SIEMENS

SIMATIC

ET 200S distributed I/O 2AI TC HF analog electronic module (6ES7134-4NB01-0AB0)

Manual

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This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

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⚠WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

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CAUTION

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Ⓟ 09/2007

Preface

Purpose of the manual

This manual supplements the *ET 200S Distributed I/O System* Operating Instructions. General functions for the ET 200S are described in the *ET 200S Distributed I/O System* Operating Instructions.

The information in this document along with the operating instructions enables you to commission the ET 200S.

Basic knowledge requirements

To understand these operating instructions you should have general knowledge of automation engineering.

Scope of the manual

This manual applies to this ET 200S module. It describes the components that are valid at the time of publication.

Recycling and disposal

Thanks to the fact that it is low in contaminants, this ET 200S module is recyclable. For environmentally compliant recycling and disposal of your electronic waste, please contact a company certified for the disposal of electronic waste.

Additional support

If you have any questions relating to the products described in these operating instructions, and do not find the answers in this document, please contact your local Siemens representative.

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Properties

1

1.1 2AI TC HF analog electronic module (6ES7134-4NB01-0AB0)

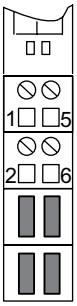
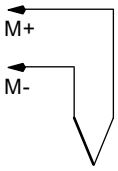
Properties

- 2 inputs for thermocouple or voltage measurement
- Input ranges:
  - Voltage measurement: ± 80 mV, resolution 15 bits + sign
  - Thermocouples: Types E, N, J, K, L, S, R, B, T, C, resolution 15 bits + sign
- Isolated from the load voltage L+
- Linearization of the sensor characteristic curves
- Permitted common-mode voltage 140 VDC/100 VAC
- Internal reference junction in connection with TM-E15S24-AT or TM-E15C24-AT

General terminal assignment

Terminal assignment for 2AI TC HF (6ES7134-4NB01-0AB0)				
Terminal	**Assignment**	**Terminal**	**Assignment**	**Notes**
1	M_{0+}	5	M_{1+}	• M_{n+}: Measuring line positive, channel n • M_{n-}: Measuring line negative, channel n
2	M_{0-}	6	M_{1-}	

Usable terminal modules

Usable terminal modules for 2AI TC HF (6ES7134-4NB01-0AB0)	
TM-E15C24-AT (6ES7193-4CL30-0AA0)	← Spring terminal
TM-E15S24-AT (6ES7193-4CL20-0AA0)	← Screw-type terminal
	Sample connection 

Block diagram

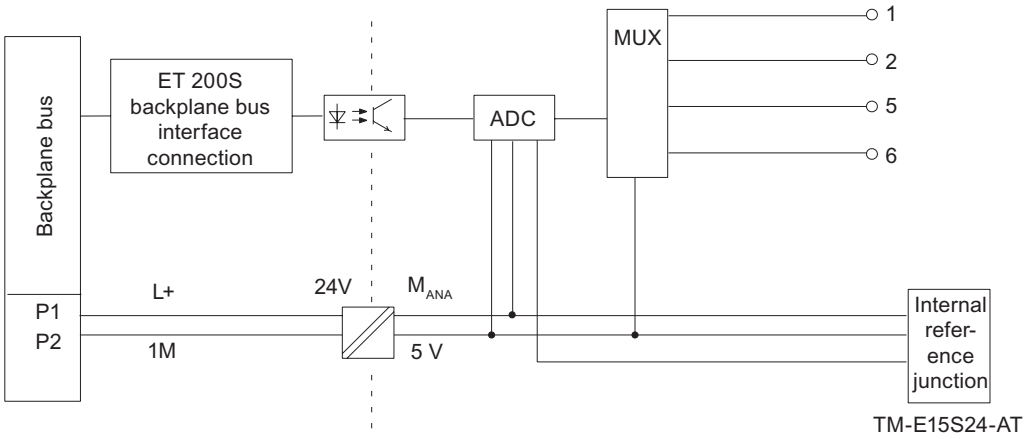


Figure 1-1 Block diagram of the 2AI TC HF

2AI TC HF technical specifications (6ES7134-4NB01-0AB0)

Dimensions and weight		
Width (mm)	15	
Weight	Approx. 40 g	
Module-specific data		
Supports isochronous operation	no	
Number of inputs	2	
Cable length		
• Shielded	Max. 50 m	
Parameter length	4 bytes	
Address space	4 bytes	
Voltages, currents, potentials		
Rated load voltage L+ (from the power module)	24 VDC	
• Reverse polarity protection	Yes	
Electrical isolation		
• Between the channels and backplane bus	Yes	
• Between the channels and load voltage L+	Yes	
• Between the channels	No	
Permissible potential difference		
• Between M_{ANA} and the central grounding point (U_{iso})	75 VDC / 60 VAC	
• Between the inputs and M_{ANA} (U_{CM})	140 VDC / 100 VAC	
Insulation tested	500 VDC	
Current consumption		
• From load voltage L+	Max. 30 mA	
Power dissipation of the module	Typically 0.6 W	
Status, interrupts, diagnostics		
Diagnostics function		
• Group error	Red "SF" LED	
• Diagnostic functions readable	Yes	
Analog value generation		
Measuring principle	Integrative	
Integration time/conversion time/resolution per channel:		
• Integration time can be assigned parameters	Yes	
• Interference frequency suppression in Hz	60	50
• Integration time in ms	16,7	20
• Basic conversion time incl. integration time in ms	66	80
• Additional conversion time for wire break check diagnosis in ms	5	5
• Cycle time in ms	Number of active channels per module x conversion time	
• Resolution (including overrange)	15 bits plus sign	

Suppression of interference, limits of error	
Noise suppression for f = n x (f1 ± 1 %), (f1 = interference frequency)	
• Common-mode interference (U_{SS}) • Series-mode interference (peak interference value < rated value of input range)	min. 90 dB min. 70 dB
Crosstalk between the inputs	Min. -50 dB
Operational limit for ±80 mV (over the entire temperature range with reference to the input range)	± 0,1 %
Operational limit for thermocouples (over the entire temperature range with reference to the input range)[1]	± 1.5 K
Operational limit for thermocouple type C (in the entire temperature range with reference to the input range)[1]	± 7 K
Basic error limit for ±80 mV (operational limit at 25 °C with reference to the input range)	± 0,05 %
Basic error limit for thermocouples (operational limit at 25 °C with reference to input range)[1]	± 1 K
Basic error limit for thermocouples of type C (operational limit at 25 °C with reference to the input range)[1]	± 5 K
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 input range)	± 0,05 %
Overall error limits using internal compensation	
• Operational limit (in the entire temperature range with a static, thermal state, ambient temperature change < 0.3 K/min)[2]	± 2.5 K
• Basic error limit (operational limit at 25°C with a static, thermal state, ambient temperature change < 0.3 K/min)[3]	± 1.5 K
Data for selecting a sensor	
Input range (rated value)/input resistance	
• Voltage	± 80m V/min. 1 MΩ
• Thermocouple	Type E, N, J, K, L, S, R, B, T, C/min. 1 MΩ
Permitted input voltage (destruction limit)	± 20 V, continuous
Connection of the sensors	
• For measuring voltage	Supported
Characteristic curve linearization	Yes, can be assigned parameters for type E, N, J, K, L, S, R, B, T, C as per IEC 584

Temperature compensation		
• Internal temperature compensation	Possible with TM-E15S24-ATTM-E15C24-AT	
• External temperature compensation by looping a compensating box into the measuring circuit	Possible, one external compensating box per channel	
Smoothing of the measured values	Yes, can be assigned parameters in 4 steps by means of digital filtering	
	Step	**Time constant**
	None	1 x cycle time
	Weak	4 x cycle time
	Medium	32 x cycle time
	Strong	64 x cycle time

[1] The specified error limits apply starting with the following temperatures:

- Thermocouple Type T: -200°C
- Thermocouple Type K: -100°C
- Thermocouple Type B: +700°C
- Thermocouple Type N: -150°C
- Thermocouple Type E: -150°C
- Thermocouple Type R: +200°C
- Thermocouple Type S: +100°C

[2] In the case of thermocouple Type C: ± 8 K

[3] In the case of thermocouple Type C: ± 6 K

Compensation of thermocouples with a compensating box

As well as the error limits of the 2AI TC HF electronic module (see Table "Technical specifications 2AI TC HF (6ES7134-4NB01-0AB0)" in this chapter) you must also take the accuracy of the compensating box into account.

Internal compensation with TM-E 15S24-AT or TM-E15C24-AT

Factors affecting the accuracy of the temperature measurement	
Rules on using internal temperature compensation	The connected channel with internal compensation must be assigned parameters separately.
	Don't insert the 2AI TC HF directly next to a power module with high incoming current (> 3 A). An incoming current of 10 A can result in a further ± 2 K error.
Additional technical specifications for the error limits of the 2AI TC HF	The station must be in a static state[1] to ensure that the specified accuracy is achieved.
	Accuracy is achieved 30 minutes after the static state has been achieved.
	The overall malfunction of the channel is caused by the combination of the input error and the internal compensation error.
[1] The static state is defined by an almost constant ambient temperature (no draft, for example, in a closed cabinet!)	

Parameters

2

2.1 Parameters

Table 2-1 Parameters for analog input module

2AI TC HF	Range of values	Default setting	Applicability
Group diagnostics (parameter assignment error, internal error)	• Disable • Enable	Disable	Module
Diagnostics: Overflow/underflow	• Disable • Enable	Disable	Module
Diagnostics: Wire-break check *	• Disable • Enable	Disable	Channel
Smoothing	• None • Weak • Medium • Strong	None	Channel
Temperature unit	• Celsius • Fahrenheit	Celsius	Module
Comparison point	• None • Yes (i.e., internal)	None	Channel
Type/range of measurement	• Deactivated • Voltage ±80 mV • TC-EL Type T (Cu-CuNi) • TC-EL Type K (NiCr-Ni) • TC-EL Type B (PtRh-PtRh) • TC-EL Type C (WRe-WRe) • TC-EL Type N (NiCrSi-NiSi) • TC-EL Type E (NiCr-CuNi) • TC-EL Type R (PtRh-Pt) • TC-EL Type S (PtRh-Pt) • TC-EL Type J (Fe-Cu-Ni) • TC-EL Type L (Fe-Cu-Ni)	TC-EL Type K (NiCr-Ni)	Channel
* Only with thermocouples. A parameter assignment error occurs when the wire break diagnostics are enabled in the voltage measuring range. The module does not start up.			

2.2 Parameter description

Smoothing

The individual measured values are smoothed by digital filtering. The smoothing can be adjusted in four steps, in which the smoothing factor k multiplied with cycle time of the electronic module equals the time constant of the smoothing filter. The greater the smoothing, the greater the time constant of the filter.

The following diagrams show the step response with the various smoothing factors in relation to the number of module cycles.

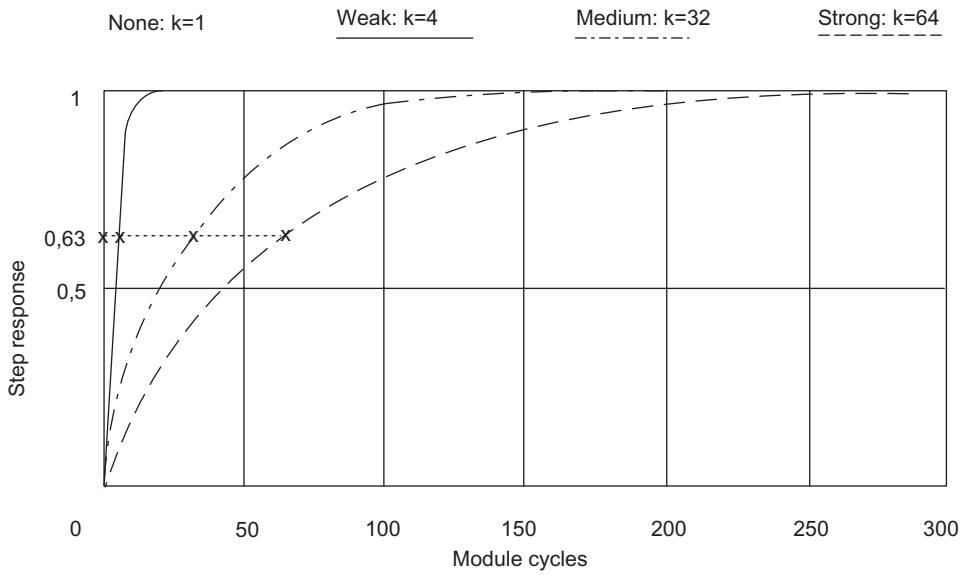


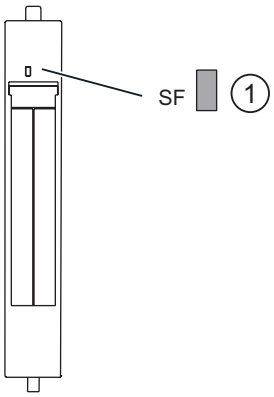
Figure 2-1 Smoothing with the 2AI TC HF

Diagnostics

3

3.1 Diagnostics using LED display

LED display



① Batch error (red)

Status and error displays

Event (LED)	Cause	Remedy
SF		
On	No configuration or incorrect module plugged in. No load voltage.present There is a diagnostic message.	Check the parameter assignment. Check the load voltage. Evaluate the diagnostics.

3.2 Error types

Analog input module error types

Table 3-1 Error types

Error type		Meaning	Remedy
16_D	10000: Parameter assignment error	Module cannot use the parameter for the channel: Inserted module does not match the one configured. Incorrect parameter assignment.	Correct the configuration (align actual and set configuration). Correct the parameter assignment (wire break diagnostics only parameterized for the permitted measuring ranges).
9_D	01001: Error	Internal module error (diagnostic message at channel 0 applies to the entire module)	Replace the module.
7_D	00111: Upper limit exceeded	Value is above the overshoot range.	Correct the module/final controlling element tuning.
8_D	01000: Lower limit value undershot	Value is below the underrange.	Correct the module/final controlling element tuning.
6_D	00110: Open circuit	Line to the encoder interrupted.	Correct the process wiring.
21_D	10101: Reference channel error	Error on the reference channel	Check the reference module

Analog value representation

4

4.1 Introduction

Electronic modules with analog outputs

With the electronic module with analog inputs, continuously variable signals, such as those occurring in temperature measurement and resistance measurement, can be acquired, evaluated, and converted to digital values for further processing.

4.2 Analog value representation for measuring range with SIMATIC S7

Analog value representation

With the same nominal range, the digitized analog value is the same for input and output values. Analog values are represented in two's complement.

The following table shows the analog value representation of the analog electronic modules.

Table 4-1 Analog value representation (SIMATIC S7 format)

Resolution	Analog value															
Bit number	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Significance of the bits	S	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}

Sign

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

- "0" → +
- "1" → –

Output value

The following table shows the representation of the binary analog values and the corresponding decimal and hexadecimal representation of the units of the analog values.

The table below shows the resolutions 11, 12, 13, and 15 bit + sign. Each analog value is entered left aligned in the ACCU. The bits marked with "x" are set to "0".

Table 4-2 Output values (SIMATIC S7 format)

Resolution in bits	Units		Analog value	
	Decimal	Hexadecimal	High byte	Low byte
11+S	16	10_H	S 0 0 0 0 0 0 0	0 0 1 x x x x
12+S	8	8_H	S 0 0 0 0 0 0 0	0 0 0 1 x x x
13+S	4	4_H	S 0 0 0 0 0 0 0	0 0 0 0 1 x x
15 + sign	1	1_H	S 0 0 0 0 0 0 0	0 0 0 0 0 0 1

4.3 Measuring ranges

4.3.1 Measuring ranges for thermocouples

Introduction

The following tables contain the digitized analog values for the measuring ranges of the analog input modules.

Since the binary representation of the analog values is always the same, these tables only compare the measuring ranges with the units.

Measuring range for thermocouple: Type B

Table 4-3 SIMATIC S7 format: Type B measuring range in °C and °F

Type B in °C	Units		Type B in °F	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
> 2070,0	32767	$7FFF_H$	> 3276,6	32767	$7FFF_H$	Overflow
2070,0 : 1820,1	20700 : 18201	$50DC_H$: 4719_H	3276,6 : 2786,6	32766 : 27866	$7FFE_H$: $6CDA_H$	Overshoot range
1820,0 : 0,0	18200 : 0	4718_H : 0000_H	2786,5 : 32	27865 : 320	$6CD9_H$: 0140_H	Nominal range
-0,1 : -120,0	-1 : -1200	$FFFF_H$: $FB50_H$	31,9 : -184,0	319 : -1840	$013F_H$: $F8D0_H$	Underrange
< -120,0	-32768	8000_H	< -184,0	-32768	8000_H	Underflow

Measuring range for thermocouple: Type C

Table 4-4 SIMATIC S7 format: Type C measuring range in °C and °F

Type C in °C	Units		Type C in °F	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
> 2500,0	32767	$7FFF_H$	> 3276,6	32767	$7FFF_H$	Overflow
2500,0 : 2315,1	25000 : 23151	$61A8_H$: $5A6F_H$	3276,6 : 2786,6	32766 : 27866	$7FFE_H$: $6CDA_H$	Overshoot range
2315,0 : 0,0	23150 : 0	$5A6E_H$: 0000_H	2786,5 : 32,0	27865 : 320	$6CD9_H$: 0140_H	Nominal range
0,1 : -120,0	-1 : -1200	$FFFF_H$: $FB50_H$	31,9 : -184,0	319 : -1840	$013F_H$: $F8D0_H$	Underrange
< -120,0	-32768	8000_H	< -184,0	-32768	8000_H	Underflow

Measuring range for thermocouple Type E

Table 4-5 SIMATIC S7 format: Type E measuring range in °C and °F

Type E in °C	Units		Type E in °F	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
> 1200,0	32767	$7FFF_H$	> 2192,0	32767	$7FFF_H$	Overflow
1200,0 : 1000,1	12000 : 10001	$2EE0_H$: 2711_H	2192,0 : 1832,1	21920 : 18321	$55A0_H$: 4791_H	Overshoot range
1000,0 : -270,0	10000 : -2700	2710_H : $F574_H$	1832,0 : -454,0	18320 : -4540	4790_H : $EE44_H$	Nominal range
< -270,0	- 32768	8000_H	< -454,0	- 32768	8000_H	Underflow

Measuring range for thermocouple Type J

Table 4-6 SIMATIC S7 format: Type J measuring range in °C and °F

Type J in °C	Units		Type J in °F	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
> 1450,0	32767	$7FFF_H$	> 2642,0	32767	$7FFF_H$	Overflow
1450,0	14500	$38A4_H$	2642,0	26420	6734_H	Overshoot range
:	:	:	:	:	:	
1200,1	12010	$2EEA_H$	2192,1	21921	$55A1_H$	
1200,0	12000	$2EE0_H$	2192,0	21920	$55A0_H$	Nominal range
:	:	:	:	:	:	
-210,0	-2100	$F7CC_H$	-346,0	-3460	$F27C_H$	
< -210,0	- 32768	8000_H	< -346,0	- 32768	8000_H	Underflow

Measuring range for thermocouple Type K

Table 4-7 SIMATIC S7 format: Type K measuring range in °C and °F

Type K in °C	Units		Type K in °F	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
> 1622,0	32767	$7FFF_H$	> 2951,6	32767	$7FFF_H$	Overflow
1622,0	16220	$3F5C_H$	2951,6	29516	$734C_H$	Overshoot range
:	:	:	:	:	:	
1372,1	13721	3599_H	2501,7	25062	$61B9_H$	
1372,0	13720	3589_H	2501,6	25061	$61B8_H$	Nominal range
:	:	:	:	:	:	
-270,0	-2700	$F574_H$	-454,0	-4540	$EE44_H$	
< -270,0	- 32768	8000_H	< -454,0	- 32768	8000_H	Underflow

Measuring range for thermocouple Type L

Table 4-8 SIMATIC S7 format: Type L measuring range in °C and °F

Type L in °C	Units		Type L in °F	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
> 1150,0	32767	$7FFF_H$	> 2102,0	32767	$7FFF_H$	Overflow
1150,0 : 900,1	11500 : 9001	$2CEC_H$: 2329_H	2102,0 : 1652,1	21020 : 16521	$521C_H$: 4089_H	Overshoot range
900,0 : -200,0	9000 : -2000	2328_H : $F830_H$	1652,0 : -328,0	16520 : -3280	4088_H : $F330_H$	Nominal range
< -200,0	-32768	8000_H	< -328,0	-32768	8000_H	Underflow

Measuring range for thermocouple Type N

Table 4-9 SIMATIC S7 format: Type N measuring range in °C and °F

Type N in °C	Units		Type N in °F	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
> 1550,0	32767	$7FFF_H$	> 2822,0	32767	$7FFF_H$	Overflow
1550,0 : 1300,1	15500 : 13001	$3C8C_H$: $32C9_H$	2822,0 : 2372,1	28220 : 23721	$6E3C_H$: $5CA9_H$	Overshoot range
1300,0 : -270,0	13000 : -2700	$32C8_H$: $F574_H$	2372,0 : -454,0	23720 : -4540	$5CA8_H$: $EE44_H$	Nominal range
< -270,0	-32768	8000_H	-32768	8000_H	$<EE44_H$	Underflow

Measuring range for thermocouple Types R, S

Table 4-10 SIMATIC S7 format: Type R, S measuring range in °C and °F

Type R, S in °C	Units		Type R, S in °F	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
> 2019,0	32767	$7FFF_H$	> 3276,6	32767	$7FFF_H$	Overflow
2019,0 : 1769,1	20190 : 17691	$4EDE_H$: $451B_H$	3276,6 : 3216,3	32766 : 32163	$7FFE_H$: $7DA3_H$	Overshoot range
1769,0 : -50,0	17690 : -500	$451A_H$: $FE0C_H$	3216,2 : -58,0	32162 : -580	$7DA2_H$: $FDBC_H$	Nominal range
-50,1 : -170,0	-510 : -1700	$FE0B_H$: $F95C_H$	-58,1 : -274,0	-581 : -2740	$FDBB_H$: $F54C_H$	Underrange
< -170,0	-32768	8000_H	< -274,0	-32768	8000_H	Underflow

Measuring range for thermocouple Type T

Table 4-11 SIMATIC S7 format: Type T measuring range in °C and °F

Type T in °C	Units		Type T in °F	Units		Range
	Decimal	Hexadecimal		Decimal	Hexadecimal	
> 540,0	32767	$7FFF_H$	> 1004,0	32767	$7FFF_H$	Overflow
540,0 : 400,1	5400 : 4001	1518_H : $0FA1_H$	1004,0 752,1	10040 7521	2738_H $1DC1_H$	Overshoot range
400,0 : -270,0	4000 : -2700	$0FA0_H$: $F574_H$	752,0 : -454,0	7520 : -4540	$1D60_H$: $EE44_H$	Nominal range
< -270,0	-32768	8000_H	< -454,0	-32768	8000_H	Underflow

4.3.2 Voltage measuring ranges

Voltage measuring ranges: ±80 mV

Table 4-12 SIMATIC S7 format: Measuring range ±80 mV

Measuring range ±80 mV	Units		Range
	Decimal	Hexadecimal	
> 94,071	32767	$7FFF_H$	Overflow
94,071 : 80,003	32511 : 27649	$7EFF_H$: $6C01_H$	Overshoot range
80,000 60,000 : -60,000 -80,000	27648 20736 : -20736 -27648	$6C00_H$ 5100_H : $AF00_H$ 9400_H	Nominal range
-80,003 : -94,074	-27649 : -32512	$93FF_H$: 8100_H	Underrange
< -94,074	-32768	8000_H	Underflow

Measured values in the event of a wire break, depending on the diagnostics enabled for voltage measurement

In the case of the measuring ranges for types B, C, E, J, K, L, N, R, S, and T thermocouples, the following additional information applies:

Table 4-13 Measured values in the event of a wire break, depending on the diagnostics enabled for voltage measurement

Format	Parameter assignment	Measured values		Description
		Decimal	Hexadecimal	
S7	• "Wire-break check" diagnostics enabled	32767	$7FFF_H$	• "Open circuit" diagnostic message
	• "Overflow/underflow" diagnostics disabled	-32767	8000_H	• Measured value after leaving the underrange • "Lower limit value undershot" diagnostic message
	• "Wire-break check" diagnostics disabled	---	---	• Open input: Undefined measured value

4.4 Effect on analog value representation

4.4.1 Effect of the supply voltage and the operating state on analog input values

The input values of the analog modules are dependent on the supply voltage for electronics/encoders and on the operating state of the PLC (CPU of the DP master). This is illustrated by the table below.

Table 4-14 Relationship between the analog input values for the operating state of the PLC (CPU of the DP master) and the supply voltage L+

Operating state of the PLC (CPU of the DP master)		Supply voltage L+ on ET 200S (power module)	Input value of the electronic module with analog inputs (evaluation possible on the CPU of the DP master)
POWER ON	RUN	L+ present	Process values
			$7FFF_H$ until first conversion after startup, or after assignment of parameters for the module is completed.
		L+ missing	$7FFF_H$
POWER ON	STOP	L+ present	Process value
		L+ missing	$7FFF_H$
POWER OFF	-	L+ present	-
		L+ missing	-

4.4.2 Effect of the value range on the 2AI TC HF analog input

The way electronic modules respond to analog inputs depends on where the input values fall within the value range. This is illustrated by the table below.

Table 4-15 Response of the analog modules, depending on where the analog input value falls within the range of values

Measured value within ...	Input value in SIMATIC S7 format	Input value in SIMATIC S5 format
Nominal range	Measured value	Measured value
Over-/underrange	Measured value	Measured value
Overflow	$7FFF_H$	End of the overshoot range +1 plus overflow bit
Underflow	8000_H	End of the underrange -1 plus overflow bit
Prior to parameter assignment, or incorrect parameter assignment	$7FFF_H$	$7FFF_H$

Connecting

5

5.1 Connecting measuring sensors

Introduction

You can connect encoders with voltage signals and thermocouples to the 2AI TC HF analog input module.

In this chapter you will find out how to connect the measuring encoders and what to watch out for when doing so.

Cables for analog signals

You should use shielded and twisted-pair cables for the analog signals. This reduces the effect of interference. You should ground the shield of the analog cables at both ends. If there are differences in potential between the cable ends, an equipotential bonding current that may interfere with the analog signals will flow across the shield. If this is the case, you should only ground the shield at one end of the cable.

Analog input modules

The analog input modules are electrically isolated:

- Between the logic and backplane bus
- Between the load voltage and the channels.
  - Electrical isolation: No link between M_{ANA} and the central grounding point (U_{ISO})

Note

Ensure that this difference in potential U_{ISO} does not exceed the permitted value. If there is a possibility of exceeding the permitted value, establish a connection between terminal M_{ANA} and the central grounding point.

Connecting measuring encoders to analog inputs

There can be only a limited potential difference U_{CM} (common mode) between the measuring lines M- of the input channels and the reference point of the measuring circuit M_{ANA}. To ensure that the permitted value is not exceeded, you must take different steps depending on the whether the encoders are isolated or non-isolated. The steps you have to take are described in this chapter.

Abbreviations used

The meanings of the abbreviations in the figures below are as follows:

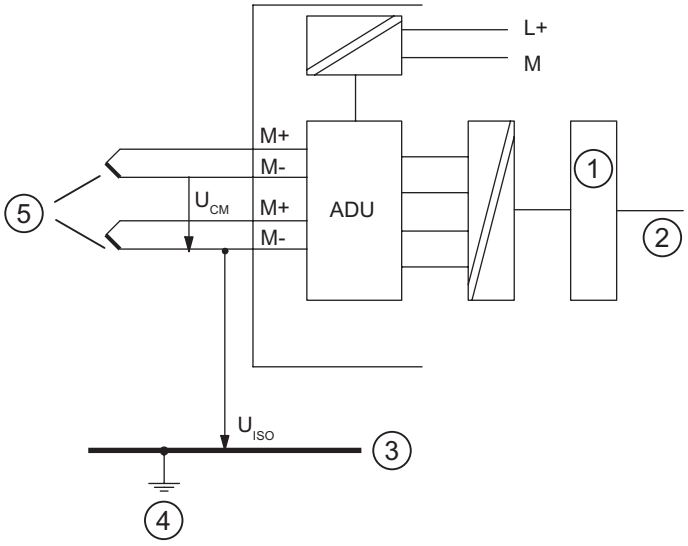
M+:	Measuring line (positive)
M-	Measuring line (negative)
M	Ground connection
L+	Rated load voltage 24 V DC
U_{CM}	Potential difference between inputs and reference potential of the measuring circuit M_{ANA}
U_{ISO}	Potential difference between M- and central grounding point

Isolated measuring encoders

The isolated measuring encoders are not connected to the local ground potential. These can be potential-free. Depending on local conditions or interference, potential differences U_{CM} (static or dynamic) can occur between the measuring lines M- of the input channels and the reference point of the measuring circuit M_{ANA}.

The permitted value for U_{CM} must not be exceeded, even in environments with strong EMC interference.

The following schematic representation illustrates the connection of isolated measuring encoders to the optically isolated analog input modules.



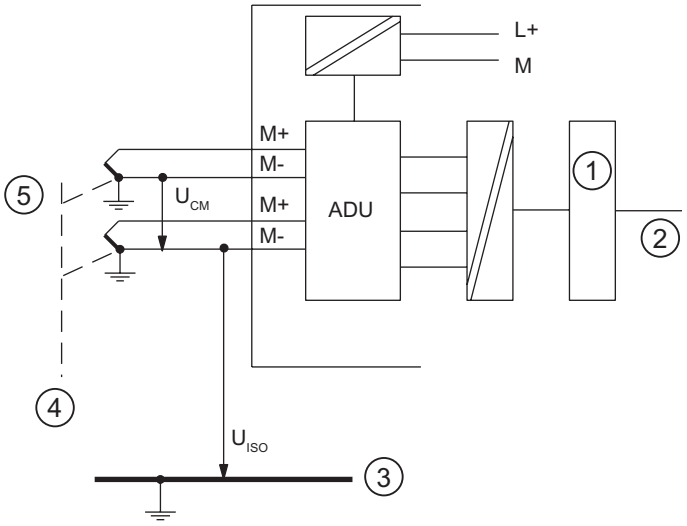
① Logic
② Backplane bus
③ Ground bus
④ Central grounding point
⑤ Isolated measuring encoders

Non-isolated measuring encoders

The non-isolated measuring encoders are connected to the local ground potential. You must connect M_{ANA} to the ground potential. Depending on local conditions or interference, potential differences U_{CM} (static or dynamic) can occur between the locally distributed measuring points.

If the permitted value for U_{CM} is exceeded, there must be equipotential bonding conductors between the measuring points.

The following schematic representation illustrates the connection of non-isolated measuring encoders to an optically isolated analog input module.



① Logic
② Backplane bus
③ Ground bus
④ Equipotential bonding conductor
⑤ Non-isolated measuring encoders

Non-isolated thermocouples

When using non-isolated thermocouples, you must comply with the permitted common mode voltage.

5.2 Connecting thermocouples

Introduction

This section contains additional information on connecting thermocouples.

Compensation of the comparison point temperature

There are various ways of obtaining the comparison point temperature in order to get an absolute temperature value from the temperature difference between the comparison point and the measuring point.

Table 5-1 Compensation of the comparison point temperature

Option	Description	Comparison point parameters
No compensation	It is not just the temperature of the measuring point that you need to record: The temperature of the comparison point (transition from Cu line to thermocouple line) also affects the thermo-electromotive force. The measured value on its own is incorrect.	None
Using a compensating box on the supply lines of a single thermocouple	You compensate using a compensating box. The compensating box is the transition point from the Cu line to the thermocouple line. No further processing is necessary using the 2AI TC ST.	None
Internal compensation in the case of the 2AI TC HF	There is a temperature sensor in the TM-E15S24-AT and TM-E15C24-AT terminal modules. The temperature sensor reports the temperature of the terminals to the 2AI TC HF. This value is then calculated together with the measured value from the channel of the electronic module.	• 2AI TC HF: Reference junction: Yes

Extension to a comparison point

The thermocouples can be extended from their connection point by means of compensating lines to the comparison point (transition to Cu line) or the compensating box. The comparison point can also be an ET 200S terminal module.

The compensating lines are made of the same material as the wires of the thermocouple. The supply lines are made of copper. Ensure the correct polarity when connecting.

Using a compensating box

The effect of the temperature on the comparison point of a thermocouple (such as a terminal box) can be adjusted with a compensating box.

The compensating box contains a bridge circuit that is adjusted for a certain comparison point temperature (compensating temperature). You connect the thermocouples or their compensating lines to the compensating box. The compensating box then forms the comparison point.

If the actual reference temperature differs from the compensating temperature, the temperature-dependent bridge resistance changes. A positive or negative compensation voltage occurs; this is added to the thermo-electromotive force.

Compensating boxes with a **comparison point temperature of 0°C** must be used for the compensation of the analog input modules.

Note:

- The power supply to the compensating box must be isolated.
- The power supply unit must have adequate interference filtering (by means of a grounded shielding winding, for example).

5.3 Wiring unused channels on analog input modules

Rules

Pay attention to the following instructions when wiring unused channels:

- "Deactivate" unused input channels when assigning parameters.
- A deactivated channel always returns the value $7FFF_H$.
- The module cycle time is halved with the 2AI TC HF standard module.
- To adhere to the permissible potential differences (U_{CM}), you must wire jumpers on the terminal module for the unused channels.

Analog input module	TM connecting terminal							
	Channel 0				Channel 1			
	1	2	3	4	5	6	7	8
2AI TC HF	●——●				●——●			

5.4 Using the shield connection

Rules

To prevent interference we recommend the following for analog electronic modules:

- Use shielded wires to the sensors and actuators.
- Lay out the wire shields on the shield connection.
- Connect the shield connection to the ground bus with low impedance.

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