SIEMENS

SIMATIC

ET 200SP HA
AI 8xU/I/TC/4xRTD 2-/3-/4-wire HA

Equipment Manual

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6DL1134-6AF00-0PH1

03/2023
A5E51713793-AA

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

indicates that minor personal injury can result if proper precautions are not taken.

NOTICE

indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

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We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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Security information

1

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Preface

2

Validity of the documentation

This manual describes the following I/O module:

System family	I/O module	Article number
SIMATIC Distributed I/O System ET 200SP HA	AI 8xU/I/TC/4xRTD 2-/3-/4-wire HA	6DL1134-6AF00-0PH1

It supplements the "ET 200SP HA Distributed I/O System" system manual.

Functions that generally relate to the system are described in this manual.

The information in this Product Manual and the System / Function Manuals makes it possible to take the ET 200SP HA into operation.

Conventions

Please also observe notes marked as follows:

Note

A note contains important information on the product described in the documentation, on the handling of the product and on the section of the documentation to which particular attention should be paid.

2D matrix code

3

The 2D matrix code (QR code / EAN code) on the product is a coded representation of the product-specific article number.

Access to product-related information

For reading the 2D matrix code, SIEMENS offers an app for mobile use.

Information on the app and its download is available on the Internet: "Mobile use via app (https://support.industry.siemens.com/cs/ww/en/sc/2067)".

The app provides direct access to the technical forum and product-related posts, such as:

- FAQs
- Application examples
- Manuals
- Certificates
- Product notices

Product overview

4

4.1 I/O module

Definition

The I/O module AI 8xU/I/TC/4xRTD 2-/3-/4-wire HA is an analog input module with 8 inputs for process control.

The I/O module is used to connect thermocouples, resistance temperature detectors and ohmic resistances and for measuring voltages and currents.

In addition to the technical specifications, this module has the following properties:

- 8 analog inputs for the connection of thermocouples (TC), voltages (U) and currents (I)
- Alternatively, four analog inputs for the connection of resistance temperature detectors (RTD) and resistors (R)
- The analog inputs have the following channel-specific configurable properties:
  - Measurement type voltage
  - Measurement type current, 2-, 4-wire transducer (TD)
  - Measurement type resistance, 2-, 3-, 4-wire connection
  - Automatic compensation of the line resistance with 3-wire connection
  - Measurement type thermal resistor (RTD), 2-, 3-, 4-wire connection
  - Thermocouple (TC) measurement type can be set per channel
  - Smoothing
  - Interference frequency suppression 10 Hz, 50 Hz, 60 Hz or 400 Hz
- Module-specific configurable diagnostics
- Configurable process value display
  - S7 format: 16 bits including sign
  - REAL format according to IEEE 754 (floating-point values)
- Common mode voltage up to 15 V
- Overload protection in the transducer supply
- Unshielded cables for current measurement
- Optional ground terminal or encoder supply channel 7 (configurable)

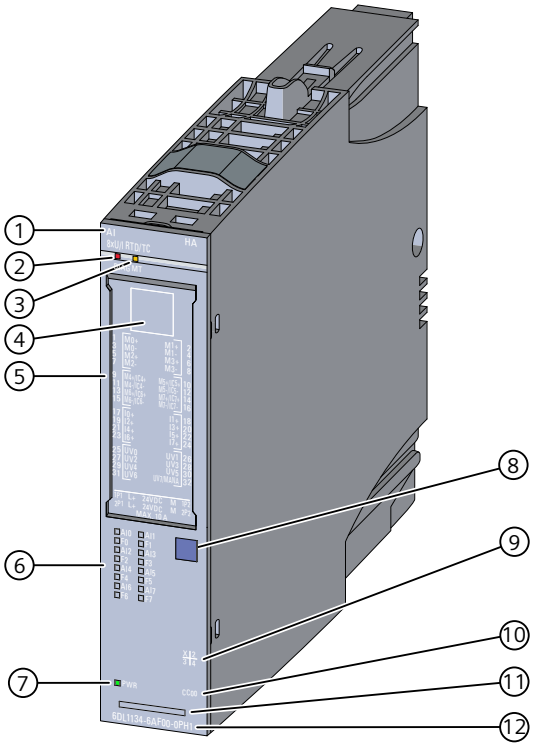
The I/O module supports the following functions:

- Firmware update
- I&M identification data

- Re-parameterization in RUN
- Value status QI

Description

The I/O module consists of the following components:



① Module type and designation
② LED for diagnostics
③ LED for maintenance
④ 2D matrix code
⑤ Wiring diagram
⑥ LEDs for channel status/channel fault
⑦ LED for supply voltage
⑧ Module type color coding
⑨ Product version
⑩ Color code for selection of the color-coded labels
⑪ Serial number
⑫ Article number

4.2 Accessories

Definition

Accessories for the I/O module must be ordered separately.

Description

The following accessories must be ordered separately:

- Labeling strips
- Color-coded labels
- Reference identification label
- Shield connector

4.3 Terminal blocks

Definition

The terminal blocks provide the process terminals (push-in terminals) for components such as devices to be connected.

Description

The following terminal blocks are available for the I/O module:

Article number	Color	Description
6DL1193-6TP00-0DH1	Lit	
6DL1193-6TP00-0BH1	Dark	
6DL1193-6TC00-0DH0	Black	D-SUB terminal block (no power bus support)
6DL1193-6TP00-0DN0	Lit	With additional potential distributors for ground connection
6DL1193-6TP00-0BN0	Dark	With additional potential distributors for ground connection

Note

Terminal blocks with potential distributors and the D-SUB terminal block have no integrated temperature sensors (no internal reference junction).

Note

Terminal blocks are not included in the scope of delivery of the I/O module and must be ordered separately.

You can find additional information on the configuration in the system manual.

Terminal

5

5.1 Pin assignment

Definition

The terminal assignment provides information about the arrangement and marking of the terminals when wiring a connector.

Description

The measurement types for resistance measurement (R, incl. PTC) and resistance thermal measurement (RTD) are only possible on channels 4...7. If a measurement type with 3- or 4-wire connection is configured on channel x (x = 4...7), then channel y (y = x-4) must be disabled.

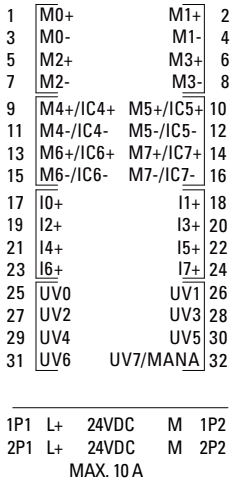
The general terminal assignment is structured as follows:

Terminal	Assignment	Terminal	Assignment
1	M_0+	**2**	M_1+
3	M_0-	**4**	M_1-
5	M_2+	**6**	M_3+
7	M_2-	**8**	M_3-
9	M_4+/IC_4+	**10**	M_5+/IC_5+
11	M_4-/IC_4-	**12**	M_5-/IC_5-
13	M_6+/IC_6+	**14**	M_7+/IC_7+
15	M_6-/IC_6-	**16**	M_7-/IC_7-
17	I0+	**18**	I1+
19	I2+	**20**	I3+
21	I4+	**22**	I5+
23	I6+	**24**	I7+
25	UV0	**26**	UV1
27	UV2	**28**	UV3
29	UV4	**30**	UV5
31	UV6	**32**	UV7/MANA
1P1	L+	**1P2**	M
2P1	L+	**2P2**	M

Explanations

M_n+: Measuring line positive, channel n
M_n-: Measuring line negative, channel n
IC_n+: Constant current line positive, channel n
IC_n-: Constant current line negative, channel n
In+: Input signal "+", channel n
UVn: Sensor supply, channel n

1P1: Supply voltage L+ of voltage bus 1P
2P1: Supply voltage L+ of voltage bus 2P
1P2: Ground reference of voltage bus 1P
2P2: Ground reference of the voltage bus 2P



Wiring and shielding

- The 2-wire and 4-wire current measurement can be wired with unshielded cables. However, shielded cables are recommended in a noisy environment.
- All voltage, TC and RTD measurements must be made with shielded cables. Shielding must be applied on both sides.

Note

The I/O module supports mixed operation. All operating modes can be combined. If an operating mode is wired with shielded cables, then all other channels (including the current measurement) must be wired shielded.

Note

Unused inputs

To avoid faulty diagnostics messages, you should deactivate unused inputs.

Analog ground at terminal UV7/MANA

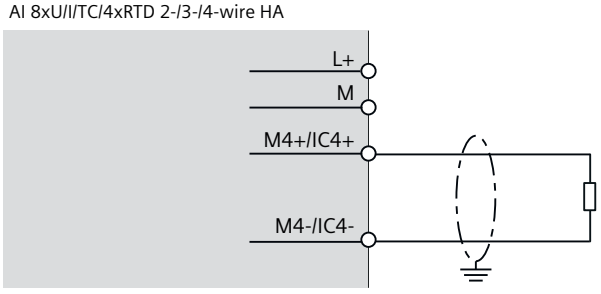
The I/O module can optionally switch through the transducer supply UV7 or the internal analog ground MANA via the parameter assignment on terminal 32. The MANA terminal is connected to the "M-" cable. In an environment prone to interference, this can lead to more stable measured values for sensitive measurements and suppress possible diagnostics messages.

5.2 Example of a wiring diagram for R/RTD 2-wire connection

Example

Measurement type RTD with 2-, 3- or 4-wire connection is possible for channel 4...7.

The figure below shows an example of the RTD measurement type with a 2-wire connection for channel 4.



Note

Shielding is mandatory and must be grounded on both sides.

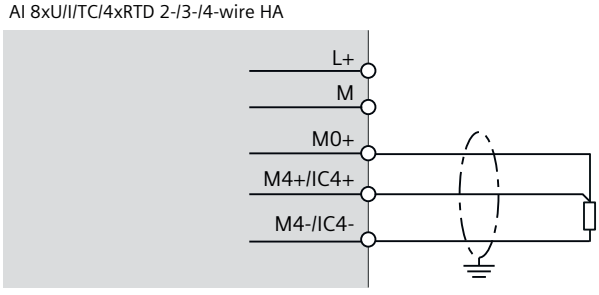
5.3 Example of a wiring diagram for R/RTD 3-wire connection

Example

Measurement type RTD with 2-, 3- or 4-wire connection is possible for channel 4...7.

If a measurement type with 3-wire connection is configured on channel x=4...7, then channel x-4 must be disabled.

The figure below shows an example of the RTD measurement type with a 3-wire connection for channel 4. Channel 0 is disabled.



Note

Shielding is mandatory and must be grounded on both sides.

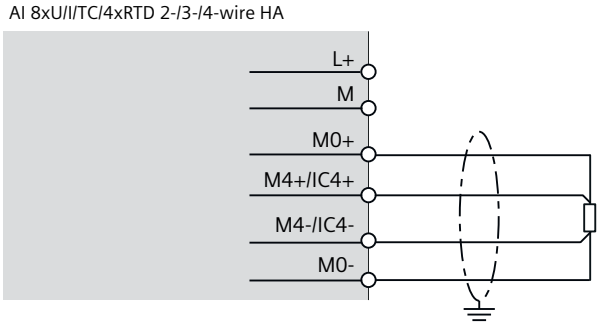
5.4 Example of a wiring diagram for R/RTD 4-wire connection

Example

Measurement type RTD with 2-, 3- or 4-wire connection is possible for channel 4...7.

If a measurement type with 4-wire connection is configured on channel x=4...7, then channel x-4 must be disabled.

The figure below shows an example of the RTD measurement type with a 4-wire connection for channel 4. Channel 0 is disabled.



Note

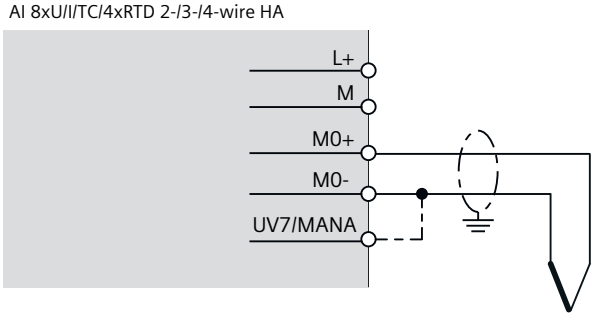
Shielding is mandatory and must be grounded on both sides.

5.5 Example of connection scheme for TC

Example

Thermocouples (TC) can be configured and connected to channel 0...7.

The figure below shows an example of the pin assignment of a thermocouple on channel 0.



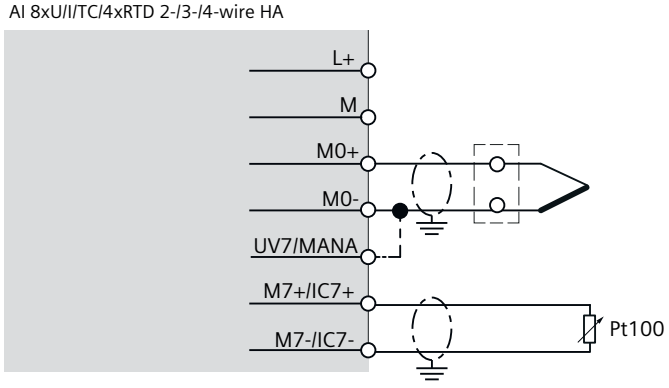
Note

MANA wiring is optional, but recommended for sensitive measurements in noisy environments. Shielding is mandatory and must be grounded on both sides.

5.6 Example of a wiring diagram for TC with external temperature compensation

Example

The figure below shows an example of the connection of a PT100 with a thermocouple for external temperature compensation.



Note

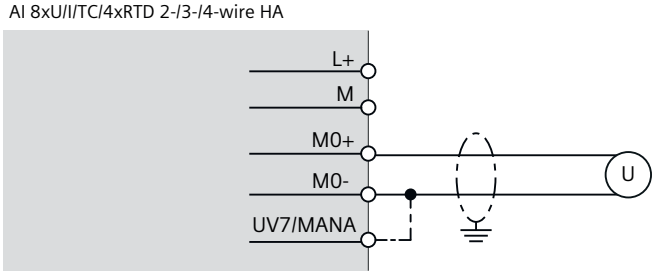
MANA wiring is optional, but recommended for sensitive measurements in noisy environments. Shielding is mandatory and must be grounded on both sides.

5.7 Example of a wiring diagram for voltage

Example

Transducers for voltage measurement can be configured and connected to channel 0...7.

The figure below shows an example of the pin assignment for voltage measurement on channel 0.



Note

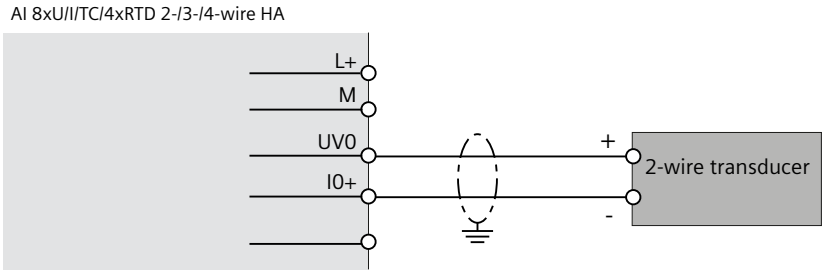
MANA wiring is optional, but recommended for sensitive measurements in noisy environments. Shielding is mandatory and must be grounded on both sides.

5.8 Example of a wiring diagram for current measurement with 2-wire transducer

Example

2-wire transducer for current measurement can be configured and connected to channel 0...7.

The figure below shows an example of current measurement with a 2-wire transducer (TD) on channel 0.



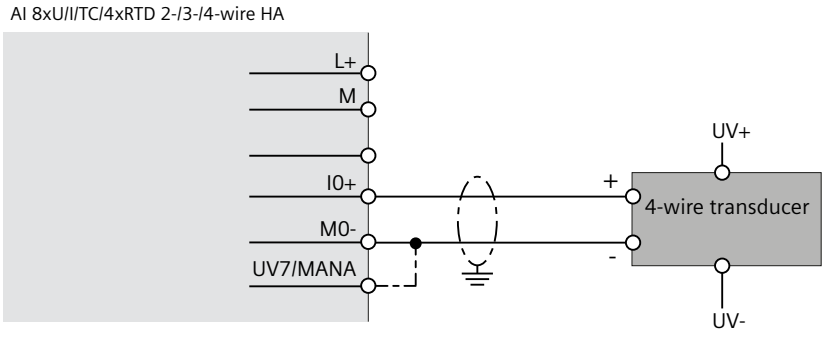
Note

Shielding is recommended for a noisy environment and must be grounded on both sides.

5.9 Example of a wiring diagram for current measurement with 4-wire transducer

Example

The figure below shows an example of current measurement with a 4-wire transducer (TD) on channel 0.



Note

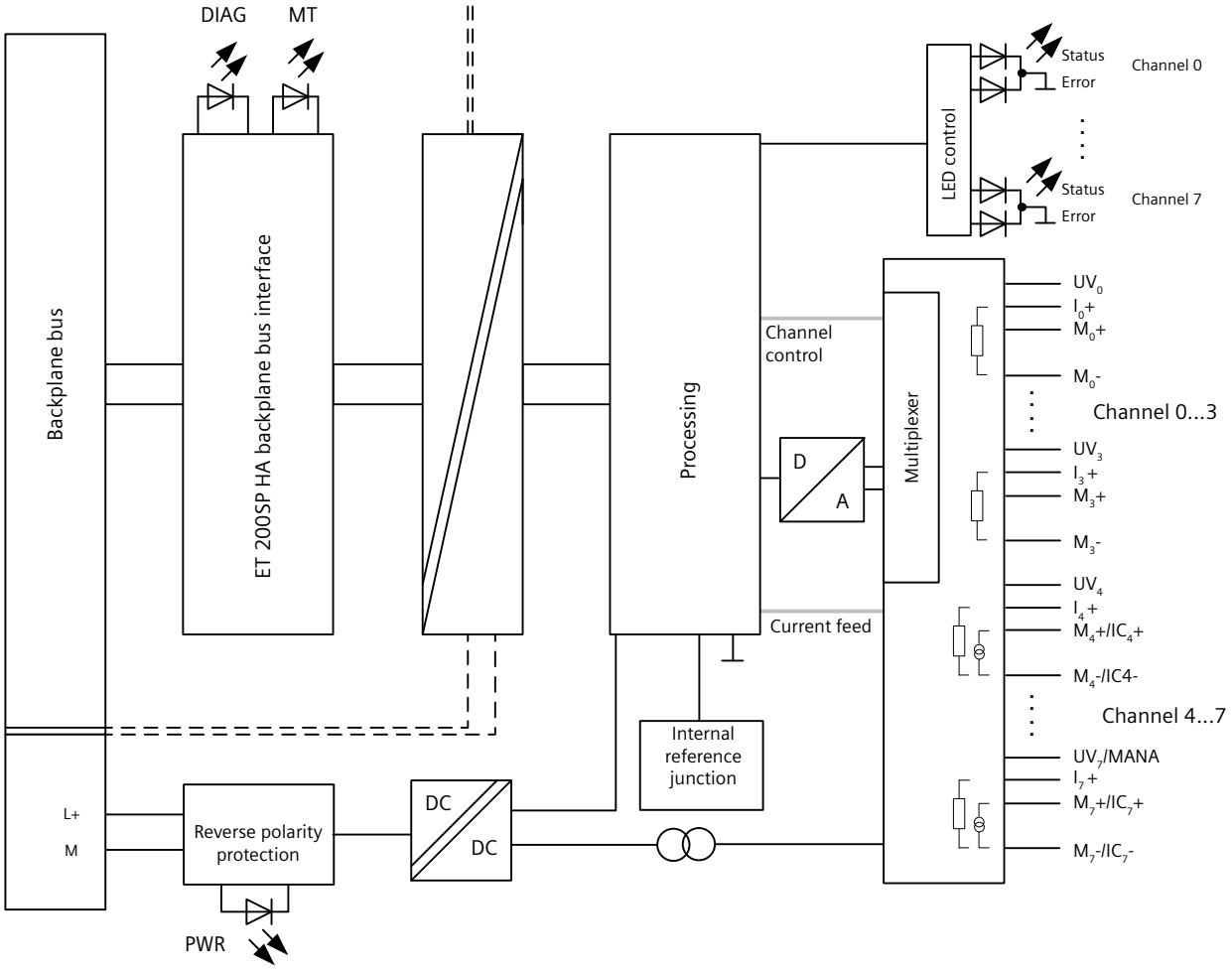
MANA wiring and shielding are optional and recommended for noisy environments. Shielding must be grounded on both sides.

5.10 Schematic circuit diagram

Definition

A block diagram contains the schematic representation of individual function blocks.

Description



Supply voltage L+/M

Connect the supply voltage L+ to the connections L+ and M. An internal protective wiring protects the module against polarity reversal. The I/O module monitors whether the supply voltage L+ is connected and present.

During parameter assignment, you can specify whether a diagnostics message is to be output in the event of failure of the supply voltage.

Firmware update

The supply voltage L+ must be applied to the I/O module at the start of a firmware update and during the firmware update.

Parameters

6

6.1 Parameter types

Definition

You define operation of the I/O module and thereby influence the functions supported by the module via the parameter types.

REAL format and S7 format

The following configurations are possible:

- AI8 with value status (QI bit): Process values in S7 format
- AI8 with value status (QI bit): Process values in REAL format

Comments:

- For configuration in REAL format, process values are provided directly in the corresponding physical unit (base unit, e.g. volt, °C etc.) of the channel by the I/O module.
  The parameter assignment of the measuring range PTC is an exception.
- The hardware interrupt limits that can be adjusted via the parameters are always in S7 format.
- For configuration in S7 format, process values are supplied in 2 bytes of input data (decimal or hexadecimal).

Description

The parameters are subdivided into two types:

- Module/channel parameters (data record 128)
- System parameters (potential group, process value formats)

6.2 Module/channel parameters

Definition

Module/channel parameters are specific parameters whose configuration can affect the entire module or channels.

Description

The following module/channel parameters are available:

Parameters	Value range	Default	Re-parameterization in RUN	Applicability
Diagnostics, Missing supply voltage L+ (Page 28)	• Enabled • Disabled	Enabled	Yes	Module
Pin assignment UV7/ MANA (Page 28)	• Enabled • Disabled	Disabled	No	Module
Diagnostics reference junction (Page 28)	• Enabled • Disabled	Disabled	Yes	Channel
Diagnostics overflow (Page 28)	• Enabled • Disabled	Enabled	Yes	Channel
Diagnostics underflow (Page 28)	• Enabled • Disabled	Enabled	Yes	Channel
Diagnostics short-circuit (Page 29)	• Enabled • Disabled	Enabled	Yes	Channel
Common mode error diagnostics (Page 29)	• Enabled • Disabled	Enabled	Yes	Channel
Diagnostics wire break (Page 29)	• Enabled • Disabled	Enabled	Yes	Channel
Measurement types and measuring ranges (Page 29)	• Disabled • Voltage • Resistor (2-, 3-, 4-wire connection) • Thermal resistor (2-, 3-, 4-wire connection) • Thermocouple • Current (2-, 4-wire transducer)	Voltage	Yes	Channel
Measuring range (for measurement type: Disabled) (Page 29)	-	-	Yes	Channel
Measuring range (for measurement type: Voltage) (Page 29)	• ±50 mV • ±80 mV • ±250 mV • ± 500 mV • ±1 V • ± 2.5 V • ± 5 V • ± 10 V • 1...5 V • 0...10 V	0...10 V	Yes	Channel

Parameters	Value range	Default	Re-parameterization in RUN	Applicability
Measuring range (for measurement type: Resistance) (Page 29)	• 150 Ω • 300 Ω • 600 Ω • 3 kΩ • 6 kΩ • PTC (only for 2-wire connection)	600 Ω	Yes	Channel
Measuring range (for measurement type: Thermal resistor) (Page 29)	• Pt 100 climatic range • Pt 200 climatic range • Pt 500 climatic range • Pt 1000 climatic range • Pt 100 standard range • Pt 200 standard range • Pt 500 standard range • Pt 1000 standard range • Ni 100 climatic range • Ni 120 climatic range • Ni 200 climatic range • Ni 500 climatic range • Ni 1000 climatic range • Ni 100 standard range • Ni 120 standard range • Ni 200 standard range • Ni 500 standard range • Ni 1000 standard range • LG Ni 1000 climatic range • LG Ni 1000 standard range • Cu 10 climatic range (only for 3-wire connection) • Cu 10 standard range (only for 3-wire connection) • Cu 50 climatic range • Cu 50 standard range • Cu 100 climatic range • Cu 100 standard range	Pt 100 standard range	Yes	Channel

Parameters	Value range	Default	Re-parameterization in RUN	Applicability
Measuring range (for measurement type: Thermocouple) (Page 29)	• Type B (PtRh-PtRh) • Type N (NiCrSi-NiSi) • Type E (NiCr-CuNi) • Type R (PtRh-Pt) • Type S (PtRh-Pt) • Type J (Fe-CuNi) • Type L (Fe-CuNi) • Type T (Cu-CuNi) • Type K (NiCr-NiAl) • Type U (Cu-CuNi) • Type C (WRe-WRe) • Type TXK	Type K (NiCr-NiAl)	Yes	Channel
Temperature coefficient (Page 32)	• Pt 0.00385055 • Pt 0.003902 • Pt 0.003910 GOST • Pt 0.003916 • Pt 0.003920 • Pt 0.003850 • Ni 0.00617 GOST • Ni 0.00618 • Ni 0.00672 • LG-Ni 0.005 • Cu 0.00428 GOST • Cu 0.00427	Pt 0.00385055	Yes	Channel
Temperature unit (Page 32)	• Degrees Celsius • Degrees Fahrenheit • Kelvin	Degrees Celsius	Yes	Channel
Reference junction (Page 32)	• Reference channel of the module • Internal reference junction • Reference channel of group 0, 1, 2 or 3 • Fixed reference temperature	Fixed reference temperature	Yes	Channel
Failure monitoring (to NE43) (Page 33)	• Enabled • Disabled	Disabled	Yes	Channel
Smoothing (Page 34)	• None • Weak • Medium • Strong	None	Yes	Channel

Parameters	Value range	Default	Re-parameterization in RUN	Applicability
Interference frequency suppression (Page 35)	• 400 Hz • 60 Hz • 50 Hz • 10 Hz	50 Hz	Yes	Channel
Conductor resistance (Page 35) Only at 2-wire connection	0 to 150 Ω (in 0.01 Ω steps)	0	Yes	Channel
Hardware interrupt high limit 1/2 (Page 35)	• Enabled • Disabled	Disabled	Yes	Channel
Hardware interrupt low limit 1/2 (Page 35)	• Enabled • Disabled	Disabled	Yes	Channel
High limit 1/2 (Page 35)	Value	^{10}1)[1]	Yes	Channel
Low limit 1 / 2 (Page 36)	Value	0[1]	Yes	Channel
Potential group (Page 36)	• Potential group of the left module (dark gray terminal block) • New potential group (light gray terminal block) • No potential group (black terminal block)	Use potential group of the left module	No	Module

1) Value results from the selected measuring range. Standard measuring range is "0...10 V"

Note

Unused channels

"Deactivate" unused analog inputs in the parameter configuration. This improves the cycle time of the module.

A disabled channel provides the "Bad" value status and following value depending on the configured format of the process values:

- Process values in S7 format: **7FFF**$_H$
- Process values in REAL format: **07F800000**$_H$

6.3 Explanation of the module/channel parameters

6.3.1 Pin assignment UV7/MANA

Definition

Selection of the pin assignment UV7/MANA

6.3.2 Diagnostics, Missing supply voltage L+

Definition

Enabling of the diagnostics for missing or insufficient supply voltage L+.

6.3.3 Diagnostics reference junction

Definition

Enable of the diagnostics reference junction. A fault in acquiring the reference temperature is signaled as a diagnostic message of the operated TC channel.

6.3.4 Diagnostics overflow

Definition

Enabling of the diagnostics for overrange.

6.3.5 Diagnostics underflow

Definition

Enable diagnostics for underrange.

6.3.6 Diagnostics short-circuit

Definition

Enabling the short-circuit diagnostics.

6.3.7 Common mode error diagnostics

Definition

Enabling common mode error diagnostics.

If the permissible common mode voltage is exceeded, a diagnostics message is generated.

6.3.8 Diagnostics wire break

Definition

A wire break diagnostics message is output when the module detects a high-impedance connection to the measuring point at the terminals through the test current and the wire break diagnostics is enabled.

Description

You can activate the wire break and underflow diagnostics at the same time. If both diagnostics occur simultaneously, the wire break diagnostics is output.

6.3.9 Measurement types and measuring ranges

Definition

With the "Measurement type" parameter, a channel is disabled or enabled via the "Measurement type".

You can choose between different measuring ranges with an active channel.

Description

The following measuring ranges and temperature coefficients are available for parameter assignment of the respective measurement type:

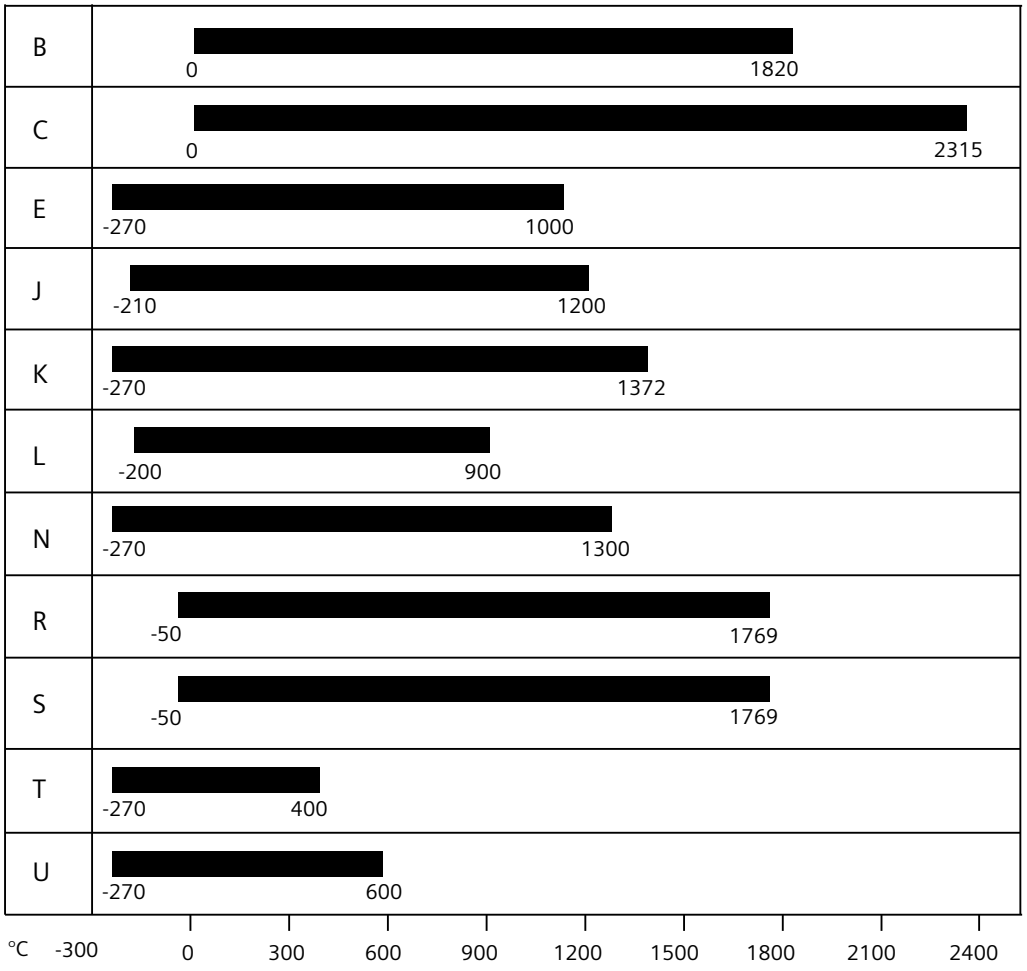
Measurement type	Channel	Measuring range	Temperature coefficient
Disabled	0...7	–	–
Resistor (2-, 3-, 4-wire connection)	4...7	150 Ω / 300 Ω / 600 Ω / 3 kΩ / 6 kΩ	–
Resistor (2-wire connection)	4...7	PTC	–
Thermal resistor RTD (3-wire connection)	4...7	Climatic / Standard Cu 10	Cu 0.00427[1]
Thermal resistor RTD (2, 3, 4-wire connection)	4...7	Climatic / Standard Pt 100 Pt 200 Pt 500 Pt 1000	Pt 0.00385 / Pt 0.003910 GOST / Pt 0.003916 / Pt 0.003902 / Pt 0.00392 / Pt 0.00385055
		Climatic / Standard Ni 100 Ni 120 Ni 200 Ni 500 Ni 1000	Ni 0.00617 GOST / Ni 0.00618 / Ni 0.00672 /
		Climatic[2] / Standard[2] LG-Ni 1000	LG-Ni 0.005
		Climatic / Standard Cu 50 Cu 100	Cu 0.00428 GOST
Thermocouple (TC)	0...7	Type E, N, J, K, L, S, R, B, T, C, U, TXK (acc. to GOST)	
Voltage	0...7	±50 mV ±80 mV ±250 mV ± 500 mV ±1 V ± 2.5 V ± 5 V ± 10 V 1...5 V 0...10 V	
Current	0...7	4...20 mA (2- and 4-wire) +/-20 mA (4-wire) 0...20 mA (4-wire)	-

[1] The preset temperature coefficients are valid for Europe.

[2] For sensors LG-Ni 1000 from Siemens Building Ltd (Landis & Stäfa)

- The measurement types for resistance measurement (R, incl. PTC) and resistance thermal measurement (RTD) are only possible on channels 4...7. If a measurement type with 2-, 3- or 4-wire connection is configured on channel x (x = 4...7), then channel y (y = x-4) must be disabled.
- The "Voltage" or "Current" measurement type is possible on channels 0...7.

The following application areas of thermocouples are available:



See also

Technical specifications (Page 43)

6.3.10 Temperature coefficient

Definition

The temperature coefficient (α value) indicates by how much the resistance of a specific material changes relatively if the temperature increases by 1 °C.

Description

The temperature coefficient depends on the chemical composition of the material.

The other values facilitate a sensor-specific setting of the temperature coefficient and enhance accuracy.

Note

In Europe, only one value is used per sensor type (default value).

6.3.11 Temperature unit

Definition

Selection for chosen measuring range between:

- Degrees Celsius
- Degrees Fahrenheit
- Kelvin

6.3.12 Reference junction

Definition

You can select one of the following options as the reference junction for the TC measurement:

- A terminal block with internal temperature sensors (internal reference junction)
- The reference channel of the group 0, 1, 2, 3.
- The "Reference channel of the module" if the measuring range was configured as "Thermal resistor Pt100 climatic range" and the temperature unit as "Degrees Celsius' for channel 7.
- Fixed reference temperature (0 °C)

Description

A possible parameter assignment is represented below:

Note

The characteristic curves of thermocouples of type B and type C are not defined below 0 °C. For this reason, the reference temperature must never be below 0 °C during operation when using type B and type C. At a reference temperature below 0 °C, a valid process value cannot be determined.

Information on the RTD channel:

Setting	Description
No reference channel mode	Applied temperature value at channel 7 can be used as a module-wide reference value.
Reference channel of group 0, 1, 2, 3	The channel acts as a **transmitter** for the reference junction temperature of a group. The distribution is performed via the interface module. This channel must be configured as "Thermal resistor Pt100 climatic range degrees Celsius" and "Reference channel of group 0,1,2,3". • Not permitted for configuration in REAL format.

Information on the TC channel:

Setting	Description
Reference channel of the module	The corresponding TC channel uses channel 7 of the same module as the reference junction temperature. This must be configured as "Thermal resistance Pt100 climatic range degrees Celsius".
Internal reference junction	The reference junction temperature is read from the internal temperature sensors on the terminal block.
Reference channel of group 0, 1, 2, 3	The channel acts as a **receiver** for the reference junction temperature of a group.
Fixed reference temperature	The reference temperature of the thermocouple is set to 0 °C. As a result, no temperature compensation is performed.

6.3.13 Failure monitoring (to NE43)

Definition

You use this to specify the current limit for detecting the failure of transducers.

- Failure monitoring can be configured for the measuring range 4...20 mA.
- The following range is monitored: 3.8 mA < valid measuring range < 20.5 mA
  - Underflow <= 3.6 mA (hysteresis 0.2 mA)
  - Overflow >= 21 (hysteresis 0.5 mA)

- Within the "Underflow"/"Overflow" ranges, QI=bad and the process values in the overflow at 0x7FFF and in the underflow at 0x8000.
  If diagnostics messages are to be generated when the overflow/underflow range is reached, you can enable the "Underflow" and "Overflow" diagnostics.
- If you additionally enable the "wire break" diagnostics, you will receive the following messages:
  – Instead of the "Underflow" diagnostics, the "Wire break" diagnostics is reported and the process value 0x7FFF appears instead of the process value 0x8000.

6.3.14 Smoothing

Definition

Compensates for measured value fluctuations.

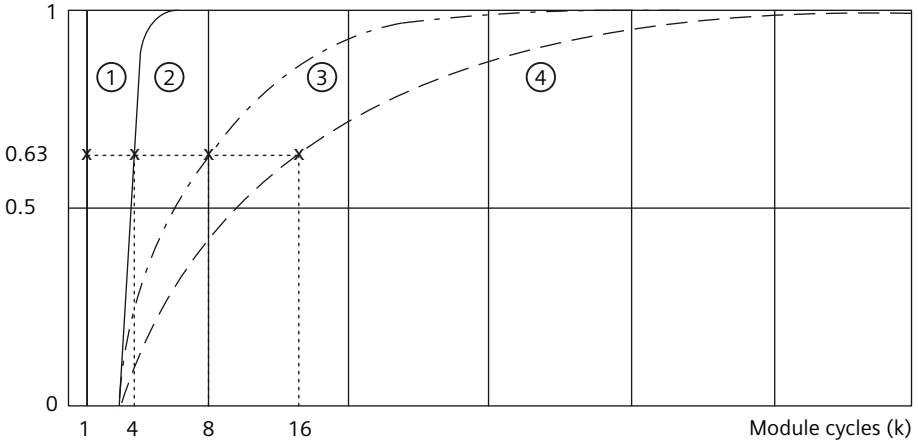
The individual measured values are smoothed by filtering.

Description

Smoothing can be set in 4 levels.

Smoothing time = number of module cycles (k) x cycle time of the module.

The following figure shows how many module cycles it takes for the smoothed analog value to approach 100%, depending on the configured smoothing. This applies to every signal change at the analog input.



① No smoothing (k = 1)
② Weak (k = 4)
③ Medium (k = 8)
④ Strong (k = 16)

6.3.15 Interference frequency suppression

Definition

Suppresses the interference that is caused by the frequency of the alternating voltage network used.

Description

The frequency of the alternating voltage network may negatively affect the measured value, in particular when measuring in the low voltage range and with thermocouples. With this parameter, you specify the line frequency that acts in your system.

6.3.16 Conductor resistance

Definition

Parameters for the measurement types resistor and thermal resistor (2-wire connection).

Used to compensate for the conductor resistance without having to interfere with the sensor wiring.

Description

The conductor resistance can be parameterized in steps of 0.01 Ω.

6.3.17 Hardware interrupt 1 / 2

Definition

A hardware interrupt is enabled if the high limit 1 / 2 is exceeded or low limit 1 / 2 is violated.

6.3.18 High limit 1/2

Definition

Specify a high threshold which triggers a hardware interrupt when violated.

6.3.19 Low limit 1 / 2

Definition

Specify a low threshold which triggers a hardware interrupt when violated.

6.3.20 Potential group

Definition

A potential group consists of a group of directly adjacent I/O modules within an ET 200SP HA station that are supplied via a common supply voltage.

Description

A potential group is built up from left to right by using terminal blocks.

A new potential group starts on the left side with a light gray terminal block, via which the supply voltage for the potential group is fed in.

The potential group is continued to the right with dark gray terminal blocks and ends when a new potential group is built up next to it.

The potential group also ends if there is a black terminal block next to it. Black terminal blocks are fed individually and cannot be included in potential groups.

You can find additional information on the configuration of the potential group in the system manual *SIMATIC; Distributed I/O System; ET 200SP HA*.

6.4 Special features when using measurement types

6.4.1 Special feature of RTD/resistor, 2-wire connection

Definition

For 2-wire connection, the complete line resistance as well as the transfer resistances in the wiring are included in the measurement as a matter of principle. You can compensate this error via the "Line resistance" parameter.

Description

The following procedure is recommended to determine the actual line resistance: In the resistance measurement type (2-wire connection), short-circuit the connections at the sensor end and configure the resistance value determined by the module as the line resistance.

6.4.2 Special features of RTD/resistor, 3-wire connection

Definition

For 3-wire connection, the complete line resistance as well as the transfer resistances in the wiring are included in the measurement as a matter of principle. In the case of a 3-wire connection, two measurements are carried out in which the line and transfer resistances are partially or fully included. The calculation algorithm then automatically compensates for this line resistance.

6.4.3 Special features when using Cu10 sensors

Definition

- The parameter assignment is selected with "Thermal resistor (3-wire connection)" and "Cu10".
- Cu10 sensor must be wired in 3-wire connection system.
- Automatic, internal compensation of the line resistance takes place during operation.

Note

To ensure optimum line compensation with Cu10, please observe the following:

- An accurate measured value is only attained if the cable resistance of the positive constant current line to the Cu10 sensor and the cable resistance of the negative measuring line are identical in value.
- Recommendation: Keep the measuring line as short as possible.
- Different resistance values may also occur due to the connection method used.

6.4.4 Special features of PTC resistors

Definition

PTCs are suitable for monitoring temperature and/or as thermal protection devices of complex drives or transformer windings.

Description

You must note the following features:

- Choose "Thermal resistor (2-wire connection)" and "PTC" in the parameter assignment:
- Connect the PTC to the 2-wire connection system.
- Use the PTC resistors, type A (PTC thermistor) in accordance with DIN/VDE 0660, part 302.

- If "Underflow" diagnostic is enabled, a "Low limit violated" diagnostic is generated for resistance values < 18 Ω, indicating a short-circuit.
- Sensor data for the PTC resistor:

PTC resistors are used as follows:

Property	Technical specifications	Comment	Value (S7 format, REAL format, dec.)
Switching points	**Reaction to rising temperature**		
	< 550 Ω	**Normal range**	0000H, 0000 0000H (+0.0)
	550 Ω to 1650 Ω	**Prewarning range**	0004H, 0004 0000H (+262134.0)
	> 1650 Ω	**Response range**	0001H, 0001 0000H (+65536.0)
	Reaction to falling temperature		
	> 750 Ω	**Response range**	0001H, 0001 0000H (+65536.0)
	750 Ω to 540 Ω	**Prewarning range**	0004H, 0004 0000H (+262134.0)
	< 540 Ω	**Normal range**	0000H, 0000 0000H (+0.0)
	Reaction to short-circuit		
	< 18 Ω	**Short-circuit**	8000H, 8000 0000H (-0.0)
(RRT-5) °C (RRT+5) °C (RRT+15) °C Measuring voltage/ voltage at the PTC	max. 550 Ω min. 1330 Ω min. 4000 Ω max. 7.5 V	TNF = Rated response temperature of the sensor (according to DIN/VDE 0660)	

Note

If the short-circuit and underflow diagnostics are enabled, they are generated in the event of a short-circuit. Irrespective of this, the value status (QI) goes to "bad".

Displays and interrupts

7

7.1 Status and error display

Definition

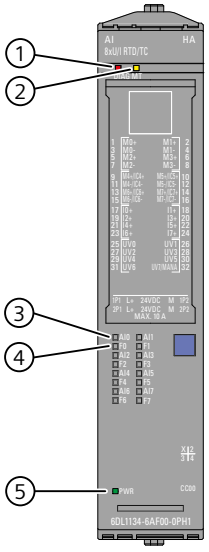
The LED displays are status and error indicators.

Diagnostics messages and maintenance events, as well as their possible causes and solutions, are described in the diagnostics messages and maintenance events.

Drivers, parameters, diagnostics messages and address space (Page 55)

Description

The following figure explains the LED displays of the I/O module.



① DIAG LED (Page 40) (green / red)
② MT LED (Page 40) (yellow)
③ Channel status (Page 41) (green)
④ Channel error (Page 41) (red)
⑤ PWR LED (Page 41) (green)

7.2 LEDs

7.2.1 DIAG LED

Definition

The DIAG LED provides you diagnostic information.

Description

The diagnostic display of the DIAG LED is as follows:

DIAG LED	Meaning
Off	The power supply of the ET 200SP HA is disrupted or switched off.
flashes	Module is not configured.
On	Module parameters are assigned. No diagnostic message is pending.
flashes	Module parameters are assigned. At least one diagnostic message is pending.

7.2.2 MT LED

Definition

The MT LED provides maintenance information.

Description

The MT LED indicates the following maintenance status:

MT LED	Meaning
Off	No maintenance is required.
On	Maintenance is required. At least one maintenance event has occurred.

7.2.3 Channel status / fault LEDs

Definition

The channel status and channel fault LEDs provide you information about the status and faults of the channels.

Description

The channel status and channel fault LEDs indicate the following:

Channel status LED	Channel fault LED	Meaning
□ Off	□ Off	Channel deactivated or module switched off
■ On	□ Off	Channel enabled and no channel/module diagnostics pending.
□ Off	■ On	Channel enabled and channel diagnostics/module diagnostics pending.

7.2.4 PWR LED

Definition

The PWR LED provides you status information about supply voltage L+.

Description

The PWR LED indicates the following status:

PWR LED	Meaning
□ Off	Supply voltage L+ missing.
■ On	Supply voltage L+ present.

7.3 Interrupts

Definition

A diagnostics interrupt is an alarm that reports activated events of a device status to the system operator with the appropriate operating authorization (maintenance and service).

Description

The I/O module generates a diagnostic interrupt at the following events:

- Wire break
- Common mode error
- Short-circuit
- High limit violated
- Low limit violated
- Parameter assignment error
- Supply voltage missing
- Reference channel error
- Hardware interrupt lost
- Channel/component temporarily unavailable
- Module is faulty
- Overtemperature
- Retentive memory in carrier module defective
- Retentive memory in terminal block defective

Note

A pending diagnosis "Module is defective" is not deleted by the module until a restart.

Technical specifications

8

Technical specifications of the AI 8xU/I/TC/4xRTD 2-/3-/4-wire HA

Note

Power supply

The supply and input voltages of the ET200SP HA system must always be generated with voltage/current supplies with safe electrical isolation (SELV/PELV according to IEC/UL61010-2-201) with a rated value of 24 V DC ±20% (⎓).

Article number	6DL1134-6AF00-0PH1
General information	
Product type designation	AI 8xU/I/TC/4xRTD 2/3/4-wire HA
Firmware version	V1.0
• FW update possible	Yes
Usable terminal block	see the system manual
Color code for module-specific color identification plate	CC00
Product function	
• I&M data	Yes; I&M0 to I&M3
Engineering with	
• STEP 7 TIA Portal configurable/integrated from version	V18
• STEP 7 configurable/integrated from version	V5.6
• PCS 7 configurable/integrated from version	V9.1 SP2
• PCS neo can be configured/integrated from version	V4.0
• PROFINET from GSD version/GSD revision	GSDML V2.42 2023.01
Redundancy	
• Redundancy capability	No
CiR - Configuration in RUN	
Reparameterization possible in RUN	Yes
Supply voltage	
Rated value (DC)	24 V
permissible range, lower limit (DC)	19.2 V
permissible range, upper limit (DC)	28.8 V
Reverse polarity protection	Yes
Input current	
Current consumption (rated value)	220 mA
Encoder supply	
24 V encoder supply	
• 24 V	Yes
• Short-circuit protection	Yes; a max. of 1 channel may be operated in short-circuit
• Output current per channel, max.	0.032 A; max. 1 channel
Power loss	
Power loss, typ.	1.95 W
Address area	
Address space per module	
• Address space per module, max.	32 byte; + 2 bytes for QI information
Analog inputs	
Number of analog inputs	
• For current measurement	8

Article number	6DL1134-6AF00-0PH1
• For voltage measurement	8
• For resistance/resistance thermometer measurement	4
• For thermocouple measurement	8
permissible input voltage for voltage input (destruction limit), max.	24 V
permissible input current for current input (destruction limit), max.	40 mA
Constant measurement current for resistance-type transmitter, typ.	1.25 mA
Technical unit for temperature measurement adjustable	Yes; °C/°F/K
Input ranges (rated values), voltages	
• 0 to +10 V	Yes; 15 bit
– Input resistance (0 to 10 V)	100 kΩ
• 1 V to 5 V	Yes; 15 bit
– Input resistance (1 V to 5 V)	100 kΩ
• -1 V to +1 V	Yes; 16 bit incl. sign
– Input resistance (-1 V to +1 V)	10 MΩ
• -10 V to +10 V	Yes; 16 bit incl. sign
– Input resistance (-10 V to +10 V)	100 kΩ
• -2.5 V to +2.5 V	Yes; 16 bit incl. sign
– Input resistance (-2.5 V to +2.5 V)	100 kΩ
• -250 mV to +250 mV	Yes; 16 bit incl. sign
– Input resistance (-250 mV to +250 mV)	10 MΩ
• -5 V to +5 V	Yes; 16 bit incl. sign
– Input resistance (-5 V to +5 V)	100 kΩ
• -50 mV to +50 mV	Yes; 16 bit incl. sign
– Input resistance (-50 mV to +50 mV)	10 MΩ
• -500 mV to +500 mV	Yes; 16 bit incl. sign
– Input resistance (-500 mV to +500 mV)	10 MΩ
• -80 mV to +80 mV	Yes; 16 bit incl. sign
– Input resistance (-80 mV to +80 mV)	10 MΩ
Input ranges (rated values), currents	
• 0 to 20 mA	Yes
– Input resistance (0 to 20 mA)	50 Ω
• -20 mA to +20 mA	Yes
– Input resistance (-20 mA to +20 mA)	50 Ω
• 4 mA to 20 mA	Yes
– Input resistance (4 mA to 20 mA)	50 Ω
Input ranges (rated values), thermocouples	
• Type B	Yes; 16 bit incl. sign
– Input resistance (Type B)	10 MΩ

Article number	6DL1134-6AF00-0PH1
• Type C	Yes; 16 bit incl. sign
– Input resistance (Type C)	10 MΩ
• Type E	Yes; 16 bit incl. sign
– Input resistance (Type E)	10 MΩ
• Type J	Yes; 16 bit incl. sign
– Input resistance (type J)	10 MΩ
• Type K	Yes; 16 bit incl. sign
– Input resistance (Type K)	10 MΩ
• Type L	Yes; 16 bit incl. sign
– Input resistance (Type L)	10 MΩ
• Type N	Yes; 16 bit incl. sign
– Input resistance (Type N)	10 MΩ
• Type R	Yes; 16 bit incl. sign
– Input resistance (Type R)	10 MΩ
• Type S	Yes; 16 bit incl. sign
– Input resistance (Type S)	10 MΩ
• Type T	Yes; 16 bit incl. sign
– Input resistance (Type T)	10 MΩ
• Type U	Yes; 16 bit incl. sign
– Input resistance (Type U)	10 MΩ
• Type TXK/TXK(L) to GOST	Yes; 16 bit incl. sign
– Input resistance (Type TXK/TXK(L) to GOST)	10 MΩ
Input ranges (rated values), resistance thermometer	
• Cu 10	Yes; 16 bit incl. sign
– Input resistance (Cu 10)	10 MΩ
• Cu 50	Yes; 16 bit incl. sign
– Input resistance (Cu 50)	10 MΩ
• Cu 100	Yes; 16 bit incl. sign
– Input resistance (Cu 100)	10 MΩ
• Ni 100	Yes; 16 bit incl. sign
– Input resistance (Ni 100)	10 MΩ
• Ni 1000	Yes; 16 bit incl. sign
– Input resistance (Ni 1000)	10 MΩ
• LG-Ni 1000	Yes; 16 bit incl. sign
– Input resistance (LG-Ni 1000)	10 MΩ
• Ni 120	Yes; 16 bit incl. sign
– Input resistance (Ni 120)	10 MΩ
• Ni 200	Yes; 16 bit incl. sign
– Input resistance (Ni 200)	10 MΩ
• Ni 500	Yes; 16 bit incl. sign

Article number	6DL1134-6AF00-0PH1
– Input resistance (Ni 500)	10 MΩ
• Pt 100	Yes; 16 bit incl. sign
– Input resistance (Pt 100)	10 MΩ
• Pt 1000	Yes; 16 bit incl. sign
– Input resistance (Pt 1000)	10 MΩ
• Pt 200	Yes; 16 bit incl. sign
– Input resistance (Pt 200)	10 MΩ
• Pt 500	Yes; 16 bit incl. sign
– Input resistance (Pt 500)	10 MΩ
Input ranges (rated values), resistors	
• 0 to 150 ohms	Yes; 15 bit
– Input resistance (0 to 150 ohms)	10 MΩ
• 0 to 300 ohms	Yes; 15 bit
– Input resistance (0 to 300 ohms)	10 MΩ
• 0 to 600 ohms	Yes; 15 bit
– Input resistance (0 to 600 ohms)	10 MΩ
• 0 to 3000 ohms	Yes; 15 bit
– Input resistance (0 to 3000 ohms)	10 MΩ
• 0 to 6000 ohms	Yes; 15 bit
– Input resistance (0 to 6000 ohms)	10 MΩ
• PTC	Yes; 15 bit
– Input resistance (PTC)	10 MΩ
Thermocouple (TC)	
Temperature compensation	
– parameterizable	Yes
– external temperature compensation via RTD	Yes
– Reference channel of the module	Yes; channel 7
– internal comparison point	Yes; with terminal block H1
– Reference channel of the group	Yes
– Number of reference channel groups	4
– fixed reference temperature	Yes
Cable length	
• shielded, max.	thermocouples: shielded cable length max. 200 m, voltages: shielded cable length max. 600 m, loop resistance max 8 kOhm; measuring ranges RTD: shielded cable length max. 600 m, cable resistance (single) max. 75 ohm, current measurement: shielded cable length max. 800 m
• unshielded, max.	200 m; Only applies when connecting current sensors
Analog value generation for the inputs	
Measurement principle	integrating (Sigma-Delta)

Article number	6DL1134-6AF00-0PH1
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	16 bit
• Integration time, parameterizable	Yes; Channel-by-channel, results from the selected interference frequency suppression
• Interference voltage suppression for interference frequency f1 in Hz	10 / 50 / 60 / 400 Hz
• Conversion time (per channel)	Channel-by-channel, results from the selected interference frequency suppression
Smoothing of measured values	
• parameterizable	Yes; none, weak, medium, strong, channel-by-channel
Encoder	
Connection of signal encoders	
• for voltage measurement	Yes
• for current measurement as 2-wire transducer	Yes
– Burden of 2-wire transmitter, max.	820 Ω
• for current measurement as 4-wire transducer	Yes
• for resistance measurement with two-wire connection	Yes; all measuring ranges incl. PTC
• for resistance measurement with three-wire connection	Yes; All measuring ranges except PTC; internal compensation of the cable resistances
• for resistance measurement with four-wire connection	Yes; All measuring ranges except PTC
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.01 %; ±0.1 % for resistance thermometers and resistance
Temperature error (relative to input range), (+/-)	0.002 %/K; ±0.005 % / K at thermocouple
Crosstalk between the inputs, min.	50 dB
Repeat accuracy in steady state at 25 °C (relative to input range), (+/-)	0.05 %
Operational error limit in overall temperature range	
• Voltage, relative to input range, (+/-)	0.3 %
• Current, relative to input range, (+/-)	0.3 %
• Resistance, relative to input range, (+/-)	0.3 %
Basic error limit (operational limit at 25 °C)	
• Voltage, relative to input range, (+/-)	0.1 %
• Current, relative to input range, (+/-)	0.1 %
• Resistance, relative to input range, (+/-)	0.1 %
Interference voltage suppression for f = n x (f1 +/- 1 %), f1 = interference frequency	

Article number	6DL1134-6AF00-0PH1
• Series mode interference (peak value of interference < rated value of input range), min.	60 dB
• Common mode voltage, max.	15 V
• Common mode interference, min.	90 dB
Interrupts/diagnostics/status information	
Diagnostics function	Yes
Alarms	
• Diagnostic alarm	Yes
• Limit value alarm	Yes; two upper and two lower limit values in each case
Diagnoses	
• Monitoring the supply voltage	Yes
• Wire-break	Yes; channel-by-channel TC, current 4 ... 20 mA, R and RTD
• Short-circuit	Yes; channel by channel for current (2-wire)
• Overflow/underflow	Yes; channel by channel
Diagnostics indication LED	
• MAINT LED	Yes; Yellow LED
• Monitoring of the supply voltage (PWR-LED)	Yes; green PWR LED
• Channel status display	Yes; green LED
• for channel diagnostics	Yes; red LED
• for module diagnostics	Yes; green/red DIAG LED
Potential separation	
Potential separation channels	
• between the channels	No
• between the channels and backplane bus	Yes
• Between the channels and load voltage L+	Yes
Permissible potential difference	
between the inputs (UCM)	15 V DC/10 V AC
Isolation	
Isolation tested with	1 500 V DC/1 min, type test
Ambient conditions	
Ambient temperature during operation	
• horizontal installation, min.	-40 °C
• horizontal installation, max.	70 °C
• vertical installation, min.	-40 °C
• vertical installation, max.	60 °C
Dimensions	
Width	22.5 mm
Height	115 mm
Depth	138 mm
Weights	
Weight, approx.	150 g

Cycle time

The cycle time describes the time slice in which signals from the inputs are acquired and processed.

The cycle time is the sum of the channel processing times (independent of parameter assignment).

Table 8-1 Processing times in S7 format

Measurement type	Processing time per channel [ms]			
Interference frequency suppression	10 Hz	50 Hz	60 Hz	400 Hz
Disabled	5	5	5	5
Voltage[3]	**360**	**120**	**110**	**60**
Current, 2-wire transducer	**330**	**90**	**80**	**40**
Current 4-wire transducer[3]	**360**	**120**	**110**	**60**
Thermocouple[2],[3]	**370**	**130**	**120**	**80**
Resistor 2-wire PTC[4]	**330**	**90**	**80**	**40**
Resistor, 2-wire	**350**	**110**	**100**	**50**
RTD 2-wire	**350**	**110**	**100**	**60**
Resistor, 3-wire[1]	**710**	**230**	**210**	**130**
RTD 3-wire[1]	**710**	**230**	**210**	**130**
Resistor, 4-wire	**360**	**120**	**110**	**70**
RTD 4-wire	**360**	**120**	**110**	**70**

1) The two measurements of the 3-wire resistance/RTD measuring range take place in one module cycle.

2) The thermocouple measurement includes wire break checks.

3) In these measuring ranges, a common mode error measurement is carried out in advance.

4) The PTC measurement does not include a wire break check.

Note

If the module is configured in "Process values in REAL format", 7% must be added to the total processing time in S7 format!

Example of mixed operation:

- Channel 0: Disabled (occupied by channel 4)
- Channel 1: Thermocouple type K
- Channel 2: 0...10V
- Channel 3: 4...20mA 4-wire transducer
- Channel 4: Resistor, 4-wire (channel 0)
- Channel 5: 4...20mA 2-wire transducer

- Channel 6: Resistor, 2-wire PTC
- Channel 7: RTD 2-wire Pt100 climatic (reference channel of the module)

Each with 50 Hz interference frequency suppression

Cycle time of the module:

In S7 format: 5 + 130 + 120 + 120 + 120 + 90 + 90 + 110 = **785 ms**

In REAL format: 785 ms + 7% = **840 ms**

Operational and basic error limits for resistance thermometers

Error limits for resistance thermometers	
Operational limit (in the entire temperature range, in relation to input range)	Accuracy
• Pt 100, Pt 200, Pt 500, Pt 1000 standard	±2.0 K
• Pt 100, Pt 200, Pt 500, Pt 1000 climatic	± 0.6 K
• Ni 100, Ni 120, Ni 200, Ni 500, Ni 1000 standard and climatic	±0.8 K
• Cu 10	±3.0 K
Basic error limit (operational limit at 25 °C, in relation to input range)	Accuracy
• Pt 100, Pt 200, Pt 500, Pt 1000 standard	±1.0 K
• Pt 100, Pt 200, Pt 500, Pt 1000 climatic	±0.3 K
• Ni 100, Ni 120, Ni 200, Ni 500, Ni 1000 standard and climatic	±0.3 K
• Cu 10	±2.0 K

Operational and basic error limits for thermocouples

Note

This limit does not cover fluctuations in the reference junction temperature.

Operational limit (in the entire temperature range -40...70 °C)			
Thermocouple	Min.	Max.	Accuracy
Type T	-200 °C	+400 °C	±1.2 K
	-230 °C	-200 °C	±3.0 K
Type U	-200 °C	+600 °C	±2.0 K
Type E	-200 °C	+1000 °C	±1.5 K
	-230 °C	-200 °C	±3.0 K
Type J	-150 °C	+1200 °C	±1.5 K
Type L	-150 °C	+900 °C	±2.0 K
Type K	-150 °C	+1372 °C	±1.8 K
	-220 °C	-150 °C	±3.0 K
Type N	-150 °C	+1300 °C	±2.5 K
	-220 °C	-150 °C	±4.0 K

Operational limit (in the entire temperature range -40...70 °C)			
Type R	+100 °C	+1769 °C	±3.0 K
	-50 °C	+100 °C	±5.0 K
Type S	+100 °C	+1769 °C	±3.0 K
	-50 °C	+100 °C	±5.0 K
Type B	+700 °C	+1820 °C	±3.0 K
	+500 °C	+700 °C	±4.0 K
	+200 °C	+500 °C	±8.0 K
Type C	+100 °C	+2315 °C	±5.0 K
Type TxK	-150 °C	+800 °C	±2.0 K
	-200 °C	-150 °C	±3.0 K

Note

This limit does not cover fluctuations in the reference junction temperature.

Basic error limit (operational limit at 25 °C)			
Thermocouple	Min.	Max.	Accuracy
Type T	-200 °C	+400 °C	±0.8 K
	-230 °C	-200 °C	±1.5 K
Type U	-150 °C	+600 °C	±0.8 K
Type E	-200 °C	+1000 °C	±0.8 K
	-230 °C	-200 °C	±2.0 K
Type J	-150 °C	+1200 °C	±0.8 K
Type L	-150 °C	+900 °C	±1.0 K
Type K	-150 °C	+1372 °C	±0.8 K
	-220 °C	-150 °C	±2.0 K
Type N	-150 °C	+1300 °C	±1.5 K
	-220 °C	-150 °C	±2.0 K
Type R	+100 °C	+1769 °C	±1.5 K
	-50 °C	+100 °C	±2.5 K
Type S	+100 °C	+1769 °C	±1.5 K
	-50 °C	+100 °C	±2.0 K
Type B	+700 °C	+1820 °C	±1.5 K
	+500 °C	+700 °C	±2.0 K
	+200 °C	+500 °C	±4.0 K
Type C	+100 °C	+2315 °C	±2.0 K
Type TxK	-150 °C	+800 °C	±1.0 K
	-200 °C	-150 °C	±2.0 K

Accuracy of temperature measurement

The accuracy of the temperature measurement when using internal compensation (terminal temperature) is composed of:

- Error for the analog input of the utilized thermocouple type
- Measuring accuracy for the temperature of the internal reference junction ±1.5 K

The accuracy of temperature measurement when using external compensation, either by means of locally connected thermal resistances or via remote access by way of an external RTD module, is composed of:

- Error for the analog input of the utilized thermocouple type
- Measuring accuracy of the thermal resistance used for compensation
- Error for the compensation input (see operational and basic error limits for resistance thermometers)

Drivers, parameters, diagnostics messages and address space

A

A.1 Parameter assignment

Parameter assignment in the user program

You can reconfigure individual channels of the I/O module in RUN without affecting the other channels.

Changing parameters in RUN

The "WRREC" instruction is used to transfer the parameters to the module using data record 128. In the process the parameters set with STEP 7 are not modified in the CPU, meaning that after a start the parameters set with STEP 7 are valid again.

STATUS output parameter

If errors occur when transferring parameters with the "WRREC" instruction, the module continues operation with the previous parameter assignment. The STATUS output parameter contains a corresponding error code.

The STATUS output parameter is 4 bytes long and is configured as followed:

- Byte1: Function_Num, general error code
- Byte2: Error_Decode, location of the error code
- Byte3: Error_Code_1, error code
- Byte4: Error_Code_2, manufacturer-specific extension of the error code

Module-specific errors are displayed via Error_Decode = 0x80 and Error_Code_1 / Error_Code_2.

Error_ Code_1	Error_ Code_2	Cause	Solution
0xB0	0x00	Number of the data record unknown	Enter valid number for data record.
0xB1	0x01	Length of the data record is incorrect	Enter valid value for data record length.
0xB2	variable	Module cannot be reached	• Check station - is the module plugged in correctly? • Check the parameters of the WRREC instruction.
0xE0	0x01	Incorrect version in header	Correct the version number of the parameter block.
0xE0	0x02	Header error (number or length of parameter block)	Correct the length and number of the parameter blocks.

Error_ Code_1	Error_ Code_2	Cause	Solution
0xE1	0x01	Reserved bit set	Check and correct the parameters
0xE1	0x02	Invalid diagnostics enable bit set for operating mode	
0xE1	0x03	Invalid hardware interrupt enable bit set for operating mode	
0xE1	0x04	Invalid value for hardware interrupt limit	
0xE1	0x08	Invalid coding for interference frequency suppression / integration time	
0xE1	0x09	Invalid coding for smoothing	
0xE1	0x0F	Invalid parameter assignment of the reference temperature (Pt100 climate)	
0x10	0x10	Invalid measurement type / output type (if PARA_DS_ERROR_RANGE is not accurate enough)	
0xE1	0x11	Invalid measuring range / output range (if PARA_DS_ERROR_RANGE is not accurate enough)	
0xE1	0x12	Incompatible TB (module cannot be operated on existing TB)	
0xE1	0x22	Invalid parameter assignment of the reference temperature for configuration in REAL format	

Valid parameters

Only the values specified in the following are permitted. Values that are not listed are rejected by the module.

Every parameter data record is checked by the module. If an incorrect parameter is detected, the entire data record is rejected and the parameters of the module remain unchanged.

A.2 Parameter assignment and structure of the module and channel parameters

Structure of data record 128

Data record 128 has a length of 188 bytes.

It contains module parameters and all channel or technology parameters of the 8 channels; 22 bytes in each case.

The channel and technology parameters are subdivided into parameters that set the actual measured value acquisition and into diagnostics enables.

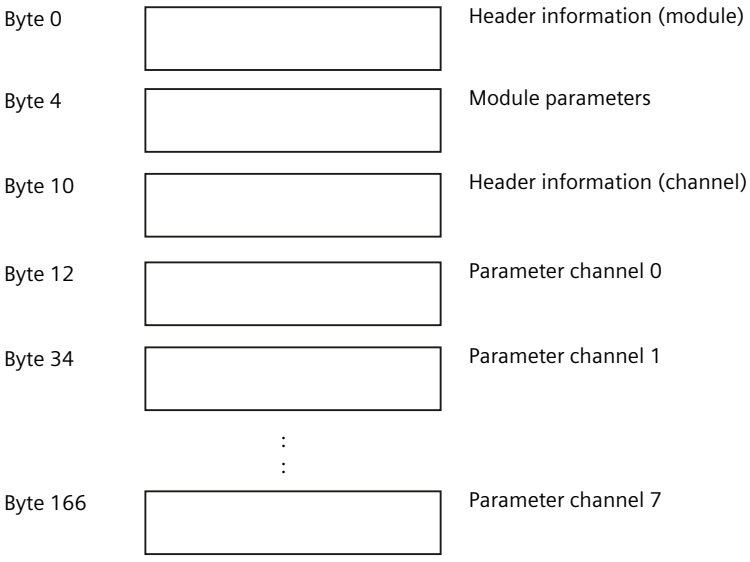


Figure A-1 Structure of data record 128

Header information and module parameters

The following figure shows the structure of the header information and module parameters.

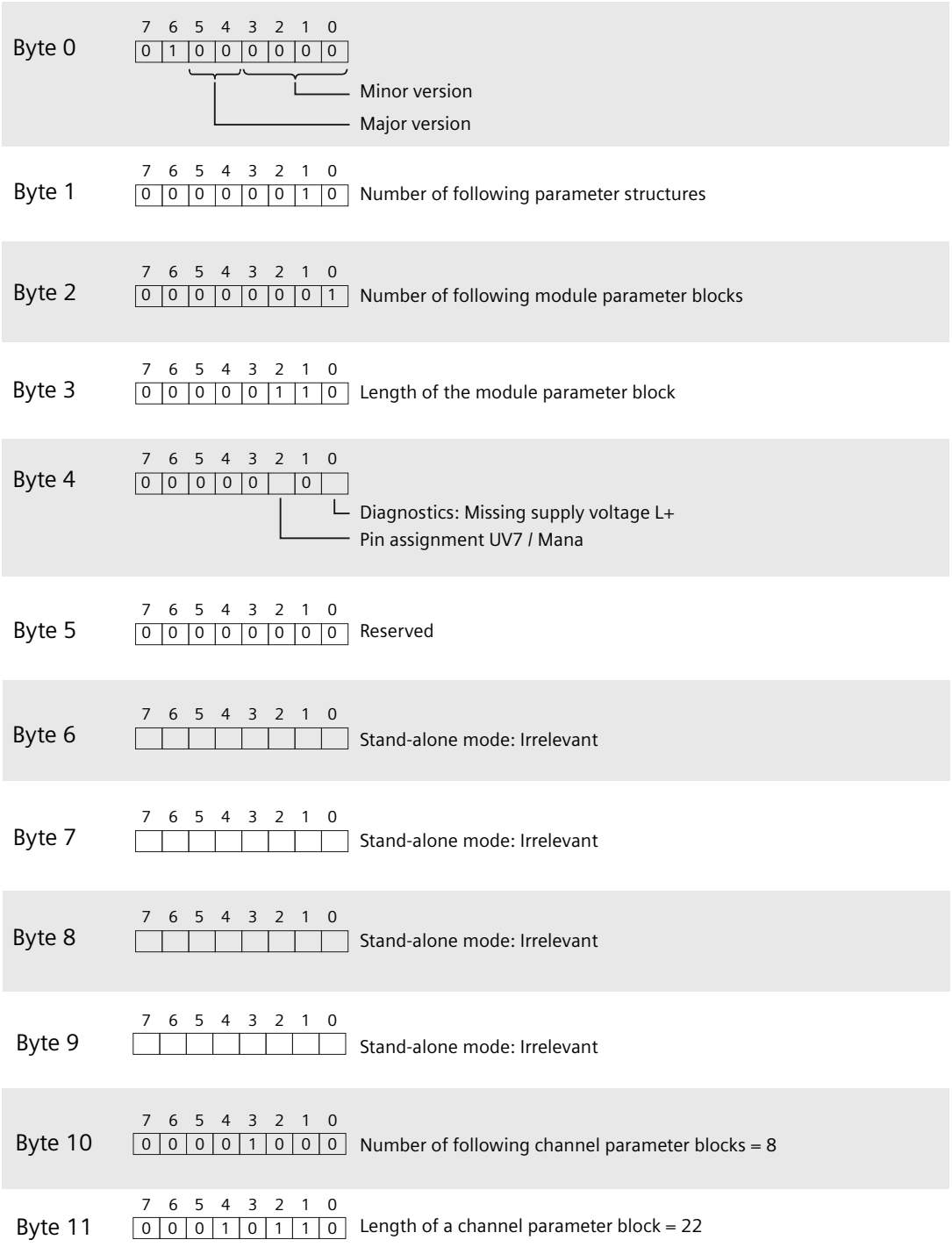


Figure A-2 Header information and module parameters of data record 128

Channel parameters

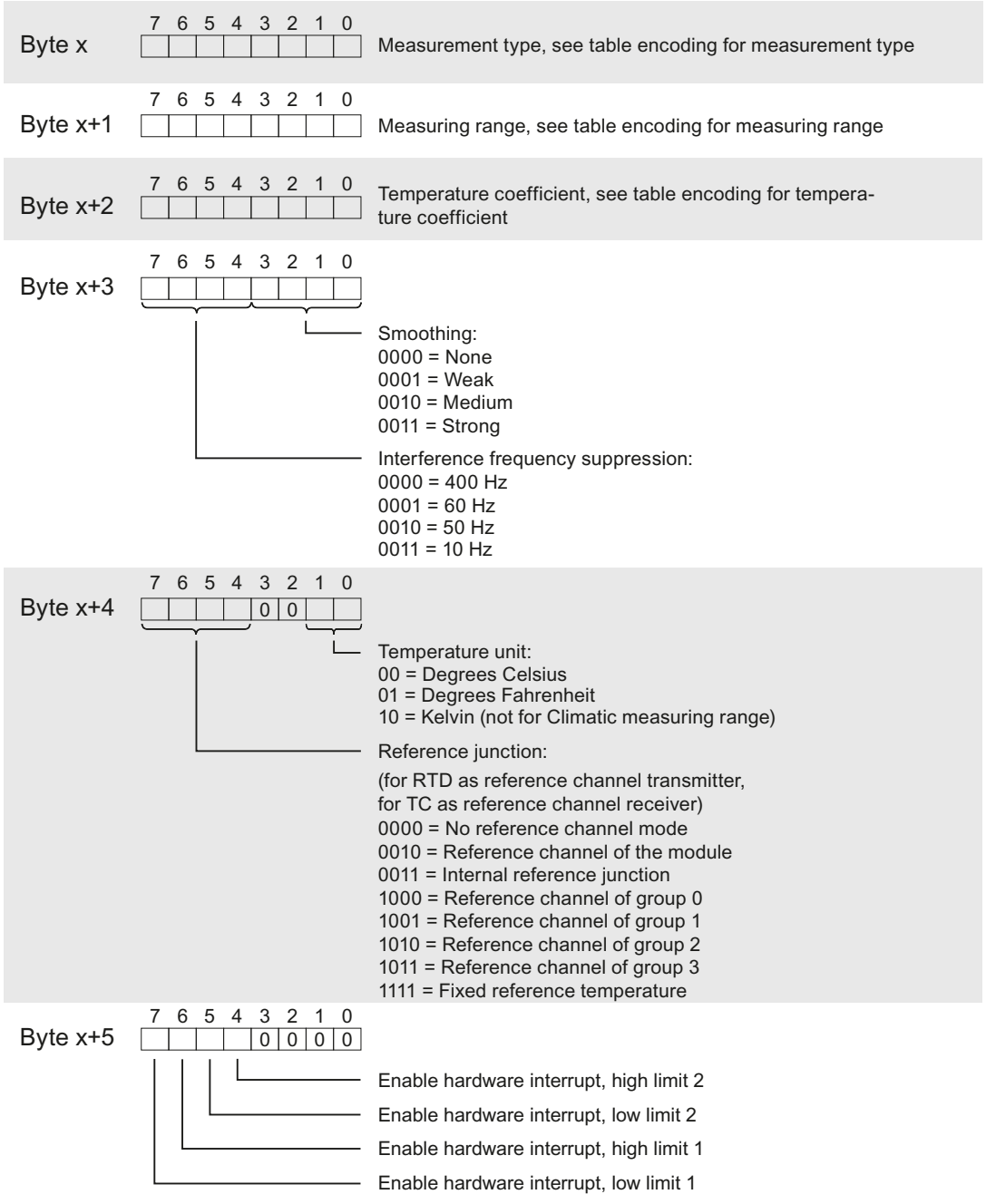
The following figure shows the configuration of the channel parameters for channels 0 to 7.

You activate a channel parameter by setting the corresponding bit to "1".

The figures below show the structure of the channel parameters for channels 0...7.

x = 12 + (channel number * 22); channel number = 0...7

Any unused bits and bits or bytes marked with "reserved" must be set to zero. You activate a channel parameter by setting the corresponding bit to "1" or to the corresponding value.



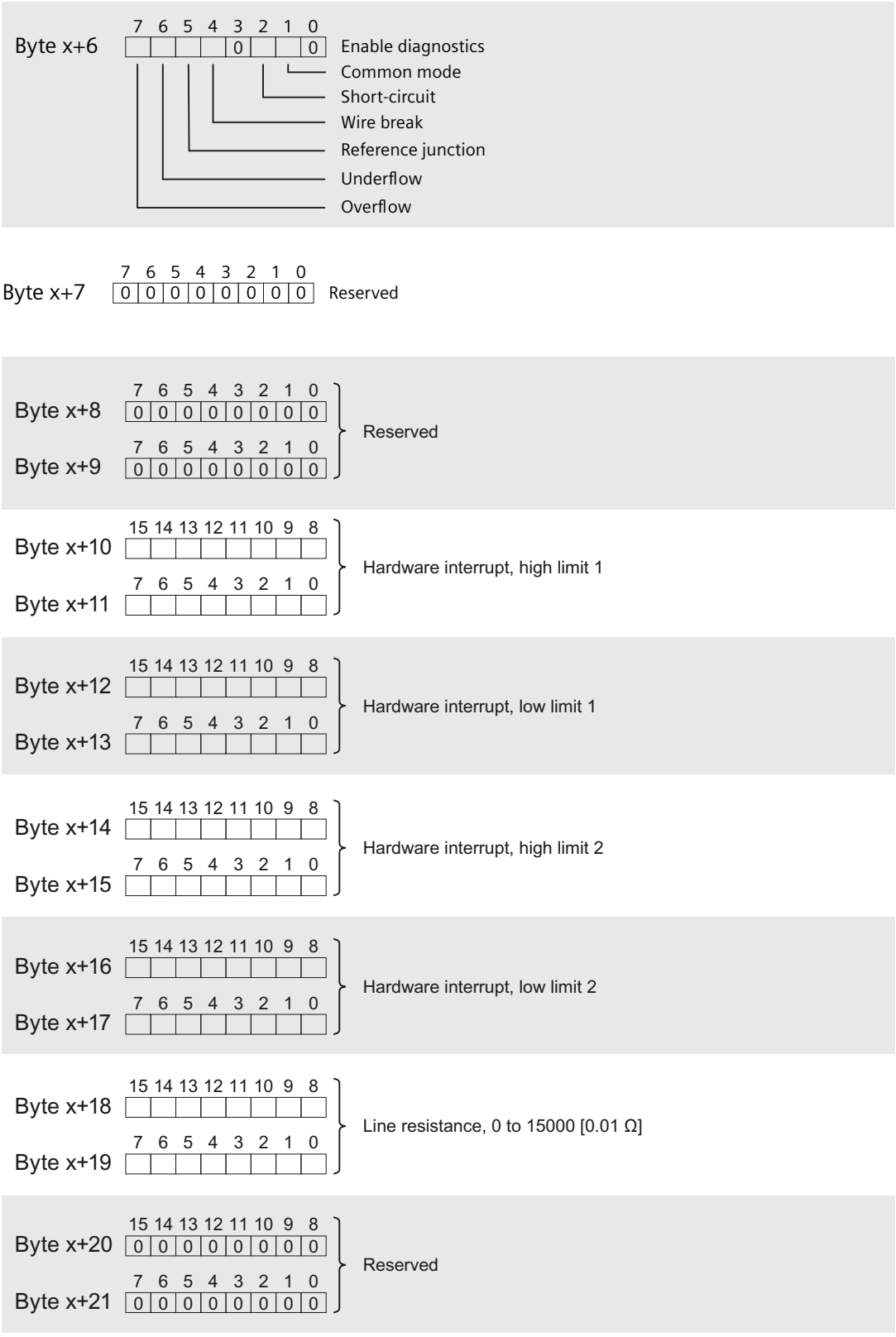


Figure A-3 Structure of byte x to x+21 for channel 0 to 7

Codes for measurement type

The following table contains the codes for the measurement types of the analog input module. You must enter these codes in byte x (see channel parameters).

Table A-1 Codes for measurement type

Measurement type	Code
Disabled	0000 0000
Voltage	0000 0001
Current, 4-wire transducer	0000 0010
Current, 2-wire transducer	0000 0011
Resistor, 4-wire connection	0000 0100
Resistor, 3-wire connection	0000 0101
Resistor, 2-wire connection	0000 0110
Thermal resistor, 4-wire connection	0000 0111
Thermal resistor, 3-wire connection	0000 1000
Thermal resistor, 2-wire connection	0000 1001
Thermocouple	0000 1010

Codes for measuring range

The following table contains the codes for the measuring ranges of the analog input module. You must enter these codes in byte x+1 (see channel parameters).

Table A-2 Codes for measuring range

Measurement type	Measuring range	Code
Current (4-wire transducer)	• 0...20 mA • 4...20mA • +/-20 mA	• 0000 0010 • 0000 0011 • 0000 0100
Current (2-wire transducer)	• 4...20mA	• 0000 0011
Voltage	• +/-50 mV • +/-80 mV • +/-250 mV • +/-500 mV • +/-1 V • +/-2.5 V • +/-5 V • +/-10 V • 1...5 V • 0...10 V	• 0000 0001 • 0000 0010 • 0000 0011 • 0000 0100 • 0000 0101 • 0000 0111 • 0000 1000 • 0000 1001 • 0000 1010 • 0000 1011

Measurement type	Measuring range	Code
Resistor	• 150 Ω • 300 Ω • 600 Ω • 3 kΩ • 6 kΩ • PTC	• 0000 0001 • 0000 0010 • 0000 0011 • 0000 0100 • 0000 0101 • 0000 1111
Thermal resistor climatic	• Pt 100 • Pt 200 • Pt 500 • Pt 1000	• 0000 0000 • 0000 0111 • 0000 1000 • 0000 1001
Thermal resistor standard	• Pt 100 • Pt 200 • Pt 500 • Pt 1000	• 0000 0010 • 0000 1011 • 0000 0100 • 0000 0101
Thermal resistor climatic	• Ni 100 • Ni 120 • Ni 200 • Ni 500 • Ni 1000 • LG-Ni 1000	• 0000 0001 • 0000 1101 • 0001 0001 • 0001 0011 • 0000 1010 • 0001 1101
Thermal resistor standard	• Ni 100 • Ni 120 • Ni 200 • Ni 500 • Ni 1000 • LG-Ni 1000	• 0000 0011 • 0000 1100 • 0001 0000 • 0001 0010 • 0000 0110 • 0001 1100
Thermal resistor climatic	• Cu 10 • Cu 50 • Cu 100	• 0000 1110 • 0001 1001 • 0001 1011

Measurement type	Measuring range	Code
Thermal resistor standard	• Cu 10 • Cu 50 • Cu 100	• 0000 1111 • 0001 1000 • 0001 1010
Thermocouple	• Type B • Type N • Type E • Type R • Type S • Type J • Type L • Type T • Type K • Type U • Type C • Type TXK	• 0000 0000 • 0000 0001 • 0000 0010 • 0000 0011 • 0000 0100 • 0000 0101 • 0000 0110 • 0000 0111 • 0000 1000 • 0000 1001 • 0000 1010 • 0000 1011

Codes for temperature coefficient for temperature measurement

The following table contains the codes for the temperature coefficients of the analog input module. You must enter these codes in byte x+2 (see channel parameters).

Table A-3 Codes for temperature coefficient for temperature measurement

Temperature coefficient	Code
• Pt 0.00385055 • Pt 0.003916 • Pt 0.003910 GOST • Pt 0.003902 • Pt 0.00392 • Pt 0.00385	• 0000 0000 • 0000 0001 • 0000 0101 • 0000 0010 • 0000 0011 • 0000 0100
• Ni 0.00617 GOST • Ni 0.00618 • Ni 0.00672	• 0000 0111 • 0000 1000 • 0000 1001
• LG-Ni 0.005	• 0000 1010
• Cu 0.00427 • Cu 0.00428 GOST	• 0000 1100 • 0000 1101

Limits for hardware interrupts

The following tables contain the permitted limits for hardware interrupts (in each case, the usable value is given). The limits depend on the selected measurement type and the selected measuring range. The value for the overflow must be larger than the value for the underflow.

For the configuration of the module in REAL format the limit values for hardware interrupts are also to be output in S7 format.

Table A-4 Limits for resistor, current and voltage

Resistor	**Current (unipolar)**	**Current**	**Voltage (unipolar)**	**Voltage**	
32510	32510	32510	32510	32510	Overflow
1	-4863	-32511	-4863	-32511	Underflow

Table A-5 Limits for thermocouple types B, C, and E

Thermocouple									
Type B			Type C			Type E			
°C	°F	K	°C	°F	K	°C	°F	K	
20699	32765	23431	24999	32765	27731	11999	21919	14731	Overflow
-1199	-1839	1533	-1199	-1839	1533	-2699	-4539	33	Underflow

Table A-6 Limits for thermocouple types R, S, J, and L

Thermocouple									
Types R, S			Type J			Type L			
°C	°F	K	°C	°F	K	°C	°F	K	
20189	32765	22921	14499	26419	17231	11499	21019	14231	Overflow
-1699	-2739	1033	-2099	-3459	633	-1999	-3279	733	Underflow

Table A-7 Limits for thermocouple types T, K, and U

Thermocouple									
Type T			Type K			Type U			
°C	°F	K	°C	°F	K	°C	°F	K	
5399	10039	8131	16219	29515	18951	8499	15619	11231	Overflow
-2699	-4539	33	-2699	-4539	33	-1999	-3279	733	Underflow

Table A-8 Limits for thermocouple types N and TXK

Thermocouple						
Type N			Type TXK			
°C	°F	K	°C	°F	K	
15499	28219	18231	10499	19219	13231	Overflow
-2699	-4539	33	-1999	-3279	733	Underflow

Table A-9 Limits for thermal resistor

Thermal resistor						
	Standard			Climatic		
	°C	°F	K	°C	°F	
Cu	3119	5935	5851	17999	32765	Overflow
	-2399	-3999	333	-5999	-7599	Underflow
Pt	9999	18319	12731	15499	31099	Overflow
	-2429	-4053	303	-14499	-22899	Underflow
Ni, Ni-LG	2949	5629	5681	29499	32765	Overflow
	-1049	-1569	1683	-10499	-15699	Underflow

A.3 Diagnostics alarms

Diagnostics messages

A diagnostics message is output for every recognized error. The DIAG LED on the module flashes.

There is additionally a channel-specific display of the diagnostics through the corresponding channel fault/channel status LEDs.

The diagnostics messages can, for example, be read from the diagnostic buffer of the CPU.

Diagnostic messages are either assigned to an input for specific channels or assigned to all inputs as a module message. All channels are switched off for diagnostics messages that affect the entire module. Only the corresponding analog input is affected for diagnostics messages that relate to individual channels.

Table A-10 Diagnostics messages, their meaning and how to deal with them

Diagnostics message	**Error code**	**Assignment**	**Meaning**	**Solution**
Channel/component temporarily unavailable	$1F_H$	Channel	Firmware being updated. The module does not carry out any measurements during this period.	• Restart firmware update • Wait for firmware update
Wire break	6_H	Channel	• Impedance of encoder circuitry is too high • Wire break between the module and sensor • Channel not connected (open)	• Use another type of encoder or wiring, for example, use conductors with a larger cross-section • Connect the cable • Disable diagnostics • Connect the encoder contacts
Common mode error	118_H	Channel	Permitted common mode voltage exceeded	• Check wiring, e.g. use grounding of the sensors, equipotential bonding cables. • Use ground terminal MANA (see section Terminal (Page 15)).

Diagnostics message	Error code	Assignment	Meaning	Solution
Overflow [1]	7_H	Channel	• The analog value is above the overrange • Wire break	• Correct the module/encoder tuning • Check the wiring
Underflow [1]	8_H	Channel	The analog value lies below the underrange	Correct the module/encoder tuning
Parameter assignment error	10_H	Module	• Parameter assignment does not match the terminal block used • Incorrect parameter assignment	• Correct the parameter assignment • Check terminal block
Supply voltage missing	11_H	Module	Missing or insufficient supply voltage L+	• Check wiring of the supply voltage L+ on the terminal block • Check the terminal block type
Reference channel error (reference junction)	15_H	Channel	Reference temperature of the reference junction for the operated TC channel with compensation is invalid	• Check the terminal block type • Check whether the reference junction parameters are correctly assigned • Check whether the reference junction (reference channel of group 0, 1, 2, 3) has been assigned exactly once in each case as a sender for the ET 200SP HA [2] • Check whether the sender of the reference junction (reference channel of group 0, 1, 2, 3) is operating error-free • When using a Type B or Type C thermocouple, the reference temperature must not be less than 0 degrees Celsius
Hardware interrupt lost	16_H	Module	Error is reported because the events occur faster than they can be processed in the system	
Module is faulty	100_H	Module	Internal module error has occurred	Replace module
Retentive memory in carrier module defective	154_H	Module	An error of the memory block on the carrier module was detected during startup	Replace carrier module
Retentive memory in the terminal block defective	155_H	Module	An error of the memory block on the terminal block was detected during startup	Replace terminal block

[1] For resistance and thermal resistance measuring ranges, the "Overflow" diagnostics is signaled at a wire break when "Wire break" diagnostics is disabled.

[2] Shared Device and "Reference temperature" diagnostics: If sender and receiver for the reference junction temperature of a group are assigned to different IO controllers, both configurations may have to be reloaded in case of a diagnostic event. First, download the configuration that contains the receiver.

A.4 Maintenance events

Maintenance events

When a maintenance requirement is determined, a maintenance event is generated. The MT LED lights up on the module.

Maintenance messages are assigned to all inputs as a module message.

Maintenance messages have no direct effect on the function of the module or the analog value acquisition.

Table A-11 Maintenance messages, their meaning and possible remedies

Maintenance message	Error code	Assignment	Meaning / Cause	Solution
Retentive memory in carrier module defective	154_H	Module	Fault detected in the data block on the carrier module during operation	Replace carrier module
Retentive memory in the terminal block defective	155_H	Module	An error in the memory module on the terminal block was recognized during operation	Replace terminal block
Overtemperature	418_H	Module	The maximum permitted temperature has been exceeded. In addition to an excessive ambient temperature, an overload of the encoder supplies (UV0-7), e.g. by a permanent short circuit, may be the cause.	Check the ambient conditions. Operate the module in the specified range. Also remove an overload of the transducer supplies (UV0-7).

A.5 Hardware interrupts

Hardware interrupts

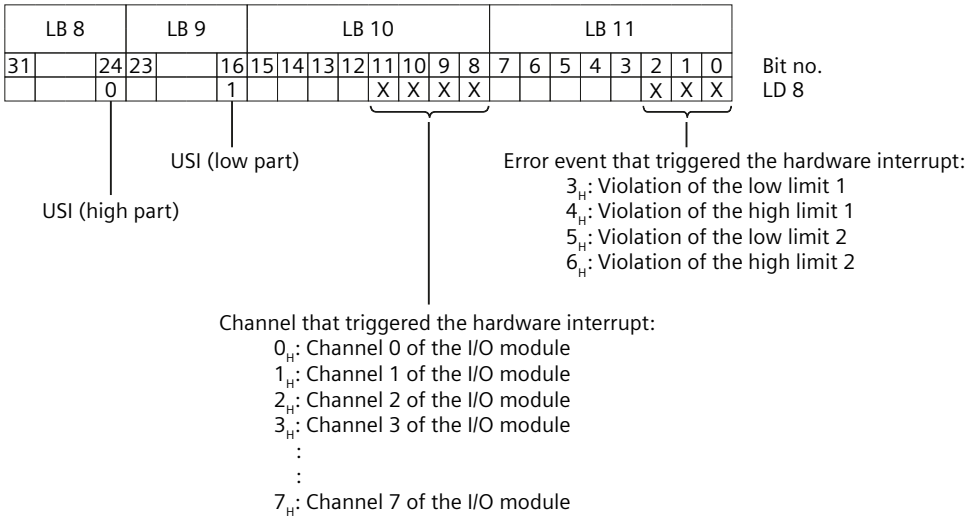
The AI 8xU/I/TC/4xRTD 2-/3-/4-wire HA generates a hardware interrupt at the following events:

- Violation of the low limit 1
- Violation of the high limit 1
- Violation of the low limit 2
- Violation of the high limit 2

Interrupt OBs are called automatically if an interrupt occurs.

The channel of the AI 8xU/I/TC/4xRTD 2-/3-/4-wire HA that has triggered the hardware interrupt is entered in the start information of the OB 40 in the variable OB40_POINT_ADDR. The following figure shows the assignment to the bits of the local data double word 8.

You can find detailed information on the event in the hardware interrupt organization block with the "RALRM" instruction (read additional interrupt information).



A.6 Address space

Abbreviations

- "IB" stands for input byte, that is, the module start address in the input area
- "QAIn" stands for value status (QI) of analog input n

Evaluating the value status

One bit value status each exists for each analog input in the input address space.

Irrespective of the diagnostics enables, each value status (each QI bit) provides information on the validity of the corresponding process value.

- Value status = 1: Process value okay, "good"
- Value status = 0: Process value not okay, "bad"

Basically, the value status is set to "good" when the analog value can be acquired without error. The value status is set to "bad" in the following cases:

- The analog value cannot be acquired to a fault or error.
- The analog input is disabled.

Address space

The following tables show the allocation of the address space of the AI 8xU/I/TC/4xRTD 2-/3-/4-wire HA.

Input area (configuration of process values in S7 format)

IB x +	7	6	5	4	3	2	1	0
0 to 1	Analog value, analog input 0							
: :								
14...15	Analog value, analog input 7							
16	QAI7	QAI6	QAI5	QAI4	QAI3	QAI2	QAI1	QAI0

Input area (configuration of process values in REAL format)

IB x +	7	6	5	4	3	2	1	0
0 to 3	Analog value, analog input 0							
: :								
28...31	Analog value, analog input 7							
32	QAI7	QAI6	QAI5	QAI4	QAI3	QAI2	QAI1	QAI0

Input range when using PTC resistors

For resistance measurement (2-wire connection) PTC, the process values (process state and process error) are provided in stead of the analog value.

- If the module is configured in S7 format: 2 bytes per channel
  - IB x: Process error
  - IB x+1: Process state
- If the module is configured in REAL format: Additional 2 bytes with fixed value = 0.
  - IB x+2: Value = 0
  - IB x+3: Value = 0

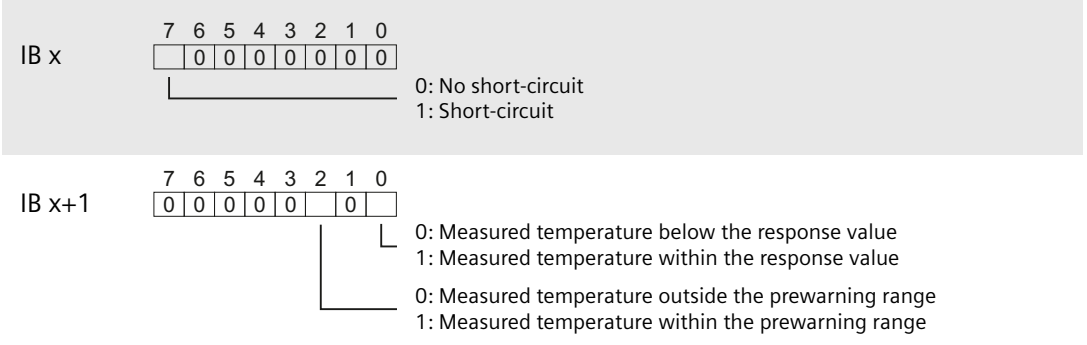


Figure A-4 Allocation of input range when using PTC resistors

Note

Process image inputs

Observe the following during programming:

- Input byte IB x (process error); bit 7 indicates a short-circuit.
- Input byte IB x+1 (process state) only bits 0 and bit 2 are relevant for the evaluation.
  These bits can be used to monitor the temperature of a motor, for example.
  The following is valid for the bits of the process state:
  - The bits can never be set simultaneously, but rather are set one after the other.
  - The bits of the process state are not latching.
    Take this into account in the parameter assignment, for example, by providing a check for the motor startup (via an acknowledgment).

NOTICE

No measurement is possible in the following cases:

- When I/O modules are removed
- When the supply voltage of the I/O module has failed
- Following a wire break or short circuit of the measuring lines
- For resistance values < 18 Ω, the corresponding channels (IB x/IB x+1) signal a short-circuit.
  In case of errors (such as "No supply voltage L+") in which measured value acquisition with PTC resistors is not possible, the corresponding channels signal an overflow.
  In both cases, the corresponding QI bit is set to "bad" (=0).

For this reason, always evaluate the diagnostic entries of the I/O module.

Analog value display

B

B.1 Analog value display

This appendix specifies the analog values for all the measuring ranges of the I/O module.

REAL format

The analog values can be supplied in REAL format (floating point number).

When configuring the I/O module in REAL format, each channel occupies 32 bits for the analog value in the input area. The bits are distributed as follows:

Sign	Exponent	Significand
Bit 31	Bit 30 to 22	Bit 21 to 0

Detailed information for representation of floating-point numbers in the simple, exact IEEE format can be found in the IEEE standard 754.

Process value "Overflow" or process value "Underflow"

For certain events, as in the case of errors for example, the process value "Overflow" or "Underflow" is output:

Process value displayed depending on the configuration of the module		Signaled event
Configuration of the module in S7 format	Configuration of the module in REAL format	
$07FFF_H$	$07F800000_H$	Overflow
08000_H	$0FF800000_H$	Underflow

B.2 Representation of analog values in voltage measuring ranges

The subsequent tables list the decimal and hexadecimal values (codes) of the possible voltage measuring ranges:

Note

Values when configuring the module for use with REAL format

For configuration of the module in REAL format, all voltage values are provided in the base unit "Volt".

Note

Note the representation in case of errors, underflow and overflow in section "Analog value display (Page 71)".

Table B-1 Voltage measuring ranges ±500 mV, ±250 mV, ±80 mV and ±50 mV

Values in S7 format		**Voltage measuring range**				**Range**
Dec.	**Hex.**	**±500 mV**	**+/-250 mV**	**+/-80 mV**	**+/-50 mV**	
32767	7FFF	>587.9 mV	> 294.0 mV	> 94.1 mV	> 58.8 mV	Overflow
32511	7EFF	587.9 mV	294.0 mV	94.1 mV	58.8 mV	Overrange
27649	6C01					
27648	6C00	500 mV	250 mV	80 mV	50 mV	Nominal range
20736	6100	375 mV	187.5 mV	60 mV	37.5 mV	
1	1	18.08 µV	9.04 µV	2.89 µV	1.81 µV	
0	0	0 mV	0 V	0 mV	0 mV	
-1	FFFF		-9.04 µV	-2.89 µV	-1.81 µV	
-20736	AF00	-375 mV	-187.5 mV	-60 mV	-37.5 mV	
-27648	9400	-500 mV	-250 mV	-80 mV	-50 mV	
-27649	93FF					Underrange
-32512	8100	-587.9 mV	-294.0 mV	-94.1 mV	-58.8 mV	
-32768	8000	<-587.9 mV	< -294.0 mV	< -94.1 mV	< -58.8 mV	Underflow

Table B-2 Voltage measuring ranges ±10 V, ±5 V, ±2.5 V, ±1 V,

Values		**Voltage measuring range**				**Range**
Dec.	**Hex.**	**±10 V**	**±5 V**	**±2.5 V**	**±1 V**	
32767	7FFF	>11.759 V	>5.879 V	>2.940 V	> 1.176 V	Overflow
32511	7EFF	11.759 V	5.879 V	2.940 V	1.176 V	Overrange
27649	6C01					
27648	6C00	10 V	5 V	2.5 V	1 V	Nominal range
20736	5100	7.5 V	3.75 V	1.875 V	0.75 V	
1	1	361.7 µV	180.8 µV	90.4 µV	36.17 µV	
0	0	0 V	0 V	0 V	0 V	
-1	FFFF					
-20736	AF00	-7.5 V	-3.75 V	-1.875 V	-0.75 V	
-27648	9400	-10 V	-5 V	-2.5 V	-1 V	
-27649	93FF					Underrange
-32512	8100	-11.759 V	-5.879 V	-2.940 V	-1.176 V	
-32768	8000	<-11.759 V	<-5.879 V	<-2.940 V	<-1.176 V	Underflow

Table B-3 Voltage measuring ranges 1...5 V and 0...10 V

Values		Voltage measuring range		Range
Dec.	**Hex.**	**1...5 V**	**0...10 V**	
32767	7FFF	>5.704 V	> 11.759 V	Overflow
32511	7EFF	5.704 V	11.759 V	Overrange
27649	6C01			
27648	6C00	5 V	10 V	Nominal range
20736	5100	4 V	7.5 V	
1	1	1 V + 144.7 µV	361.7 µV	
0	0	1 V	0 V	
-1	FFFF			Underrange
-4864	ED00	0.296 V	-1.759 V	
-32768	8000	< 0.296 V	< -1.759 V	Underflow

B.3 Analog value display in the current measuring range +/- 20 mA

The following tables list the decimal and hexadecimal values (codes) of the possible current measuring ranges.

Table B-4 Current measuring range ±20 mA

Values		Current measuring range	
Dec.	**Hex.**	**±20 mA**	
32767	7FFF	>23.52 mA	Overflow
32511	7EFF	23.52 mA	Overrange
27649	6C01		
27648	6C00	20 mA	Nominal range
20736	5100	15 mA	
1	1	723.4 nA	
0	0	0 mA	
-1	FFFF		
-20736	AF00	-15 mA	
-27648	9400	-20 mA	
-27649	93FF		Underrange
-32512	8100	-23.52 mA	
-32768	8000	<-23.52 mA	Underflow

Note

Values when configuring the module for use with REAL format

For configuration of the module in REAL format, all current values are provided in the base unit "Ampere".

B.4 Analog value display in the current measuring range 0...20 mA and 4...20 mA

Table B-5 Current measuring ranges 0 to 20 mA and 4 to 20 mA

Values		**Current measuring range**		
Dec.	**Hex.**	**0 to 20 mA**	**4 to 20 mA**	
32767	7FFF	>23.52 mA	>22.81 mA	Overflow
32511	7EFF	23.52 mA	22.81 mA	Overrange
27649	6C01			
27648	6C00	20 mA	20 mA	Nominal range
20736	5100	15 mA	16 mA	
1	1	723.4 nA	4 mA + 578.7 nA	
0	0	0 mA	4 mA	
-1	FFFF			Underrange
-4864	ED00	-3.52 mA	1.185 mA	
-32768	8000	<- 3.52 mA	< 1.185 mA	Underflow

Note

Values when configuring the module for use with REAL format

For configuration of the module in REAL format, all current values are provided in the base unit "Ampere".

B.5 Analog value display in current measuring range 4...20 mA (according to NE43)

Table B-6 Display / current measuring range with failure monitoring according to NE43 (current measuring range 4 to 20 mA)

Values		**NE43**			
hex	mA	Ranges		QI	Interrupt
		Overflow range (upper failure range)	7FFF	bad	Overflow
7EFF	22.81				
72C0	21				
		Hysteresis [1)]			
6F60	20.5				

Values		**NE43**			
		Measuring range	Process values	good	
6C00	20				
0	4				
FFFF	3.9994				
FEA6	3.8	Hysteresis [2]			
FD4D	3.6	Underflow range (lower failure range)	8000	bad	Underflow
ED00	1.185				

[1] Hysteresis at the upper end of the measuring range (detection "Overflow/nominal range"):

- The analog value is invalid as of 21 mA.
- The analog value becomes valid again when it falls below the value 20.5 mA.

[2] Hysteresis at the lower end of the measuring range (detection "Underflow/nominal range"):

- The analog value is invalid as of 3.6 mA.
- The analog value becomes valid again when it rises above the value 3.8 mA.

Note

If wire break diagnostics is enabled, a wire break with process value 0x7FFF is reported in the underflow area.

Note

Values when configuring the module for use with REAL format

For configuration of the module in REAL format, all current values are provided in the base unit "Ampere".

B.6 Representation of analog values for resistance-type sensors

The following tables list the decimal and hexadecimal values (codes) of the possible resistance measuring ranges.

Note

Values when configuring the module for use with REAL format

For configuration of the module in REAL format, all resistance values are provided in the base unit "Ohm".

Note

Note the representation in case of errors, underflow and overflow in section "Analog value display (Page 71)".

Table B-7 Resistance-type sensors from 150 Ω to 6000 Ω

Values in S7 format		Resistance measuring range					Range
Dec.	**Hex.**	**150 Ω**	**300 Ω**	**600 Ω**	**3000 Ω**	**6000 Ω**	
32767	7FFF	> 176.38 Ω	> 352.77 Ω	> 705.53 Ω	> 3527.7 Ω	> 7055.3 Ω	Overflow
32511	7EFF	176.38 Ω	352.77 Ω	705.53 Ω	3527.7 Ω	7055.3 Ω	Overrange
27649	6C01						
27648	6C00	150 Ω	300 Ω	600 Ω	3000 Ω	6000 Ω	Nominal range
20736	5100	112.5 Ω	225 Ω	450 Ω	2250 Ω	4500 Ω	
1	1	5.43 mΩ	10.85 mΩ	21.70 mΩ	108.5 mΩ	217 mΩ	
0	0	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω	
-32768	8000	(negative values are physically impossible)					Underflow[1)]

[1)] In the case of faulty connection of the resistors or line resistances that are parameterized too high (for example at different resistance values of the three connection conductors at the 3-wire connection)

B.7 Representation of analog values for thermal resistors

The tables below list the decimal and hexadecimal values (codes) of the thermal resistors.

Note

Values when configuring the module for use with REAL format

For configuration of the module in the REAL format, all temperature values, both for the "Standard" and the "Climatic" parameter assignment, are provided in one of the following base units:

- Degrees Celsius
- Degrees Fahrenheit
- Kelvin

Note

Note the representation in case of errors, underflow and overflow in section "Analog value display (Page 71)".

Table B-8 Thermal resistor Pt 100, 200, 500, 1000 standard for temperature coefficient: (incl. 0.003910 GOST)

Pt x00 standard in °C [1]	Values in S7 format		Pt x00 standard in °F [1]	Values in S7 format		Pt x00 standard in K [1]	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1000.0	32767	7FFF	> 1832.0	32767	7FFF	> 1273.2	32767	7FFF	Overflow
1000.0	10000	2710	1832.0	18320	4790	1273.2	12732	31BC	Overrange
:	:	:	:	:	:	:	:	:	
850.1	8501	2135	1562.1	15621	3D05	1123.3	11233	2BE1	
850.0	8500	2134	1562.0	15620	3D04	1123.2	11232	2BE0	Nominal range
:	:	:	:	:	:	:	:	:	
-200.0	-2000	F830	-328.0	-3280	F330	73.2	732	2DC	
-200.1	-2001	F82F	-328.1	-3281	F32F	73.1	731	2DB	Underrange
:	:	:	:	:	:	:	:	:	
-243.0	-2430	F682	-405.4	-4054	F02A	30.2	302	12E	
< -243.0	-32768	8000	< -405.4	-32768	8000	< 30.2	32768	8000	Underflow

[1] Depending on the base unit (degrees Celsius: 1 digit = 0.1°C; degrees Fahrenheit: 1 digit = 0.1°F; Kelvin: 1 digit = 0.1 K)

Table B-9 Thermal resistor Pt 100, 200, 500, 1000 climatic for temperature coefficient: (incl. 0.003910 GOST)

Pt x00 climatic °C [1]	Values in S7 format		Pt x00 climatic in °F [1]	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.	
> 155.00	32767	7FFF	> 311.00	32767	7FFF	Overflow
155.00	15500	3C8C	311.00	31100	797C	Overrange
:	:	:	:	:	:	
130.01	13001	32C9	266.01	26601	67E9	
130.00	13000	32C8	266.00	26600	67E8	Nominal range
:	:	:	:	:	:	
-120.00	-12000	D120	-184.00	-18400	B820	
-120.01	-12001	D11F	-184.01	-18401	B81F	Underrange
:	:	:	:	:	:	
-145.00	-14500	C75C	-229.00	-22900	A68C	
< -145.00	-32768	8000	< -229.00	-32768	8000	Underflow

[1] Depending on the base unit (degrees Celsius: 1 digit = 0.01°C; degrees Fahrenheit: 1 digit = 0.01 °F)

Table B-10 Thermal resistor Ni 100, 120, 200, 500, 1000, LG-Ni 1000 standard

Ni x00, 120, 1000 standard in °C [1]	Values in S7 format		Ni x00, +120, 1000 standard in °F [1]	Values in S7 format		Ni x00, 120, 1000 standard in K [1]	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 210.00	32767	7FFF	> 410.00	32767	7FFF	> 483.2	32767	7FFF	Overflow
210 : 180.01	21000 : 18001	5208 : 4651	410.00 : 356.01	32766 : 28001	7FFE : 6D61	483.2 : 453.3	4832 : 4533	12E0 : 11B5	Overrange
180.00 : -60.00	18000 : -6000	4650 : E890	356 : -76	28000 : -7600	6D60 : E250	453.2 : 213.2	4532 : 2132	11B4 : 854	Nominal range
-60.01 : -105	-6001 : -10500	E88F : D6FC	-76.01 : -157	-7601 : -15700	E24F : C2AC	213.1 : 168.2	2131 : 1682	853 : 692	Underrange
< -105.00	-32768	8000	< -157.00	-32768	8000	< 168.2	-32768	8000	Underflow

[1] Depending on the base unit (degrees Celsius: 1 digit = 0.1°C; degrees Fahrenheit: 1 digit = 0.1°F; Kelvin: 1 digit = 0.1 K)

Table B-11 Thermal resistor Ni 100, 120, 200, 500, 1000, LG-Ni 1000 climatic (0.006170 GOST)

Ni x00, 120, 1000 climatic in °C [1]	Values in S7 format		Ni x00, +120, 1000 climatic in °F [1]	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.	
> 210.00	32767	7FFF	> 410.00	32767	7FFF	Overflow
210 : 180.01	21000 : 18001	5208 : 4651	410.00 : 356.01	32766 : 28001	7FFE : 6D61	Overrange
180.00 : -60.00	18000 : -6000	4650 : E890	356 : -76	28000 : -7600	6D60 : E250	Nominal range
-60.01 : -105	-6001 : -10500	E88F : D6FC	-76.01 : -157	-7601 : -15700	E24F : C2AC	Underrange
< -105.00	-32768	8000	< -157.00	-32768	8000	Underflow

[1] Depending on the base unit (degrees Celsius: 1 digit = 0.1°C; degrees Fahrenheit: 1 digit = 0.1°F; Kelvin: 1 digit = 0.1 K)

Table B-12 Thermal resistor Ni 100, 120, 200, 500, 1000, standard for temperature coefficient (incl. 0.006170 GOST)

Ni x00 climatic in °C [1]	Values in S7 format		Ni x00 climatic in °F [1]	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.	
> 295.00	32767	7FFF	> 327.66	32767	7FFF	Overflow
295.00 : 250.01	29500 : 25001	733C : 61A9	327.66 : 280.01	32766 : 28001	7FFE : 6D61	Overrange

Ni x00 climatic in °C [1]	Values in S7 format		Ni x00 climatic in °F [1]	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.	
250.00	25000	61A8	280.00	28000	6D60	Nominal range
:	:	:	:	:	:	
-60.00	-6000	E890	-76.00	-7600	E250	
-60.01	-6001	E88F	-76.01	-7601	E24F	Underrange
:	:	:	:	:	:	
-105.00	-10500	D6FC	-157.00	-15700	C2AC	
< -105.00	-32768	8000	< -157.00	-32768	8000	Underflow

[1] Depending on the base unit (degrees Celsius: 1 digit = 0.1°C; degrees Fahrenheit: 1 digit = 0.1°F; Kelvin: 1 digit = 0.1 K)

Table B-13 Thermal resistor Ni 100, 120, 200, 500, 1000, climatic for temperature coefficient 0.006170 GOST

Ni x00 climatic in °C [1]	Values in S7 format		Ni x00 climatic in °F [1]	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.	
> 155.0	32767	7FFF	> 311.00	32767	7FFF	Overflow
155.0	15500	3C8C	311.00	31100	797C	Overrange
:	:	:	:	:	:	
130.01	13001	32C9	266.01	26601	67E9	
130.00	13000	32C8	266.00	26600	E24F	Nominal range
:	:	:	:	:	:	
-60.00	-6000	E890	-76.0	-7600	C2AC	
-60.01	-6001	E88F	-76.01	-7601	E24F	Underrange
:	:	:	:	:	:	
-105.00	-10500	D6FC	-157.00	-15700	C2AC	
<-105.00	-32768	8000	<-157.00	-32768	8000	Underflow

[1] Depending on the base unit (degrees Celsius: 1 digit = 0.1°C; degrees Fahrenheit: 1 digit = 0.1°F; Kelvin: 1 digit = 0.1 K)

Table B-14 Thermal resistor Cu 10 standard

Cu 10 standard in °C [1]	Values in S7 format		Cu 10 standard in °F [1]	Values in S7 format		Cu 10 standard in K [1]	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 312.0	32767	7FFF	> 593.6	32767	7FFF	> 585.2	32767	7FFF	Overflow
312.0	3120	C30	593.6	5936	1730	585.2	5852	16DC	Overrange
:	:	:	:	:	:	:	:	:	
260.1	2601	A29	500.1	5001	12D5	533.3	5333	14D5	
260.0	2600	A28	500.0	5000	1389	533.2	5332	14D4	Nominal range
:	:	:	:	:	:	:	:	:	
-200.0	-2000	F830	-328.0	-3280	F330	73.2	732	2DC	

Cu 10 standard in °C [1]	Values in S7 format		Cu 10 standard in °F [1]	Values in S7 format		Cu 10 standard in K [1]	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
-200.1	-2001	F82F	-328.1	-3281	F32F	73.1	731	2DB	Underrange
:	:	:	:	:	:	:	:	:	
-240.0	-2400	F6A0	-400.0	-4000	F060	33.2	332	14C	
< -240.0	-32768	8000	< -400.0	-32768	8000	< 33.2	32768	8000	Underflow

[1] Depending on the base unit (degrees Celsius: 1 digit = 0.1°C; degrees Fahrenheit: 1 digit = 0.1°F; Kelvin: 1 digit = 0.1 K)

Table B-15 Thermal resistor Cu 10 climatic and Cu 50, 100 climatic for temperature coefficient 0.004280 GOST

Cu 10, 50, 100 climatic in °C (1 digit = 0.01 °C)	Values in S7 format		Cu 10 climatic in °F (1 digit = 0.01 °F)	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.	
> 180.00	32767	7FFF	> 325.11	32767	7FFF	Overflow
180.00	18000	4650	327.66	32766	7FFE	Overrange
:	:	:	:	:	:	
150.01	15001	3A99	280.01	28001	6D61	
150.00	15000	3A98	280.00	28000	6D60	Nominal range
:	:	:	:	:	:	
-50.00	-5000	EC78	58.00	-5800	E958	
-50.01	-5001	EC77	-58.01	-5801	E957	Underrange
:	:	:	:	:	:	
-60.00	-6000	E890	-76.00	-7600	E250	
< 60.00	-32768	8000	< 76.00	-32768	8000	Underflow

[1] Depending on the base unit (degrees Celsius: 1 digit = 0.1°C; degrees Fahrenheit: 1 digit = 0.1°F; Kelvin: 1 digit = 0.1 K)

Table B-16 Thermal resistor Cu 50, 100 standard for temperature coefficient 0.004280 GOST

Cu 50, 100 standard in °C [1]	Values in S7 format		Cu 10 standard in °F [1]	Values in S7 format		Cu 10 standard in K [1]	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 240	32767	7FFF	> 464.0	32767	7FFF	> 513.2	32767	7FFF	Overflow
240.0	2400	960	464.0	4640	1220	513.2	5132	140C	Overrange
:	:	:	:	:	:	:	:	:	
200.1	2001	7D1	392.1	3921	F51	473.3	4733	127D	
200.0	2000	7D0	392.0	3920	F50	473.2	4732	127C	Nominal range
:	:	:	:	:	:	:	:	:	
-180.1	-1800	F8F8	-292.0	-3920	F0B0	93.2	932	3A4	

Cu 50, 100 standard in °C [1]	Values in S7 format		Cu 10 standard in °F [1]	Values in S7 format		Cu 10 standard in K [1]	Values in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
-180.1 : -220.0	-1801 : -2200	F8F7 : F768	-292.1 : -364.0	-3921 : -3640	F0AF : F1C8	93.1 : 53.2	931 : 532	3A3 : 214	Underrange
< -220	-32768	8000	< -364.0	-32768	8000	< 53.2	-32768	8000	Underflow

[1] Depending on the base unit (degrees Celsius: 1 digit = 0.1°C; degrees Fahrenheit: 1 digit = 0.1°F; Kelvin: 1 digit = 0.1 K)

B.8 Representation of analog values for thermocouples

The tables below list the decimal and hexadecimal values (codes) of the thermocouples.

Note

Values when configuring the module for use with REAL format

For configuration of the module in REAL format, all temperature values are provided in the following base units:

- Degrees Celsius
- Degrees Fahrenheit
- Kelvin

Note

Note the representation in case of errors, underflow and overflow in section "Analog value display (Page 71)".

Table B-17 Thermocouple type B

Type B in °C	Value in S7 format		Type B in °F	Value in S7 format		Type B in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 2070.0	32767	7FFF	> 3276.6	32767	7FFF	> 2343.2	32767	7FFF	Overflow
2070.0 : 1820.1	20700 : 18201	50DC : 4719	3276.6 : 2786.6	32766 : 27866	7FFE : 6CDA	2343.2 : 2093.3	23432 : 20933	5B88 : 51C5	Overrange
1820.0 : 0.0	18200 : 0	4718 : 0000	2786.5 : 32.0	27865 : 320	6CD9 : 0140	2093.2 : 273.2	20932 : 2732	51C4 : 0AAC	Nominal range

Type B in °C	Value in S7 format		Type B in °F	Value in S7 format		Type B in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
-0.1	-1	FFFF	31.9	319	013F	273.1	2731	0AAB	Underrange
:	:	:	:	:	:	:	:	:	
-120.0	-1200	FB50	-184.0	-1840	F8D0	153.2	1532	05FC	
< -120.0	-32768	8000	< -184.0	-32768	8000	< 153.2	-32768	8000	Underflow

Table B-18 Thermocouple type C

Type C in °C	Value in S7 format		Type C in °F	Value in S7 format		Type C in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 2500.0	32767	7FFF	> 3276.6	32767	7FFF	> 2773.2	32767	7FFF	Overflow
2500.0	25000	61A8	3276.6	32766	7FFE	2773.2	27732	6C54	Overrange
:	:	:	:	:	:	:	:	:	
2315.1	23151	5A6F	2786.6	27866	6CDA	2588.3	25883	651B	
2315.0	23150	5A6E	2786.5	27865	6CD9	2588.2	25882	651A	Nominal range
:	:	:	:	:	:	:	:	:	
0.0	0	0000	32.0	320	0140	273.2	2732	0AAC	
-0.1	-1	FFFF	31.9	319	013F	273.1	2731	0AAB	Underrange
:	:	:	:	:	:	:	:	:	
-120.0	-1200	FB50	-184.0	-1840	F8D0	153.2	1532	05FC	
< -120.0	-32768	8000	< -184.0	-32768	8000	< 153.2	-32768	8000	Underflow

Table B-19 Thermocouple type E

Type E in °C	Value in S7 format		Type E in °F	Value in S7 format		Type E in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1200.0	32767	7FFF	> 2192.0	32767	7FFF	> 1473.2	32767	7FFF	Overflow
1200.0	12000	2EE0	2192.0	21920	55A0	1473.2	14732	398C	Overrange
:	:	:	:	:	:	:	:	:	
1000.1	10001	2711	1832.1	18321	4791	1273.3	12733	31BD	
1000.0	10000	2710	1832.0	18320	4790	1273.2	12732	31BC	Nominal range
:	:	:	:	:	:	:	:	:	
-270.0	-2700	F574	-454.0	-4540	EE44	3.2	32	0020	
< -270.0	-32768	8000	< -454.0	-32768	8000	< 3.2	-32768	8000	Underflow

Table B-20 Thermocouple type J

Type J in °C	Value in S7 format		Type J in °F	Value in S7 format		Type J in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1450.0	32767	7FFF	> 2642.0	32767	7FFF	> 1723.2	32767	7FFF	Overflow
1450.0	14500	38A4	2642.0	26420	6734	1723.2	17232	4350	Overrange
:	:	:	:	:	:	:	:	:	
1200.1	12001	2EE1	2192.1	21921	55A1	1473.3	14733	398D	
1200.0	12000	2EE0	2192.0	21920	55A0	1473.2	14732	398C	Nominal range
:	:	:	:	:	:	:	:	:	
-210.0	-2100	F7CC	-346.0	-3460	F27C	63.2	632	0278	
< -210.0	-32768	8000	< -346.0	-32768	8000	< 63.2	-32768	8000	Underflow

Table B-21 Thermocouple type K

Type K in °C	Value in S7 format		Type K in °F	Value in S7 format		Type K in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1622.0	32767	7FFF	> 2951.6	32767	7FFF	> 1895.2	32767	7FFF	Overflow
1622.0	16220	3F5C	2951.6	29516	734C	1895.2	18952	4A08	Overrange
:	:	:	:	:	:	:	:	:	
1372.1	13721	3599	2501.7	25017	61B9	1645.3	16453	4045	
1372.0	13720	3598	2501.6	25016	61B8	1645.2	16452	4044	Nominal range
:	:	:	:	:	:	:	:	:	
-270.0	-2700	F574	-454.0	-4540	EE44	3.2	32	0020	
< -270.0	-32768	8000	< -454.0	-32768	8000	< 3.2	-32768	8000	Underflow

Table B-22 Thermocouple type L

Type L in °C	Value in S7 format		Type L in °F	Value in S7 format		Type L in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1150.0	32767	7FFF	> 2102.0	32767	7FFF	> 1423.2	32767	7FFF	Overflow
1150.0	11500	2CEC	2102.0	21020	521C	1423.2	14232	3798	Overrange
:	:	:	:	:	:	:	:	:	
900.1	9001	2329	1652.1	16521	4089	1173.3	11733	2DD5	
900.0	9000	2328	1652.0	16520	4088	1173.2	11732	2DD4	Nominal range
:	:	:	:	:	:	:	:	:	
-200.0	-2000	F830	-328.0	-3280	F330	73.2	732	02DC	
< -200.0	-32768	8000	< -328.0	-32768	8000	< 73.2	-32768	8000	Underflow

Table B-23 Thermocouple type N

Type N in °C	Value in S7 format		Type N in °F	Value in S7 format		Type N in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1550.0	32767	7FFF	> 2822.0	32767	7FFF	> 1823.2	32767	7FFF	Overflow
1550.0	15500	3C8C	2822.0	28220	6E3C	1823.2	18232	4738	Overrange
:	:	:	:	:	:	:	:	:	
1300.1	13001	32C9	2372.1	23721	5CA9	1573.3	15733	3D75	
1300.0	13000	32C8	2372.0	23720	5CA8	1573.2	15732	3D74	Nominal range
:	:	:	:	:	:	:	:	:	
-270.0	-2700	F574	-454.0	-4540	EE44	3.2	32	0020	
< -270.0	-32768	8000	< -454.0	-32768	8000	< 3.2	-32768	8000	Underflow

Table B-24 Thermocouples R and S

Types R, S in °C	Value in S7 format		Types R, S in °F	Value in S7 format		Types R, S in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 2019.0	32767	7FFF	> 3276.6	32767	7FFF	> 2292.2	32767	7FFF	Overflow
2019.0	20190	4EDE	3276.6	32766	7FFE	2292.2	22922	598A	Overrange
:	:	:	:	:	:	:	:	:	
1769.1	17691	451B	3216.3	32163	7DA3	2042.3	20423	4FC7	
1769.0	17690	451A	3216.2	32162	7DA2	2042.2	20422	4FC6	Nominal range
:	:	:	:	:	:	:	:	:	
-50.0	-500	FE0C	-58.0	-580	FDBC	223.2	2232	08B8	
-50.1	-501	FE0B	-58.1	-581	FDBB	223.1	2231	08B7	Underrange
:	:	:	:	:	:	:	:	:	
-170.0	-1700	F95C	-274.0	-2740	F54C	103.2	1032	0408	
< -170.0	-32768	8000	< -274.0	-32768	8000	< 103.2	< 1032	8000	Underflow

Table B-25 Thermocouple type T

Type T in °C	Value in S7 format		Type T in °F	Value in S7 format		Type T in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 540.0	32767	7FFF	> 1004.0	32767	7FFF	> 813.2	32767	7FFF	Overflow
540.0	5400	1518	1004.0	10040	2738	813.2	8132	1FC4	Overrange
:	:	:	:	:	:	:	:	:	
400.1	4001	0FA1	752.1	7521	1D61	673.3	6733	1AAD	
400.0	4000	0FA0	752.0	7520	1D60	673.2	6732	1AAC	Nominal range
:	:	:	:	:	:	:	:	:	
-270.0	-2700	F574	-454.0	-4540	EE44	3.2	32	0020	
< -270.0	-32768	8000	< -454.0	-32768	8000	< 3.2	-32768	8000	Underflow

Table B-26 Thermocouple type U

Type U in °C	Value in S7 format		Type U in °F	Value in S7 format		Type U in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 850.0	32767	7FFF	> 1562.0	32767	7FFF	> 1123.2	32767	7FFF	Overflow
850.0	8500	2134	1562.0	15620	2738,0	1123.2	11232	2BE0	Overrange
:	:	:	:	:	:	:	:	:	
600.1	6001	1771	1112.1	11121	2B71	873.3	8733	221D	
600.0	6000	1770	1112.0	11120	2B70	873.2	8732	221C	Nominal range
:	:	:	:	:	:	:	:	:	
-200.0	-2000	F830	-328.0	-3280	F330	73.2	732	02DC	
< -200.0	-32768	8000	< -328.0	-32768	8000	< 73.2	-32768	8000	Underflow

Table B-27 Thermocouple type TXK (GOST)

Type TXK in °C	Value in S7 format		Type TXK in °F	Value in S7 format		Type TXK in K	Value in S7 format		Range
	Dec.	Hex.		Dec.	Hex.		Dec.	Hex.	
> 1050.0	32767	7FFF	> 1922.0	32767	7FFF	> 1323.2	32767	7FFF	Overflow
1050.0	10500	2904	1922.0	19220	4B14	1323.2	13232	33B0	Overrange
:	:	:	:	:	:	:	:	:	
800.1	8001	1F41	1472.1	14721	3981	1073.3	10733	29ED	
800.0	8000	1F40	1472.0	14720	3980	1073.2	10732	29EC	Nominal range
:	:	:	:	:	:	:	:	:	
0.0	0	0000	32.0	320	0140	273	2730	0AAA	
:	:	:	:	:	:	:	:	:	
-200.0	-2000	F830	-328.0	-3280	F330	73.2	732	02DC	
< -200.0	-32768	8000	< -328.0	-32768	8000	< 73.2	-32768	8000	Underflow