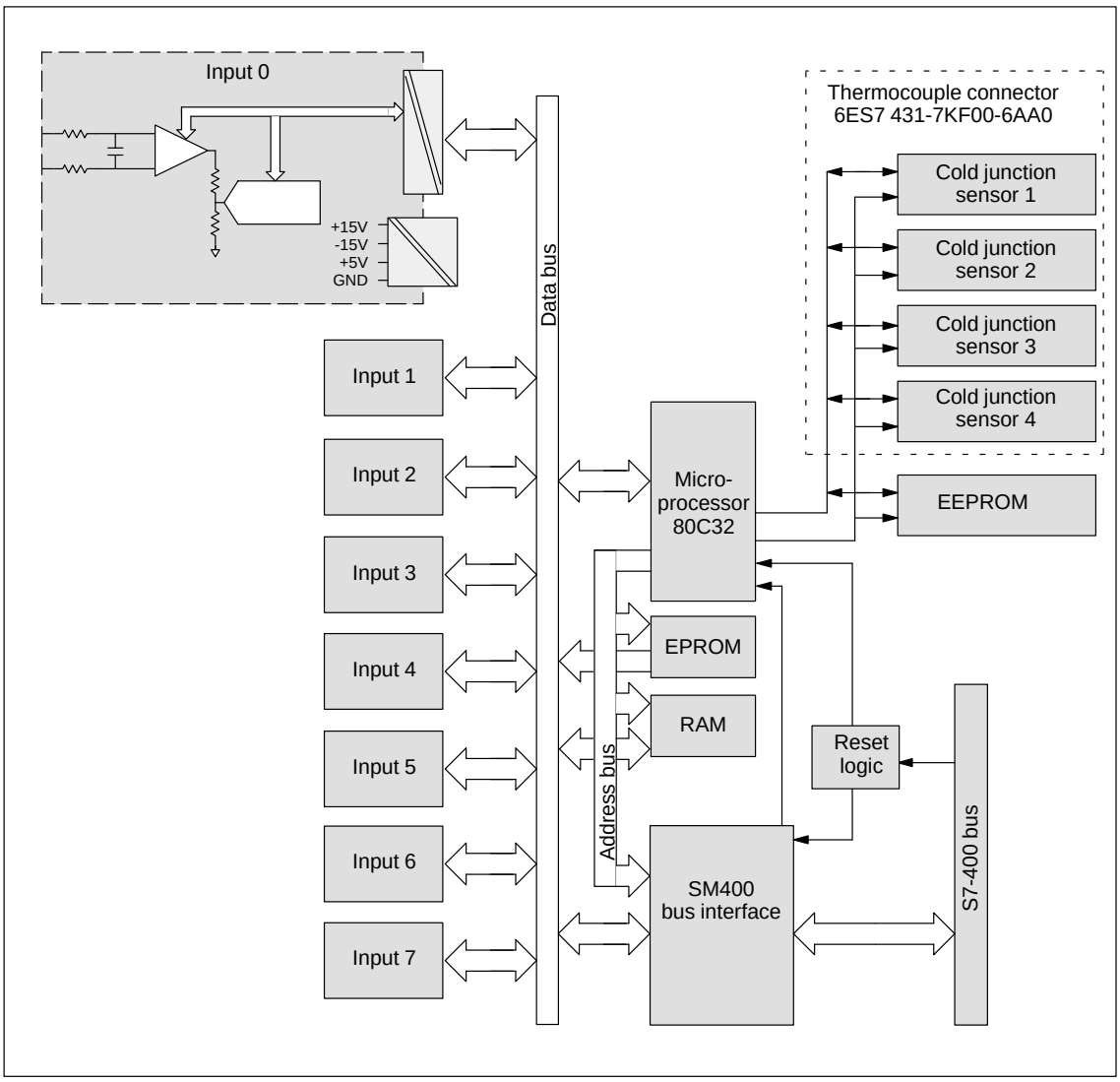


Figure 8 Circuit Block Diagram of the Analog Input Module SM 431 (AI 8 x 16 Bit)

Static Parameters

Table 1-3 shows the static parameters used by the analog input module SM 431 (AI 8 x 16 bit).

Table 1-3 Static Parameters of the SM 431 (AI 8 x 16 Bit)

Parameter	Value Range
Destination CPU for interrupts	1 to 4
The following settings can be made channel-by-channel:	
Measuring range deactivated	Yes/No
Voltage measuring range	± 25 mV ± 50 mV ± 80 mV ± 100 mV ± 250 mV ± 500 mV ± 1 V ± 2.5 V ± 5 V ± 10 V 1 to 5 V
Current measuring range for 4-wire transducers	± 3.2 mA ± 5 mA ± 10 mA ± 20 mA 0 to 20 mA 4 to 20 mA
Thermocouples with linearization	Type B Type N Type E Type R Type S Type J Type L Type T Type K Type U
Cold reference junction	None Internal Dynamic
Wire break check	Yes/No
Underflow check	Yes/No
Overflow check	Yes/No
Reference check	Yes/No
Interference frequency suppression	10 Hz 50 Hz 60 Hz 400 Hz

Table 1-3 Static Parameters of the SM 431 (AI 8 x 16 Bit)

Parameter	Value Range
Smoothing	None Weak Medium Strong
The following settings can be made only to all channels:	
Temperature format*	Degrees C Degrees F
* Affects output temperature format and dynamic reference temperature format.	

Dynamic Parameters

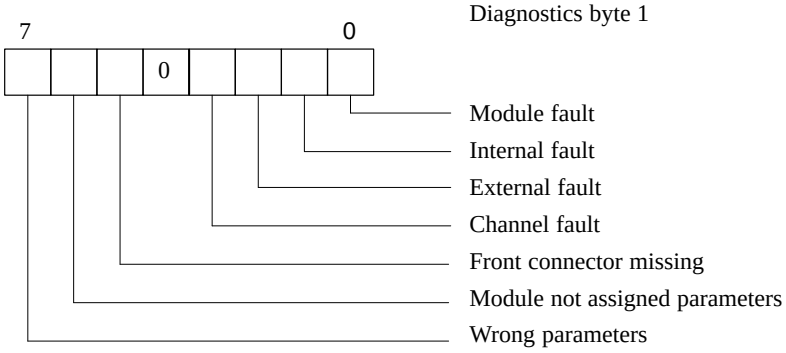
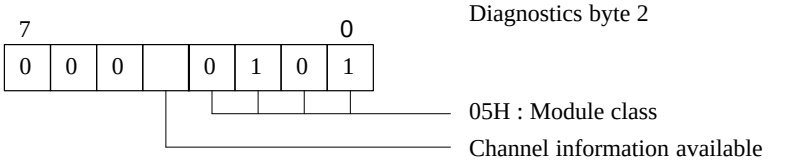
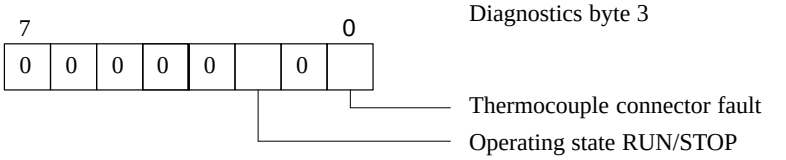
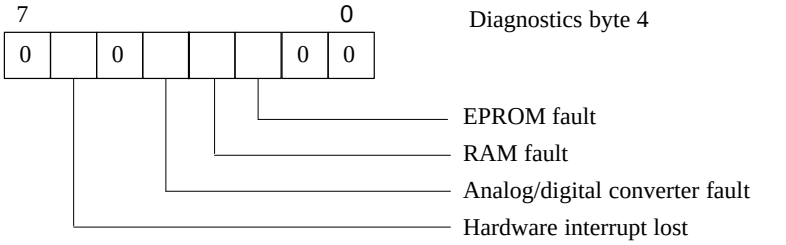
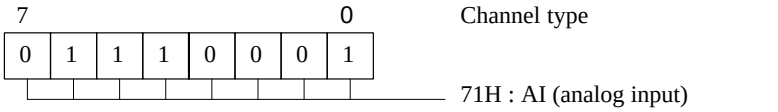
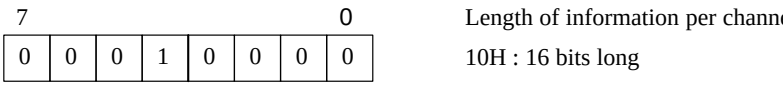
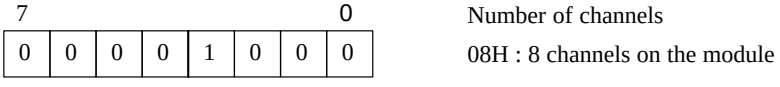
Table 1-4 shows the dynamic parameters used by the analog input module SM 431 (AI 8 x 16 bit).

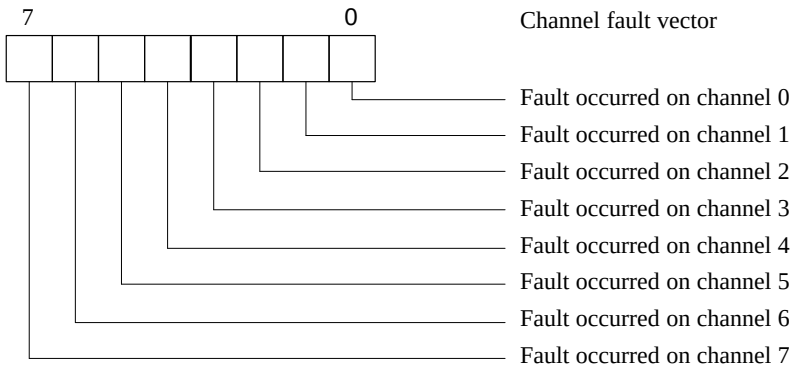
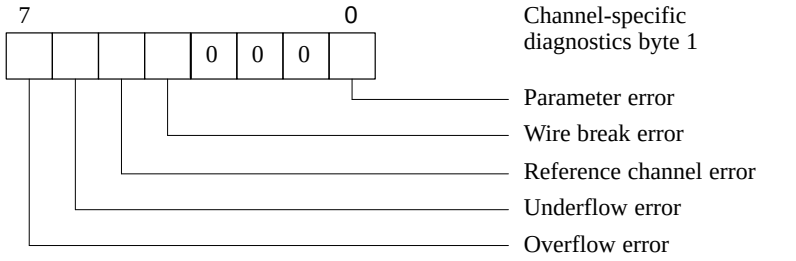
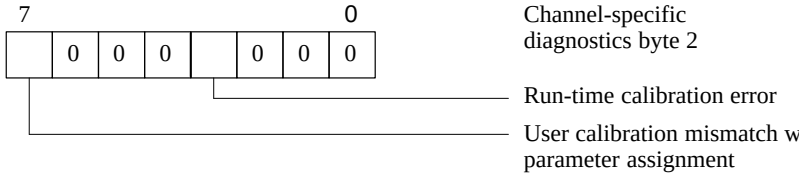
Table 1-4 Dynamic Parameters of the SM 431 (AI 8 x 16 Bit)

Parameter	Value Range
Hardware interrupt enable	Yes/No
Diagnostic interrupt enable	Yes/No
Reference temperature • 1/100° C • 1/100° F	 -273.15 to 327.67° C -327.68 to 327.67° F
The following settings can be made channel-by-channel:*	
Upper hardware interrupt limit value range	-32768 to 32767
Lower hardware interrupt limit value range	-32768 to 32767
* Hardware interrupt settings must be within the rated temperature range of the set sensor type.	

Diagnostic Functions

The SM 431 (AI 8 x 16 bit) uses the following options for carrying out diagnostics:

Address	Meaning	Location
0	Diagnostics byte 1 	DS0/DS1
1	Diagnostics byte 2 	DS0/DS1
2	Diagnostics byte 3 	DS0/DS1
3	Diagnostics byte 4 	DS0/DS1
4	Channel type 	DS1
5	Length of information per channel 	DS1
6	Number of channels 	DS1

Address	Meaning	Location
7		DS1
8, 10 to 22		DS1
9, 11 to 23		DS1

0 = default value 0; the module does not process this diagnostics function

1 = default value 1; the module uses constants

❑ = no default; the module uses variables, value 1 corresponds to a fault

Smoothing Filter

Smoothing can be set to four different levels for each channel. The smoothing filter function is implemented in the module by calculating the output of a digital filter. The number of readings (smoothing factor) used in calculating the digital filter output for a given smoothing level is shown below.

None	1
Weak	2
Medium	16
Strong	32

Step Response

The amount of smoothing assigned to a given channel determines the step response for that channel. Figure 9 shows the full range response for any analog input signal using none, weak, medium, and strong smoothing. The time the output value takes to read the specified accuracy is determined by the interference suppression selected.

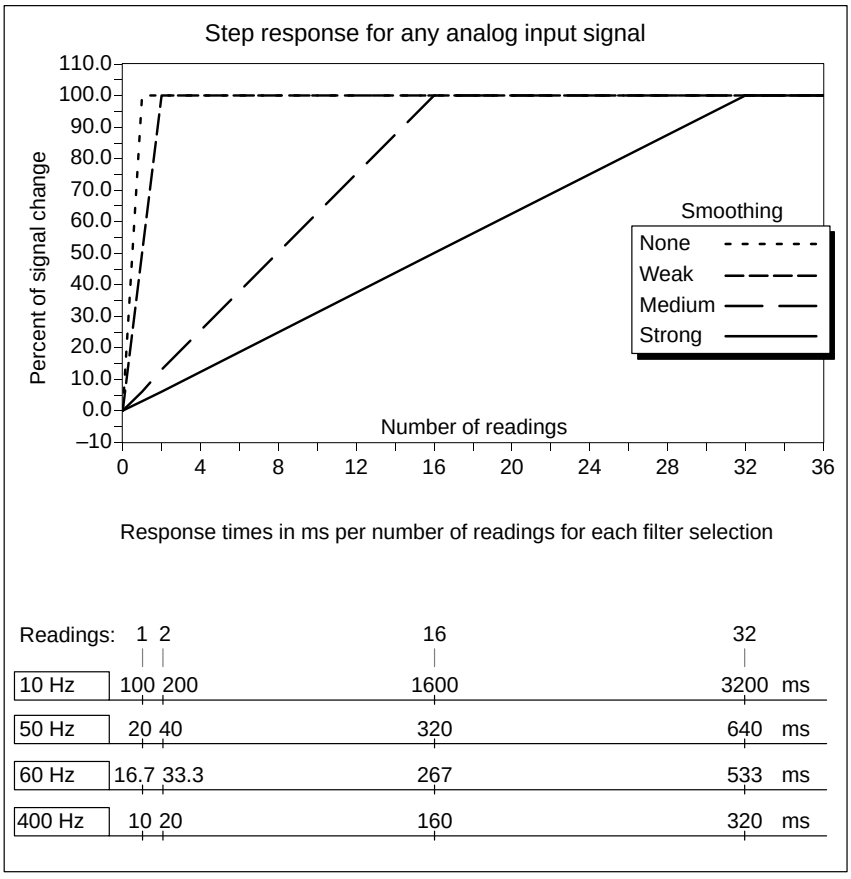


Figure 9 Step Response for Weak, Medium, Strong, and No Smoothing

Parameter Errors

The module has diagnostics capability. Parameter errors are indicated via diagnostics information:

- Module fault
- Internal fault
- Wrong parameters
- Module not assigned parameters

If the fault can be assigned to specific channels, the following diagnostics information is indicated:

- Module fault
- Internal fault
- Channel fault
- Wrong parameters
- Channel information available
- Channel fault vector
- Channel parameter error
- Calibration mismatch with parameter assignment

Dynamic Parameters (Data Set 1)

The parameter “Upper limit value” of the channel n must be greater than the parameter “Lower limit value” of the channel n.

Technical Specifications

The technical specifications of the SM 431 (AI 8 x 16 bit) module are listed below.

Dimensions, Cable Length and Weight	
Dimensions W × H × D (mm)	25 × 290 × 210
Weight	approx. 650 g
Module-Specific Data	
Number of inputs	8
Overvoltage protection in acc. with IEC 1000-4-5	External protection device required in the signal lines
Cable length, shielded	200 m
Voltages, Currents, Potentials	
Galvanic isolation between bus, analog inputs and chassis ground	Yes, 3 mm clearance
Test voltage	
• Between bus and analog input section	1500 VAC
• Between bus and chassis ground	500 VAC
• Between analog inputs (channel-to-channel)	1500 VAC
• Between analog inputs and chassis ground	1500 VAC
Common-mode test voltage	
• Inputs to each other	120 VAC
• Inputs to common grounding point (input voltage 0 V)	120 VAC
Current consumption from S7-400 bus (5 VDC)	max. 1200 mA typ. 820 mA
Interference Suppression, Error Limits	
Interference voltage suppression for f = n × (f1 ± 1%), (f1 = set interference frequency)	
• Common-mode interference (V_{CM} < 120V)	> 130 dB
• Common-mode interference (peak value of interference < nominal value of the input range)	> 80 dB
• Cross-talk attenuation between the inputs	> 130 dB

Accuracy and Repeatability		
Basic accuracy	typ. 25° C	max. 0 to 60° C
• ± 25 mV	± 0.05%	± 0.3%
• ± 50 mV	± 0.05%	± 0.3%
• ± 80 mV	± 0.05%	± 0.3%
• ± 100 mV	± 0.05%	± 0.3%
• ± 250 mV	± 0.05%	± 0.3%
• ± 500 mV	± 0.05%	± 0.3%
• ± 1 V	± 0.05%	± 0.3%
• ± 2.5 V	± 0.05%	± 0.3%
• ± 5 V	± 0.05%	± 0.3%
• ± 10 V	± 0.05%	± 0.3%
• 1 to 5 V	± 0.05%	± 0.3%
• ± 3.2 mA	± 0.15%	± 0.5%
• ± 5 mA	± 0.15%	± 0.5%
• ± 10 mA	± 0.15%	± 0.5%
• ± 20 mA	± 0.15%	± 0.5%
• 0 to 20 mA	± 0.15%	± 0.5%
• 4 to 20 mA	± 0.15%	± 0.5%
• Type B	± 0.9° C	± 3.5° C
• Type N	± 0.7° C	± 2.7° C
• Type E	± 0.5° C	± 1.8° C
• Type R	± 0.9° C	± 3.3° C
• Type S	± 0.8° C	± 3.2° C
• Type J	± 0.6° C	± 2.4° C
• Type L	± 0.4° C	± 1.7° C
• Type T	± 0.2° C	± 0.8° C
• Type K	± 0.6° C	± 2.5° C
• Type U	± 0.3° C	± 1.2° C
Full range drift (0 to 60° C)	± 2 ppm/°C	
Deviation internal resistance-type sensor	± 25 ppm/°C	

Note:

The accuracy of thermocouples is given for a reference junction temperature of 0° C. The accuracy when recording the reference junction temperature must be added to the values.

The accuracy of 4-wire transducers includes the accuracy of the internal resistance-type sensor and the deviation values.

Thermocouple connector (6ES7431-7KF00-6AA0)

Accuracy of the internal reference junction temperature 0 to 60° C: ± 2° C

Accuracy and Repeatability (continued)		
Repeatability (full temperature range)	Typical. 10, 50, 60,	400 Hz
• ± 25 mV	± 0.011%	± 0.014%
• ± 50 mV	± 0.011%	± 0.014%
• ± 80 mV	± 0.011%	± 0.014%
• ± 100 mV	± 0.011%	± 0.014%
• ± 250 mV	± 0.007%	± 0.011%
• ± 500 mV	± 0.007%	± 0.011%
• ± 1 V	± 0.004%	± 0.007%
• ± 2.5 V	± 0.004%	± 0.007%
• ± 5 V	± 0.004%	± 0.007%
• ± 10 V	± 0.004%	± 0.007%
• 1 to 5 V	± 0.004%	± 0.007%
• ± 3.2 mA	± 0.007%	± 0.011%
• ± 5 mA	± 0.007%	± 0.011%
• ± 10 mA	± 0.004%	± 0.007%
• ± 20 mA	± 0.004%	± 0.007%
• 0 to 20 mA	± 0.004%	± 0.007%
• 4 to 20 mA	± 0.004%	± 0.007%
• Type B	± 0.2° C	± 0.2° C
• Type N	± 0.1° C	± 0.2° C
• Type E	± 0.1° C	± 0.1° C
• Type R	± 0.2° C	± 0.2° C
• Type S	± 0.2° C	± 0.2° C
• Type J	± 0.1° C	± 0.2° C
• Type L	± 0.1° C	± 0.1° C
• Type T	± 0.1° C	± 0.1° C
• Type K	± 0.1° C	± 0.2° C
• Type U	± 0.1° C	± 0.1° C

Status, Interrupts, Diagnostics	
Interrupts	
• Limit value interrupts	Yes, can be set
• Diagnostic interrupts	Yes, can be set
Diagnostics functions	Yes, can be set
• Fault indicators on the module	
for internal faults	Yes, red LED (upper)
for external faults	Yes, red LED (lower)
• Diagnostics information read out via data sets	Yes

Data for Selecting a Sensor	
Input impedance (input range/input impedance)	± 25 mV / > 2 MΩ ± 50 mV / > 2 MΩ ± 80 mV / > 2 MΩ ± 100 mV / > 2 MΩ ± 250 mV / > 2 MΩ ± 500 mV / > 2 MΩ ± 1 V / > 2 MΩ ± 2.5 V / > 2 MΩ ± 5 V / > 2 MΩ ± 10 V / > 2 MΩ 1 to 5 V / > 2 MΩ ± 3.2 mA / 50 Ω ± 5 mA / 50 Ω ± 10 mA / 50 Ω ± 20 mA / 50 Ω 0 to 20 mA / 50 Ω 4 to 20 mA / 50 Ω Type B / > 2 MΩ Type N / > 2 MΩ Type E / > 2 MΩ Type R / > 2 MΩ Type S / > 2 MΩ Type J / > 2 MΩ Type L / > 2 MΩ Type T / > 2 MΩ Type K / > 2 MΩ Type U / > 2 MΩ
Analog value resolution	
• ± 25 mV	904 nV
• ± 50 mV	1.8 µV
• ± 80 mV	2.9 µV
• ± 100 mV	3.6 µV
• ± 250 mV	9.0 µV
• ± 500 mV	18.1 µV
• ± 1 V	36.2 µV
• ± 2.5 V	90.4 µV
• ± 5 V	180.8 µV
• ± 10 V	361.7 µV
• 1 to 5 V	144.7 µV
• ± 3.2 mA	115.7 nA
• ± 5 mA	180.8 nA
• ± 10 mA	361.7 nA
• ± 20 mA	723.4 nA
• 0 to 20 mA	723.4 nA
• 4 to 20 mA	578.7 nA
• All thermocouple types	0.1° C or 0.1° F

Rated Temperature Range	
Type B	0° C to 1820° C
Type N	-270° C to 1300° C
Type E	-270° C to 1000° C
Type R	-50° C to 1768° C
Type S	-50° C to 1768° C
Type J	-210° C to 1200° C
Type L	-200° C to 900° C
Type T	-270° C to 400° C
Type K	-270° C to 1372° C
Type U	-200° C to 600° C
Smoothing of the measured values	Yes, can be set in 4 levels by means of digital filtering
Smoothing level	Time constant
None	1 * conversion time
Weak	2 * conversion time
Medium	16 * conversion time
Strong	32 * conversion time

Analog Value Generation		
Analog/digital conversion method	Sigma/Delta type (one per channel)	
Resolution (including overrange)	24 bits	
Interference frequency suppression	10, 50, 60, and 400 Hz	
Time required for run-time calibration with no new data updates (not deselectable)	9 * update time, occurring every 2 to 5 seconds	
Interference frequency	Conversion time	Conversion resolution*
10 Hz	100 ms	>20 bits
50 Hz	20 ms	>20 bits
60 Hz	16.7 ms	>19 bits
400 Hz	10 ms	>15 bits

* Effective resolution due to conversion noise; includes repeatability

Thermocouple Temperature Ranges

Figure 10 shows the temperature ranges (in °C) for each thermocouple type in the analog input module SM 431 (AI 8 x 16 bit).

In the case of thermocouples, temperature data refers to differential temperatures or absolute temperatures at a reference junction temperature of 0° C.

System Word		Thermocouple Temperature Ranges									
Decimal	Hex.	Type B	Type R	Type S	Type T	Type E	Type J	Type K	Type U	Type L	Type N
32767	7FFF										
						Overflow					
1820	4718	1820.0									
0											
	451A		1769.0	1769.0							
1769											
0	3598							1372.0			
1372	32C8										1300.0
0											
	2EE0						1200.0				
1300											
0	2710					1000.0					
1200	2328									900.0	
0											
	1770								600.0		
1000											
0	FA0				400.0						
9000											
6000											
4000	1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1	FFFF		-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
-500	FE0C		-50.0	-50.0							
-2000	F830								-200.0	-200.0	
-2100	F7CC						-210.0				
-2700	F574				-270.0	-270.0		-270.0			-270.0
						Underflow					
-32768	8000										
Standard: 1 digit = 0.1° C											

Nominal range
Overflow/underflow

Figure 10 SM 431 (AI 8 x 16 Bit) Thermocouple Temperature Ranges

7 Digital Output Module SM 422: DO 16 x 20-125 VDC/1.5 A

Order Number

6ES7 422-5EH10-0AB0

Characteristics

The SM 422 (DO 16 x 20-125 VDC/1.5 A) is a digital output module with the following characteristics:

- 16 outputs, with channel-by-channel overload protection and reporting
- Isolated and reverse-polarity protection in two groups of eight
- 20 to 125 VDC rated output voltage
- Diagnostics interrupt capability
- Selectable output level in STOP mode

Fault/Error LEDs

Two LEDs on the front of the module signal the following errors:

- INTF (internal fault): parameter assignment error or EPROM fault
- EXTF (external fault): output short circuit, voltage fault, or front connector missing

Reading Error Messages with SFCs

With the system functions (SFCs), you can read module-specific and channel-specific diagnostic messages from the module at any time.

You can use the STEP 7 SIMATIC Manager to read out the cause of errors from the diagnostic buffer (refer to the *STEP 7 User Manual* for more detailed information).

Connection Diagram

Figure 11 shows the connection diagram for the digital output module SM422 (DO 16 x 20-125 VDC/1.5A).

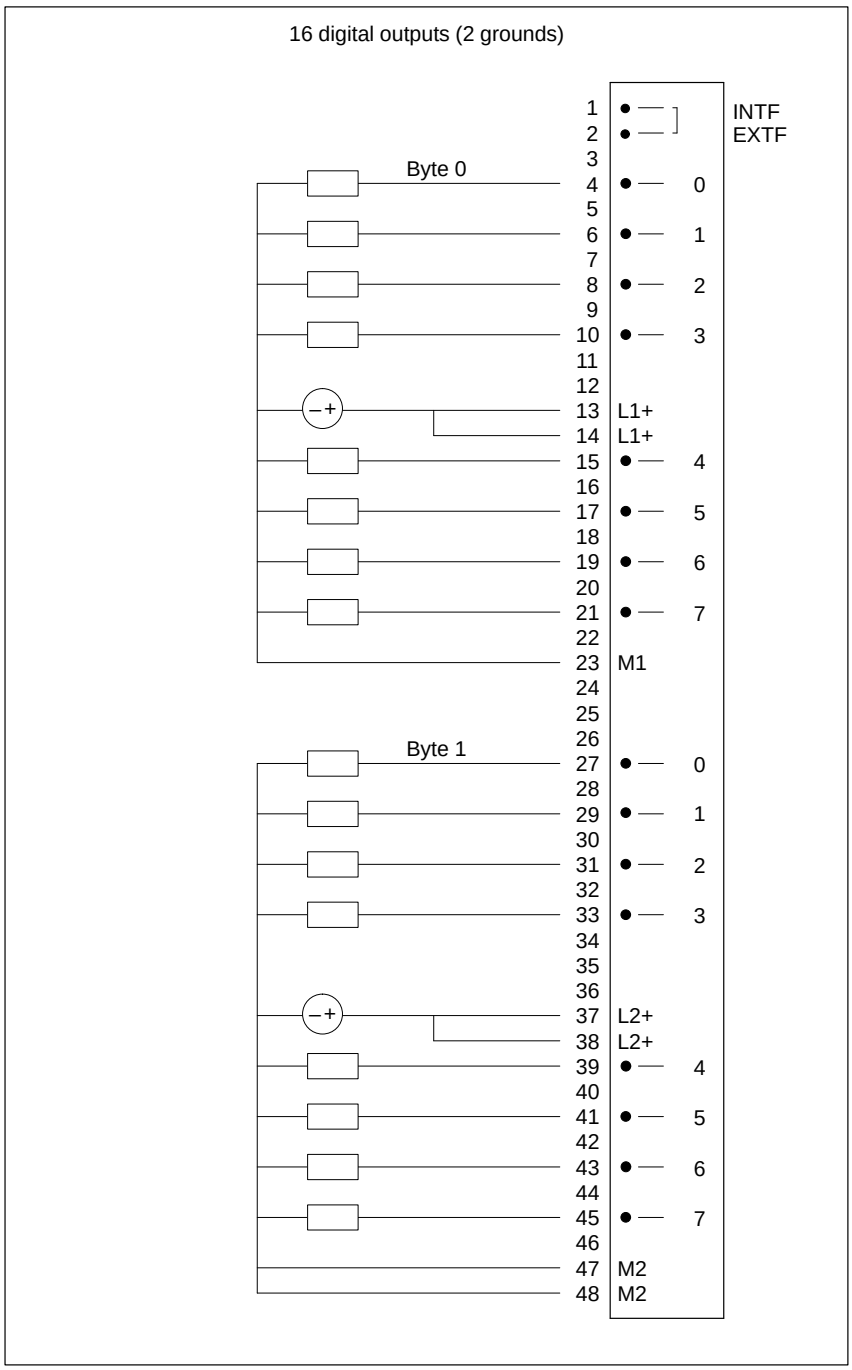


Figure 11 Connection Diagram for the Digital Output Module SM 422 (DO 16 x 20-125 VDC/1.5 A)

Block Diagram

Figure 12 shows the block diagram of the digital output module SM 422 (DO 16 x 20-125 VDC/1.5 A).

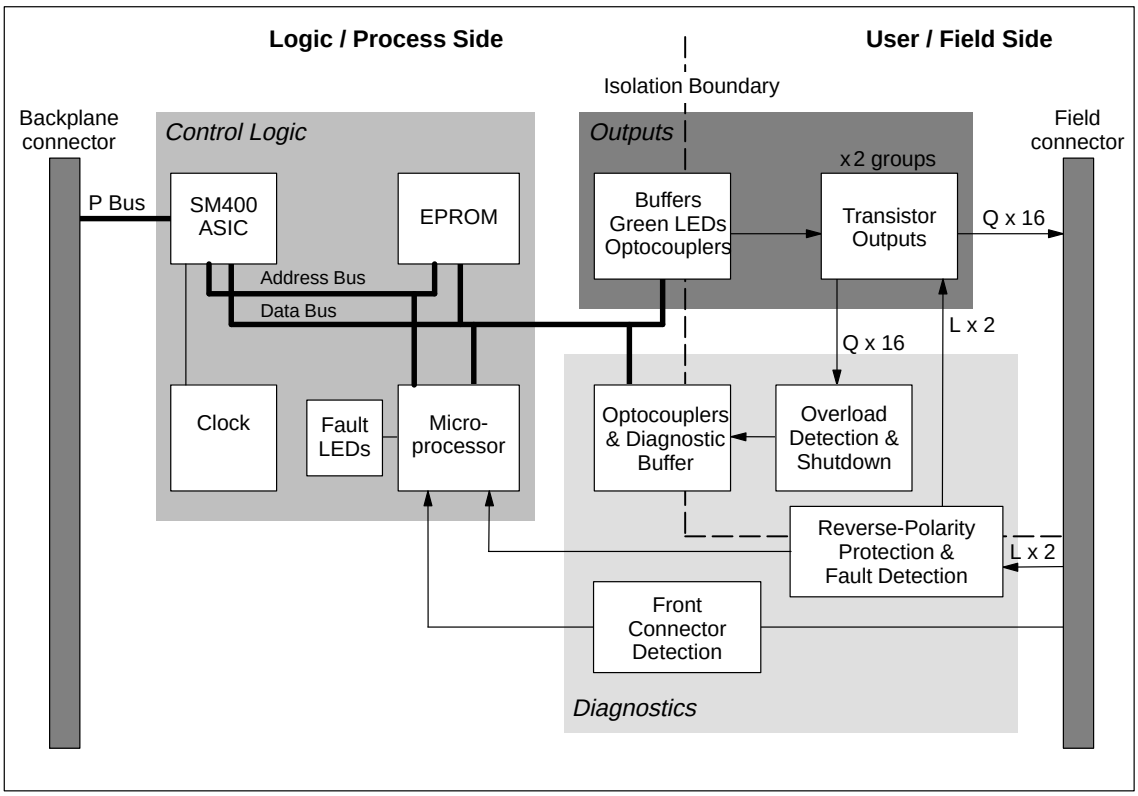


Figure 12 Block Diagram of Digital Output Module SM 422 (DO 16 x 20-125 VDC/1.5 A)

Diagnostics Parameters

The module checks for internal and external errors. Use the module properties dialog box in STEP 7 to activate the individual diagnostic options.

- Missing load voltage: The module monitors the voltage supply for both output groups. An error indicates that the voltage is too low (typically less than 14 V), the L+ or M connection is missing, or a fuse has blown.
- Short circuit to ground: The module reports on a channel-by-channel basis outputs that have been overloaded or shorted.

Diagnostic Interrupt Parameter

If you enable the Diagnostic Interrupt parameter, the module sends an interrupt to the CPU for both incoming and outgoing error events.

Note

If you are using the module in expansion racks 1 or 2, you will have to disable the Diagnostic Interrupt parameter, since the interrupt lines in expansion racks 1 and 2 are not available.

Default Parameters

If you have not assigned parameters to the module in STEP 7, all output channels will function with the default settings of all parameters after a complete restart. Table 1-5 lists the default parameters for the module.

Table 1-5 Default Parameters for the Digital Output Module

Default Parameter	Value
Target CPU for interrupt	CPU 1
All diagnostics	Deactivated
Output state in STOP mode	All outputs off

Note

Starting up the digital modules in default parameter assignment is possible only in the central rack.

Static and Dynamic Parameters

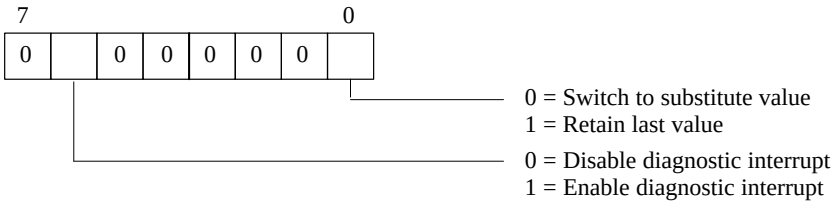
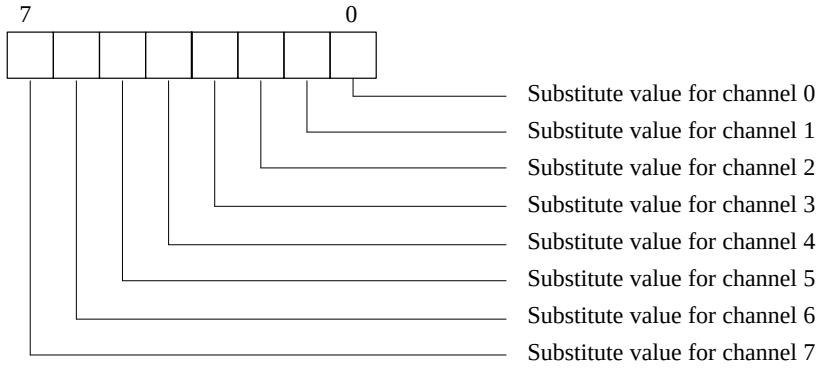
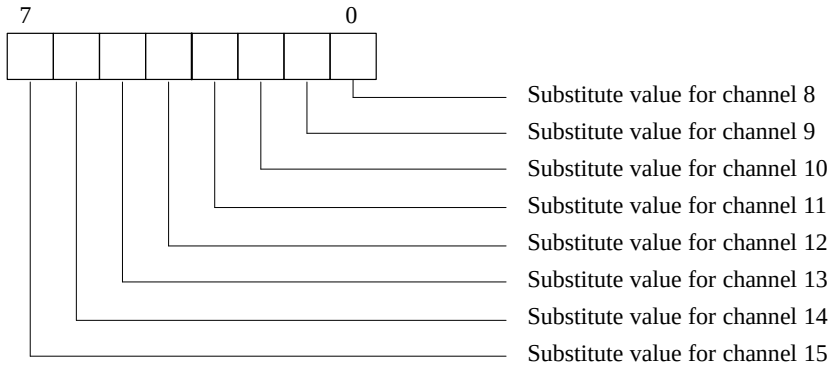
Table 1-6 shows the static and dynamic parameters used by the digital output module SM422 (DO 16 x 20-125 VDC/1.5 A).

Table 1-6 Static and Dynamic Parameters for the Digital Output Module

Parameters	Value Range
Static Parameters (Data Set 0)	
Target CPU for interrupts	1 to 4
Missing load voltage L+	On/Off per group
Short circuit to ground	On/Off per output
Dynamic Parameters (Data Set 1)	
Diagnostic Interrupt Enable	On/Off
Switch to substitute value/retain last value	SSV/RLV
Substitute values	On/Off per output

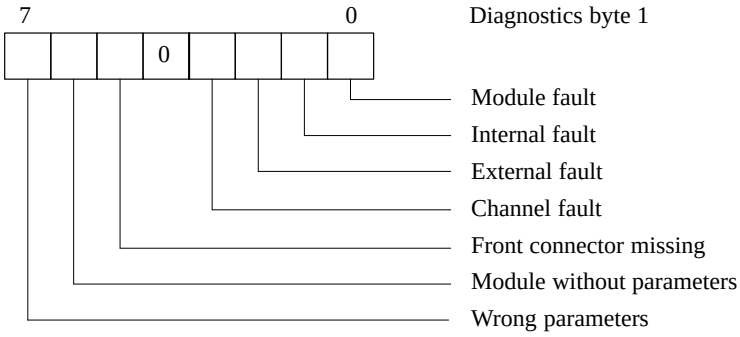
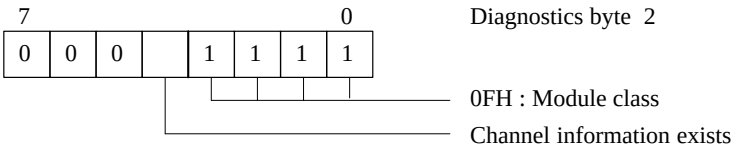
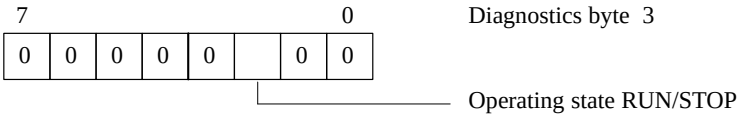
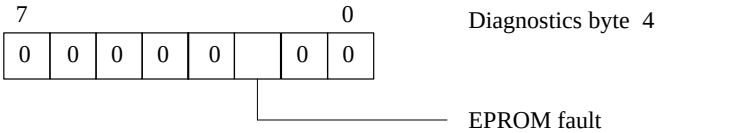
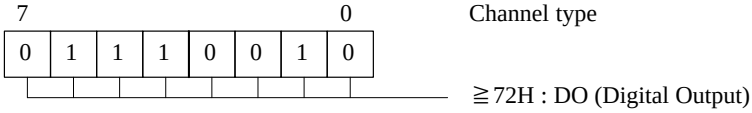
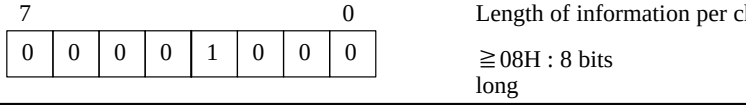
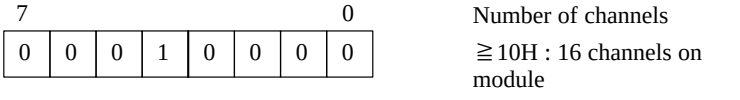
You can modify dynamic parameters in your user program using system function commands.

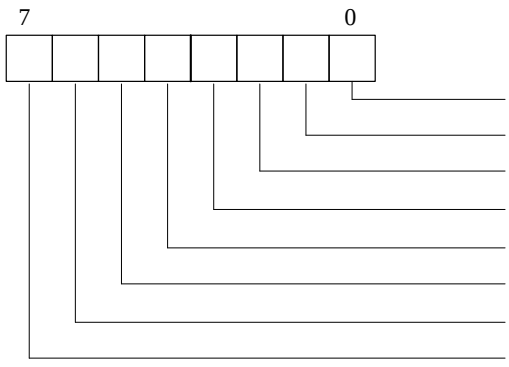
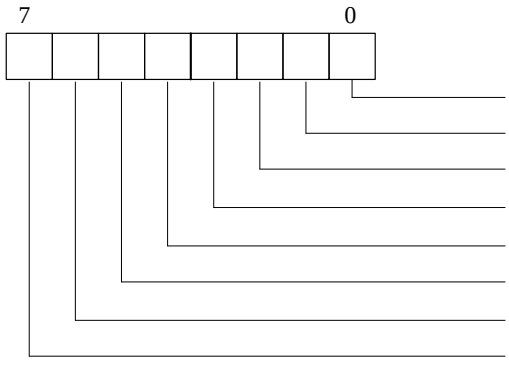
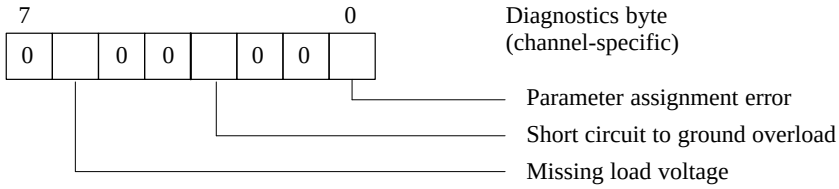
The structure of the dynamic parameters for Data Set 1 is shown below:

Address	Meaning	Location
0		DS1
1		DS1
2		DS1

Diagnostic Functions

The following diagnostic data can be read from the SM422 (DO 16 x 20-125 VDC/1.5 A) using SFC51.

Address	Meaning	Location
0		DS0/DS1
1		DS0/DS1
2		DS0/DS1
3		DS0/DS1
4		DS1
5		DS1
6		DS1

Address	Meaning	Location
7		DS1
8		DS1
9 to 25		DS1

0 = default value 0; the module does not process this diagnostics function

1 = default value 1; the module uses constants

❑ = no default; the module uses variables; the value 1 corresponds to a fault

Technical Data

The technical data for the digital output module SM 422 (DO 16 x 20-125 VDC/1.5 A) are listed below.

Dimensions and Weight		
Dimensions W × H × D	25 x 290 x 210 mm (1.0 x 11.4 x 8.3 in.)	
Weight	approx. 800 g (32 oz.)	
Module-Specific Data		
Number of outputs	16	
Voltages, Currents, Potentials		
Rated load voltage L +	20 to 138 VDC	
• reverse-polarity protection	yes, fuse	
Maximum module current of outputs[1]	without fan	with fan
	20 A	24A
• up to 25° C (77° F)	16 A	21A
• up to 40° C (104° F)	8 A	14A
• up to 60° C (140° F)		
Isolation	yes (optocoupler)	
• in groups of	8	
Permissible potential difference		
• between isolated groups	250 VAC	
• between process side and controller side	1500 VAC	
Current consumption		
• from S7-400 bus (5 VDC)	0.7 A max.	
• from each group (without load)	2 mA max.	
Module power loss	typically 10 W	
Status, Interrupts, Diagnostics		
Status display	yes, green LED per channel	
Interrupts	yes	
Diagnostics interrupt	yes, can be assigned parameters	
Diagnostic functions	yes, can be assigned parameters	
• Fault indication internal fault external fault	yes, red LED (INTF) yes, red LED (EXTF)	
• Diagnostic information	yes, can be read out	
Actuator Selection Data		
Output voltage		
• On-state voltage drop	1.0 VDC max.	
Output current (per point)		
• Rated value	1.5 A	
• Permissible range for 0° C to 60° C	1.5 A	
• Minimum current	10 mA	
• Maximum surge current	3 A max. for 10 ms	
• Leakage current	0.5 mA max.	
On delay	typically 1 ms	
Off delay	typically 10 ms	
Parallel connection of 2 outputs	yes	
Connecting to digital input	yes	
Short circuit protection of the outputs	Electronically protected[2]	
• Overload threshold	typically 5 A	
Reverse-polarity protection for outputs (1 fuse per group)	fuse, 12.5 A, 250 V, (2 required)	
Spare fuses	12.5 A fuse, fast-acting	
• Company “Schurter”	SP001.1015	

[1] To obtain maximum performance, distribute high current loads between the two groups.

[2] To reset an output that has tripped off, toggle the output signal to 0 then 1.

If an output signal of 1 is written to a tripped output and the short circuit remains, additional interrupts will be generated (provided that the diagnostic interrupt parameter has been enabled).

Note: When the power supply is switched on using a mechanical contact, a voltage pulse may occur at the outputs. The duration of the transient pulse will be less than 0.5 ms.

8 Analog Output Module SM 432: AO 8 x 13 Bit (6ES7 432-1HF00-0AB0)

The information on the error limits in the manual must be corrected as follows:

Error Limits

Basic error limit (at 25 °C, specific to output range)

- Voltage ± 0.5%
- Current ± 0.5%

9 PROFIBUS DP Master Interface IM 467

Order Number

6ES7 467-5GJ00-0AB0

Use

PROFIBUS DP, standardized according to EN 50170, facilitates fast communication in the field range between programmable logic controllers, PCs, and field devices. Field devices can be: distributed I/O devices (ET 200), drives, valve islands, switching devices, and many others.

The IM 467 interface module is intended for use in an S7-400 programmable logic control system. It enables you to connect an S7-400 to PROFIBUS DP.

Assembly

- Configuration according to S7-400
- 9-pin sub-D socket for connecting to PROFIBUS DP
- Can be operated without a fan
- A maximum of four IM 467 can be used in the central rack (CR). No slot rules apply
- A total of four IM 467 and CP 443-5 Extended can be used together
- Transmission rate 9.6 Kbps to 12 Mbps; can be set to various rates in the software
- Remote configuring and programming via PROFIBUS DP possible

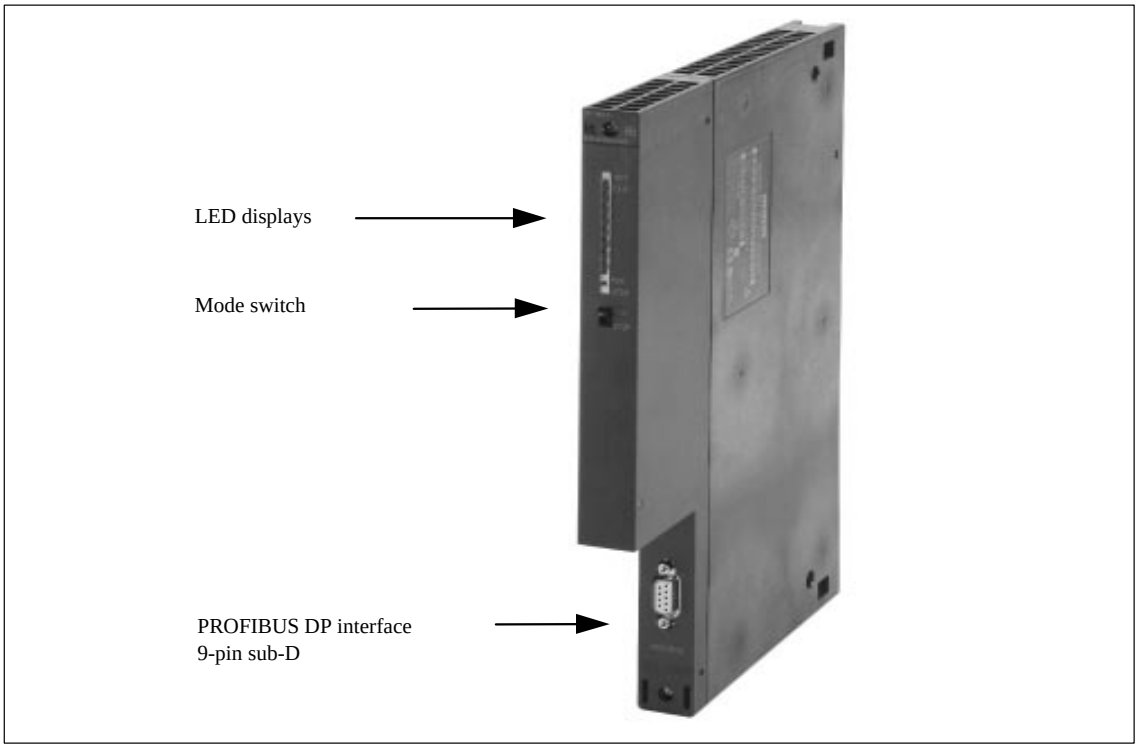


Figure 13 Configuration of the IM 467

Communication Services

IM 467 offers you two means of communication:

- PROFIBUS DP

  IM 467 is a PROFIBUS DP master which conforms to EN 50 170. The configuration is carried out completely with STEP 7. The behavior is identical to the integrated PROFIBUS DP interfaces on the CPU modules.

  No function calls are necessary for DP communication in the STEP 7 user program.

- S7 functions

  S7 functions ensure optimum, simple communication in a SIMATIC S7/M7/C7 automation solution. For IM 467, the S7 functions are used for:

– SIMATIC programming devices (programming device functions via PROFIBUS DP)

– SIMATIC operator interface devices (operator control and monitoring functions via PROFIBUS DP)

  Communication is carried out without further configuration being necessary on the IM 467.

  The S7 functions can be used alone or parallel to the PROFIBUS DP protocol. If they are used parallel to DP communication, this will affect the PROFIBUS DP bus cycle time.

Configuration

Configuring IM 467 is carried out with STEP 7. The configuring data are also maintained during power failure; a submodule is not necessary. With the help of the S7 functions, all connected IM 467 on the network and all CPUs connected via the SIMATIC S7 400 backplane bus can be remotely programmed or configured.

Technical Specifications

The technical data of the IM 467 are listed below.

Dimensions and Weight	
Dimensions WxHxD	25 x 290 x 210 mm (1.0 x 11.4 x 8.3 in.)
Weight	700 g (28 oz)
Ambient Conditions	
Ambient temperature	
• Operation	0 to 60 degrees C
• Transport and storage	–40 to +70 degrees C
Operating altitude	3000 m above sea level

PROFIBUS DP	
• Standard	PROFIBUS, EN 50 170
• Transmission rate	9.6 Kbps to 12 Mbps, can be set to various rates
• Transmission method	RS 485
• Ports	9-pin Sub-D socket

Conditions for Use	
For use with	SIMATIC S7-400, max. 4 IM 467 in the central rack
Power supply	5 VDC via the backplane bus
Current consumption	1.2 A
• from 5 VDC	
Addressing volume	max. 4 Kbytes for inputs and 4 Kbytes for outputs
Number of connectable I/Os (slaves)	96
Number of connections for S7 functions for programming devices and operator interface devices	32
Data volume per slave	max. 240 bytes
Consistency	max. 240 bytes
Configuration software	STEP 7

Maximum Performance Characteristics of the PROFIBUS DP

Transmission rate in Kbps	9.6	19.2	93.75	187.5	500	1500	3000	6000	12000
Max. length of a bus segment in m	1 000	1 000	1 000	1 000	400	200	100	100	100
Max number of bus segments 1)	10	10	10	10	10	10	10	10	10
Max. length in m	10 000	10 000	10 000	10 000	4 000	2 000	1 000	1 000	1 000

[1)] Bus segments are interconnected via an RS 485 repeater