MANUFACTURER DOCUMENT PACKAGE

Manufacturer's Manual

SIEMENS SIMATIC S7

6ES7512-1CK00-0AB0

CPU 1512C COMPACT CONTROLLER

Applicable product family: SIMATIC S7-1500 automation systems

OFFICIAL SOURCE

6ES7512-1CK00-0AB0.pdf

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SIMATIC

S7-1500

CPU 1512C-1 PN (6ES7512-1CK00-0AB0)

Manual

Edition 06/2015

Answers for industry.

Preface

Purpose of the documentation

This manual supplements the system manual of the S7-1500 automation system / ET 200MP distributed I/O system as well as the function manuals. This manual contains a description of the module-specific information. The system-related functions are described in the system manual. Cross-system functions are described in the function manuals.

The information provided in this manual and the system manual enables you to commission the CPU 1512C-1 PN.

Conventions

STEP 7: In this documentation, "STEP 7" is used as a synonym for all versions of the configuration and programming software "STEP 7 (TIA Portal)".

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 or on the section of the documentation to which particular attention should be paid.

Security information

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For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action (e.g. cell protection concept) and integrate each component into a holistic, state-of-the-art industrial security concept. Third-party products that may be in use should also be considered. You can find more information about industrial security on the Internet (http://www.siemens.com/industrialsecurity).

To stay informed about product updates as they occur, sign up for a product-specific newsletter. You can find more information on the Internet (http://support.automation.siemens.com).

2.2 Properties

The hardware of the CPU 1512C-1 PN consists of a CPU part, an analog on-board I/O (X10) and a digital on-board I/O (X11 and X12). When configured in the TIA Portal, the compact CPU therefore occupies a single shared slot (slot 1).

The properties of the CPU part, the analog on-board I/O and the digital on-board I/O can be found in the subsections below.

Article number of the compact CPU

6ES7512-1CK00-0AB0

Accessories

The following accessories are included in the scope of delivery and can also be ordered separately as spare parts:

- 3 x front connector (push-in terminals) including cable ties
- 3 x shield clamp
- 3 x shield terminal
- 3 x infeed element (push-in terminals)
- 3 x labeling strip
- 3 x universal front cover

For more information on accessories, refer to the S7-1500, ET 200MP system manual (http://support.automation.siemens.com/WW/view/en/59191792).

2.2.1 Properties of the CPU part

View of the CPU

The figure below shows the CPU part of the CPU 1512C-1 PN.

Figure 2-1 CPU 1512C-1 PN

Note

Protective film

Note that a protective film is attached to the display of the CPU when shipped from the factory. Remove the protective film if necessary.

Properties

The CPU 1512C-1 PN has the following technical properties:

- Communication
  - Interfaces

    The CPU 1512C-1 PN has a PROFINET interface (X1) with two ports (P1 R and P2 R). It supports not only PROFINET basic functionality but also PROFINET IO RT (real time) and IRT (isochronous real time), which means you can configure PROFINET IO communication or real-time settings on the interface. Port 1 and port 2 can also be used as ring ports for configuration of redundant ring structures in Ethernet (media redundancy).
    PROFINET basic functionality supports HMI communication, communication with the configuration system, communication with a higher-level network (backbone, router, Internet) and communication with another machine or automation cell.
    For more information on "PROFINET IO", refer to the online help of STEP 7 and the PROFINET (http://support.automation.siemens.com/WW/view/en/68035307) function manual.
- Integrated Web server:

  A Web server is integrated in the CPU. You can read the following information with the Web server:
  - Start page with general CPU information
  - Identification information
  - Contents of the diagnostics buffer
  - Status query of analog and digital on-board I/O and additional modules that are plugged in
  - Alarms (without acknowledgment option)
  - Information about communication
  - PROFINET topology
  - Tag status
  - Watch tables
  - Memory usage
  - User pages
  - Data logs (if used)

- Supported technology:
  - Counting, measuring, position detection

    The technology functions high-speed counting, measuring and position detection for motion control are integrated in the CPU.
    For more information on integrated technology functions, refer to the section Technology functions.
  - Motion Control

    The motion control functionality supports speed axes, positioning axes, synchronous axes and external encoders as well as PLCopen blocks for programming the motion functionality.
    For more information about motion control, refer to the section Technology functions.
    For a detailed description of the use of motion control and its configuration, refer to the S7-1500 Motion Control (http://support.automation.siemens.com/WW/view/en/59381279) function manual.
  - Integrated closed-loop control functionality

    - Universal PID controller

    - 3-point step controller/valve controller with integrated optimization

    - Integrated temperature controller
- Trace functionality:
  - The trace functionality supports troubleshooting and optimization of the user program, especially for motion control and closed-loop control applications.
    For more information on "Trace", refer to the Using the trace and logic analyzer functions (http://support.automation.siemens.com/WW/view/en/64897128) function manual.
- Integrated system diagnostics:
  - The alarms for the system diagnostics are automatically created by the system and displayed by a PG/PC, HMI device, Web server or the integrated display. System diagnostics is also available when the CPU is in STOP mode.

- Integrated security:
  - Copy protection

    Copy protection links user blocks to the serial number of the SIMATIC memory card or to the serial number of the CPU. User programs cannot run without the corresponding SIMATIC memory card or CPU.
  - Know-how protection

    The know-how protection protects user blocks against unauthorized access and modifications.
  - Access protection

    Extended access protection provides high-quality protection against unauthorized configuration changes. You can use authorization levels to assign separate rights to different user groups.
  - Integrity protection

    The system protects the data transferred to the CPU against manipulation. The CPU detects incorrect or manipulated engineering data.
- The CPU 1512C-1 PN supports the following functions:
  - CPU memory reset
    For information on "Memory reset", refer to the S7-1500, ET 200MP system manual (http://support.automation.siemens.com/WW/view/en/59191792).
  - Reset CPU to factory settings
    For information on "Reset CPU to factory settings", refer to the S7-1500, ET 200MP system manual (http://support.automation.siemens.com/WW/view/en/59191792).
  - Firmware update
    For information on "Firmware update", refer to the S7-1500, ET 200MP system manual (http://support.automation.siemens.com/WW/view/en/59191792).
  - Configuration control
    For information on "Configuration control", refer to the S7-1500, ET 200MP system manual (http://support.automation.siemens.com/WW/view/en/59191792) and the PROFINET (http://support.automation.siemens.com/WW/view/en/58139307) function manual.
  - PROFIenergy
    For information on "PROFIenergy", refer to the PROFINET (http://support.automation.siemens.com/WW/view/en/58139307) function manual and the PROFINET specification on the Internet (http://www.profibus.com).

2.2.2 Properties of the analog on-board I/O

View

The following figure shows the analog on-board I/O (X10) of the CPU 1512C-1 PN:

Figure 2-2 Analog on-board I/O

Properties

The analog on-board I/O has the following technical properties:

- Analog inputs
  - 5 analog inputs
  - Resolution 16 bits including sign
  - Voltage measurement type can be set individually for channel 0 to 3
  - Current measurement type can be set individually for channel 0 to 3
  - Resistor measurement type can be set for channel 4
  - Thermal resistor measurement type can be set for channel 4
  - Configurable diagnostics (per channel)
  - Hardware interrupt on limit violation can be set per channel (two low and two high limits in each case)
- Analog outputs
  - 2 analog outputs
  - Resolution: 16 bits incl. sign
  - Voltage output selectable by channel
  - Current output selectable by channel
  - Configurable diagnostics (per channel)

The analog on-board I/O supports the following functions:

- Reconfiguration in RUN
  (for more information, refer to the section Parameter assignment and structure of parameter data records of the analog on-board I/O (Page 110))

2.2.3 Properties of the digital on-board I/O

View

The following figure shows the digital on-board I/O (X11 and X12) of the CPU 1512C-1 PN.

Figure 2-3 Digital on-board I/O

Properties

The digital on-board I/O has the following technical properties:

- Digital inputs
  - 32 high-speed digital inputs for signals up to max. 100 kHz
    The inputs can be used as standard inputs and as inputs for technology functions.
  - Rated input voltage 24 V DC
  - Suitable for switches and 2-/3-/4-wire proximity switches
  - Configurable diagnostics
  - Hardware interrupt can be set (for each channel)
- Digital outputs
  - 32 digital outputs, 8 of which can be used as high-speed outputs for technology functions
    The outputs can be used as standard outputs and as outputs for technology functions.
  - Rated output voltage 24 V DC
  - Rated output current
    as output for standard mode: 0.5 A per channel
    as output for technology function 0.1 A per channel
  - Suitable for solenoid valves, DC contactors, and indicator lights
  - Configurable diagnostics

The digital on-board I/O supports the following functions:

- Reconfiguration in RUN
  (for more information, refer to the section Parameter assignment and structure of parameter data records of the digital on-board I/O (Page 118))

Simultaneous use of technology and standard functions

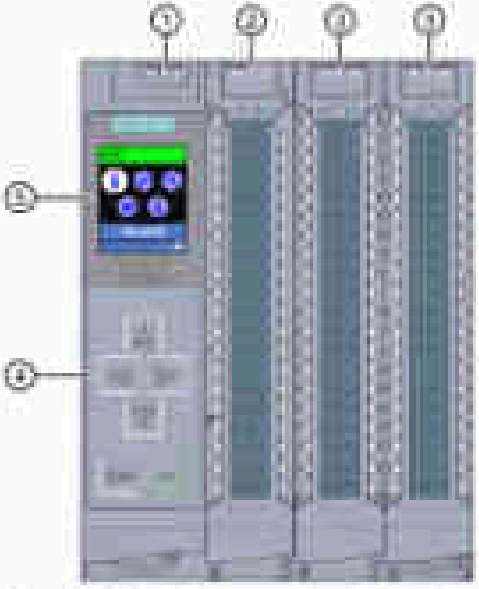
You can use technology and standard functions at the same time, provided the hardware allows this. For example, all the digital inputs not assigned to the counting, measuring or position detection technology functions can be used as standard DI.

Inputs to which technology functions are assigned can be read. Outputs to which technology functions are assigned cannot be written.

2.3 Operator controls and display elements

2.3.1 Front view with closed front panels

The following figure shows the front view of the CPU 1512C-1 PN.



1. LEDs for the current operating mode and diagnostics status of the CPU
2. Status and error displays RUN/ERROR of the analog on-board I/O
3. Status and error displays RUN/ERROR of the digital on-board I/O
4. Control keys
5. Display

Figure 2-4 View of the CPU 1512C-1 PN with closed front panels (front)

Note

Temperature range for display

To increase its service life, the display switches off at a temperature below the permitted operating temperature of the device. When the display cools down again, it automatically switches itself on again. When the display is switched off, the LEDs continue to show the status of the CPU.

For more information on the temperatures at which the display switches itself on and off, refer to the Technical specifications (Page 90).

Pulling and plugging the front panel with display

You can pull and plug the front panel with display during operation. The CPU retains its operating mode when the front panel is pulled and plugged.

WARNING

Personal injury and damage to property may occur

If you pull or plug the front panel of an S7-1500 automation system during operation, personal injury or damage to property can occur in zone 2 hazardous areas.

Before you pull or plug the front panel in hazardous area zone 2, always ensure that the S7-1500 automation system is de-energized.

Locking the front panel

You can lock the front panel to protect your CPU against unauthorized access.

You can attach a security seal or a padlock with a hoop diameter of 3 mm to the front panel.

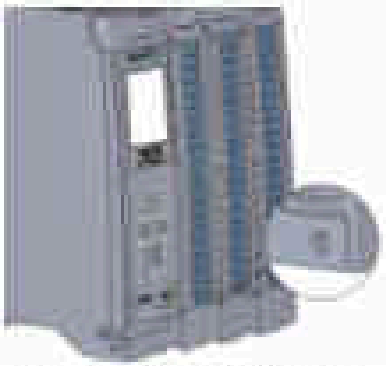


Figure 2-5 Locking latch on the CPU

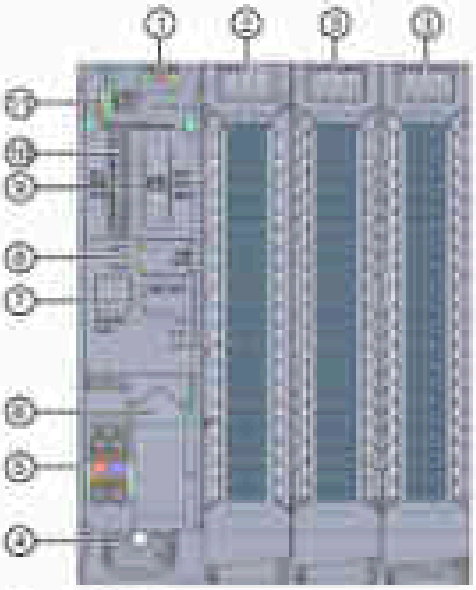
In addition to the mechanical lock, you can also block access to a password-protected CPU on the display (local lock) and assign a password for the display. For more information on the display, the configurable protection levels and the local lock, refer to the S7-1500, ET 200MP (http://support.automation.siemens.com/WW/view/en/59191792) system manual.

Reference

You will find detailed information on the individual display options, a training course and a simulation of the available menu commands in the SIMATIC S7-1500 Display Simulator (http://www.automation.siemens.com/salesmaterial-as/interactive-manuals/getting-started_simatic-s7-1500/disp_tool/start_en.html).

2.3.2 Front view without front panel on the CPU

The following figure shows the operator control and connection elements of the CPU 1512C-1 PN with the front cover of the CPU open.

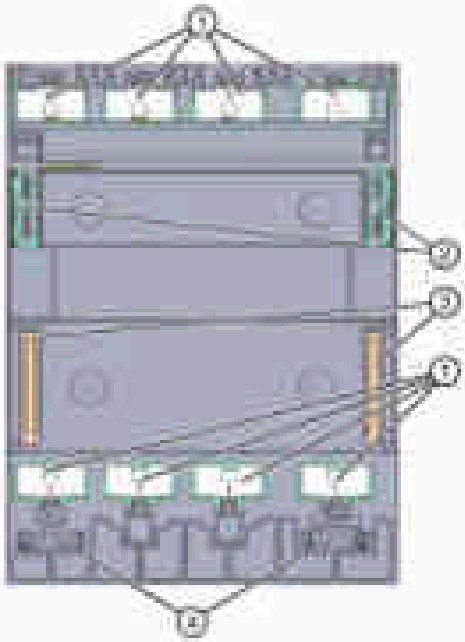


1. LEDs for the current operating mode and diagnostics status of the CPU
2. Status and error displays RUN/ERROR of the analog on-board I/O
3. Status and error displays RUN/ERROR of the digital on-board I/O
4. Fastening screw
5. Connection for supply voltage
6. PROFINET interface (X1) with 2 ports (X1 P1 and X1 P2)
7. MAC address
8. LEDs for the 2 ports (X1 P1 and X1 P2) of the PROFINET interface X1
9. Mode selector
10. Slot for the SIMATIC memory card
11. Display connection

Figure 2-6 View of the CPU 1512C-1 PN without front panel on the CPU (front)

2.3.3 Rear view

The following figure shows the connection elements on the rear of the CPU 1512C-1 PN.



① Shield contact surfaces
② Plug-in connection for power supply
③ Plug-in connection for backplane bus
④ Fastening screws

Figure 2-7 View of the CPU 1512C-1 PN - rear

2.4 Mode selector

You use the mode selector to set the operating mode of the CPU.

The following table shows the position of the selector and the corresponding meaning:

Position of the mode selector

Position	Meaning	Explanation
RUN	RUN mode	The CPU executes the user program.
STOP	STOP mode	The user program is not executed.
MRES	Memory reset	Position for CPU memory reset.

Wiring

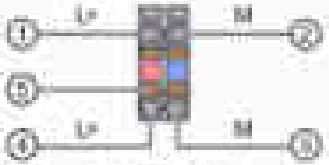
4

4.1 Supply voltage

24 V DC supply voltage (X80)

The connecting plug for the supply voltage is plugged in when the CPU ships from the factory.

The following table shows the terminal assignment for a 24 V DC power supply.



① +24 V DC of the supply voltage
② Ground of the supply voltage
③ Ground of the supply voltage for loop-through (maximum of 10 A permitted)
④ +24 V DC of the supply voltage for loop-through (maximum of 10 A permitted)
⑤ Spring-loaded NC contact (one spring-loaded NC contact per terminal)

Bridged internally:
① and ④
② and ③

Figure 4-1 Connection for supply voltage

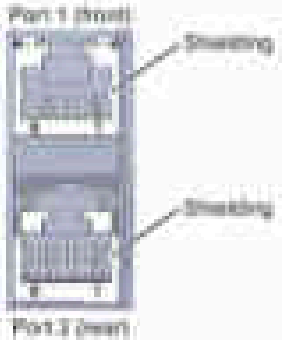
If the CPU is supplied by a system power supply, it is not necessary to connect the 24 V supply.

4.2 PROFINET interfaces

PROFINET interface X1 with 2-port switch (X1 P1 R and X1 P2 R)

The following table shows the terminal assignment for the PROFINET interface with 2-port switch. The assignment corresponds to the Ethernet standard for an RJ45 plug.

Table 4- 1 Terminal assignment of the PROFINET interface with 2-port switch

View		Signal name	Pin assignment
	1	TD	Transmit Data +
	2	TD_N	Transmit Data -
	3	RD	Receive Data +
	4	–	Unassigned
	5	–	Unassigned
	6	RD_N	Receive Data -
	7	–	Unassigned
	8	–	Unassigned

Reference

For more information on "Wiring the CPU" and "Accessories/spare parts", refer to the S7-1500, ET 200MP system manual (http://support.automation.siemens.com/WW/view/en/59191792).

Assignment of the MAC addresses

The CPU 1512C-1 PN has a PROFINET interface with two ports. The PROFINET interface itself has a MAC address, and each of the two PROFINET ports has its own MAC address. The CPU 1512C-1 PN therefore has three MAC addresses in total.

The MAC addresses of the PROFINET ports are needed for the LLDP protocol, for example for the neighborhood discovery function.

The number range of the MAC addresses is continuous. The first and last MAC address are lasered on the rating plate on the right side of each CPU 1512C-1 PN.

The table below shows how the MAC addresses are assigned.

Table 4- 2 Assignment of the MAC addresses

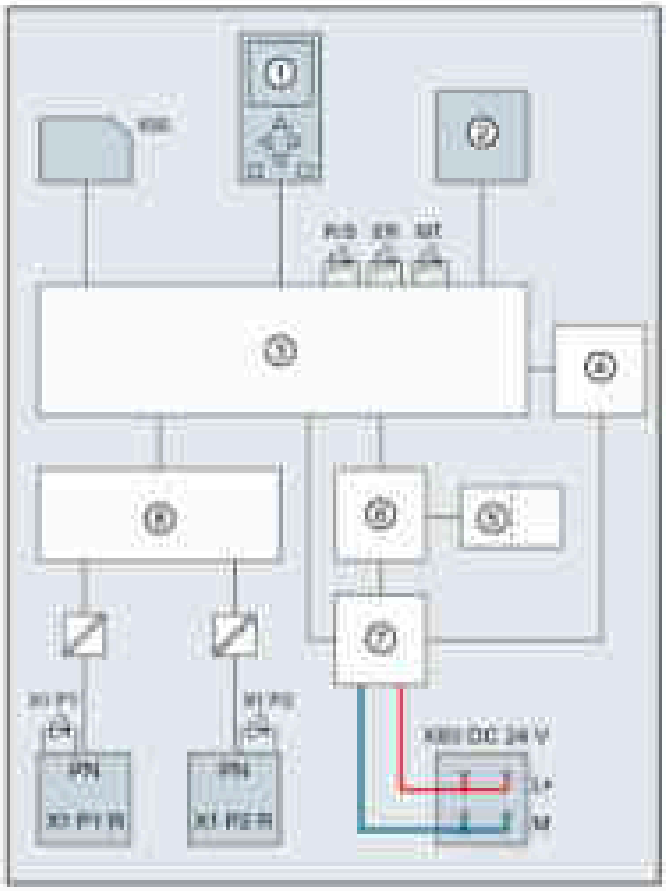
	Assignment	Labeling
MAC address 1	PROFINET interface X1 (visible in STEP 7 for accessible devices)	• Front, lasered • Right side, lasered (start of number range)
MAC address 2	Port X1 P1 R (required for LLDP, for example)	• Front and right side, not lasered
MAC address 3	Port X1 P2 R (required for LLDP, for example)	• Front, not lasered • Right side, lasered (end of number range)

4.3 Terminal and block diagrams

4.3.1 Block diagram of the CPU part

Block diagram

The following figure shows the block diagram of the CPU part.



①	Display	X60 24 V DC	Infeed of supply voltage
②	RUN/STOP/RESET mode selector	PN X1 P1 R	PROFINET interface X1 port 1
③	Electronics	PN X1 P2 R	PROFINET interface X1 port 2
④	Interface to on-board I/O	L+	24 V DC supply voltage
⑤	Interfaces to the backplane bus	M	Ground
⑥	Backplane bus interface	RUN/STOP LED (yellow/green)	
⑦	Internal supply voltage	ERR	ERROR LED (red)
⑧	PROFINET switch	MNT	MAINT LED (yellow)
X50	SIMATIC Memory Card	X1 P1, X1 P2	Link TX/RX LED

Figure 4-2 Block diagram of the CPU part

4.3.2 Terminal and block diagram of the analog on-board I/O

This section contains the block diagram of the analog on-board I/O (X10) and various wiring options.

For information on wiring the front connector, establishing the cable shield, etc., refer to the S7-1500, ET 200MP (http://support.automation.siemens.com/WW/view/en/59191792) system manual.

Note

You can use and combine the different wiring options for all channels. Note, however, that unneeded terminals of an analog input channel must not be connected.

Definition

U_n+/U_n-	Voltage input channel n (voltage only)
M_n+/M_n-	Measuring input channel n
I_n+/I_n-	Current input channel n (current only)
$I_{Cn}+/I_{Cn}-$	Current output for RTD, channel n
QV_n	Voltage output channel
QI_n	Current output channel
M_{ANA}	Reference potential of the analog circuit
CH_n	Channel or display of the channel status

Infeed element

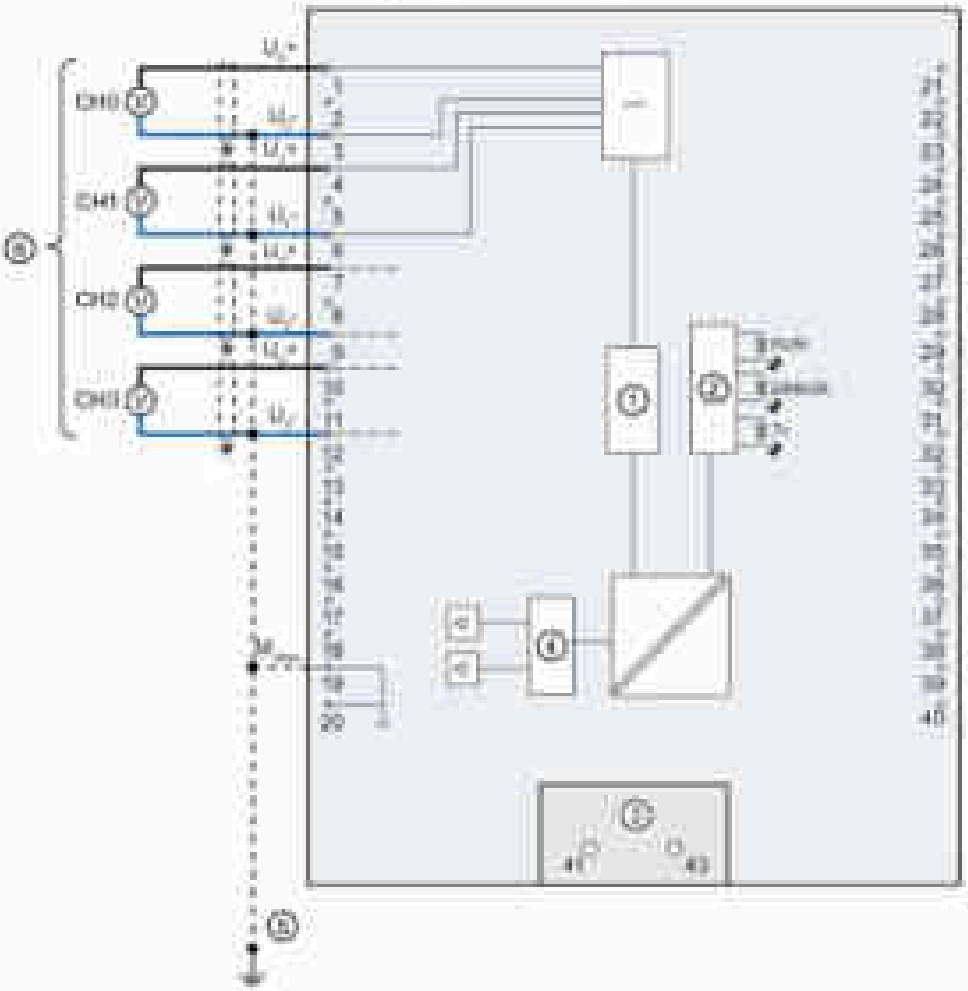
The infeed element is inserted on the front connector and serves to shield the analog on-board I/O.

Note

The analog on-board I/O does not require power to be supplied by the infeed element. The infeed element is, however, necessary for shielding.

Wiring: Voltage measurement

The following figure shows the terminal assignment for voltage measurement at the channels available for this measurement type (channels 0 to 3).

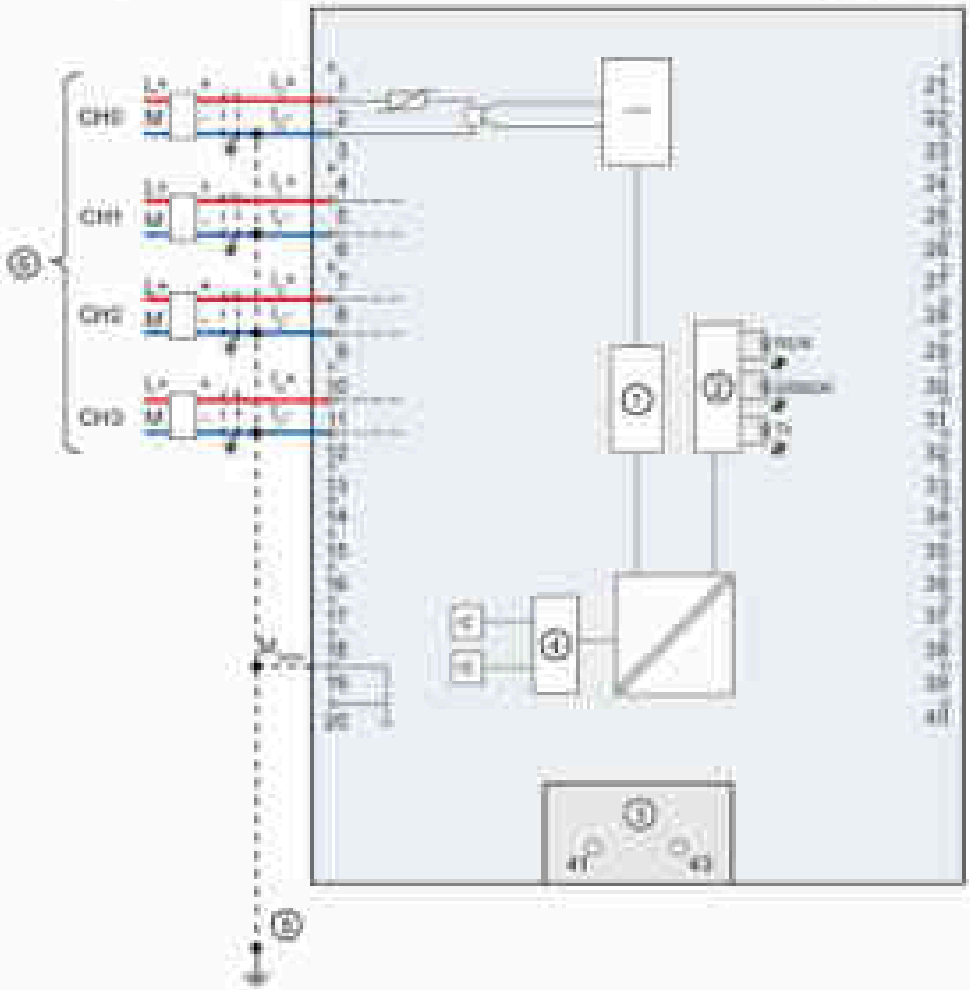


① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ Equipotential bonding cable (optional)
⑥ Voltage measurement

Figure 4-3 Block diagram and terminal assignment for voltage measurement

Wiring: 4-wire measuring transducer for current measurement

The following figure shows the terminal assignment for current measurement with 4-wire measuring transducer at the channels available for this measurement type (channels 0 to 3).

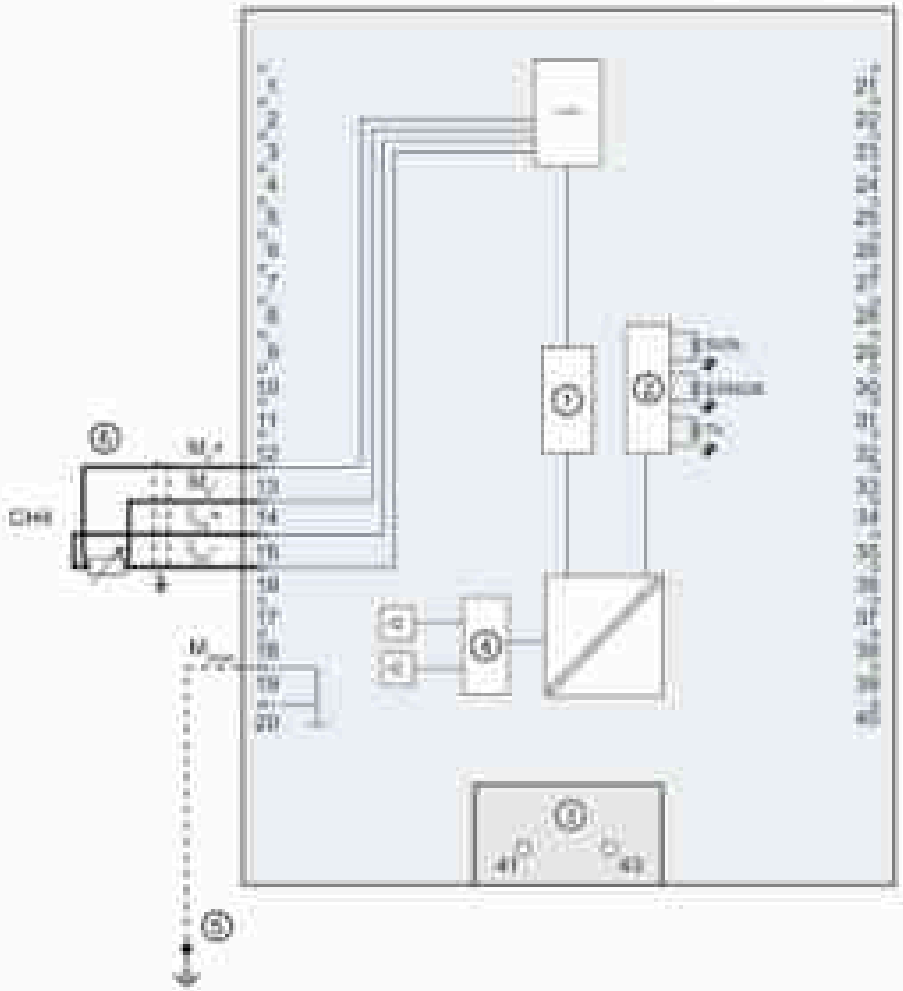


① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ Equipotential bonding cable (optional)
⑥ Connector 4-wire measuring transducer

Figure 4-4 Block diagram and terminal assignment for current measurement with 4-wire measuring transducer

Wiring: 4-wire connection of resistance-type sensors or thermal resistors (RTD)

The following figure shows the terminal assignment for 4-wire connection of resistance-type sensors or thermal resistors at the channel available for this (channel 4).



① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ Equipotential bonding cable (optional)
⑥ 4-wire connection

Figure 4-5 Block diagram and terminal assignment for 4-wire connection

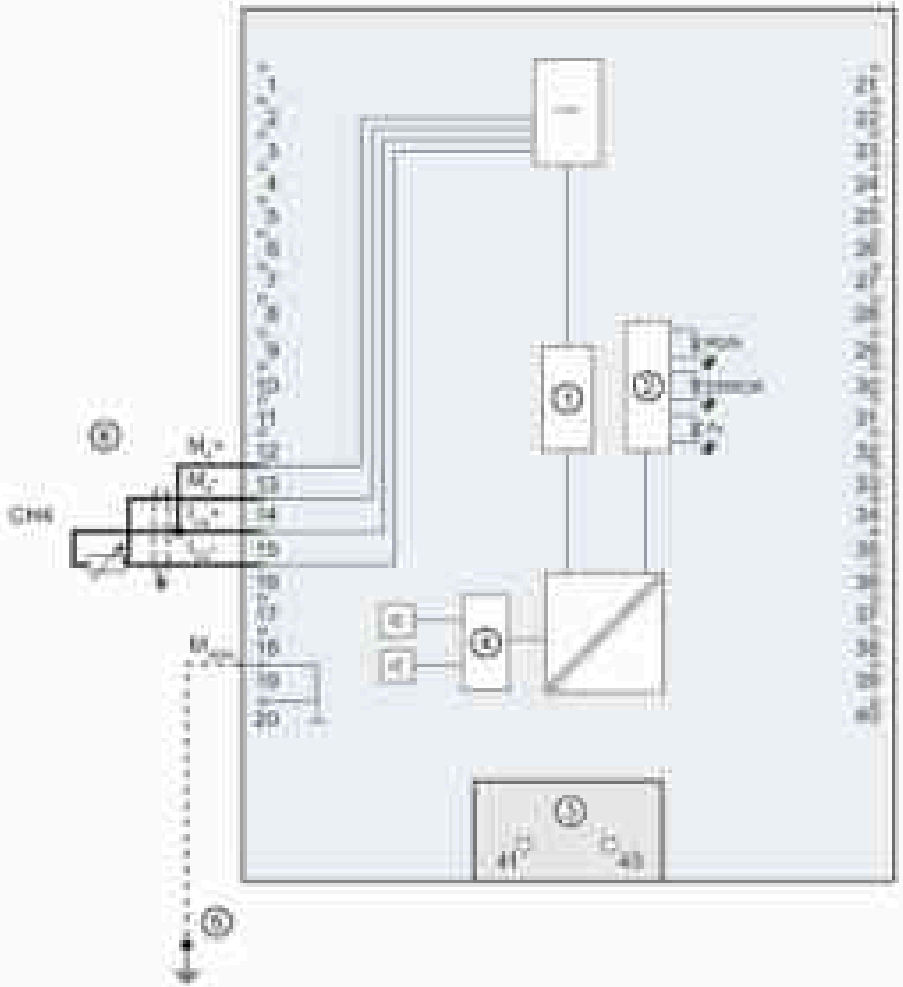
Wiring: 3-wire connection of resistance-type sensors or thermal resistors (RTD)

The following figure shows the terminal assignment for 3-wire connection of resistance-type sensors or thermal resistors at the channel available for this (channel 4).

Note

Parameter assignment of 3-wire connections

Note that line resistances are not compensated with a 3-wire connection.



① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ Equipotential bonding cable (optional)
⑥ 3-wire connection

Figure 4-6 Block diagram and terminal assignment for 3-wire connection

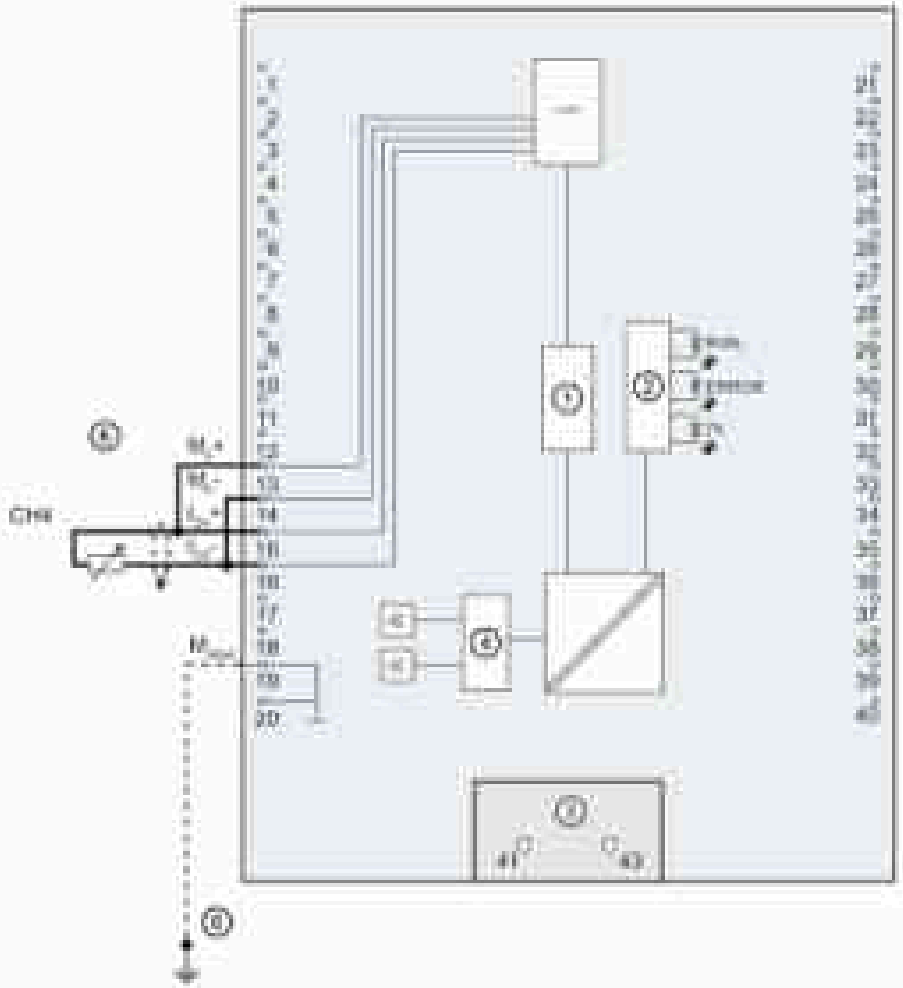
Wiring: 2-wire connection of resistance-type sensors or thermal resistors (RTD)

The following figure shows the terminal assignment for 2-wire connection of resistance-type sensors or thermal resistors at the channel available for this (channel 4).

Note

Parameter assignment of 2-wire connections

Note that line resistances are not compensated with a 2-wire connection.



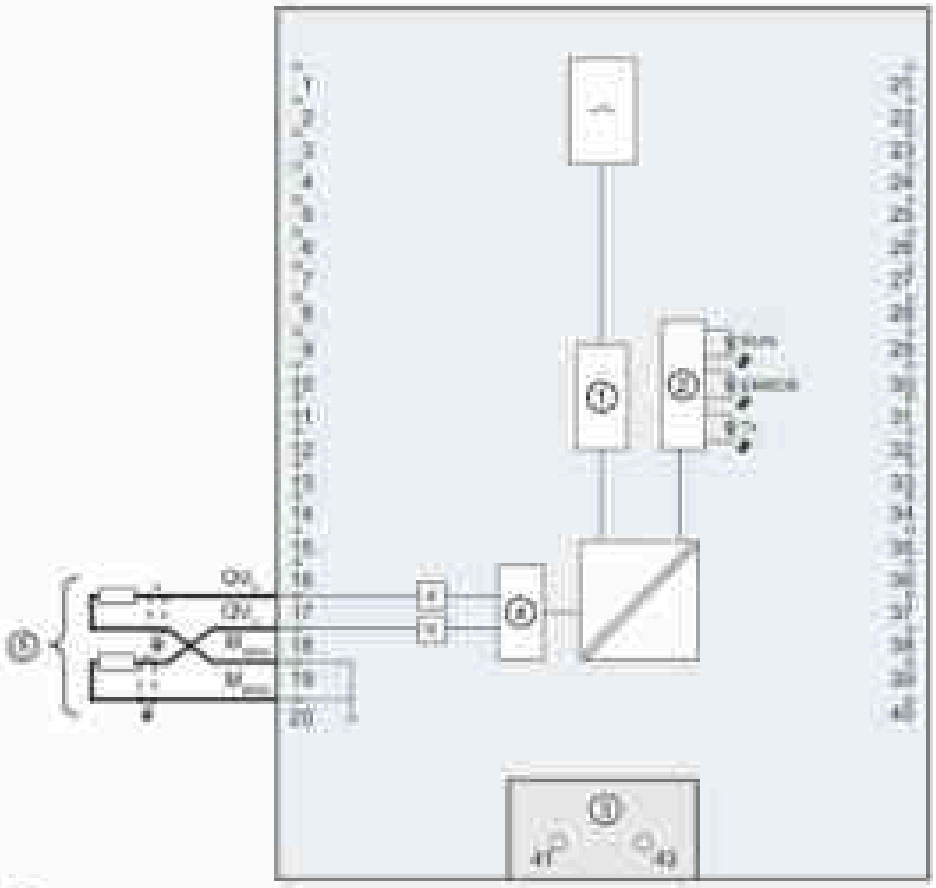
① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ Equipotential bonding cable (optional)
⑥ 2-wire connection

Figure 4-7 Block diagram and terminal assignment for 2-wire connection

Wiring: Voltage output

The figure below shows the terminal assignment for the wiring of the voltage outputs with:

- 2-wire connection, no compensation for line resistances

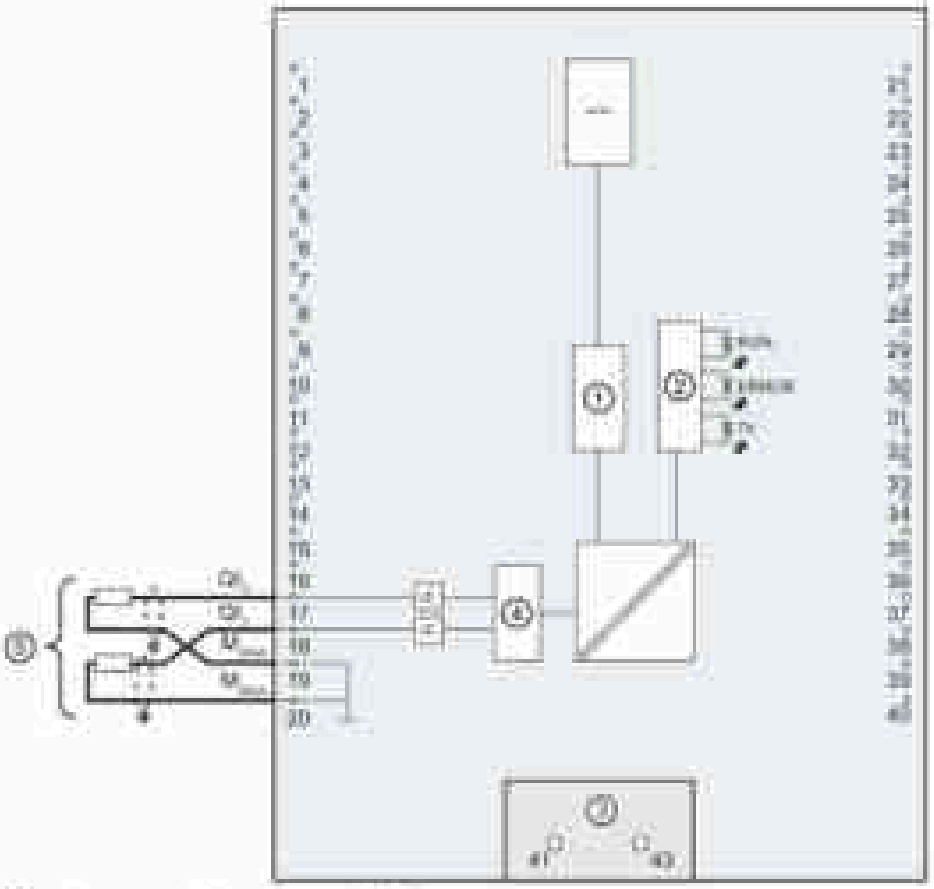


① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ 2-wire connection CH0 and CH1

Figure 4-8 Block diagram and terminal assignment for voltage output

Wiring: Current output

The following figure shows an example of the terminal assignment for wiring current outputs.



① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ Current output CH0 and CH1

Figure 4.9 Block diagram and terminal assignment for current output

4.3.3 Terminal and block diagram of the digital on-board I/O

This section contains the block diagram of the digital on-board I/O (X11 and X12) with standard inputs and outputs and the encoder supply, as well as the rules for the correct wiring of the ground connections.

For information on wiring the front connector, establishing the cable shield, etc., refer to the S7-1500, ET 200MP (http://support.automation.siemens.com/WW/view/en/59191792) system manual.

Infeed element

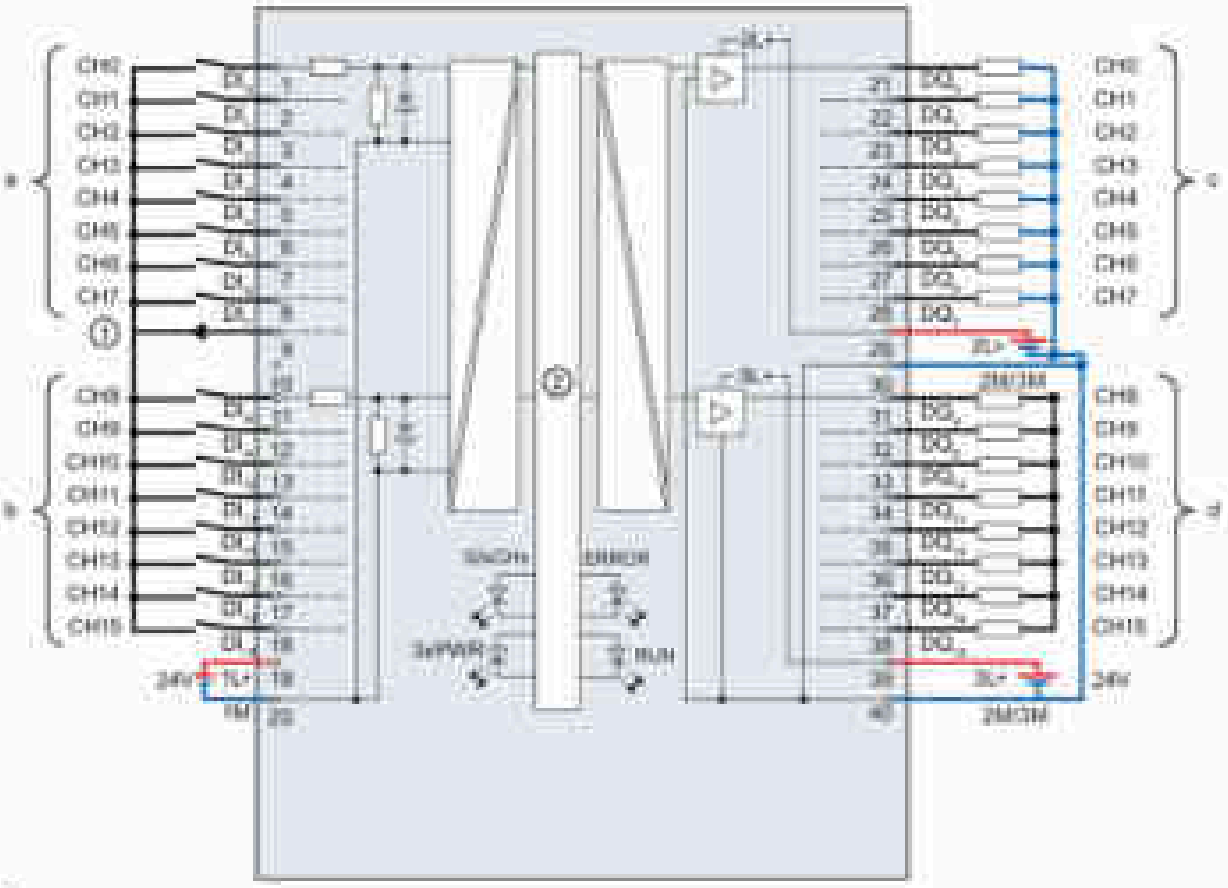
The infeed element is inserted on the front connector and serves to shield the digital on-board I/O.

Note

The digital on-board I/O is supplied via the front connector terminals and therefore does not require power to be supplied by the infeed element. The infeed element is, however, necessary for shielding.

Block diagram and terminal assignment X11

The figure below shows you how to connect the digital on-board I/O X11 and the assignment of the channels to the addresses (input byte a and b, output byte c and d).

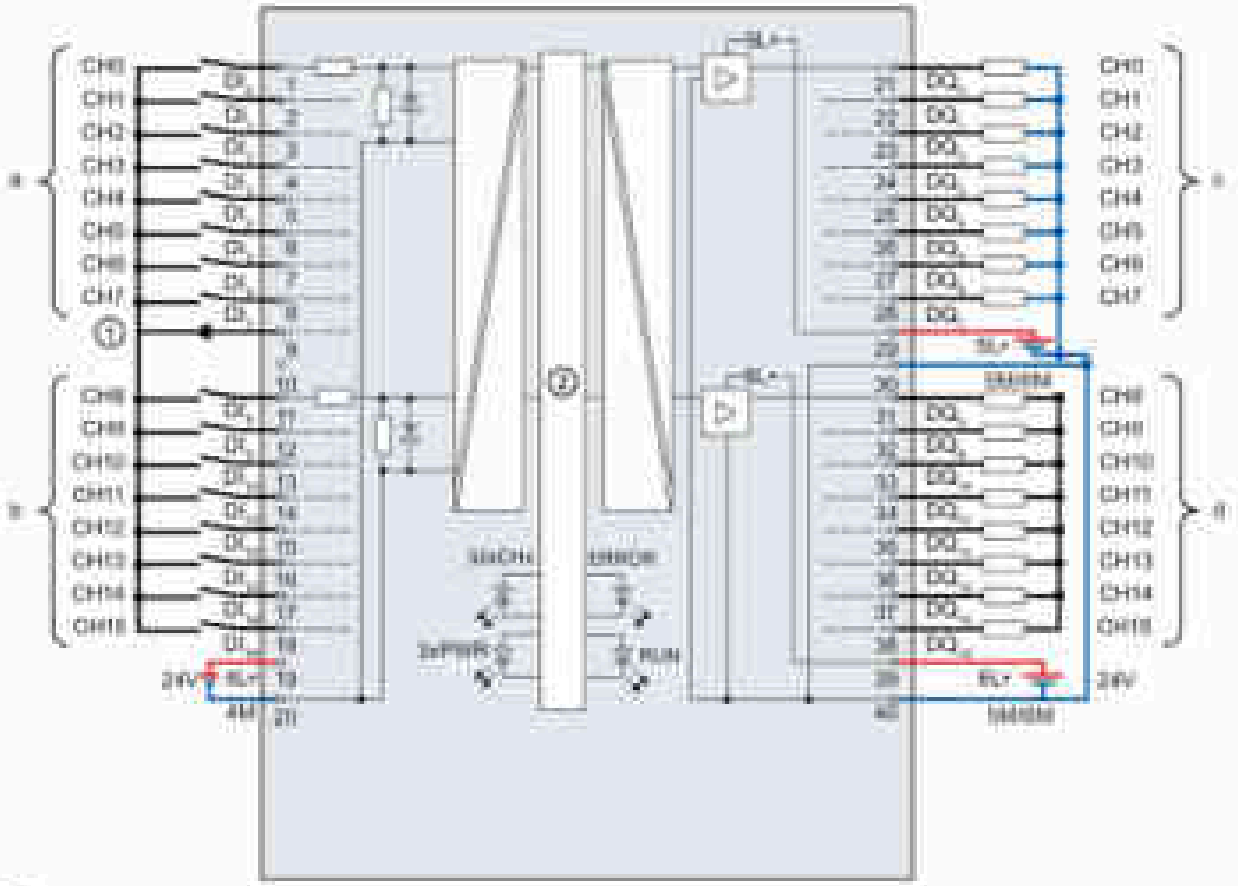


①	Encoder supply for the digital inputs
②	CPU interface
xL+	Connection for 24 V DC supply voltage
xM	Connection for ground
CHx	Channel or channel status LED (green)
RUN	Status display LED (green)
ERROR	Error display LED (red)
PWR	POWER supply voltage LED (green)

Figure 4-10 Block diagram and terminal assignment of the digital on-board I/O X11

Block diagram and terminal assignment X12

The figure below shows you how to connect the digital on-board I/O X12 and the assignment of the channels to the addresses (input byte a and b, output byte c and d).



①	Encoder supply for the digital inputs
②	CPU interface
xL+	Connection for 24 V DC supply voltage
xM	Connection for ground
CHx	Channel or channel status LED (green)
RUN	Status display LED (green)
ERROR	Error display LED (red)
PWR	POWER supply voltage LED (green)

Figure 4-11 Block diagram and terminal assignment of the digital on-board I/O X12

Supply voltage using the digital on-board I/O X11 as an example

The inputs and outputs of the digital on-board I/O are divided into two load groups, which are supplied with 24 V DC.

The digital inputs DI0 to DI15 form a load group and are supplied via the connections 1L+ (terminal 19) and 1M (terminal 20).

The digital outputs DQ0 to DQ7 are supplied via the connection 2L+ (terminal 29). The digital outputs DQ8 to DQ15 are supplied via the connection 3L+ (terminal 39). Please note that the digital outputs DQ0 to DQ15 only have a common ground. In each case, they are led through to the two terminals 30 and 40 (2M/3M) and bridged in the module. The digital outputs form a common load group.

Note

Polarity reversal of the supply voltage

An internal protective circuit protects the digital on-board I/O against destruction if the polarity of the supply voltage is reversed. In the case of polarity reversal of the supply voltage, however, unexpected states can occur at the digital outputs.

Response of the digital outputs to a wire break at ground connection of the outputs

Due to the characteristics of the output driver used in the module, approx. 25 mA supply current flows out through the outputs via a parasitic diode in the event of a ground wire break. This behavior can lead to non-set outputs also carrying high levels and emitting up to 25 mA output current. Depending on the type of load, 25 mA can be sufficient to control the load with high level. To prevent unintended switching of the digital outputs in the event of a ground wire break, follow these steps:

Wire to ground twice

Connect ground to terminal 30 and to terminal 40.

1. Route the first ground connection from terminal 30 to the central ground connection of the plant.

2. Route the second ground connection from terminal 40 to the central ground connection of the plant.

If terminal 30 or 40 are interrupted by a ground wire break, the outputs will continue to be supplied via the second, intact ground connection.

⚠ WARNING

Wire break at ground connection

Never bridge from terminal 30 to terminal 40 in the front connector and **never** lead only one wire to the central ground connection.

Connect terminal 30 and terminal 40 to a common ground point.

The following figure shows how this works using a 400 Hz interference frequency suppression as an example. A 400 Hz interference frequency suppression corresponds to an integration time of 2.5 ms. The analog on-board I/O supplies a measured value to the CPU every 1.25 milliseconds within the integration time.

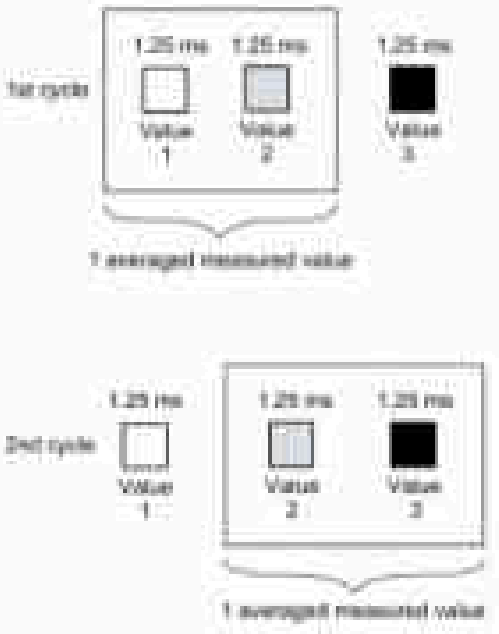


Figure C-1 Interference frequency suppression 400 Hz

The following figure shows how this works using a 60 Hz interference frequency suppression as an example. A 60 Hz interference frequency suppression corresponds to an integration time of 16.6 ms. The analog on-board I/O supplies a measured value to the CPU every 1.04 milliseconds within the integration time.

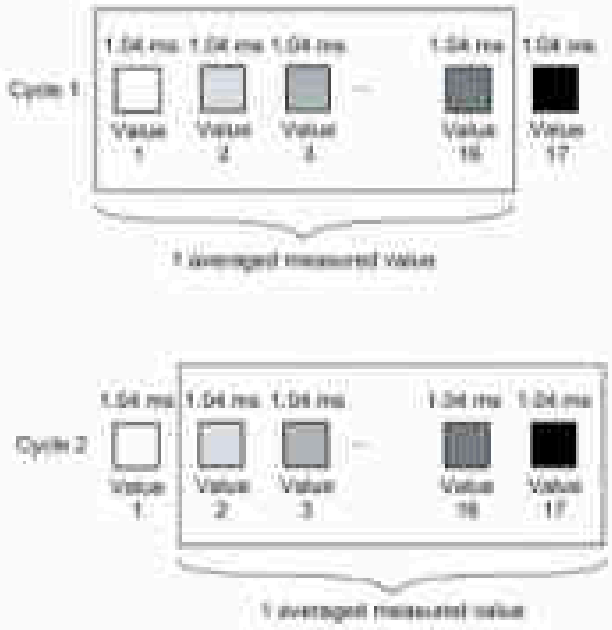


Figure C-2 Interference frequency suppression 60 Hz

The following figure shows how this works using a 50 Hz interference frequency suppression as an example. A 50 Hz interference frequency suppression corresponds to an integration time of 20 ms. The analog on-board I/O supplies a measured value to the CPU every millisecond within the integration time.

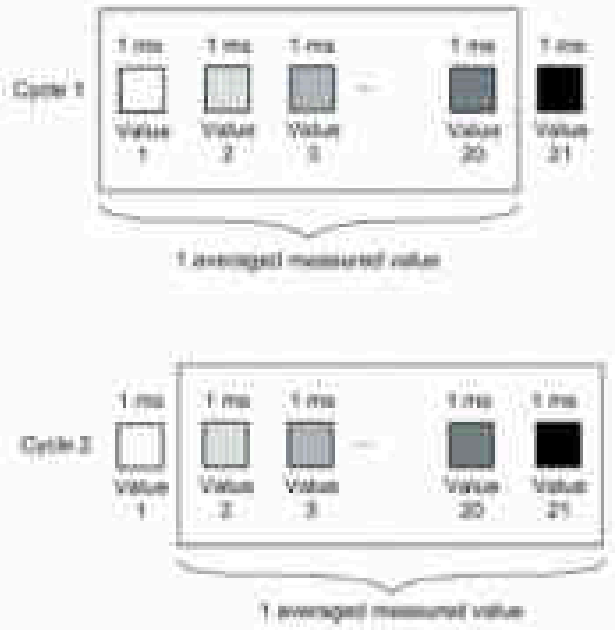


Figure C-3 Interference frequency suppression 50 Hz

The following figure shows how this works using a 10 Hz interference frequency suppression as an example. A 10 Hz interference frequency suppression corresponds to an integration time of 100 ms. The analog on-board I/O supplies a measured value to the CPU every millisecond within the integration time.

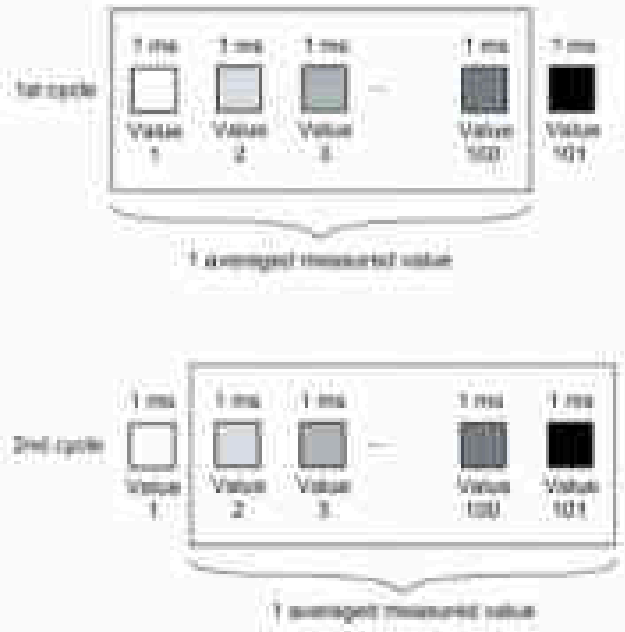


Figure C-4 Interference frequency suppression 10 Hz

The following table provides an overview of the configurable line frequencies, the integration time and the intervals within which measured values are supplied to the CPU.

Table C- 1 Overview of the configurable line frequencies

Interference frequency suppression	Integration time	Interval
400 Hz	2.5 ms	2 x 1.25 ms
60 Hz	16.6 ms	16 x 1.04 ms
50 Hz	20 ms	20 x 1 ms
10 Hz	100 ms	100 x 1 ms

Note

Basic error with an integration time of 2.5 ms.

With an integration time of 2.5 ms, the measured value is changed by the following values based on the additionally obtained basic error and noise:

- with "voltage", "current" and "resistance" by ±0.1 %
- with "Thermal resistor Pt 100 Standard" by ±0.4 K
- with "Thermal resistor Pt 100 Climatic" by ±0.3 K
- with "Thermal resistor Ni 100 Standard" by ±0.2 K
- with "Thermal resistor Ni 100 Climatic" by ±0.1 K

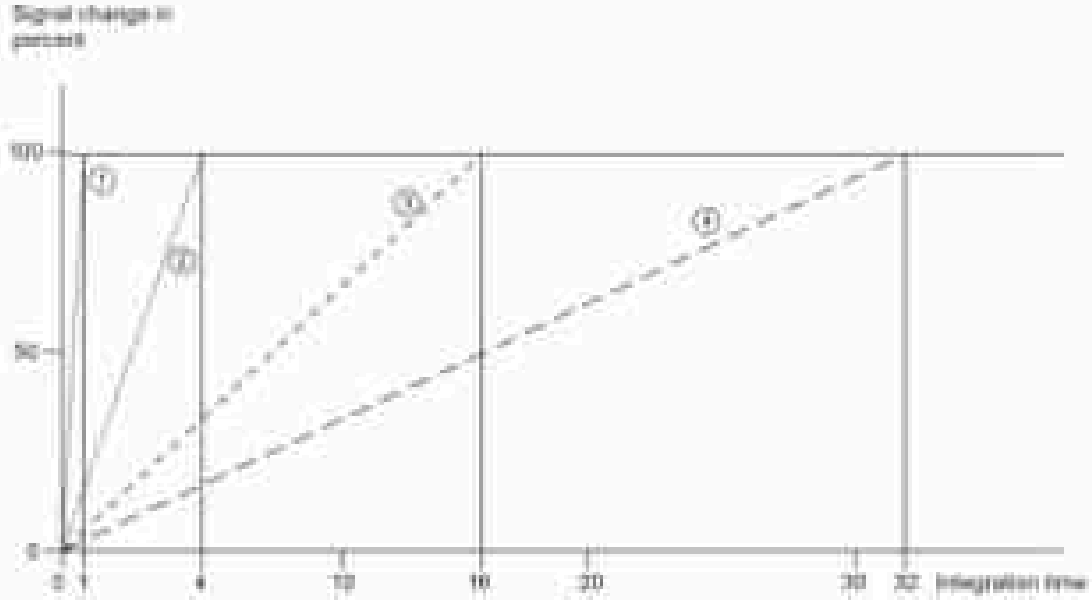
A detailed description of the basic and operating error is available in the function manual Analog value processing (http://support.automation.siemens.com/WW/view/en/67989094).

Smoothing

The individual measured values are smoothed by filtering. The smoothing can be set in 4 levels.

Smoothing time = Smoothing (x) x configured integration time

The following figure shows the time it takes for the smoothed analog value to reach approximately 100 % depending on the set smoothing. This is valid for all signal changes at the analog input.



① None (smoothing = 1 x integration time)
② Weak (smoothing = 4 x integration time) *
③ Medium (smoothing = 16 x integration time) *
④ Strong (smoothing = 32 x integration time) *

* The smoothing time can increase by 1 x integration time.

Figure C-5 Smoothing time depending on the set smoothing level

The following table shows the time it takes for the smoothed analog value to reach approximately 100 % depending on the set smoothing and the set interference frequency suppression.

Table C- 2 Smoothing time depending on the set smoothing level and interference frequency suppression

Selection of the smoothing (mean value generation from scan values)	Interference frequency suppression/smoothing time			
	400 Hz	60 Hz	50 Hz	10 Hz
None	2.5 ms	16.6 ms	20 ms	100 ms
Weak	10 ms	66.4 ms	80 ms	400 ms
Medium	40 ms	265.8 ms	320 ms	1600 ms
Strong	80 ms	531.2 ms	640 ms	3200 ms

Cycle time

The cycle times (1 ms, 1.04 ms and 1.25 ms) result from the configured interference frequency suppression. The cycle time is independent of the number of configured analog channels. The values for the analog input channels are detected sequentially in each cycle.

Reference

For more information on conversion time, cycle time and conversion method, refer to the Analog value processing (http://support.automation.siemens.com/WW/view/en/67989094) function manual.

C.2 Representation of analog values

Introduction

The analog values for all measuring ranges that you can use with the analog on-board I/O are represented in this appendix.

For cross-product information on "analog value processing", refer to the Analog value processing (http://support.automation.siemens.com/WW/view/en/67989094) function manual.

Measured value resolution

Each analog value is entered left aligned into the tags. The bits marked with "x" are set to "0".

Note

This resolution does not apply to temperature values. The digitalized temperature values are the result of a conversion in the analog on-board I/O.

Table C- 3 Resolution of the analog values

Resolution in bits including sign	Values		Analog value	
	Decimal	Hexadecimal	High byte	Low byte
16	1	1H	Sign 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1

C.3 Representation of input ranges

C.3.1 Representation of input ranges

The tables below set out the digitized representation of the input ranges separately for bipolar and unipolar input ranges. The resolution is 16 bits.

Table C- 4 Bipolar input ranges

Dec. value	Measured value in %	Data word																Range
		2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	
32767	>117.589	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Overflow
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Overrange
27649	100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	Nominal range
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-1	-0.003617	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
-27648	-100.000	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	
-27649	-100.004	1	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	Underrange
-32512	-117.593	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
-32768	<-117.593	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Underflow

Table C- 5 Unipolar input ranges

Dec. value	Measured value in %	Data word																Range
		2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	
32767	>117.589	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Overflow
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Overrange
27649	100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	Nominal range
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-1	-0.003617	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Underrange
-4864	-17.593	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	
-32768	<-17.593	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Underflow

C.3.2 Representation of analog values in voltage measuring ranges

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

Table C- 6 Voltage measuring ranges ±10 V, ±5 V

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

Table C- 7 Voltage measuring range 1 to 5 V, 0 to 10 V

Values		Voltage measuring range		Range
dec.	hex.	1 to 5 V	0 to 10 V	
32767	7FFF	>5.704 V	11.852 V	Overflow
32511	7EFF	5.704 V	11.759 V	Overrange
27649	6C01			
27648	6C00	5 V	10.0 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

C.3.3 Representation of analog values in current measuring ranges

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

Table C- 8 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

Table C- 9 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

C.3.4 Representation of the analog values of resistance-type sensors/resistance-type thermometers

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

Table C- 10 Resistance-type sensors of 150 Ω, 300 Ω and 600 Ω

Values		Resistance-type sensor range			
dec.	hex.	150 Ω	300 Ω	600 Ω	
32767	7FFF	>176.38 Ω	>352.77 Ω	>705.53 Ω	Overflow
32511	7EFF	176.38 Ω	352.77 Ω	705.53 Ω	Overrange
27649	6C01				
27648	6C00	150 Ω	300 Ω	600 Ω	Nominal range
20736	5100	112.5 Ω	225 Ω	450 Ω	
1	1	5.43 mΩ	10.85 mΩ	21.70 mΩ	
0	0	0 Ω	0 Ω	0 Ω	

Table C- 11 Resistance-type thermometer Pt 100 Standard

Pt 100 Standard in °C (1 digit = 0.1°C)	Values		Pt 100 Standard in °F (1 digit = 0.1 °F)	Values		Pt 100 Standard in K (1 digit = 0.1 K)	Values		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

Table C- 12 Resistance-type thermometer Pt 100 Climate

Pt 100 Climate/ in °C (1 digit = 0.01 °C)	Values		Pt 100 Climate/ in °F (1 digit = 0.01 °F)	Values		Range
	dec.	hex.		dec.	hex.	
> 155.00	32767	7FFF	> 311.00	32767	7FFF	Overflow
155.00	15500	3C8C	311.00	31100	797C	Overrange
:	:	:	:	:	:	
139.01	13901	32CD	266.01	26601	67E9	
139.00	13900	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	C79C	-229.00	-22900	A68C	
< -145.00	-32768	8000	< -229.00	-32768	8000	Underflow

Table C- 13 Resistance-type thermometer Ni 100 standard

Ni 100 Standard in °C (1 digit = 0.1 °C)	Values		Ni 100 Standard in °F (1 digit = 0.1 °F)	Values		Ni 100 Standard in K (1 digit = 0.1 K)	Values		Range
	dec.	hex.		dec.	hex.		dec.	hex.	
> 295.0	32767	7FFF	> 563.0	32767	7FFF	> 568.2	32767	7FFF	Overflow
295.0	2950	B86	563.0	5630	15FE	568.2	5682	1632	Overrange
:	:	:	:	:	:	:	:	:	
250.1	2501	9C5	482.1	4821	12D5	523.3	5233	1471	
250.0	2500	9C4	482.0	4820	12D4	523.2	5232	1470	Nominal range
:	:	:	:	:	:	:	:	:	
-60.0	-600	FDA8	-76.0	-760	FD08	213.2	2132	854	
-60.1	-601	FDA7	-76.1	-761	FD07	213.1	2131	853	Underrange
:	:	:	:	:	:	:	:	:	
-106.0	-1060	FBE6	-157.0	-1570	F9DE	166.2	1662	682	
< -106.0	-32768	8000	< -157.0	-32768	8000	< 166.2	32768	8000	Underflow

Table C- 14 Resistance-type thermometer Ni 100 Climate

Ni 100 Climate in °C (1 digit = 0.01 °C)	Values		Ni 100 Climate in °F (1 digit = 0.01 °F)	Values		Range
	dec.	hex.		dec.	hex.	
> 155.00	32767	7FFF	> 311.00	32767	7FFF	Overflow
155.00	15500	3C8C	311.00	31100	797C	Overrange
:	:	:	:	:	:	
139.01	13901	32CD	266.01	26601	67E9	

Ni 100 Climate in °C (1 digit = 0.01 °C)	Values		Ni 100 Climate in °F (1 digit = 0.01 °F)	Values		Range
	dec.	hex.		dec.	hex.	
130.00	13000	32C8	266.00	26600	67E8	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

C.3.5 Measured values for wire break diagnostics

Measured values for "Wire break" diagnostics as a function of diagnostics enables

With suitable parameter assignment, events that occur trigger a diagnostics entry and a diagnostics interrupt.

Table C- 15 Measured values for wire break diagnostics

Format	Parameter assignment	Measured values		Explanation
S7	• "Wire break" diagnostics enabled • "Overflow/Underflow" diagnostics enabled or disabled ("Wire break" diagnostics has a higher priority than "Overflow/Underflow" diagnostics)	32767	7FFFH	"Wire break" or "Cable break" diagnostics alarm
	• "Wire break" diagnostics disabled • "Overflow/Underflow" diagnostics enabled	-32767	8000H	• Measured value after leaving the underrange • Diagnostics alarm "Low limit" violated
	• "Wire break" diagnostics disabled • "Overflow/Underflow" diagnostics disabled	-32767	8000H	Measured value after leaving the underrange

C.4 Representation of output ranges

C.4.1 Representation of output ranges

The tables below set out the digitalized representation of the output ranges separately for bipolar and unipolar ranges. The resolution is 16 bits.

Table C- 16 Bipolar output ranges

Dec. value	Output value in %	Data word																Range
		2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Maximum output value*
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Overrange
27649	100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	Nominal range
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-1	-0.003617	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
-27648	-100.000	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	
-27649	-100.004	1	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	Underrange
-32512	-117.593	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
-32512	-117.593	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	Minimum output value**

* When values > 32511 are specified, the output value is limited to 117.589%.

** When values < -32512 are specified, the output value is limited to -117.593%.

Table C- 17 Unipolar output ranges

Dec. value	Output value in %	Data word																Range
		2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	
32511	117.589	0	1	1	1	1	1	1	1	x	x	x	x	x	x	x	x	Maximum output value*
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Overrange
27649	100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	Nominal range
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Minimum output value**

* When values > 32511 are specified, the output value is limited to 117.589%.

** When values < 0 are specified, the output value is limited to 0%.