

MANUFACTURER DOCUMENT PACKAGE

Manufacturer's Manual

Selected official pages for procurement and maintenance review

PRODUCT BRAND

Siemens

PRODUCT MODEL

6ES7331-7KF01-0AB0

Configurable Analog Input Module. Relevant section pages: 182, 183, 184, 185, 186, 187, 188, 189, 190, 191. Adjacent model text on shared pages is outside this product reference.

OFFICIAL SOURCE

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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

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SIMATIC TOP connect

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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.

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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.

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.

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.

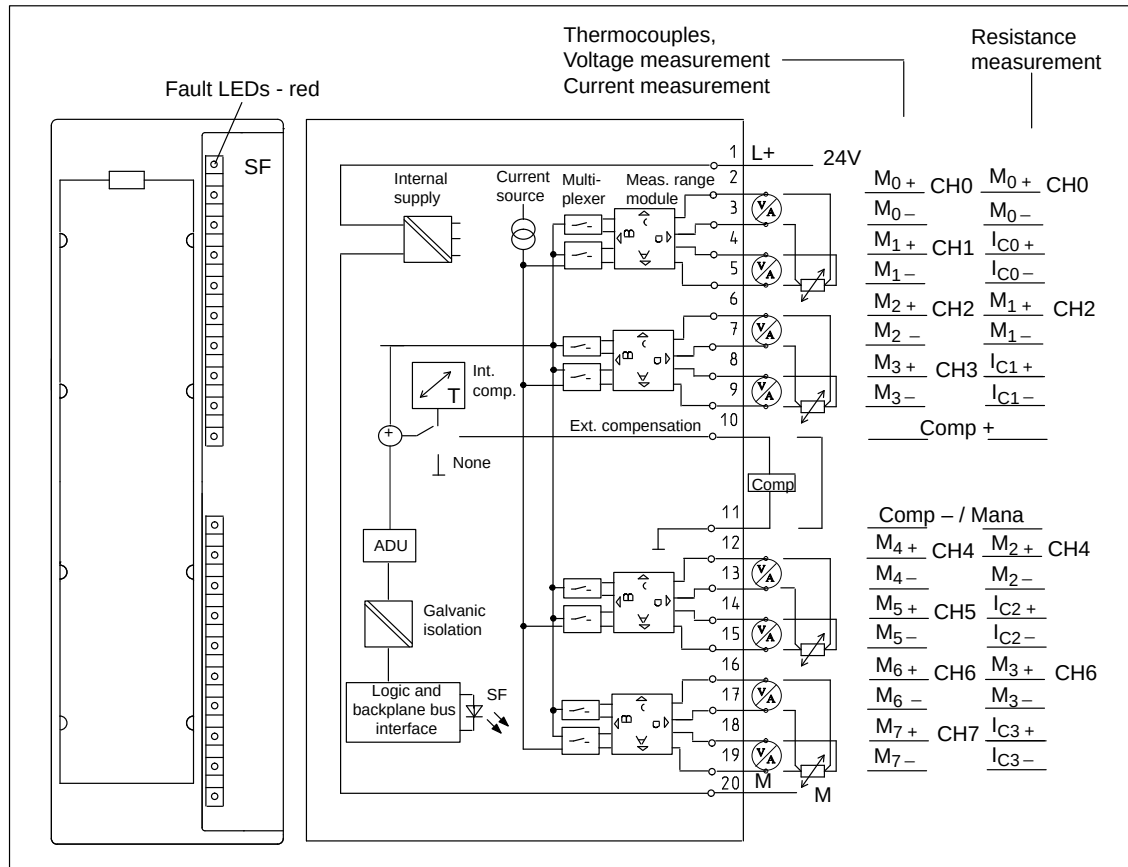


Figure 4-22 Module View and Block Diagram of the Analog Input Module SM 331; AI 8 × 12 Bit

Dimensions and Weight		Analog Value Generation				
Dimensions W × H × D	40 × 125 × 120mm (1.56 × 4.88 × 4.68 in.)	Measuring principle	Integrating			
Weight	approx. 250 g (8.75 oz.)	Integrations/conversion time/resolution (per channel)				
Module-Specific Data		• Programmable	Yes			
Number of inputs	8	• Integration time in ms	2.5	16 ² / ₃	20	100
• with resistance measurement	4	• Basic conversion time incl. integr. time in ms	3	17	22	102
Length of cable (shielded)	max. 200 m (218 yd.) max. 50 m (54.5 yd.) at 80 mV and thermocouples	Additional conversion time for resistance measurement in ms	1	1	1	1
Voltages and Currents		or				
Rated load voltage L +	24 VDC	Additional conversion time for wire-break monitoring in ms	10	10	10	10
• Reverse polarity protection	Yes	or				
Power supplies of the transducers		Additional conversion time for resistance measurement and wire-break monitoring in ms	16	16	16	16
• Supply current (for 2 channels each of a channel group):	max: 62 mA	• Possible resolution in bits + sign (incl. overrange)				
• Short-circuit-proof	Yes	unipolar measuring range	9	12	12	14
• Constant current for resistance-type sensor	typ. 1.67 mA	bipolar measuring range	9+ sign	12+ sign	12+ sign	14+ sign
Galvanic isolation		• Noise suppression for frequency f1 in Hz	400	60	50	10
• between channels and backplane bus	Yes	Noise Suppression and Error Limits				
• between channels and load voltage L+	Yes	Noise suppression for F = n × (f1 ± 1 %), (f1 = interference frequency)				
Possible potential difference		• Common-mode noise (U _{pp} < 2.5 V)	> 70 dB			
• between inputs and M _{ANA} (U _{CM})	2.5 VDC	• Series-mode noise (peak value of noise < nominal value of input range)	> 40 dB			
– at signal = 0 V						
– not for 2-wire transducer		Crosstalk between inputs	> 50 dB			
• 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					

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 compensation with compensating box	Possible	

4.4.2 Starting Up the Analog Input Module SM 331; AI 8 × 12 Bit

Parameter Assignment

The analog input module SM 331; AI 8 × 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 × 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 × 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 × 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 × 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 k Ω 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 × 12 Bit

Measuring Methods

You can set the following measuring methods on the analog input module SM 331; AI 8 × 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 (thermoelectric 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 (thermoelectric 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.	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 (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