SIEMENS

SIMATIC

ET 200S distributed I/O
Analog electronic module
2AI TC ST (6ES7134-4JB01-0AB0)

Manual

05/2012

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Legal information

Warning notice system

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.

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

CAUTION

without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

NOTICE

indicates that an unintended result or situation can occur if the relevant information is not taken into account.

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Preface

Preface

Purpose of the manual

This manual supplements the *ET 200S Distributed I/O System* Operating Instructions. Functions which apply to the ET 200S in general are described in the ET 200S operating instructions on the Internet (http://support.automation.siemens.com/WW/view/en/1144348).

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 validity 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

Due 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 use of the products described in this manual and do not find the answers in this document, please contact your local Siemens representative or office nearest to you on the Internet (http://www.automation.siemens.com/partner/).

A guide to the technical documentation for the various SIMATIC products and systems is available on the Internet. (http://www.siemens.com/simatic-tech-doku-portal)

The online catalog and ordering system are available on the Internet (http://www.siemens.com/automation/mall).

Training center

We offer courses to help you get started with the ET 200S and the SIMATIC S7 automation system. Please contact your regional training center or the central training center in D-90327, Nuremberg, Germany on the Internet (http://www.siemens.com/sitrain).

Technical Support

You can reach Technical Support for all industry automation products via the support request Web form on the Internet (http://www.siemens.com/automation/support-request).

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In addition to our documentation, we offer a comprehensive knowledge base on the Internet (http://www.siemens.com/automation/service&support).

There you will find:

- Our Newsletter, which constantly provides you with the latest information about your products.
- The right documentation for you using our Service & Support search engine.
- The bulletin board, a worldwide knowledge exchange for users and experts.
- Your local contact for Automation & Drives in our contact database.
- Information about on-site services, repairs, spare parts, and lots more.

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Properties

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1.1 2AI TC ST analog electronic module (6ES7134-4JB00-0AB0)

Properties

- 2 inputs for thermocouple or voltage measurement
- Input ranges:
  - Voltage measurement: ± 80 mV, resolution 15 bits + sign
  - Thermocouples: Type E, N, J, K, L, S, R, B, T, resolution 15 bits + sign
- Isolated from the load voltage L+
- Linearization of the sensor characteristic curves
- Permissible common mode voltage 2 VAC_{SS}
- Extended temperature range from 0 to 50°C with vertical installation
- supports I&M functions
- compatible with 2AI TC ST (6ES7134-4JB00-0AB0)

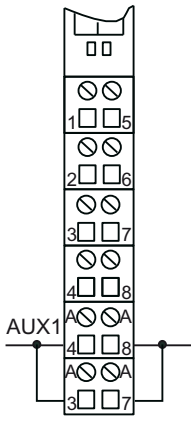
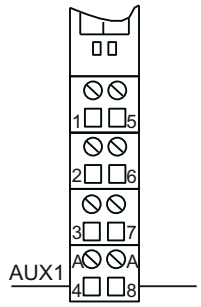
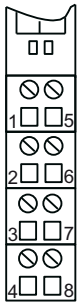
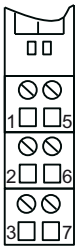
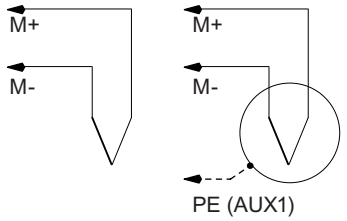
General terminal assignment

Note

Terminals 4, 8, A4, A8, A3 and A7 are only available at specified terminal modules.

Terminal assignment for 2AI TC ST (6ES7134-4JB01-0AB0)				
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 • M_{ana}: Ground of the module • n.c.: Not connected (max. 30 VDC can be connected) • AUX1: Protective-conductor terminal or potential bus (freely usable up to 230 VAC)
2	M_{0-}	**6**	M_{1-}	
3	M_{ana}	**7**	M_{ana}	
4	n.c.	**8**	n.c.	
A4	AUX1	**A8**	AUX1	
A3	AUX1	**A7**	AUX1	

Usable terminal modules

Usable terminal modules for 2AI TC ST (6ES7134-4JB01-0AB0)				
TM-E15C26-A1 (6ES7193-4CA50-0AA0)	TM-E15C24-A1 (6ES7193-4CA30-0AA0)	TM-E15C24-01 (6ES7193-4CB30-0AA0)	TM-E15C23-01 (6ES7193-4CB10-0AA0)	← Spring terminal
TM-E15S26-A1 (6ES7193-4CA40-0AA0)	TM-E15S24-A1 (6ES7193-4CA20-0AA0)	TM-E15S24-01 (6ES7193-4CB20-0AA0)	TM-E15S23-01 (6ES7193-4CB00-0AA0)	← Screw-type terminal
TM-E15N26-A1 (6ES7193-4CA80-0AA0)	TM-E15N24-A1 (6ES7193-4CA70-0AA0)	TM-E15N24-01 (6ES7193-4CB70-0AA0)	TM-E15N23-01 (6ES7193-4CB60-0AA0)	← Fast Connect
				Connection examples  Voltage measurement as for 2AI U ST

Block diagram

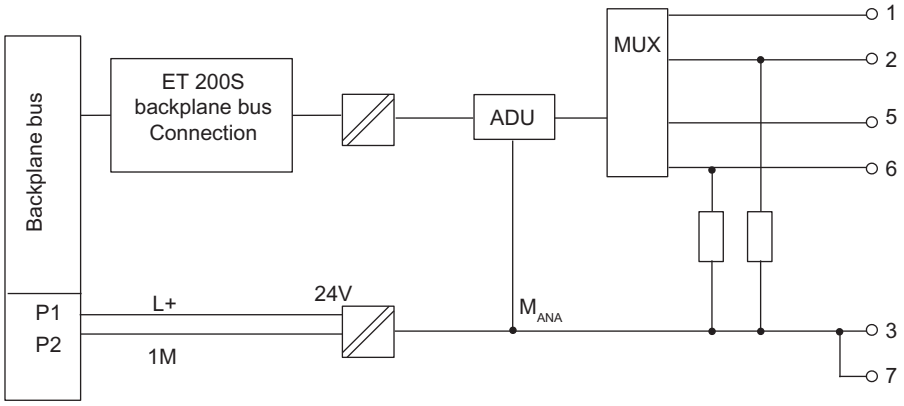


Figure 1-1 Block diagram of the 2AI TC ST

2AI TC ST technical specifications (6ES7134-4JB01-0AB0)

Dimensions and weight	
Width (mm)	15
Weight	Approx. 40 g
Module-specific data	
Supports isochronous operation	No
Supports I&M functions	Yes
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
• Between the channels and 24 V supply voltage	Yes
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})	2 VAC_{SS}
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	55	65
• Additional conversion time for wire break check diagnostics in ms	20	20
• 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}) • Common mode interference (peak value of interference < rated value of input range)	Min. 90 dB Min. 70 dB	
Crosstalk between the inputs	Min. -50 dB	
Operational limit (over the entire temperature range, with reference to the input range)[1]	± 0.6 %	
Basic error limit (operational limit at 25°C with reference to input range)[1]	± 0.4 %	
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 %	

Data for selecting a sensor		
Input range (rated value)/input resistance		
• Voltage	± 80 mV/min. 1 MΩ	
• Thermocouple	Type E, N, J, K, L, S, R, B, T/min. 1 MΩ	
Permitted input voltage (destruction limit)	± 10 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 as per IEC 584	
Temperature compensation		
• Internal temperature compensation	Not supported	
• External temperature compensation by looping a compensating box into the measuring circuit	Possible, one external compensating box per channel	
• External compensation by means of temperature value obtained at an analog module of the same ET 200S station	Yes	
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] For Type N: From -150 C, Type B: from 200 °C, Type T: from -230 C		

Compensation of thermocouples with a compensating box

As well as the error limits of the 2AI TC ST electronic module (see table "Technical data 2AI TC ST (6ES7134-4JB01-0AB0)" in this chapter) you must also take the accuracy of the compensating box into account.

Compensation of thermocouples with a Pt100 on 2AI RTD ST, 2/4AI RTD ST and 2AI RTD HF

Factors affecting the accuracy of the temperature measurement	
Wiring rules	Ensure there is good thermal contact between the reference junction and the Pt100 used for compensation.
	We recommend that you wire the Pt100 with a four-wire connection.
Additional technical data on the error limits of the 2AI TC	The accuracy of the thermal resistor (Pt100) used for compensation must be taken into account.[1]
	The error of the measurement input (2AI RTD ST) used for compensation must be taken into account.[1]

[1] In the case of thermocouples with a characteristic curve with a very shallow gradient, these errors can lead to a major measurement discrepancy.
For the following thermocouples, this causes a limitation of the input range of the thermocouples in which the accuracy information in the manual applies:

- Type N: -100 °C
- Type K: -230 C
- Type E: -230 C

I&M functions

The interface modules identified in the table below (as of order number) can be used to read and write I&M data from the module and for the firmware update:

Interface module	as of order number
IM 151-1 STANDARD	6ES7151-1AA05-0AB0
IM 151-1 FO STANDARD	6ES7151-1AB05-0AB0
IM 151-1 HIGH FEATURE	6ES7151-1BA02-0AB0
IM 151-3 PN	6ES7151-3AA22-0AB0
IM 151-3 PN HIGH FEATURE	6ES7151-3BA22-0AB0
IM 151-3 PN HIGH SPEED	6ES7151-3BA60-0AB0
IM 151-3 PN FO	6ES7151-3BB22-0AB0
IM 151-7 CPU	6ES7151-7AA20-0AB0
IM 151-7 F-CPU	6ES7151-7FA20-0AB0
IM 151-8 PN/DP CPU	6ES7151-8AB00-0AB0
IM 151-8 PN/DP F-CPU	6ES7151-8FB00-0AB0

Parameters

2

2.1 Parameters

Table 2- 1 Parameters for analog input module

2AI TC ST	Range of values	Default setting	Applicability
Group diagnostics (parameter assignment error, internal error, channel diagnostics)	• 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
Comparison point	• None • RTD	None	Channel
Reference junction number	• None • 1 to 8 (in the case of the IM151-1 STANDARD and IM151-1 FO STANDARD) • 1 (in the case of the IM151-1 BASIC, IM151-1 COMPACT, IM151-1 HIGH FEATURE)	None	Module
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 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 diagnosis is 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.

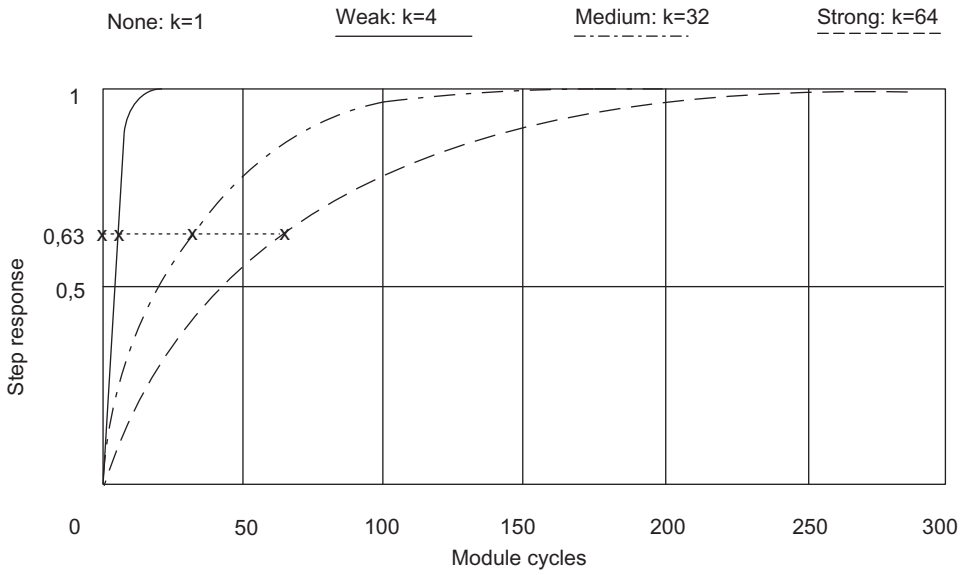


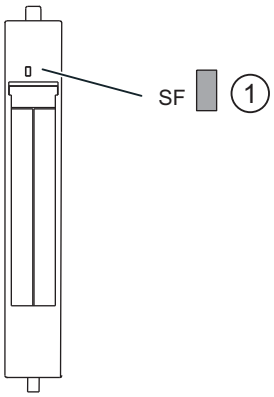
Figure 2-1 Smoothing with the 2AI TC ST

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
21_D	10101: Reference channel error*	Error on the reference channel	Check the reference module (2 AI RTD ST).
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 overrange.	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.
* Reference channel error is not reported if the RTD module is not parameterized in the GSD file using the PT100 Climatic. This applies to IM151-1 HIGH FEATURE (6ES7151-1BA00-0AB0 or higher), IM151-7 CPU and IM151-3 PROFINET IO (6ES7151-3AA00-0AB0 or higher).			

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 for 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" → –

Analog values

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 11, 12, 13, 14, and 15 bit resolutions + sign. Each analog value is entered left aligned in the ACCU. The bits marked with "x" are set to "0".

Table 4- 2 Analog 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 0 1 x x x x
12+S	8	8_H	S 0 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 0 1 x x
14+S	2	4_H	S 0 0 0 0 0 0 0	0 0 0 0 0 0 1 x
15 + sign	1	1_H	S 0 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.

Measured values in the case of a wire break depending on diagnostic being enabled

Table 4- 3 Measured values in the case of a wire break depending on diagnostic being enabled

Format	Parameter assignment	Measured values		Description
		Decimal	Hexadecimal	
• S7	• "Wire-break check" and "Group diagnostics" enabled	32767	$7FFF_H$	• "Open circuit" diagnostic message
	• "Wire-break check" or "Group diagnostics" disabled	---	---	• Open input: Undefined measured value

Measuring range for thermocouple: Type B

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

Type B in °C	Units		Range
	Decimal	hexadecimal	
> 2070.0	32767	$7FFF_H$	Overflow
2070.0 : 1820.1	20700 : 18201	$50DC_H$: 4719_H	Overrange
1820.0 : 0.0	18200 : 0	4718_H : 0000_H	Nominal range
-0.1 : -120.0	-1 : -1200	$FFFF_H$: $FB50_H$	Underrange
< -120.0	-32768	8000_H	Underflow

Measuring range for thermocouple Type E

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

Type E in °C	Units		Range
	Decimal	hexadecimal	
> 1200.0	32767	$7FFF_H$	Overflow
1200.0 : 1000.1	12000 : 10001	$2EE0_H$: 2711_H	Overrange
1000.0 : -270.0	10000 : -2700	2710_H : $F574_H$	Nominal range
< -270.0	- 32768	8000_H	Underflow

Measuring range for thermocouple Type J

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

Type J in °C	Units		Range
	Decimal	hexadecimal	
> 1450.0	32767	$7FFF_H$	Overflow
1450.0 : 1200.1	14500 : 12010	$38A4_H$: $2EEA_H$	Overrange
1200.0 : -210.0	12000 : -2100	$2EE0_H$: $F7CC_H$	Nominal range
< -210.0	- 32768	8000_H	Underflow

Measuring range for thermocouple Type K

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

Type K in °C	Units		Range
	Decimal	hexadecimal	
> 1622.0	32767	$7FFF_H$	Overflow
1622.0 : 1372.1	16220 : 13721	$3F5C_H$: 3599_H	Overrange
1372.0 : -270.0	13720 : -2700	3589_H : $F574_H$	Nominal range
< -270.0	- 32768	8000_H	Underflow

Measuring range for thermocouple Type L

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

Type L in °C	Units		Range
	Decimal	hexadecimal	
> 1150.0	32767	$7FFF_H$	Overflow
1150.0 : 900.1	11500 : 9001	$2CEC_H$: 2329_H	Overrange
900.0 : -200.0	9000 : -2000	2328_H : $F830_H$	Nominal range
< -200.0	-32768	8000_H	Underflow

Measuring range for thermocouple Type N

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

Type N in °C	Units		Range
	Decimal	hexadecimal	
> 1550.0	32767	$7FFF_H$	Overflow
1550.0 : 1300.1	15500 : 13001	$3C8C_H$: $32C9_H$	Overrange
1300.0 : -270.0	13000 : -2700	$32C8_H$: $F574_H$	Nominal range
< -270.0	-32768	8000_H	Underflow

Measuring range for thermocouple Types R, S

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

Type R, S in °C	Units		Range
	Decimal	hexadecimal	
> 2019.0	32767	$7FFF_H$	Overflow
2019.0 : 1769.1	20190 : 17691	$4EDE_H$: $451B_H$	Overrange
1769.0 : -50.0	17690 : -500	$451A_H$: $FE0C_H$	Nominal range
-50.1 : -170.0	-510 : -1700	$FE0B_H$: $F95C_H$	Underrange
< -170.0	-32768	8000_H	Underflow

Measuring range for thermocouple Type T

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

Type T in °C	Units		Range
	Decimal	hexadecimal	
> 540.0	32767	$7FFF_H$	Overflow
540.0 : 400.1	5400 : 4001	1518_H : $0FA1_H$	Overrange
400.0 : -270.0	4000 : -2700	$0FA0_H$: $F574_H$	Nominal range
< -270.0	-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

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- 13 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 2 AI TC Standard 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- 14 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 overrange +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 ST 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_{ANA}	Reference potential of the analog measuring circuit
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_{ANA} and central grounding point

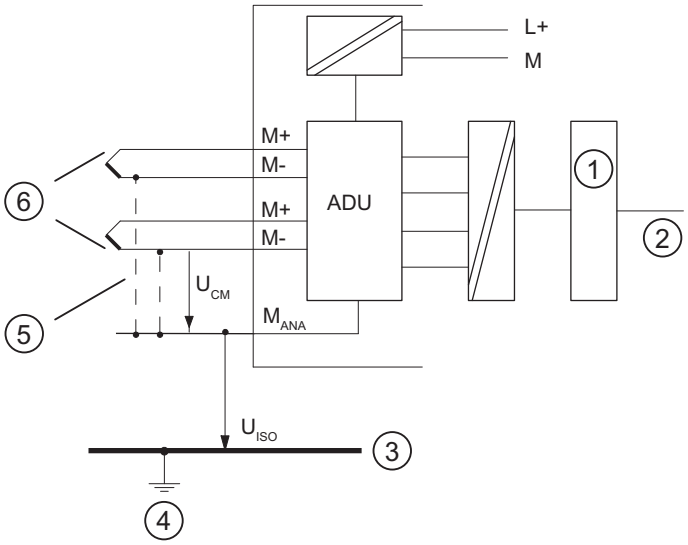
Isolated measuring encoders

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}.

To ensure that the permitted value for U_{CM} is not exceeded in environments with strong EMC interference, the following applies:

- For the 2AI TC analog input module: Connect M- to M_{ANA}!

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 Recommended connection
⑥ Isolated measuring encoders

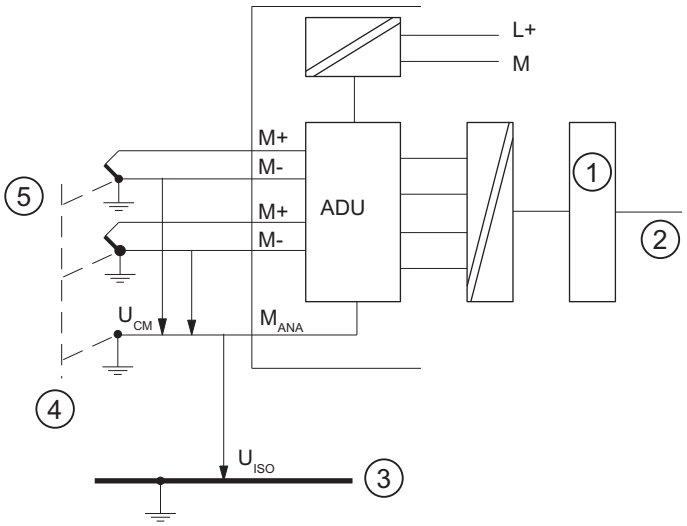
Non-isolated measuring encoders

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.

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

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.	None
Use of a Pt 100 Climatic Range resistance thermometer to record the reference junction temperature (best method)	You can record the reference junction temperature using a resistance thermometer (Pt 100 Climatic Range). Given appropriate parameter assignment, this temperature value in the ET 200S is distributed to the 2AI TC modules and calculated in the modules together with the temperature value obtained for the measurement point. Number of reference junctions: 1	The parameter assignment of the IM151-1 and the 2AI TC must be coordinated: • 2AI RTD configured to Pt 100 climatic range at the correct slot; • 2AI TC: Reference junction : RTD; select reference junction number 1 • IM : Assignment of the reference junction to a slot with the 2AI RTD; selection of a channel;

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).

Compensation by means of a resistance thermometer at the 2AI RTD

If thermocouples that are connected to the inputs of the 2AI TC have the same reference junction, compensate by means of a 2AI RTD.

For both channels of the 2AI TC module, you can select "RTD" or "None" as the reference junction. If you select "RTD," the same reference junction (RTD channel) is always used for both channels.

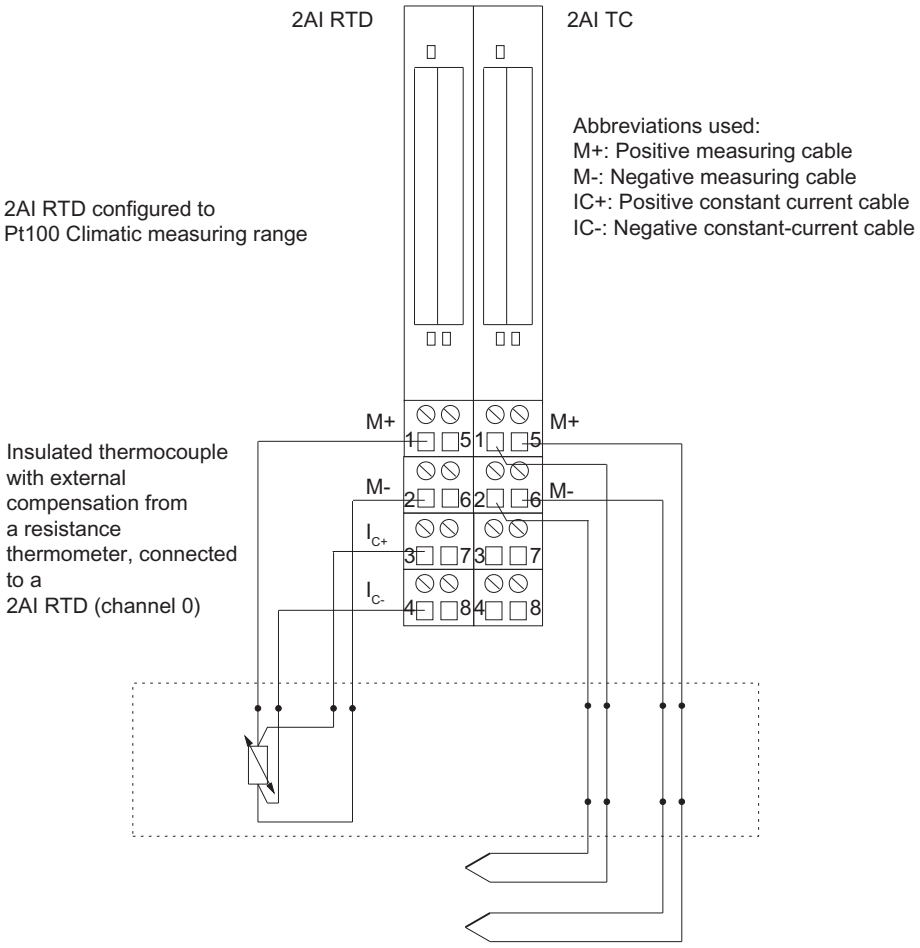


Figure 5-1 Compensation by means of the 2AI RTD

Note

In the case of 2/4AI RTD ST analog electronic module, use the channels 0 and 1 for compensation.

Parameter assignment of the reference junction for the 2AI TC and the interface module

You set the reference junctions for the 2AI TC electronic modules by means of the following parameters:

Table 5- 2 Reference junction parameters

Parameters	Module	Range of values	Explanation
Reference junction slot	IM 151	None, 2 to 12 (IM151-1 BASIC) None, 2 to 13 (IM151-1 COMPACT) none, 2 to 63 (IM151-1 HIGH FEATURE, IM151-1 STANDARD, IM151-1 FO STANDARD)	A slot with the channel for measuring the reference temperature (determining the compensation value) can be assigned with this parameter.
Reference junction input	IM 151	RTD at Channel 0 RTD at Channel 1	This parameter can be used to set the channel (0/1) for measuring the reference temperature (calculation of the compensation value) for the assigned slot
Reference junction E0 and reference junction E1	AI TC	None, RTD	This parameter allows you to enable the use of the reference junction.
Reference junction number	AI TC	1	With this parameter, you assign the reference junction (1) containing the reference temperature (compensation value).

Example of assigning parameters of reference junctions

Setup: For simplification, only RTD and TC modules are shown in the following figure:

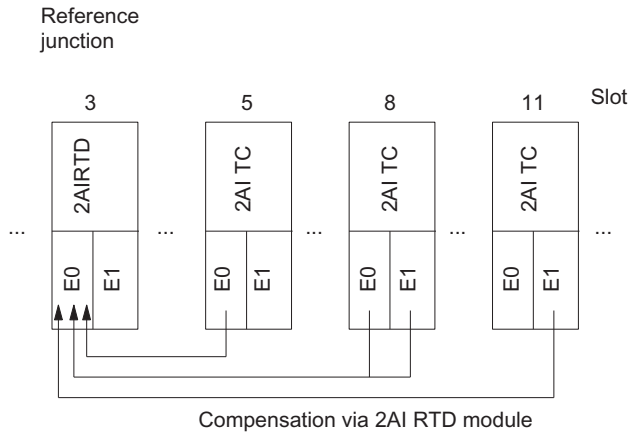


Figure 5-2 Example of assigning parameters of reference junctions

Relevant parameters to be set for the interface module:

Parameters	Value
Reference junction slot	3
Reference junction input	RTD at Channel 0

Relevant parameters to be set for the 2AI TC:

Slot	Parameters	Value
5 (2AI TC)	Reference junction E0	RTD
	Reference junction E1	None
	Reference junction number	1
	Type/range of measurement E0	TC-EL Type...
	Type/range of measurement E1	(any)
8 (2AI TC)	Reference junction E0	RTD
	Reference junction E1	RTD
	Reference junction number	1
	Type/range of measurement E0	TC-EL Type...
	Type/range of measurement E1	TC-EL Type...
11 (2AI TC)	Reference junction E0	None
	Reference junction E1	RTD
	Reference junction number	1
	Type/range of measurement E0	(any)
	Type/range of measurement E1	TC-EL Type...

Non-isolated thermocouples

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

5.3 Wiring unused channels of the 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 ST 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 ST	●——●——●				●——●——●			

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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