SIEMENS

Product Information

SIMATIC S7-300

Isolated Analog Input Module SM 331; AI 8 × 16 Bit as of Version X2 / 34

New Analog Input Module Available

The S7-300 Isolated Analog Input Module SM 331; AI 8 × 16 Bit has been added to the S7-300 family. The order number for this module is 6ES7 331-7NF10-0AB0.

This product information includes details about the characteristics and technical specifications of the isolated analog input module SM 331; AI 8 × 16 Bit. Refer to the *S7-300 Installation and Hardware Manual* for more information about the S7-300 product family.

You will also learn:

- How to start up isolated analog input module SM 331; AI 8 × 16 Bit
- The measuring ranges available for isolated analog input module SM 331; AI 8 × 16 Bit
- How to configure isolated analog input module SM 331; AI 8 × 16 Bit

Additional Assistance

For assistance in answering technical questions, for training on this product, or for ordering, contact your Siemens distributor or sales office.

2810013-0001

Characteristic Features and Technical Specifications of the Isolated Analog Input Module SM 331; AI 8 × 16 Bit

Order No.

6ES7 331-7NF10-0AB0

Characteristic Features

The isolated analog input module SM 331; AI 8 × 16 Bit has the following characteristic features:

- 8 isolated inputs in 4 channel groups
- Measured-value resolution 15 Bit + sign
- Fast update mode for up to 4 channels
- Arbitrary measuring type selection per channel group
- Programmable diagnostics
- Programmable diagnostic interrupt
- Eight channels with limit monitoring
- Programmable limit interrupt
- Programmable end of cycle interrupt
- Galvanic isolation >500V to CPU

Special Feature

The isolated analog input module SM 331; AI 8 × 16 Bit can only be used in the ET200M distributed I/O configuration with the following versions of the IM153 (or later)

- IM153-1 6ES7 153-1AA03-0XB0 V.1
- IM153-2 6ES7 153-2AA02-0XB0 V.5
  6ES7 153-2AB01-0XB0 V.4

Terminal Connection Diagram

Figure 1 shows the isloated analog terminal connection diagram and the wiring diagram for the isolated analog SM331 AI 8 × 16 Bit Module.

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

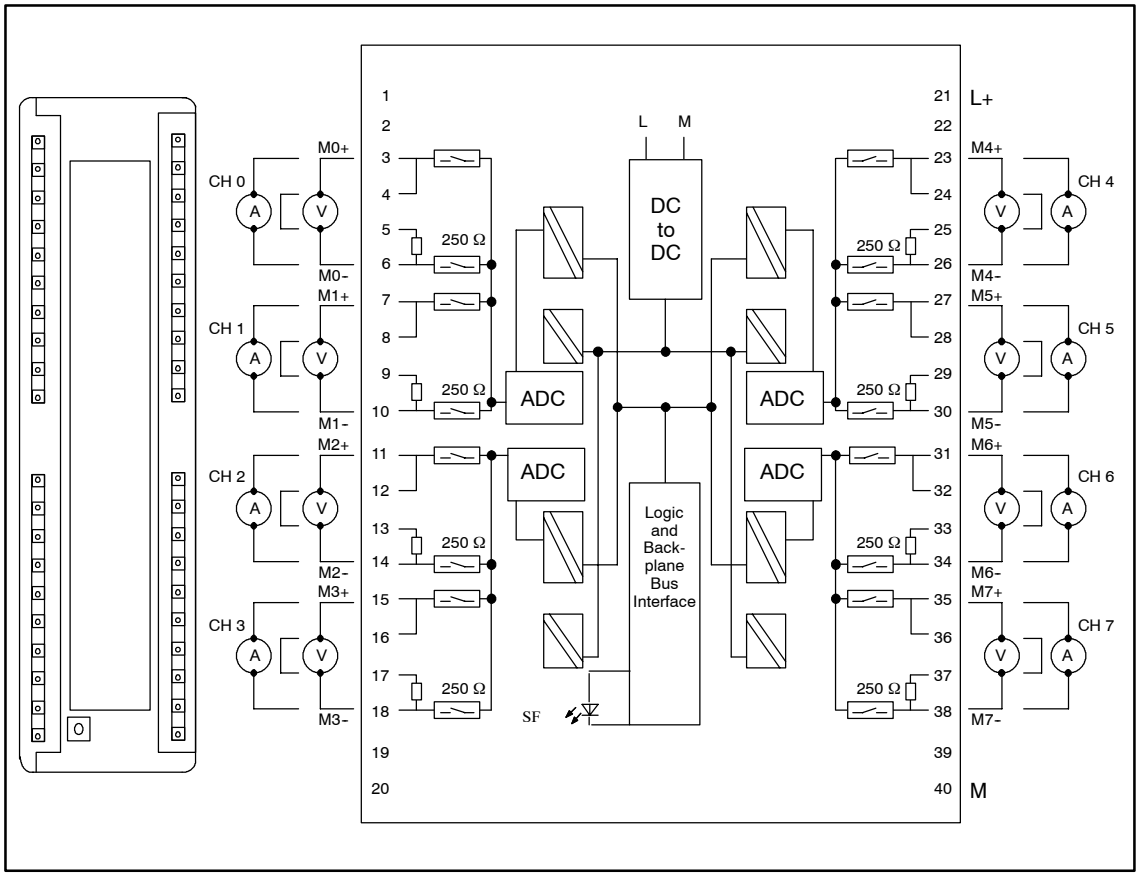

Figure 1 Connection Diagram of Isolated Analog Input Module SM 331; AI 8 x 16 Bit

Dimensions and Weight	
Dimensions W × H × D	40 × 125 × 120mm (1.56 × 4.88 × 4.68 in.)
Weight	approx. 272 g (9.6 oz.)
Data for Specific Module	
Number of inputs	8
Length of cable	
• Shielded	max. 200 m (218 yd.)
Voltage, Currents, Potentials	
Power rated voltage of the electronics L+	24 VDC
• Reverse polarity protection	Yes
Isolation	
• Between channels and backplane bus	Yes
• Between channels and power supply of the electronics	Yes
• Between the channels	Yes
Permitted potential difference	
• Between the inputs (U_{CM})	60 VAC / 75 VDC
• Between M_{ANA} and $M_{internal}$ (E_{ISO})	60 VAC / 75 VDC
Insulation Tested with	500 VAC
Current source	
• From the back plane bus	max. 100 mA
• From the power supply L+	max. 200 mA
Power dissipation of the module	typ. 3.0 W

Analog Value Generation	
Measuring Principle	Integrating
Integration time/ conversion time/ resolution (per channel)	
• Parameters can be assigned	Yes
• Basic conversion time in milliseconds for 8 channel mode	95/83/72/23
• Basic conversion time in milliseconds for 4 channel mode	10
• Resolution including sign	16 bits
• Suppression of interference voltage for interference frequency f1 in Hertz	All/50/60/400
Smoothing of the measured values	Parameters can be assigned in 4 levels
Basic response time of module (8 channel mode)	190/166/144/ 46
Basic response time of module (4 channel mode)	10

*Interference frequency 50/60/400HZ is designated as “All”.

Suppression of Interference, Limits of Error	
Suppression of interference for F=n×(fl ± 1%), (f1=interference frequency) n=1,2,...	
• Common-mode interference (E_{cm} < 60 VAC)	> 100 dB
• Series mode interference (peak value of the interference< rated value of the input range)	> 90 dB [1)]
Crosstalk between the inputs	> 100 dB
Operational limit (in the entire temperature range, with reference to the input range)	
• Voltage input	±0.1%
• Current input	±0.1%
Basic error (operational limit at 25° C, with reference to the input range)	
• Voltage input	± 0.05%
• Current input	± 0.05%
Temperature error (with reference to the input range)	±0.005% /K
Linearity error (with reference to the input range)	± 0.01%
Repeatability (in steady state at 25° C, with reference to the input range)	±0.01%

Status, Interrupts, Diagnostics	
Interrupts	
• Hardware interrupt when limit has been exceeded	Programmable all channels
• Hardware interrupt when end of cycle has occurred.	Programmable
• Diagnostics interrupt	Programmable
Diagnostics functions	Programmable
• Group error display	Red LED (SF)
• Diagnostics information can be displayed	Possible

Data for Selecting a Sensor	
Input range (rated values)/ Input Resistance	
• Voltage	± 5 VDC /10 MΩ 1 to 5 VDC /10 MΩ ± 10 VDC /10 MΩ
• Current	0 to 20mA /250Ω 4 to 20mA/250Ω ± 20mA /250Ω
Maximum input voltage for voltage input (destruction limit)	35 VDC continuous; 75 VDC for max. 1 s (pulse duty factor 1:20)
Maximum input current for current input (destruction limit)	40mA
Connection of the Sensor	
• For measuring voltage	Possible
• For measuring current	
As two-wire transmitter	Possible, with separate supply for transmitter
As four-wire transmitter	Possible

Note[1:] Normal mode rejection for the 8 channel mode is reduced as shown below:

50 HZ	>70 dB
60 HZ	>70 dB
400 HZ	>80 dB
50/60/400 HZ	>90 dB

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

Parameter Assignment

The isolated 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 isolated analog input module SM 331; AI 8 × 16 Bit has default settings for operating mode, measuring type, diagnostics, interrupts, etc., (see Table 1).

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

Table 1 Parameters and Default Settings for the Isolated Analog Input Module SM 331 AI 8 x 16 Bit.

Parameter	SM 331; AI 8 × 16 Bit		Parameter Type	Scope
	Value Range	Default Settings		
Enable				
• Hardware interrupt when limit value is exceeded	Yes/No	No	Dynamic	Module
• Hardware interrupt on end of cycle	Yes/No	No	Dynamic	Module
• Diagnostics interrupt	Yes/No	No	Dynamic	Module
Trigger for process interrupt				
• Upper Limit	32511 to -32512	-	Dynamic	Channel
• Lower Limit	-32512 to 32511	-	Dynamic	Channel
Diagnostics				
• Group Diagnostics	Yes/No	No	Static	Channel
• With wire-break check	Yes/No	No		Group
Measurement				
• Module Mode	• 8 channel • 4 channel	Yes No	Dynamic	Module
• Interference frequency suppression	50 Hz 60 Hz 400 Hz 50/60/400 Hz	50/60/400 Hz		Group
• Smoothing	• None • Weak • Medium • Strong	None	Dynamic	Group
• Measuring Type	• Measuring Range:		Dynamic	Group
Deactivated				
Voltage	• ± 5V • 1 to 5V • ± 10V	± 10V		
Current (4-Wire Transmitter)	• 0 to 20mA • 4 to 20mA • ± 20mA	4 to 20mA		

Channel Groups

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

Table 2 shows which channels of the isolated analog input module SM 331; AI 8 × 16 Bit are configured as one channel group. You 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 2 Assignment of Channels of the Isolated 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	

Operating Modes

The isolated analog input module SM 331; AI 8 × 16 Bit operates in the following modes:

- 8 Channel
- 4 Channel

8 Channel Mode

Module Cycle Description

When operating in the 8 Channel Mode the isolated analog input module SM331; AI 8 × 16 Bit switches between the two channels in each group. Since the module contains four analog-to-digital converters (ADC), all four ADCs convert simultaneously for channels 0, 2, 4 and 6. Upon completion of the even numbered channels, all four ADCs convert simultaneously for channels 1, 3, 5 and 7 the odd numbered channels (see Figure 2).

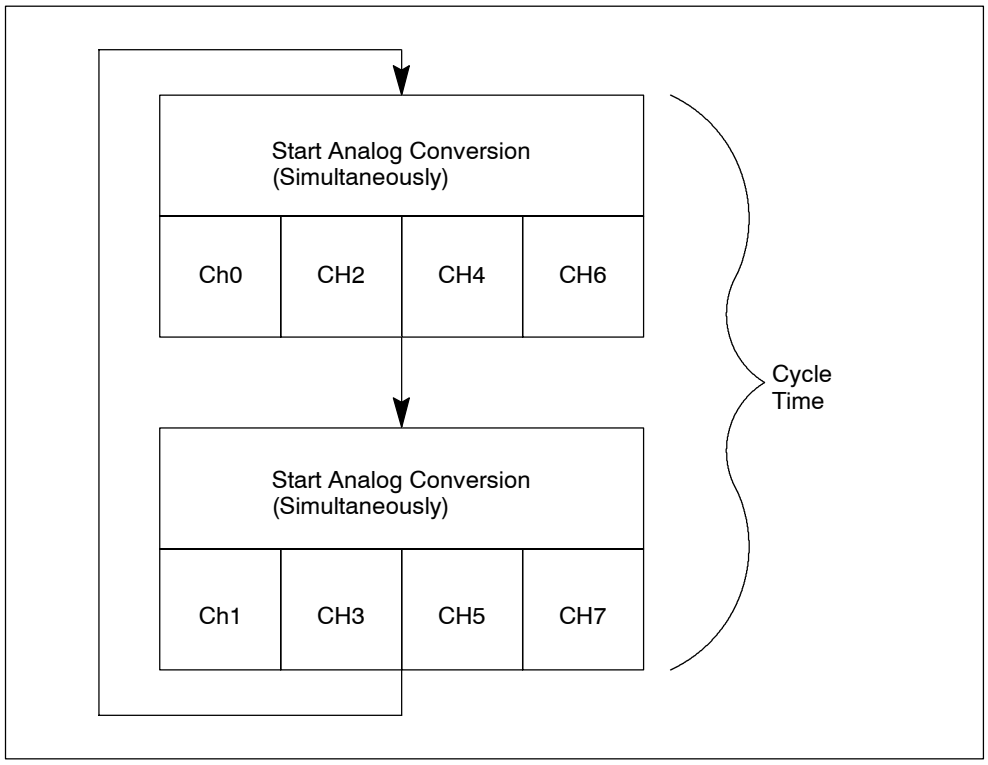

Figure 2 8 Channel Mode Cycle

Module Cycle Time

When operating in the 8 Channel Mode the isolated analog input module SM331; AI 8 × 16 Bit channel conversion time is dependent of the interference frequency selected. Selecting an interference frequency of 50 Hz, the channel conversion time, including communication overhead, is 76 ms. Selecting an interference frequency of 60 Hz, the channel conversion time is 65 ms. Selecting an interference frequency of 400 Hz, the channel conversion time reduces to16 ms. By selecting 50/60/400 Hz, the channel conversion time is 88 ms.The module must then switch to the opposite channel in the group using the opto-mos relays. The opto-mos relays require 7 ms to switch and settle fully. Table 3 shows specific interference frequency module cycle times.

Table 3 8 Channel Mode Cycle Times

Interference Frequency (Hz)	Channel Cycle Time (ms)	Module Cycle Time (for all Channels)
50	83	166
60	72	144
400	23	46
50/60/400	95	190

4 Channel Mode

Module Cycle Description

When you operate in the 4 Channel Mode, the isolated analog input module SM331; AI 8 × 16 Bit does not switch between the channels in each group. Since the module contains four analog-to-digital converters (ADC), all four ADCs convert simultaneously for channels 0, 2, 4 and 6.

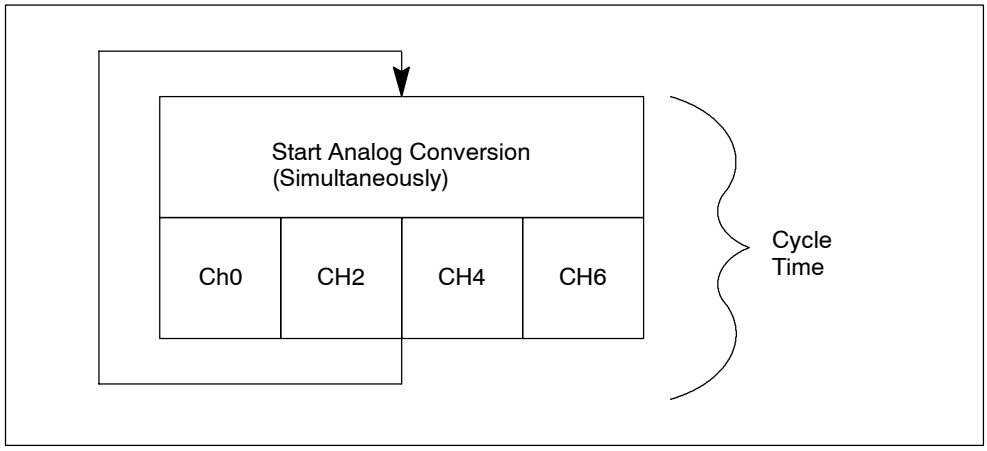

Figure 3 4 Channel Mode Cycle

Module Cycle Time

When operating in the 4 Channel Mode, the isolated analog input module SM331; AI 8 × 16 Bit channel conversion time, including communication overhead is 10 ms. Since the module does not switch between the channels within the groups, the channel cycle time and the module cycle time are the same, 10 ms.

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

Measuring Methods

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

- Voltage
- Current (4-Wire Transmitter)

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 5 and Table 6 lists the measuring ranges you can use with the isolated analog input module. Use STEP 7 to select the desired measuring ranges.

Common Mode Voltage

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

The AC and DC common mode voltage rejection is accomplished by the use of opto-mos relays. By operating on a break-before-make switching scheme, the channel-to-channel common mode voltage is rejected.

Wire-Break Check

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

With the measuring range ± 5V, 1 to 5V or ± 10V and:

- **activated** wire-break check, the isolated analog input module enters a wire break in the diagnostics if the process value is pulled to positive full scale (32768). If you have enabled the diagnostic interrupt during configuration, the analog input module additionally triggers a diagnostic 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 diagnostic bytes in the user program.

With the measuring range 4 to 20 mA and:

- **activated** wire-break check, the isolated analog input module enters a wire break in the diagnostics if the process value falls below 3.6 mA. If you have enabled the diagnostic interrupt during configuration, the analog input module additionally triggers a diagnostic 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 diagnostic bytes in the user program.

- If the wire-break check is not activated, the islolated analog input module triggers a diagnostics interrupt when the underflow limit has been reached.

Measuring Ranges for Analog Input Measurements

Table 4 shows all of the measuring ranges for the SM331; AI 8 × 16 Bit module.

Table 4 Measuring Ranges for Analog Input Measurements

Measuring Method Selected	Description	Measuring Range
Voltage	Table 5 and Table 6 show the digitized analog values in the analog input measuring range.	± 5V 1 to 5V ± 10V
Current (4-Wire Transmitter)	Table 5 and Table 6 show the digitized analog values in the analog input measuring range.	0 to 20 mA 4 to 20 mA ± 20 mA

Short to M or L

If you short an input channel to M or L, no damage will occur to the module. The channel continues to report valid data and no diagnostics are reported.

Overflow, Underflow, and Process Interrupt 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.

Process interrupt limits should not be set at values higher than the minimum potential overflow or underflow threshold limits shown in Table 5 and Table 6.

Analog Value Representation of the Measuring Ranges of the Isolated Analog Input Module SM 331: AI 8 × 16 Bit

Introduction

The tables in this section contain the digitized analog values for the various measuring ranges of the isolated analog input module. See Table 5 and Table 6.

How to Read the Measured-Value Tables

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

Voltage and Current Measuring Ranges

Table 5 shows the representation of the digitized measured value:

- For the voltage measuring ranges ±5 VDC, ±10 VDC and
- For the current measuring range ± 20 mA.

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

Range	System Word Units		Measuring Range ± 5 VDC	Measuring Range ± 10 VDC	Measuring Range ± 20 mA
	Decimal	Hexadecimal			
Overflow	32767	$7FFF_H$	>5.8794	>11.7589	>23.515
Overrange	32511 : 27649	$7EFF_H$: $6C01_H$	5.8794 : 5.0002	11.7589 : 10.0004	23.515 : 20.0007
Nominal Range	27648 20736 : -20736 -27648	$6C00_H$ 5100_H : $AF00_H$ 9400_H	5.00 3.75 : -3.75 -5.00	10.00 7.5 : -7.5 -10.00	20.000 14.998 : -14.998 -20.000
Underrange	-27649 : -32512	$93FF_H$: 8100_H	-5.0002 : -5.8796	-10.0004 : -11.759	-20.0007 : -23.516
Underflow	-32768	8000_H	<-5.8796	<-11.759	<-23.516

Voltage and Current Measuring Ranges

Table 6 shows the representation of the digitized measured value:

- For the voltage measuring ranges 1 to 5 VDC and
- For the current measuring range 0 to 20 mA, 4 to 20 mA.

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

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

Parameter Sets for the Isolated Analog Input Module SM 331; AI 8 × 16 Bit

Parameter Assignment in the User Program

You have already set the parameters for the S7-300 module using STEP 7. You can use an SFC in the user program to change the AI 8 × 16 bit module dynamic parameters. You can also use an SFC in the user program to transfer the parameters from the CPU to the addressed module.

Parameters Stored in Data Records

The parameters for the AI 8 × 16 bit module are stored in three data records: records 0, 1 and 128.

Modifiable Parameters

You can change the parameters of record 1 and/or record 128 and pass them to the AI 8 × 16 bit module using SFC 55. This does not change the parameters set on the CPU. You cannot change the S7-300 parameters of record 0 in the user program.

The following section shows an overview of the parameters that are stored in records 0, 1, and 128 for the AI 8 × 16 bit module.

SFCs for Parameter Assignment

The following SFCs are available for assigning the parameters for the AI 8 × 16 bit module in the user program.

Table 7 SFCs for Assigning Module Parameters

SFC No.	Identifier	Application
55	WR_PARM	Transfer modifiable parameters (record 1 and 128) to the addressed signal module.
56	WR_DPARM	Transfer parameters (records 0, 1 or 128) from the CPU to the addressed signal module.
57	PARM_MOD	Transfer all parameters (records 0, 1, and 128) from the CPU to the addressed signal module.

Description of the Parameters

The following section contains all the modifiable parameters for the AI 8 × 16 bit module.

The parameters for the AI 8 × 16 bit module are described in this Product Information document and in the online help of STEP 7.

Parameters of the Isolated Analog Input Module SM 331; AI 8 × 16 Bit

Parameters

Table 8 contains all the parameters that you can set for the Isolated Analog Input Module SM 331; AI 8 × 16 bit. The comparison shows:

- Parameters you can change using STEP 7.
- Parameters you can change using SFC 55 “WR_PARM”.

The parameters you set using STEP 7 can also be transferred to the module using SFCs 56 and 57.

Table 8 Parameters for the Analog Input Module SM 331; AI 8 × 16 bit

Parameter	Data Record No.	Configurable with...	
		...SFC 55	...Programming Device
Diagnostics: Group	0	No	Yes
Diagnostics: with wire-break	0	No	Yes
Limit value interrupt enable	1	Yes	Yes
Diagnostic interrupt enable	1	Yes	Yes
End of cycle interrupt enable	1	Yes	Yes
Module Mode	128	Yes	Yes
Interference frequency suppression	128	Yes	Yes
Measurement type	128	Yes	Yes
Measurement range	128	Yes	Yes
Measurement smoothing	128	Yes	Yes
Upper limit value	128	Yes	Yes
Lower limit value	128	Yes	Yes
Note: Before you can enable the diagnostic 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 4 shows the structure of data record 1 for the parameters of the Isolated Analog Input Module SM 331; AI 8 × 16 bit.

You can activate a parameter by setting the corresponding bit in byte 0 to “1”.

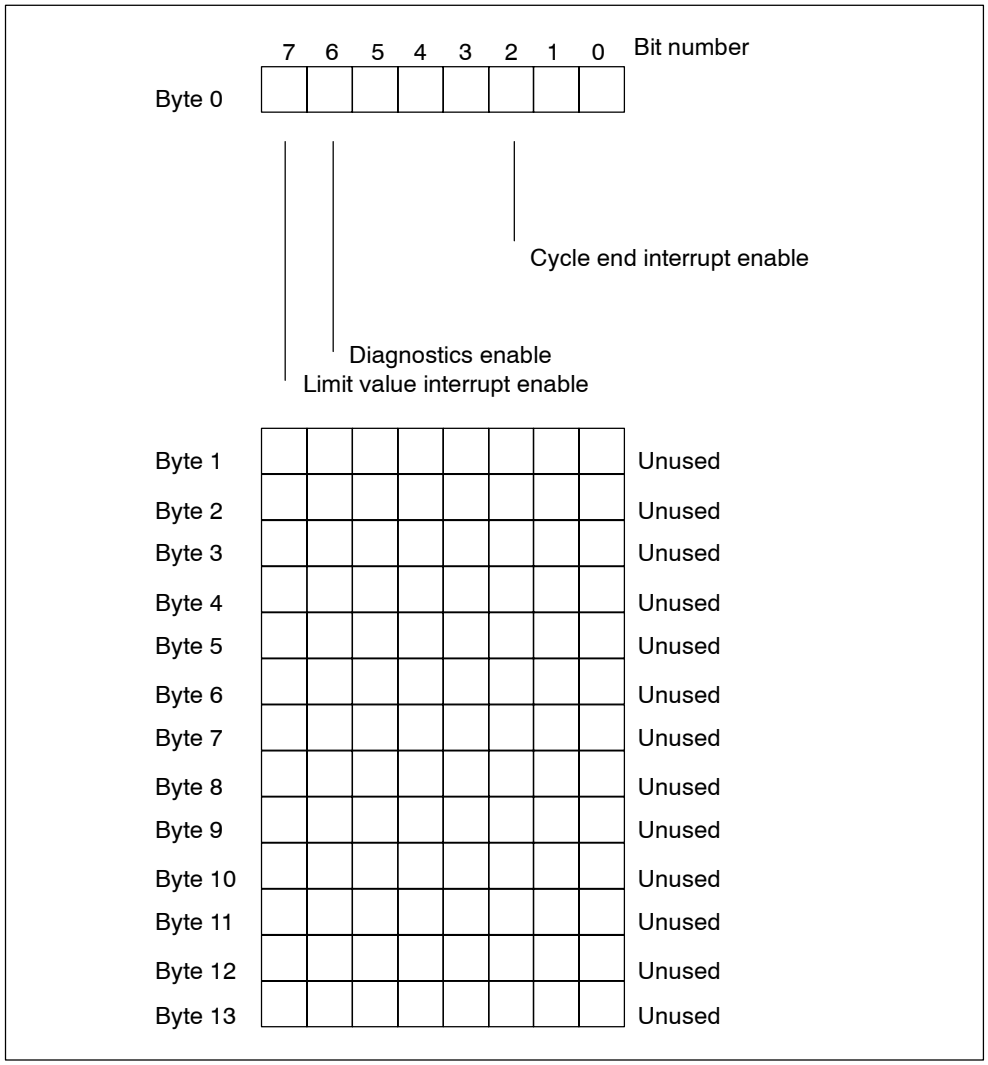

Figure 4 Data Record 1 for Parameters of the Isolated Analog Input Module SM 331; AI 8 × 16 Bit

Structure of Data Record 128

Figure 5 shows the structure of data record 128 for the parameters of the Isolated Analog Input Module SM 331; AI 8 × 16 bit.

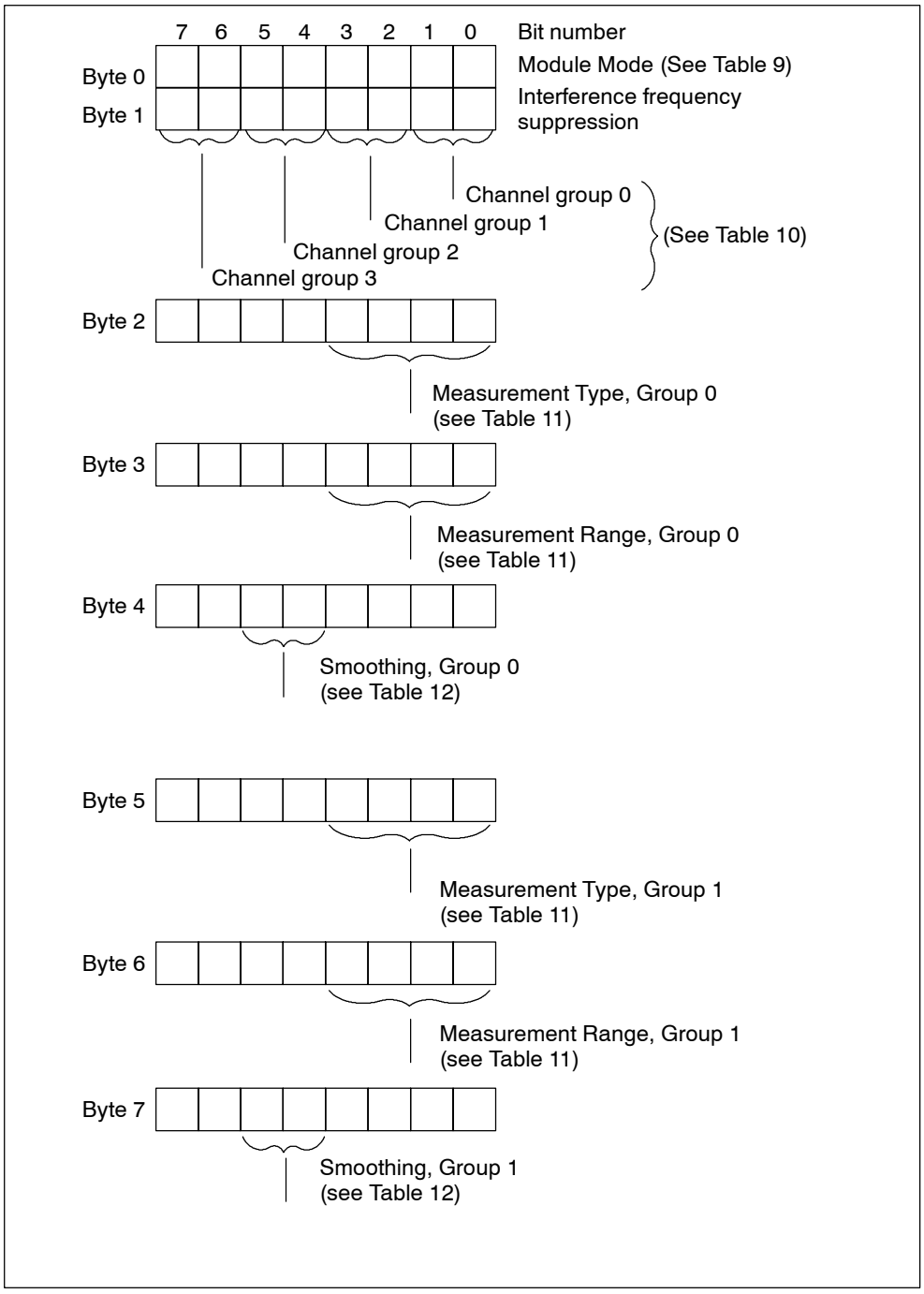

Figure 5 Data Record 128 for Parameters of the Isolated Analog Input Module SM 331; AI 8 × 16 Bit

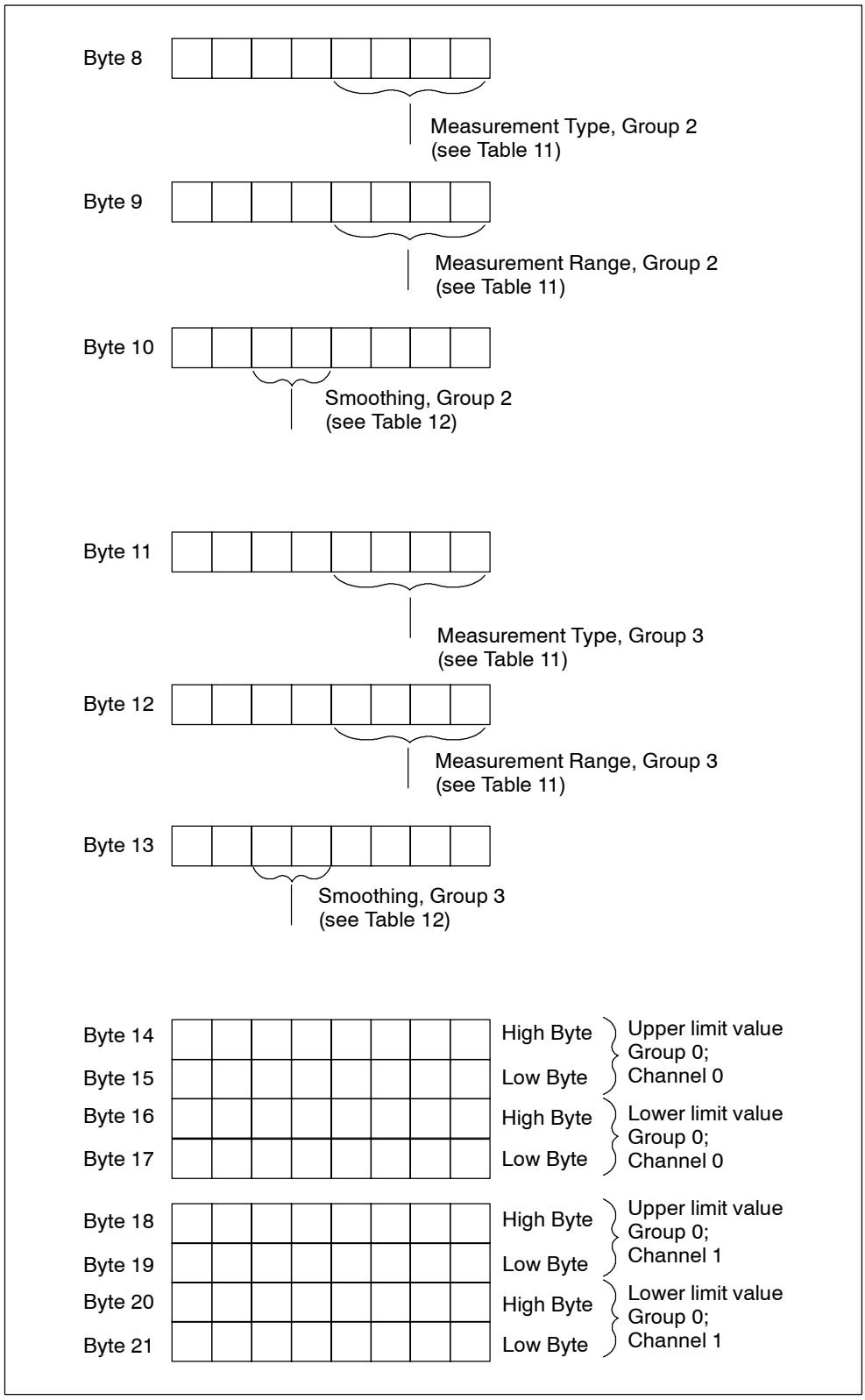

Figure 5 Data Record 128 for Parameters of the Isolated Analog Input Module SM 331; AI 8 × 16 Bit (continued)

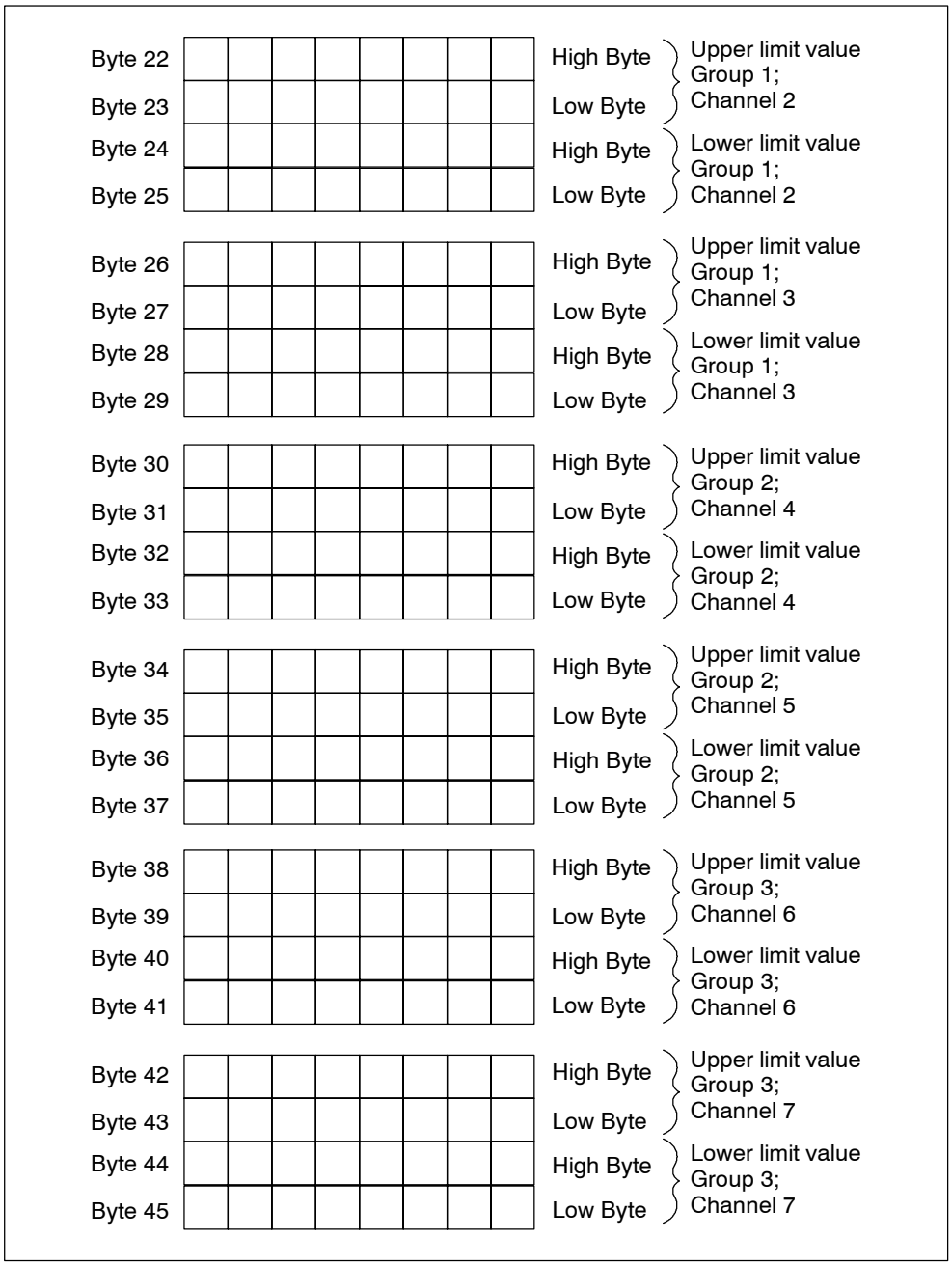

Figure 5 Data Record 128 for Parameters of the Isolated Analog Input Module SM 331; AI 8 × 16 bit (continued)

The representation of the limit values matches the analog value representation. Observe the range limits when setting the limit values.

Module Mode

Table 9 contains the codes for the various module operating modes that you enter in byte 0 of data record 128 (see Figure 5).

Table 9 Codes for the module modes of the Isolated Analog Input Module SM 331; AI 8 × 16 bit

Module Mode	Code
8 Channel	2#00000000
4 Channel	2#00000001

Interference Frequency Suppression

Table 10 contains the codes for the various frequencies that you enter in byte 1 of data record 128 (see Figure 5). Note that the 4 channel mode only operates in the 50/60/400 Hz interference frequency selection.

Table 10 Codes for the Interference Frequency Suppression of the Isolated Analog Input Module SM 331; AI 8 × 16 bit

Interference Frequency Suppression	Code
400 Hz	2#00
60 Hz	2#01
50 Hz	2#10
50/60/400 Hz	2#11

Measurement Type and Measurement Range

Table 11 contains all the measuring ranges for the Isolated Analog Input Module SM 331; AI 8 × 16 Bit. Table 11 also shows the codes for the measurement types and the measuring range. You must enter these codes, according to the measuring range desired, in the appropriate bytes of data record 128 (see Figure 5).

Table 11 CodesfortheMeasuringRangesoftheIsolated AnalogInputModuleSM331:AI 8 × 16 Bit

Measurement Type	Code	Measurement Range	Code
Deactivated	2#0000	Deactivated	2#0000
Voltage	2#0001	± 5 VDC 1 to 5 VDC ± 10 VDC	2#0110 2#0111 2#1001
Current (4-Wire Transmitter)	2#0002	0 to 20 mA 4 to 20 mA ± 20 mA	2#0010 2#0011 2#0100

Input Smoothing Selection

Table 12 contains all the smoothing selections for the Isolated Analog Input Module SM 331; AI 8 × 16 bit. You must enter these codes, according to the smoothing option desired, in the appropriate bytes of data record 128 (see Figure 5).

Table 12 Codes for the Smoothing Selection of the Isolated Analog Input Module SM 331; AI 8 × 16 Bit

Smoothing Selection	Code
None	2#00
Weak	2#01
Medium	2#10
Strong	2#11