

## 6.7 Analog input module SM 331; AI 8 x 12 bit;(6ES7331-7KF02-0AB0)

### 6.7.1 Analog input module SM 331; AI 8 x 12 bit;(6ES7331-7KF02-0AB0)

#### Order number

6ES7331-7KF02-0AB0

#### Properties

- 8 inputs in 4 channel groups
- Programmable measurement type at each channel group
  - Voltage
  - Current
  - Resistance
  - Temperature
- Programmable resolution at each channel group (9/12/14 bits + sign)
- Any measuring range selection per channel group
- Programmable diagnostics and diagnostic interrupt
- Programmable limit value monitoring for 2 channels
- Programmable hardware interrupt when limit is exceeded
- Electrically isolated to CPU and load voltage (not for 2-wire transducers)

#### Resolution

The measured value resolution is directly proportional to the selected integration time, that is, the measured value resolution increases in proportion to length of the integration time at the analog input channel.

#### Diagnostics

For information on diagnostics messages at the "group diagnostics" parameter, refer to chapter Diagnostic messages of analog input modules.

#### Hardware interrupts

Hardware interrupts for channel groups 0 and 1 can be programmed in *STEP 7*. However, set a hardware interrupt only for the first channel of a channel group, that is, either at channel 0, or at channel 2

### Terminal assignment

The diagrams below show various wiring options. The input impedance depends on the setting of the measuring range module, see table *Measurement types and ranges*.

### Wiring: Voltage measurement

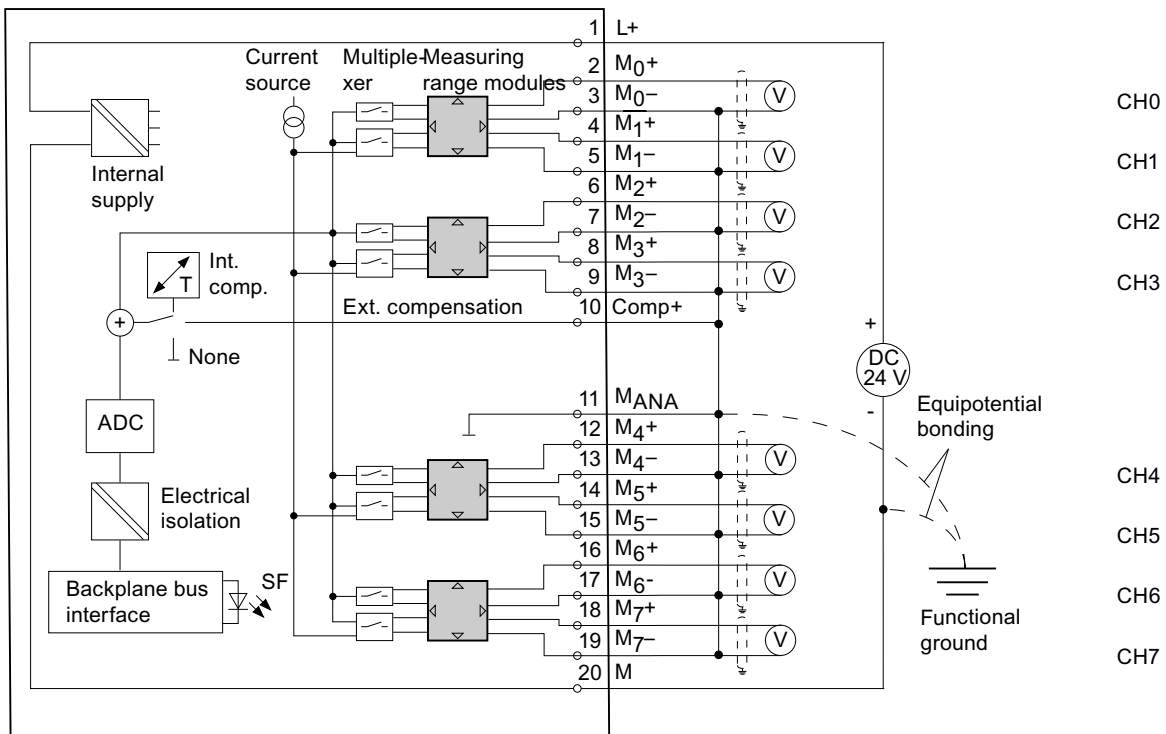


Figure 6-13 Block diagram and wiring diagram

### Measuring range module settings

Measuring range	Measuring range module setting
$\pm 80 \text{ mV}$ $\pm 250 \text{ mV}$ $\pm 500 \text{ mV}$ $\pm 1,000 \text{ mV}$	A
$\pm 2.5 \text{ V}$ $\pm 5 \text{ V}$ $1 \text{ V to } 5 \text{ V}$ $\pm 10 \text{ V}$	B

Wiring: 2-wire and 4-wire transducers for current measurement

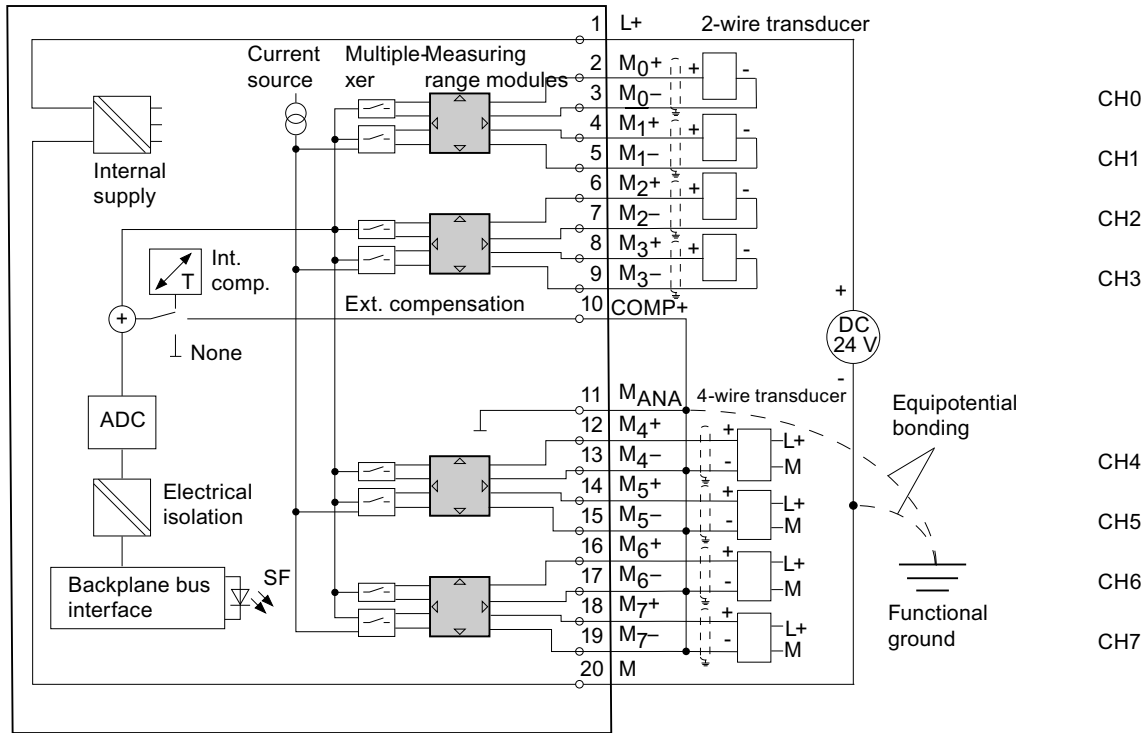


Figure 6-14 Block diagram and wiring diagram

**Note**

The interconnection between M<sub>ANA</sub> and M<sub>-</sub> (terminals 11, 13, 15, 17, 19) is not required when using grounded 4-wire transducers with non-isolated supply.

Measuring range module settings

Measuring range		Measuring range module setting
2-wire transducer	4 mA to 20 mA	D
4-wire transducer	± 3.2 mA	C
	± 10 mA	
	0 mA to 20 mA	
	4 mA to 20 mA	
	± 20 mA	

**CAUTION**

**Measuring range module in "Current" position**

Any voltage measurement will destroy the measuring range module if "current" measuring mode is set.

Wiring: 2-, 3- and 4-wire connection of resistance transducers or thermoresistors

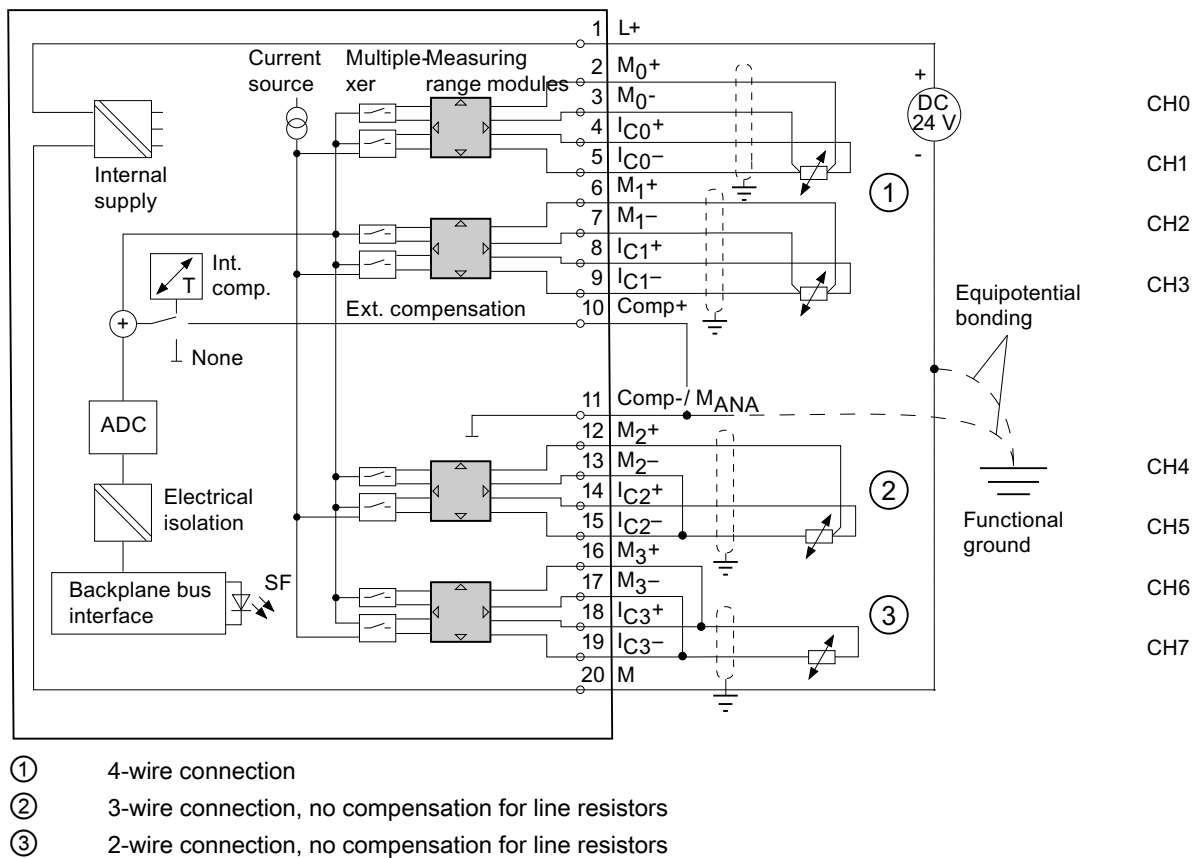


Figure 6-15 Block diagram and wiring diagram

**Measuring range module settings**

Measuring range		Measuring range module setting
150 Ω 300 Ω 600 Ω		A
Thermoresistor (linear, 4-wire connection) (temperature measurement) RTD-4L	Pt 100 Klima Ni 100 Klima Pt 100 Standard Ni 100 Standard	A

**Note**

- "Resistance measurement" is only available at one channel per group. The "2nd" channel of the group is used accordingly for current measuring mode (Ic). The "1st" channel of the group returns the measured value. The "2nd" channel of the group is assigned the default overflow value "7FFF<sub>H</sub>."
- There is no compensation for power resistors for "2- and 3-wire connections".

**Wiring: Thermocouples with external compensation**

Insert a bridge between Comp+ and M<sub>ANA</sub> when using the internal compensation.

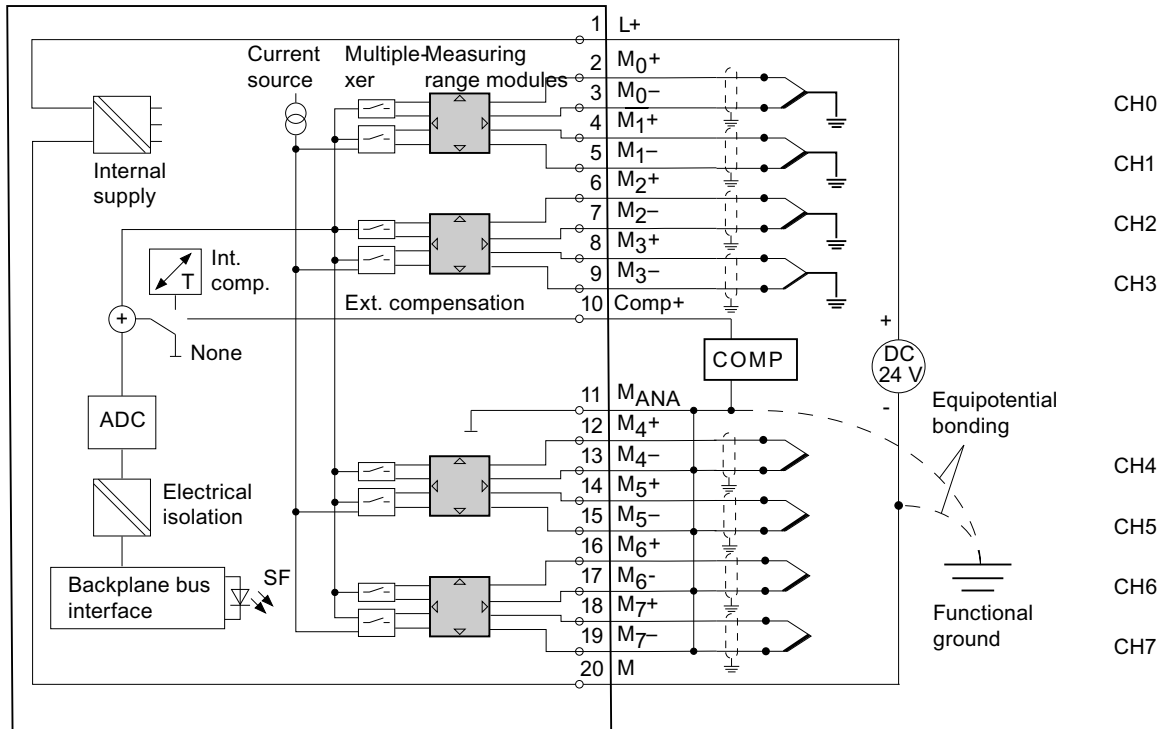


Figure 6-16 Block diagram and wiring diagram

**Measuring range module settings**

Measuring range		Measuring range module setting
Thermocouple TC-I (internal comparison) (thermal voltage measurement) Linearization is ignored	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
Thermocouple TC-E (external comparison) (thermovoltage measurement) Linearization is ignored		
Thermocouple (linear, internal comparison) (temperature measurement) TC- IL	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
Thermocouple (linear, external comparison) (temperature measurement) TC- EL		

**Note**

- An interconnection of M- and M<sub>ANA</sub> is prohibited when using grounded thermocouples. In this case, you must ensure that low-resistance equipotential bonding is in place so that the permitted common-mode voltage is not exceeded.
- Interconnect M- and M<sub>ANA</sub> when using non-grounded thermocouples

## Technical specifications

Technical specifications	
<b>Dimensions and weight</b>	
Dimensions W x H x D (mm)	40 x 125 x 117
Weight	approx. 250 g
<b>Module-specific data</b>	
Supports isochronous mode	No
Number of inputs	8
• with resistive transducers	4
Cable length	max. 200 m
• shielded	max. 50 m at 80 mV and with thermocouples
<b>Voltages, currents, electrical potentials</b>	
Rated electronics supply voltage L +	24 VDC
• Reverse polarity protection	Yes
Transducer power supply	
• Supply current	max. 60 mA (per channel)
• short circuit-proof	Yes
Constant current for resistive transducers	typ. 1.67 mA (pulsed)
Electrical isolation	
• between channels and the backplane bus	Yes
• between channels and electronics power supply	Yes
– Not for 2-wire transducers	
Maximum potential difference	
• between inputs and $M_{ANA}$ ( $V_{CM}$ )	typ. 2.5 VDC (> 2.3 VDC)
– at signal = 0 V	
• between inputs ( $V_{CM}$ )	typ. 2.5 VDC (> 2.3 VDC)
• between $M_{ANA}$ and $M_{internal}$ ( $V_{iso}$ )	75 VDC / 60 VAC
Isolation test voltage	500 VDC
Current consumption	
• from the backplane bus	max. 50 mA
• from load voltage L+	max. 30 mA (without 2-wire transducer)
Power loss of the module	typ. 1 W



Technical specifications				
Generation of analog values				
Measuring principle	Integrating			
Integration/conversion time/resolution (per channel)				
• programmable	Yes			
• Integration time in ms	2.5	16 <sup>2</sup> / <sub>3</sub>	20	100
• Basic conversion time, including the integration time in ms	3	17	22	102
Additional conversion time for resistance measurement, in ms or	1	1	1	1
additional conversion time for wire-break monitoring in ms or	10	10	10	10
additional conversion time for resistance measurements <b>and</b> wire-break monitoring in ms	16	16	16	16
• Resolution in bits (including overrange)	9 bits	12 bits	12 bits	14 bits
• Interference frequency suppression at interference frequency f1 in Hz	400	60	50	10
• Basic execution time of the module in ms (all channels enabled)	24	136	176	816
Measured value smoothing	none			
Interference frequency suppression, error limits				
Interference frequency suppression at F = n (f1 ± 1 %), (f1 = interference frequency)				
• Common mode interference (V <sub>CM</sub> < 2.5 V)	> 70 dB			
• Seriesmode interference (peak interference value < rated input range)	> 40 dB			
Crosstalk between inputs	> 50 dB			
Operational limit (across entire temperature range, relative to the measurement range end value in the selected input range)				
• Voltage input	80 mV 250 mV to 1,000 mV 2.5 V to 10 V	± 1 % ± 0.6 % ± 0.8 %		
• Current input	3.2 mA to 20 mA	± 0.7 %		
• Resistance	150 Ω; 300Ω; 600 Ω	± 0.7 %		
• Thermocouple	Types E, N, J, K, L	± 1, 1 %		
• Resistance thermometer	Pt 100/Ni 100	± 0.7 %		
	Pt 100 Klima	± 0.8 %		
Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected input range)				
• Voltage input	80 mV 250 mV to 1,000 mV 2.5 V to 10 V	± 0.7 % ± 0.4 % ± 0.6 %		
• Current input	3.2 mA to 20 mA	± 0.5 %		
• Resistance	150 Ω; 300 Ω; 600 Ω	± 0.5 %		

Technical specifications		
• Thermocouple	Types E, N, J, K, L	± 0.7 %
• Resistance thermometer	Pt 100/Ni 100	± 0.5 %
	Pt 100 Klima	± 0.6 %
Temperature error (relative to input range)	± 0.005%/K	
Linearity error (relative to input range)	± 0.05 %	
Repeat accuracy (in settled state at 25 °C, relative to input range)	± 0.05 %	
Temperature error of internal compensation	± 1 %	
Status, interrupts, diagnostics		
Interrupts	programmable	
• Limit interrupt	Channels 0 and 2	
• Diagnostic interrupt	programmable	
Diagnostic functions	programmable	
• Group error display	red LED (SF)	
• Reading diagnostics information	supported	
Sensor selection data		
Input ranges (rated values) / input impedance		
• Voltage	± 80 mV ± 250 mV ± 500 mV ± 1,000 mV ± 2.5 V ± 5 V 1 V to 5 V ± 10 V	10 MΩ 10 MΩ 10 MΩ 10 MΩ 100 kΩ 100 kΩ 100 kΩ 100 kΩ
• Current	± 3.2 mA ± 10 mA ± 20 mA 0 mA to 20 mA 4 mA to 20 mA	25 Ω 25 Ω 25 Ω 25 Ω 25 Ω
• Resistance	150 Ω 300 Ω 600 Ω	10 MΩ 10 MΩ 10 MΩ
• Thermocouples	Types E, N, J, K, L	10 MΩ
• Resistance thermometer	Pt 100, Ni 100	10 MΩ
Maximum voltage at voltage input (destruction limit)	max. 20 V, continuous 75 V for the duration of max. 1 s (duty factor 1:20)	
Maximum current at current input (destruction limit)	40 mA	

<b>Technical specifications</b>	
Wiring of the signal sensors	using a 20-pin front connector
<ul style="list-style-type: none"> <li>for voltage measurement</li> </ul>	supported
<ul style="list-style-type: none"> <li>for current measurement as 2-wire transducer</li> <li>as 4-wire transducer</li> </ul>	supported supported
<ul style="list-style-type: none"> <li>For thermoresistor/resistance measurement with 2-wire connection</li> </ul>	Supported, cable resistances are not compensated
with 3-wire connection	Supported, cable resistances are not compensated
with 4-wire connection	Supported, cable resistances are compensated
<ul style="list-style-type: none"> <li>Load of the 2-wire transducer</li> </ul>	max. 820 Ω
Characteristics linearization	programmable
<ul style="list-style-type: none"> <li>for thermocouples</li> </ul>	Types E, N, J, K, L
<ul style="list-style-type: none"> <li>for resistance thermometers</li> </ul>	Pt 100 (Standard and Klima range) Ni 100 (Standard and Klima range)
Temperature compensation	programmable
<ul style="list-style-type: none"> <li>Internal temperature compensation</li> </ul>	supported
<ul style="list-style-type: none"> <li>External temperature compensation with compensating box</li> </ul>	supported
<ul style="list-style-type: none"> <li>Compensation for 0 °C reference junction temperature</li> </ul>	supported
<ul style="list-style-type: none"> <li>Technical unit of temperature measurement</li> </ul>	degrees Centigrade

## 6.7.2 Measurement types and ranges

### Introduction

Module SM 331; AI 8 x 12 Bit has measuring range modules

The measurement type and range is configured at the "measuring range" parameter in *STEP 7*.

The default setting of the module is "voltage" measurement with "± 10V" range. You can use these default settings without having to program the SM 331; AI 8 x 12 Bit in *STEP 7*.

### Measuring range modules

You may have to change the position of the measuring range modules to suit the measurement type and range (see the chapter *Setting the measuring types and ranges of analog input channels*). The necessary settings are also available on the module's imprint. Mark the position of the measuring range module on the front door (see figure).

Range:

A	B
C	D

## Measurement types and ranges

Table 6- 18 Measurement types and ranges

Selected type of measurement	Measuring range (type of sensor)	Measuring range module settings
Voltage V	± 80 mV ± 250 mV ± 500 mV ± 1000 mV	A
	± 2.5 V ± 5 V 1 V to 5 V ± 10 V	B
Thermocouple TC-I (internal comparison) (thermal voltage measurement) Linearization is ignored	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
Thermocouple TC-E (external comparison) (thermovoltage measurement) Linearization is ignored		
Thermocouple (linear, internal comparison) (temperature measurement) TC-IL	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
Thermocouple (linear, external comparison) (temperature measurement) TC-EL		
Current (2-wire transducer) 2DMU	4 mA to 20 mA	D
Current (4-wire transducer) 4DMU	± 3.2 mA ± 10 mA 0 mA to 20 mA 4 mA to 20 mA ± 20 mA	C
Resistance (4-wire connection) R-4L	150 Ω 300 Ω 600 Ω	A
Thermoresistor (linear, 4-wire connection) (temperature measurement) RTD-4L	Pt 100 Klima Ni 100 Klima Pt 100 Standard Ni 100 Standard	A

## Channel groups

The channels of SM 331; AI 8 x 12 Bit are arranged in four groups of two channels. You can assign parameters only to one channel group.

SM 331; AI 8 x 12 Bit is equipped with one measuring range module per channel group.

The table below shows the relevant configuration of channel groups. The channel group number is required to program SFC parameters in the user program.

Table 6- 19 Assignment of SM 331; AI 8x12 bit channels 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	

## See also

Programming analog modules (Page 307)

Diagnostics messages of analog input modules (Page 309)

### 6.7.3 Programmable parameters

#### Introduction

For information on programming analog modules, refer to the chapter Programming analog modules (Page 307).

#### Parameters

Table 6- 20 Overview of the parameters for SM 331; AI 8 x 12 Bit

Parameters	Range of values	Default	Parameter type	Scope
Enable <ul style="list-style-type: none"> <li>• Diagnostics interrupt</li> <li>• Process interrupt when limit exceeded</li> </ul>	yes/no yes/no	no no	dynamic	Module
Process interrupt trigger <ul style="list-style-type: none"> <li>• High limit</li> <li>• Low limit</li> </ul>	May be restricted by the measuring range from 32511 to - 32512 from - 32512 to 32511	-	dynamic	Channel
Diagnostics <ul style="list-style-type: none"> <li>• Group diagnostics</li> <li>• with line continuity check</li> </ul>	yes/no yes/no	no no	static	Channel group
Measurement <ul style="list-style-type: none"> <li>• Measurement type</li> </ul>	disabled Voltage V 4DMU current (4-wire transducer) 2DMU current (2-wire transducer) R-4L resistance (4-wire connection) RTD-4L thermoresistor (linear, 4-wire connection) TC-I thermocouple (internal comparison) TC-E thermocouple (external comparison) TC-IL thermocouple (internal comparison) TC-EL thermocouple (linear, external comparison)	V	dynamic	Channel or channel group
<ul style="list-style-type: none"> <li>• Measuring range</li> </ul>	See the table <i>Measurement types and ranges</i>	± 10 V		
<ul style="list-style-type: none"> <li>• Noise suppression</li> </ul>	400 Hz; 60 Hz; 50 Hz; 10 Hz	50 Hz		

## 6.7.4 Additional information on SM 331; AI 8 x 12 Bit

### Unused channels

As certain programmed inputs may remain unused due to the channel group configuration, make allowances for the special features of these inputs outlined below in order to be able to use the diagnostics functions at these used channels:

- **Voltage measurement (except 1 V to 5V)** and for thermocouples: Short-circuit unused channels and connect these with  $M_{ANA}$ . This optimizes interference immunity of the analog input module. Set the "disabled" value at the "measurement type" parameter for unused channels. This setting reduces module cycle times. Also short-circuit the COMP input if this is not used.
- **Measuring range 1 V to 5 V:** wire the used and unused inputs of the same channel group in parallel.
- **Current measurement, 2-wire transducer:** There are two options of wiring the channel circuit.
  - a) Open unused input; channel group diagnostics disabled. If you were to enable diagnostics, the analog module would trigger a single diagnostic interrupt, and light up its SF LED.
  - b) Loading the unused input using a 1.5 k $\Omega$  to 3.3 k $\Omega$  resistor. This allows you to enable diagnostics for this channel group.
- **Current measurement 4 mA to 20 mA, 4-wire transducer:** wire the unused inputs of the same channel group in series.

### All channels deactivated

If you disable **all** input channels of the module and enable diagnostics at the parameters of SM 331; AI 8 x 12 Bit, the module does **not** report "external auxiliary voltage missing."

### Line continuity check for the 4 mA to 20 mA measuring range

If you configured a measuring range of 4 mA to 20 mA, and **enabled the line continuity check**, the analog input module logs a wire-break event to diagnostics data when the current drops below 3.6 mA.

The module also triggers a diagnostics interrupt if this function is enabled in the program.

A wire break can only be signaled by means of the lit SF LED and the diagnostic bytes must be evaluated in the user program if diagnostics interrupts are disabled.

If you configured a measuring range of 4 mA to 20 mA, **disabled** the line continuity check, and enabled diagnostic interrupts, the module triggers a diagnostic interrupt when the underflow value is reached.

### Line continuity check

The line continuity check is designed only for temperature measurements (thermocouples and thermoresistors.)



**See also**

Representation of the values for analog input channels (Page 275)

## 6.8 Analog input module SM 331; AI 2 x 12 Bit; (6ES7331-7KB02-0AB0)

### 6.8.1 Analog input module SM 331; AI 2 x 12 Bit; (6ES7331-7KB02-0AB0)

**Order number: "Standard module"**

6ES7331-7KB02-0AB0

**Order number: "SIPLUS S7-300 module"**

6AG1331-7KB02-2AB0

**Properties**

- Two inputs in one channel group
- Programmable measurement type for each channel group
  - Voltage
  - Current
  - Resistance
  - Temperature
- Programmable resolution at each channel group (9/12/14 bits + sign)
- Any measuring range selection per channel group
- Programmable diagnostics and diagnostic interrupt
- Programmable limit value monitoring for one channel
- Programmable hardware interrupt when limit is exceeded
- Electrically isolated from the CPU and load voltage (not for 2DMU)

**Resolution**

The measured value resolution is directly proportional to the selected integration time, that is, the measured value resolution increases in proportion to length of the integration time at the analog input channel.

### Diagnostics

For information on diagnostics messages at the "group diagnostics" parameter, refer to chapter Diagnostic messages of analog input modules.

### Hardware interrupts

Hardware interrupts for channel groups can be programmed in *STEP 7*. However, set a hardware interrupt only for the first channel of a channel group, that is channel 0.

### Terminal assignment

The diagrams below show various wiring options. The input impedance depends on programmed measuring range.

### Wiring: Voltage measurement

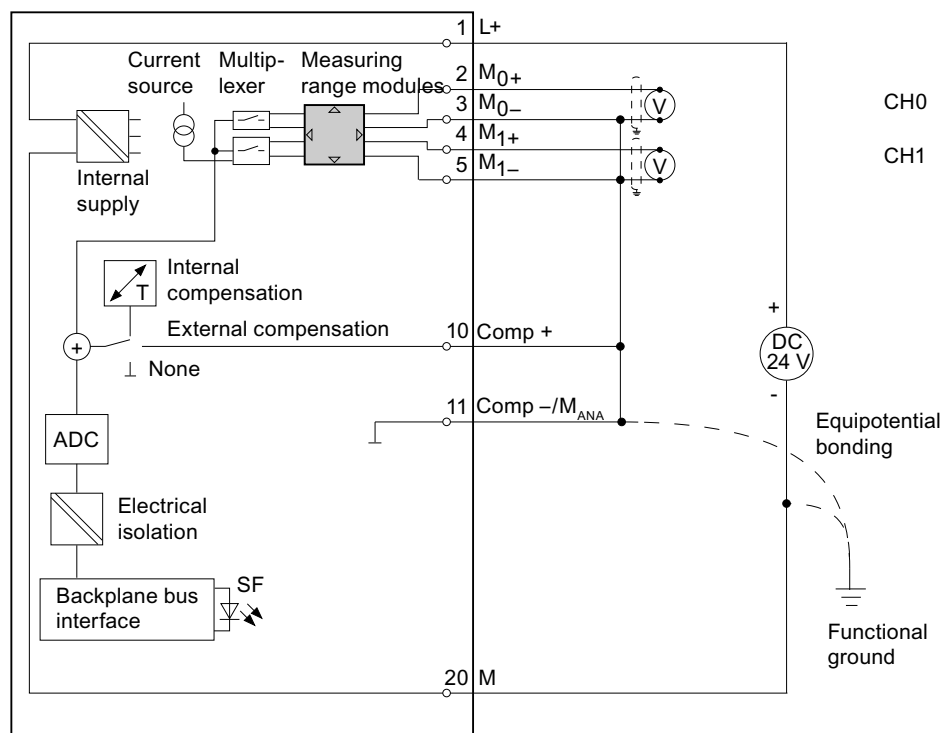


Figure 6-17 Wiring and block diagrams

Measuring range module settings

Measuring range	Measuring range module setting
± 80 mV ± 250 mV ± 500 mV ± 1,000 mV	A
± 2.5 V ± 5 V 1 V to 5 V ± 10 V	B

Wiring: Thermocouple with external compensation

Insert a bridge between Comp+ and M<sub>ANA</sub> when using the internal compensation.

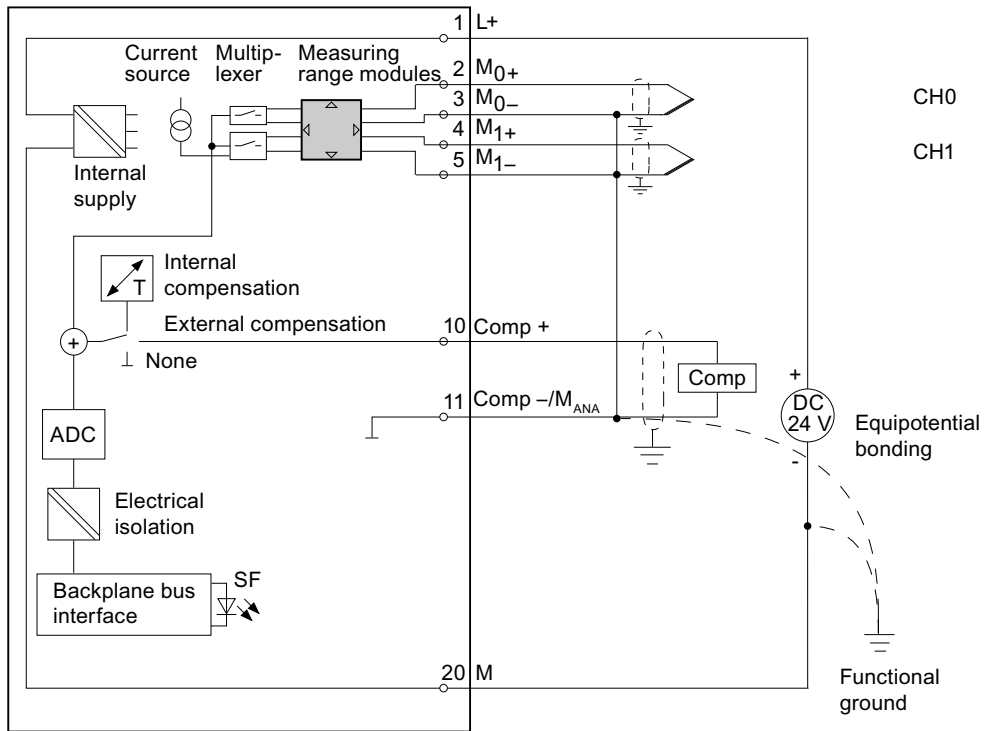
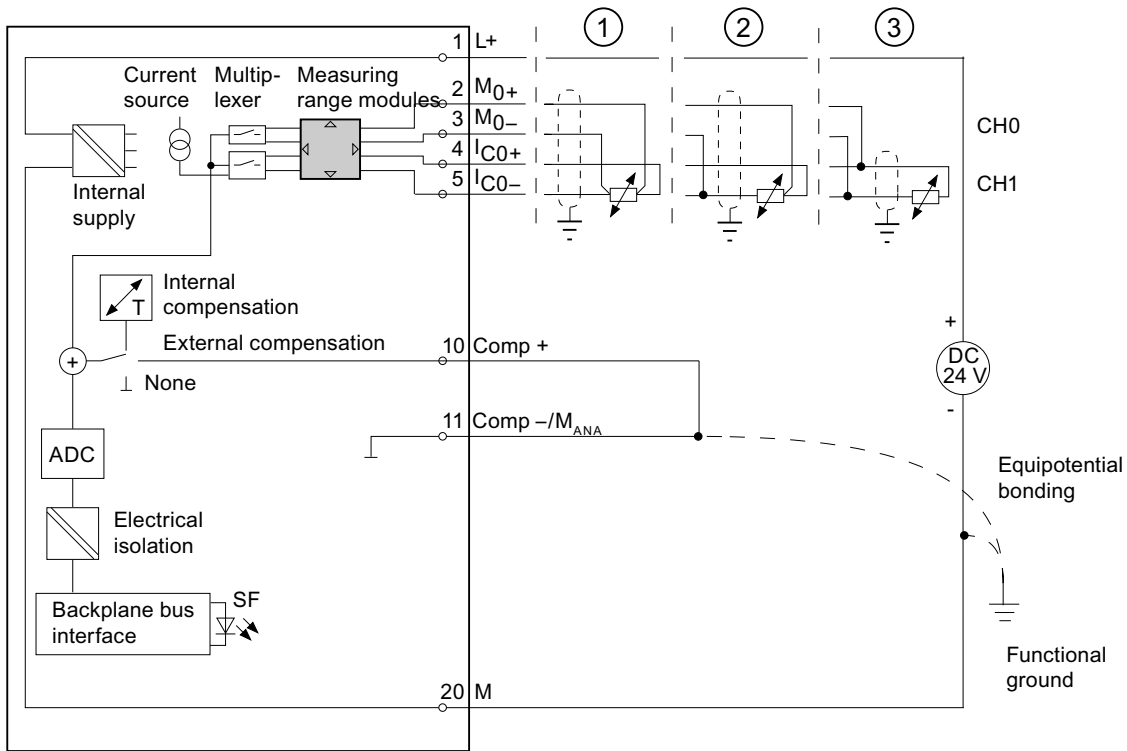


Figure 6-18 Wiring and block diagrams

**Measuring range module settings**

Measuring range		Measuring range module setting
TC-I: Thermocouple (internal comparison) (thermal voltage measurement)	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
TC-E: Thermocouples (external comparison) (thermovoltage measurement)	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
TC-IL: Thermocouples (linear, internal comparison) (temperature measurement)	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
TC-EL: Thermocouples (linear, external comparison) (temperature measurement)	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A

**Wiring: 2-, 3- and 4-wire connection of resistance transducers or thermoresistors**



- ① 4-wire connection
- ② 3-wire connection, no compensation for line resistors
- ③ 2-wire connection, no compensation for line resistors

Figure 6-19 Wiring and block diagrams

**Measuring range module settings**

Measuring range		Measuring range module setting
150 Ω		A
300 Ω		
600 Ω		
RTD-4L: Thermal resistance (linear, 4-wire connection) (temperature measurement)	Pt 100 Klima Ni 100 Klima Pt 100 Standard Ni 100 Standard	A

**Note**

"Resistance measurement" is only available at one channel per group. The "2nd" channel of the group is used accordingly for current measuring mode (I<sub>C</sub>).

The "1st" returns the measured value. The "2nd" channel of the group is assigned the default overflow value "7FFF<sub>H</sub>."

**Wiring: 2-wire and 4-wire transducers for current measurement**

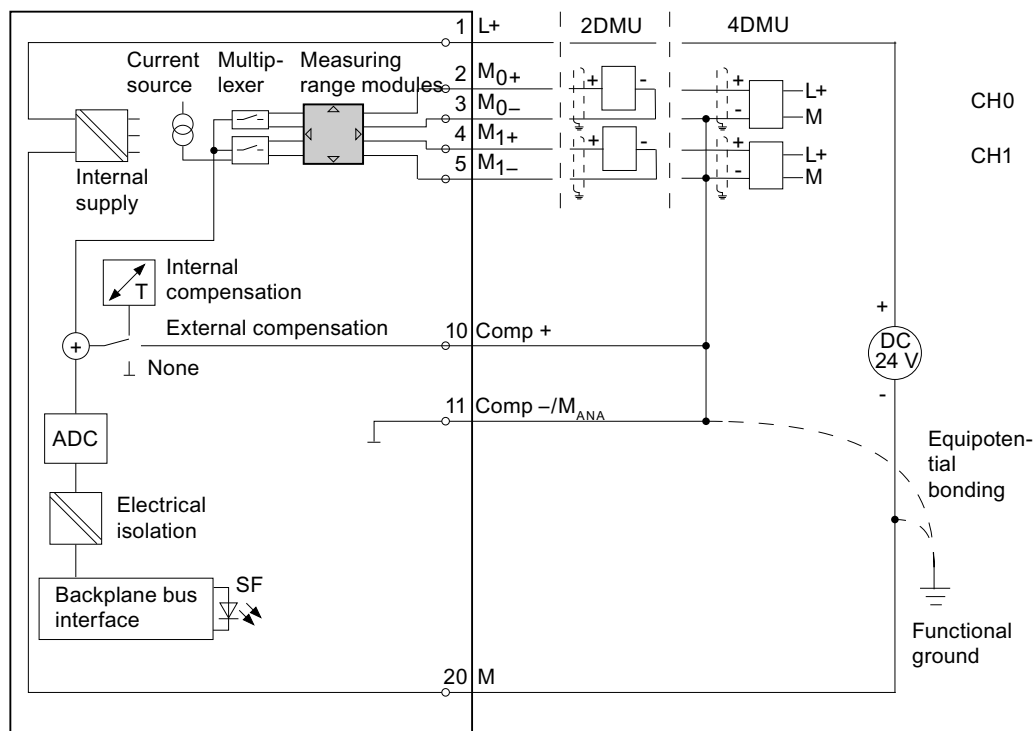


Figure 6-20 Wiring and block diagrams

**Measuring range module settings**

Measuring range	Measuring range module setting
2-wire transducer	4 mA to 20 mA D
4-wire transducer	± 3.2 mA ± 10 mA 0 mA to 20 mA 4 mA to 20 mA ± 20 mA C

**CAUTION****Measuring range module in "Current" position**

If "current" measuring mode is set, any voltage measurement will destroy the measuring range module.

**Technical specifications**

<b>Technical specifications</b>	
<b>Dimensions and weight</b>	
Dimensions W x H x D (mm)	40 x 125 x 117
Weight	approx. 250 g
<b>Module-specific data</b>	
Supports isochronous mode	No
Number of inputs	2
• with resistive transducers	1
Cable length	max. 200 m
• shielded	max. 50 m at 80 mV and with thermocouples
<b>Voltages, currents, electrical potentials</b>	
Rated electronics supply voltage L +	24 VDC
• Reverse polarity protection	Yes
Transducer power supply	
• Supply current	max. 60 mA (per channel)
• short circuit-proof	Yes
Constant current for resistive transducers	typ. 1.67 mA (pulsed)
Electrical isolation	
• between channels and the backplane bus	Yes
• between channels and electronics power supply	Yes
– Not for 2-wire transducers	
Maximum potential difference	
• between inputs and $M_{ANA}$ ( $V_{CM}$ )	typ. 2.5 VDC (> 2.3 VDC)
– at signal = 0 V	
• between inputs ( $V_{CM}$ )	typ. 2.5 VDC (> 2.3 VDC)
• between $M_{ANA}$ and $M_{internal}$ ( $V_{iso}$ )	75 VDC / 60 VAC
Isolation test voltage	500 VDC
Current consumption	
• from the backplane bus	max. 50 mA
• from load voltage L+	max. 30 mA (without 2-wire transducer)
Power loss of the module	typ. 1 W

Technical specifications				
Generation of analog values				
Measuring principle	Integrating			
Integration/conversion time/resolution (per channel)				
• programmable	Yes			
• Integration time in ms	2.5	16 <sup>2</sup> / <sub>3</sub>	20	100
• Basic conversion time, including the integration time in ms	3	17	22	102
Additional conversion time for resistance measurement, in ms or	1	1	1	1
additional conversion time for wire-break monitoring in ms or	10	10	10	10
additional conversion time for resistance measurements <b>and</b> wire-break monitoring in ms	16	16	16	16
• Resolution in bits (including overshoot range)	9 bits	12 bits	12 bits	14 bits
• Interference frequency suppression at interference frequency f1 in Hz	400	60	50	10
• Basic execution time of the module in ms (all channels enabled)	6	34	44	204
Measured value smoothing	none			
Interference frequency suppression, error limits				
Interference frequency suppression at $f = n (f1 \pm 1\%)$ , ( $f1 =$ interference frequency) $n=1.2\dots$				
• Common mode interference ( $V_{CM} < 2.5 V$ )	> 70 dB			
• Seriesmode interference (peak interference value < rated input range)	> 40 dB			
Crosstalk between inputs	> 50 dB			
Operational limit (across entire temperature range, relative to the measurement range end value of the selected input range)				
• Voltage input	80 mV 250 mV to 1,000 mV 2.5 V to 10 V	± 1 % ± 0.6 % ± 0.8 %		
• Current input	3.2 mA to 20 mA	± 0.7 %		
• Resistance	150 Ω; 300 Ω; 600 Ω	± 0.7 %		
• Thermocouple	Types E, N, J, K, L	± 1, 1 %		
• Resistance thermometer	Pt 100/Ni 100	± 0.7 %		
	Pt 100 Klima	± 0.8 %		
Basic error limit (operational limit at 25 °C, relative to the measurement range end value in the selected input range)				
• Voltage input	80 mV 250 mV to 1,000 mV 2.5 V to 10 V	± 0.6 % ± 0.4 % ± 0.6 %		
• Current input	3.2 mA to 20 mA	± 0.5 %		
• Resistance	150 Ω; 300 Ω; 600 Ω	± 0.5 %		



<b>Technical specifications</b>		
• Thermocouple	Types E, N, J, K, L	± 0.7 %
• Resistance thermometer	Pt 100/Ni 100	± 0.5 %
	Pt 100 Klima	± 0.6 %
Temperature error (relative to input range)	± 0.005%/K	
Linearity error (relative to input range)	± 0.05 %	
Repeat accuracy (in settled state at 25°C, relative to input range)	± 0.05 %	
Temperature error of internal compensation	± 1 %	
<b>Status, interrupts, diagnostics</b>		
Interrupts	programmable	
• Limit interrupt	Channels 0	
• Diagnostic interrupt	programmable	
Diagnostic functions	programmable	
• Group error display	red LED (SF)	
• Reading diagnostics information	supported	
<b>Sensor selection data</b>		
Input ranges (rated values) / input impedance		
• Voltage	± 80 mV ± 250 mV ± 500 mV ± 1,000 mV ± 2.5 V ± 5 V 1 V to 5 V ± 10 V	10 MΩ 10 MΩ 10 MΩ 10 MΩ 100 kΩ 100 kΩ 100 kΩ 100 kΩ
• Current	± 3.2 mA ± 10 mA ± 20 mA 0 mA to 20 mA 4 mA to 20 mA	25 Ω 25 Ω 25 Ω 25 Ω 25 Ω
• Resistance	150 Ω 300 Ω 600 Ω	10 MΩ 10 MΩ 10 MΩ
• Thermocouples	Types E, N, J, K, L	10 MΩ
• Resistance thermometer	Pt 100, Ni 100	10 MΩ
Maximum voltage at voltage input (destruction limit)	max. 20 V continuous; 75 V for the duration of max. 1 s (duty factor 1:20)	
Maximum current at current input (destruction limit)	40 mA	
Wiring of the signal sensors		
• for voltage measurement	supported	

Technical specifications	
<ul style="list-style-type: none"> <li>for current measurement as 2-wire transducer as 4-wire transducer</li> </ul>	supported supported
<ul style="list-style-type: none"> <li>For thermoresistor/resistance measurement With 2-wire connection With 3-wire connection With 4-wire connection</li> </ul>	Supported, cable resistances are not compensated Supported, cable resistances are not compensated Supported, cable resistances are compensated
<ul style="list-style-type: none"> <li>Load of the 2-wire transducer</li> </ul>	max. 820 $\Omega$
Characteristics linearization <ul style="list-style-type: none"> <li>for thermocouples</li> <li>for resistance thermometers</li> </ul>	programmable Types E, N, J, K, L Pt 100 (Standard and Klima range) Ni 100 (Standard and Klima range)
Temperature compensation <ul style="list-style-type: none"> <li>Internal temperature compensation</li> <li>External temperature compensation with compensating box</li> <li>Compensation for 0 °C reference junction temperature</li> <li>Technical unit of temperature measurement</li> </ul>	programmable supported supported supported degrees Centigrade

## 6.8.2 Measurement types and measuring ranges

### Introduction

SM 331; AI 2 x 12 Bit is equipped with a measuring range module. The measurement type and range is configured at the "measuring range" parameter in *STEP 7*. You can use the default "voltage" measurement type and "± 10 V range without having to program the SM 331; AI 2 x 12 Bit in *STEP 7*.

### Measuring range module

Change the position of the measuring range module to set the measurement type and range (see the chapter *Setting the measurement types and ranges of analog input channels*). The necessary settings are also available on the module's imprint. Mark the position of the measuring range module on the front door (see figure).

Range:

A	B
C	D

Table 6- 21 Measurement types and ranges

Selected type of measurement	Measuring range (type of sensor)	Measuring range module settings
V: Voltage	± 80 mV ± 250 mV ± 500 mV ± 1000 mV	A
	± 2.5 V ± 5 V 1 V to 5 V ± 10 V	B
TC-I: Thermocouple (internal comparison) (thermal voltage measurement)	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi]	A
TC-E: Thermocouples (external comparison) (thermal voltage measurement)	Type K [NiCr-Ni] Type L [Fe-CuNi]	
2DMU: Current (2-wire transducer)	4 mA to 20 mA	D
4DMU: Current (4-wire transducer)	± 3.2 mA ± 10 mA 0 mA to 20 mA 4 mA to 20 mA ± 20 mA	C
R-4L: Resistance (4-wire connection)	150 Ω 300 Ω 600 Ω	A

Selected type of measurement	Measuring range (type of sensor)	Measuring range module settings
TC-IL: Thermocouples (linear, internal comparison) (temperature measurement)	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
TC-EL: Thermocouples (linear, external comparison) (temperature measurement)	Type N [NiCrSi-NiSi] Type E [NiCr-CuNi] Type J [Fe-CuNi] Type K [NiCr-Ni] Type L [Fe-CuNi]	A
RTD-4L: Thermal resistance (linear, 4-wire connection) (temperature measurement)	Pt 100 Klima Ni 100 Klima Pt 100 Standard Ni 100 Standard	A

### Channel groups

The two channels of SM 331; AI 2 x 12 Bit form a channel group. You can assign parameters only to one channel group.

SM 331; AI 2 x 12 Bit is equipped with a measuring range module for channel group 0.

### Line continuity check

The line continuity check is designed only for temperature measurements (thermocouples and thermoresistors.)

### Special features of the line continuity check for the 4 mA to 20 mA measuring range

If you configured a measuring range of 4 mA to 20 mA, and **enabled the line continuity check**, the analog input module logs a wire-break event to diagnostics data when the current drops below 3.6 mA.

The module also triggers a diagnostics interrupt if this function is enabled in the program.

A wire break can only be signaled by means of the lit SF LED and the diagnostic bytes must be evaluated in the user program if diagnostics interrupts are disabled.

If you configured a measuring range of 4 mA to 20 mA, **disabled** the line continuity check, and enabled diagnostic interrupts, the module triggers a diagnostic interrupt when the underflow value is reached.

### 6.8.3 Programmable parameters

#### Introduction

For general information on programming analog modules, refer to the chapter Programming analog modules (Page 307).

#### Parameters

Table 6- 22 Overview of the parameters of SM 331; AI 2 x 12 Bit

Parameters	Range of values	Default	Parameter type	Scope
Enable <ul style="list-style-type: none"> <li>• Diagnostics interrupt</li> <li>• Process interrupt when limit exceeded</li> </ul>	yes/no yes/no	no no	dynamic	Module
Process interrupt trigger <ul style="list-style-type: none"> <li>• High limit</li> <li>• Low limit</li> </ul>	32511 to -32512 from - 32512 to 32511	-	dynamic	Channel
Diagnostics <ul style="list-style-type: none"> <li>• Group diagnostics</li> <li>• with line continuity check</li> </ul>	yes/no yes/no	no no	static	Channel group
Measurement <ul style="list-style-type: none"> <li>• Measurement type</li> </ul>	disabled Voltage V 4DMU current (4-wire transducer) 2DMU current (2-wire transducer) R-4L resistance (4-wire connection) RTD-4L thermoresistor (linear, 4-wire connection) TC-I thermocouple (internal comparison) TC-E thermocouple (external comparison) TC-IL thermocouple (internal comparison) TC-EL thermocouple (linear, external comparison)	V	dynamic	Channel or channel group
<ul style="list-style-type: none"> <li>• Measuring range</li> </ul>	Refer to the chapter Measuring methods and ranges (Page 396) for the adjustable measuring ranges of the input channels	$\pm 10$ V		
<ul style="list-style-type: none"> <li>• Noise suppression</li> </ul>	400 Hz; 60 Hz; 50 Hz; 10 Hz	50 Hz		

## See also

Diagnostics messages of analog input modules (Page 309)

## 6.8.4 Additional information on SM 331; AI 2 x 12 Bit

### Unused channels

Short-circuit unused channels and connect these with  $M_{ANA}$ . This optimizes interference immunity of the analog input module. Set the "disabled" value at the "measurement type" parameter for unused channels. This setting reduces module cycle times.

Also short-circuit the COMP input if this is not used.

As certain programmed inputs may remain unused due to the channel group configuration, make allowances for the special features of these inputs outlined below in order to be able to use the diagnostics functions at these used channels:

- **Measuring range 1 V to 5 V:** wire the used input and unused input of the same channel group in parallel.
- **Current measurement, 2-wire transducer:** There are two options of setting up the channel circuit:
  - a) Open unused input; channel group diagnostics disabled. The analog module would trigger a single diagnostics interrupt and set its SF LED if diagnostics is enabled.
  - b) Terminating the unused input using a 1.5 k $\Omega$  to 3.3 k $\Omega$  resistor. This allows you to enable diagnostics for this channel group.
- **Current measurement 4 mA to 20 mA, 4-wire transducer:** wire the used input and unused input of the same channel group in series.

### Line continuity check

The line continuity check is designed only for temperature measurements (thermocouples and thermoresistors.)

### Special features of the line continuity check for the 4 mA to 20 mA measuring range

If you configured a measuring range of 4 mA to 20 mA, and **enabled the line continuity check**, the analog input module logs a wire-break event to diagnostics data when the current drops below 3.6 mA.

The module also triggers a diagnostics interrupt if this function is enabled in the program.

A wire break can only be signaled by means of the lit SF LED and the diagnostic bytes must be evaluated in the user program if diagnostics interrupts are disabled.

If you configured a measuring range of 4 mA to 20 mA, **disabled the line continuity check** and enabled diagnostic interrupts, the module triggers a diagnostic interrupt when the underflow value is reached.