2.3.1 Properties of the CPU part

View of the CPU

The figure below shows the CPU part of the CPU 1511C-1 PN.



Figure 2-1 CPU 1511C-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 1511C-1 PN has the following technical properties:

- Communication:
  - Interfaces

    The CPU 1511C-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 configuring 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.
    You can find more information on "PROFINET IO" in the online help of STEP 7 (TIA Portal) and the PROFINET Function Manual (http://support.automation.siemens.com/WW/view/en/68039307).
  - OPC UA

    With OPC UA, data is exchanged via an open and vendor-neutral communication protocol. The CPU, as OPC UA server, can communicate with OPC UA clients such as HMI panels, SCADA systems, etc.

- Integrated Web server:

  A Web server is integrated in the CPU. The Web server enables monitoring and administering of the CPU by authorized users over a network. Evaluations, diagnostics, and modifications are thus possible over long distances. All you need is a Web browser.

  With the Web server, you can read out the following data from the CPU and, in some cases, modify and write back the data to the CPU.

  – Start page with general CPU information
  – Identification information
  – Contents of the diagnostics buffer
  – Querying module information
  – Firmware update
  – Alarms (without acknowledgment option)
  – Information about communication
  – PROFINET topology
  – Tag status, writing tags
  – Watch tables
  – Memory usage
  – User pages
  – Data logs (if used)
  – Online backup and restoration of the configuration
  – Diagnostics information for the Motion Control technology objects
  – Display of trace recordings stored on the SIMATIC memory card
  – Readout service data
  – Basic websites
  – Display of the Web server in 3 project languages, for example, comments and message texts
  – Recipes
  – User pages

- Supported technology:
  - Counting, measuring, position detection and pulse generators

    The technology functions high-speed counting, measuring, position detection and pulse generators (PWM/frequency output/PTO) are integrated in the compact CPU. For more information on integrated technology functions, refer to the section Technology functions.
  - Motion Control

    Through technology objects, the Motion Control functionality supports speed-controlled axes, positioning axes, synchronous axes and external encoders, cams, cam tracks and probes as well as PLC open blocks for programming the motion control 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/109739589) function manual.

    You can also use the *TIA Selection Tool* or the *SIZER* to create or configure axes.
  - Integrated closed-loop control functionality

    - PID Compact (continuous PID controller)

    - PID 3Step (step controller for integrating actuators)

    - PID Temp (temperature controller for heating and cooling with two separate actuators)
- 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 function (http://support.automation.siemens.com/WW/view/en/64897128) function manual.
- Integrated system diagnostics:
  - The system automatically generates the alarms for the system diagnostics and outputs these alarms via a PG/PC, HMI device, the 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.
- Additional supported functions:
  - PROFIenergy
    For information on "PROFIenergy", refer to the PROFINET (http://support.automation.siemens.com/WW/view/en/68039307) function manual and the PROFINET specification on the Internet (http://www.profibus.com).
  - Shared device
    For information on "Shared device", refer to the PROFINET (http://support.automation.siemens.com/WW/view/en/68039307) function manual.
  - 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/68039307) function manual.

Reference

You can find more information on the topic of "Integrated security/Access protection" in the S7-1500, ET 200MP system manual (http://support.automation.siemens.com/WW/view/en/59191792).

2.3.2 Properties of the analog on-board I/O

View

The following figure shows the analog on-board I/O (X10) of the CPU 1511C-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)
  - Support of the value status (Quality Information, QI)
- Analog outputs
  - 2 analog outputs
  - Resolution: 16 bits incl. sign
  - Voltage output selectable by channel
  - Current output selectable by channel
  - Configurable diagnostics (per channel)
  - Support of the value status (Quality Information, QI)

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 the parameter data records of the analog on-board I/O (Page 148))

2.3.3 Properties of the digital on-board I/O

View

The following figure shows the digital on-board I/O (X11) of the CPU 1511C-1 PN.



Figure 2-3 Digital on-board I/O

Properties

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

- Digital inputs
  - 16 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)
  - Support of the value status (Quality Information, QI)
- Digital outputs
  - 16 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 functions, you can select between an output current of up to 0.5 A for an output frequency up to 10 kHz (load-dependent) and a reduced output current of max. 0.1 A at an increased output frequency of up to 100 kHz
  - Suitable, for example, for solenoid valves, DC contactors and indicator lights as well as for signal transmission or proportional valves
  - Configurable diagnostics
  - Support of the value status (Quality Information, QI)

  You can find a table showing the output frequencies and output currents through which outputs is available in the section Interconnection overview of the outputs (Page 99).

  The digital outputs feature driver blocks with push-pull outputs. Due to their basic functional design, such driver blocks always contain parasitic diodes, that act as freewheeling diodes when shutting off inductive loads (see figure "Current flow with correct wiring using the digital on-board I/O X11 as an example" in the section Wiring and block diagrams of the digital on-board I/O (Page 82)). The shutdown voltage is limited to -0.8 V. Therefore, the demagnetization of inductive loads takes longer and can be approximately calculated using the following formula.

  tau = L / R (tau= time constant, L = inductance value, R = ohmic resistance value)

  After the expiration of a period of 5 * tau, the current has decreased in effect to 0 A due to the inductive load.

  The maximum value is derived from: tau = 1.15H / 48 Ohm = 24ms. After 5 * 24 ms = 120 ms, the current has decreased in effect to 0 A.

  For comparison: With standard modules, inductive shutdown voltage, for example, is limited to Vcc -53 V (supply voltage – 53 V), so that the current has decreased to about to 0 A after 15 ms.

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

- Reconfiguration in RUN
  You can reconfigure some of the technological functions in RUN mode of the CPU (for more information, refer to the section Parameter assignment and structure of the parameter data records of the digital on-board I/O (Page 156)).

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 or PTO 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.

Wiring

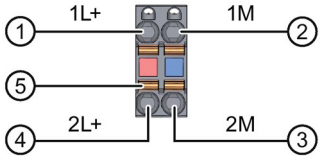
4

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

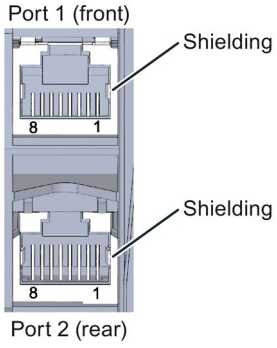
If the CPU is supplied by a system power supply, it is not necessary to connect the 24 V supply.

4.2 PROFINET interfaces

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

The assignment corresponds to the Ethernet standard for an RJ45 plug.

- When autonegotiation is deactivated, the RJ45 socket is allocated as a switch (MDI-X).
- When autonegotiation is activated, autocrossing is in effect and the RJ45 socket is allocated either as data terminal equipment (MDI) or a switch (MDI-X).



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 1511C-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 1511C-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 1511C-1 PN.

The table below shows how the MAC addresses are assigned.

Table 4- 1 Assignment of the MAC addresses

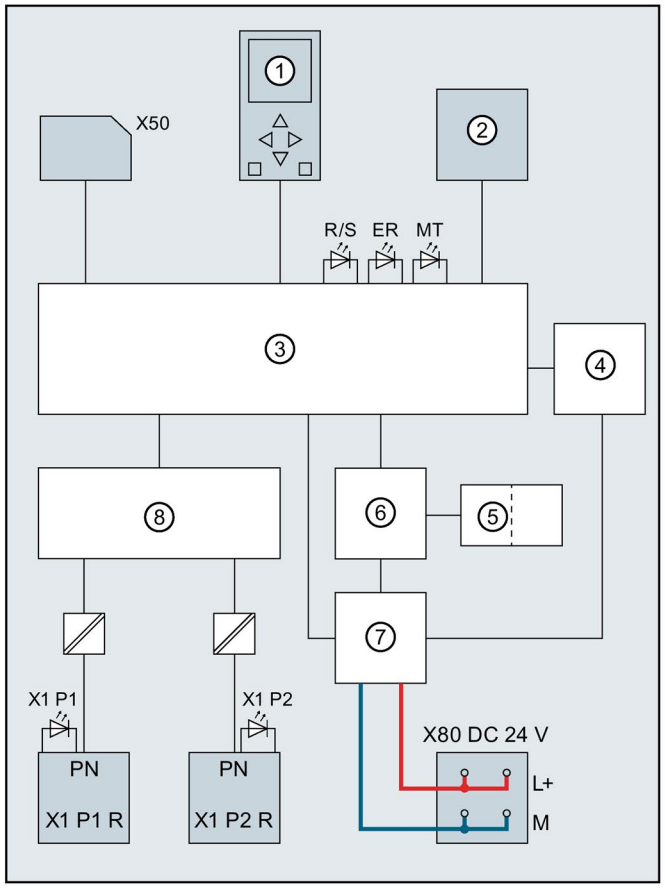
	Assignment	Labeling
MAC address 1	PROFINET interface X1 (visible in STEP 7 for accessible devices)	• Front, lasered • Right side, lasered (start of number range)
MAC address 2	Port X1 P1 R (required for LLDP, for example)	• Front and right side, not lasered
MAC address 3	Port X1 P2 R (required for LLDP, 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	X80 24 V DC	Infeed of supply voltage
②	RUN/STOP/MRES 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	R/S	RUN/STOP LED (yellow/green)
⑦	Internal supply voltage	ER	ERROR LED (red)
⑧	2-port switch	MT	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 (only resistance-type transmitters or thermal resistors (RTD))
I_n+/I_n-	Current input channel n (current only)
$I_{c\,n}+/I_{c\,n}-$	Current output for RTD, channel n
QV_n	Voltage output channel
QI_n	Current output channel
M_{ANA}	Reference potential of the analog circuit
CHx	Channel or display of the channel status

Infeed element

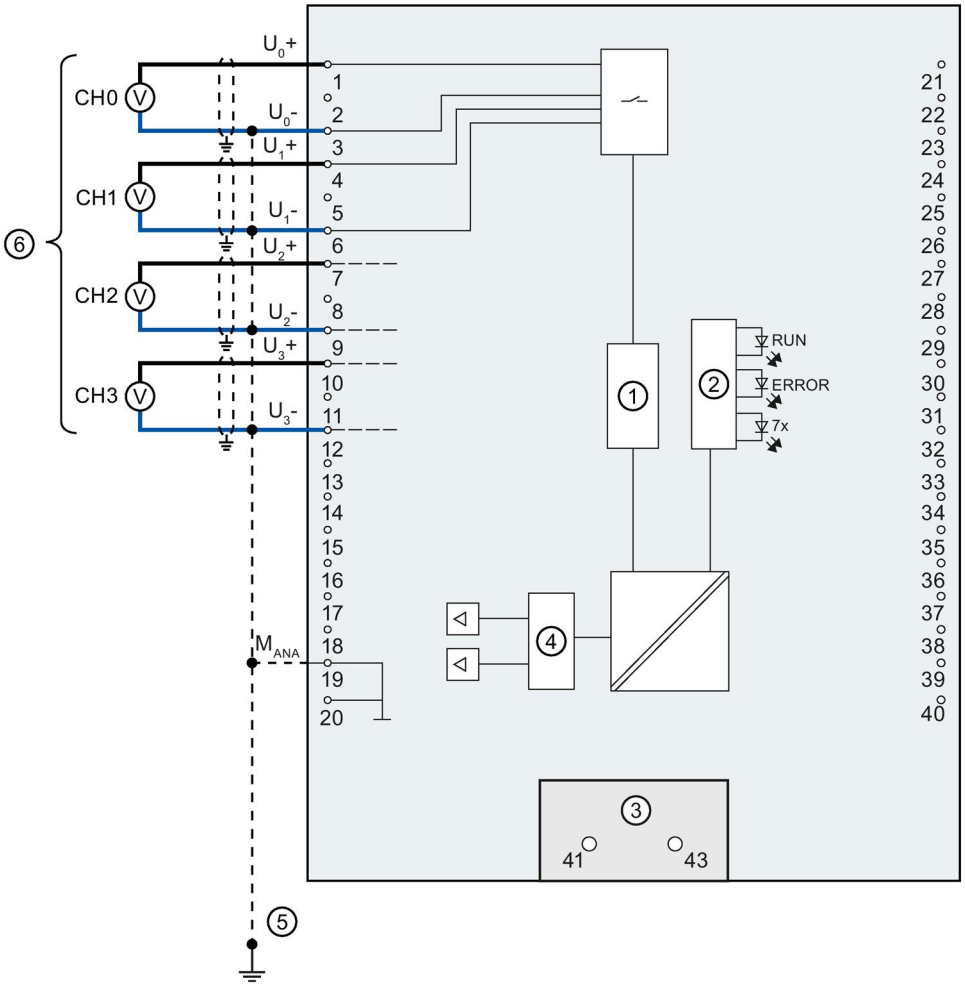
The infeed element is inserted on the front connector and serves to shield the analog on-board I/O.

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).

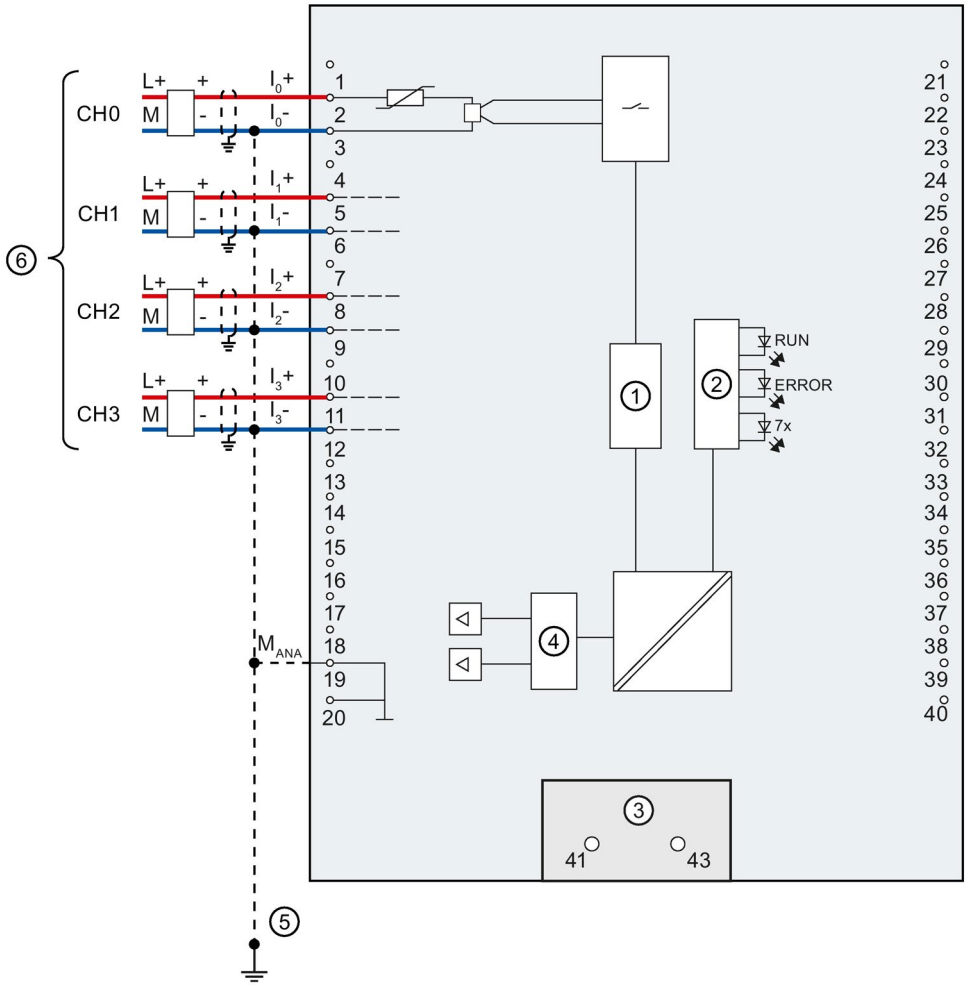


① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ Equipotential bonding cable (optional)
⑥ Voltage measurement

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

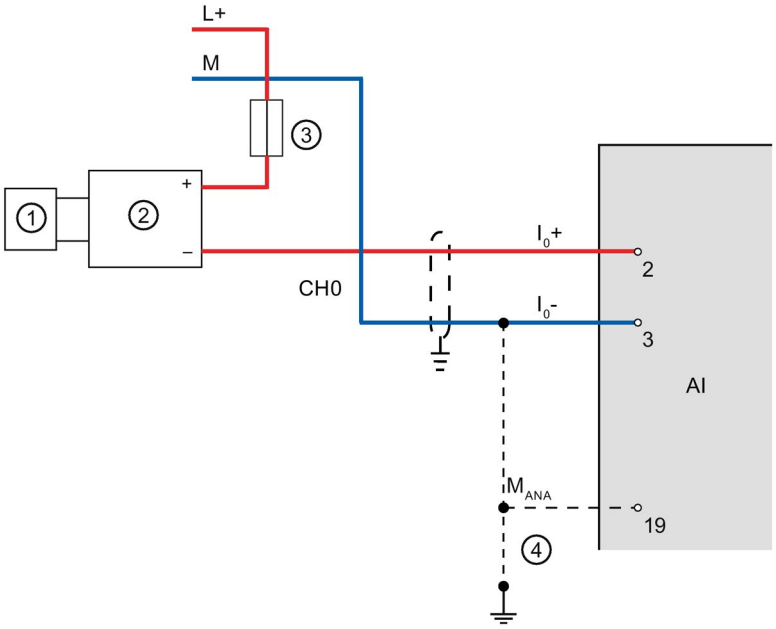
Figure 4-4 Block diagram and terminal assignment for current measurement with 4-wire measuring transducer

Wiring: 2-wire measuring transducer for current measurement

As an alternative to connecting a 4-wire measuring transducer, you can also connect 2-wire measuring transducers to channels 0 to 3. An external 24 V power supply is required to connect a 2-wire measuring transducer to the analog on-board I/O of the compact CPU. Feed this voltage short-circuit proof to the 2-wire transducer. Use a fuse to protect the power supply unit.

NOTICE
Defective measuring transducer
Note that the analog input of the measuring transducer is not protected against destruction in the event of a defect (short circuit). Take the necessary precautions against such cases.

The figure below shows an example of the connection of a 2-wire measuring transducer to channel 0 (CH0) of the analog on-board I/O.



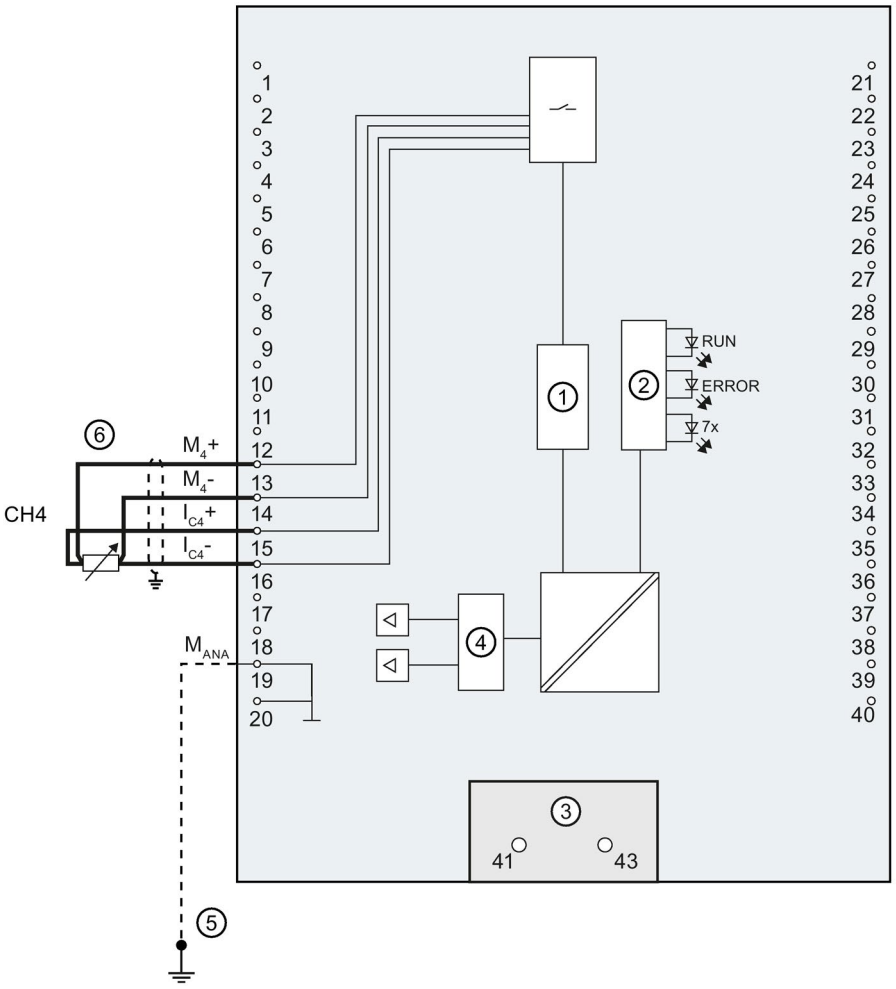
① Sensor (e.g. pressure gauge)
② 2-wire measuring transducer
③ Fuse
④ Equipotential bonding cable (optional)

Figure 4-5 2-wire measuring transducer at channel 0

Use the measurement type "Current (4-wire transducer)" and the measuring range 4 to 20 mA for the parameter assignment of the 2-wire measuring transducer in STEP 7 (TIA Portal).

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

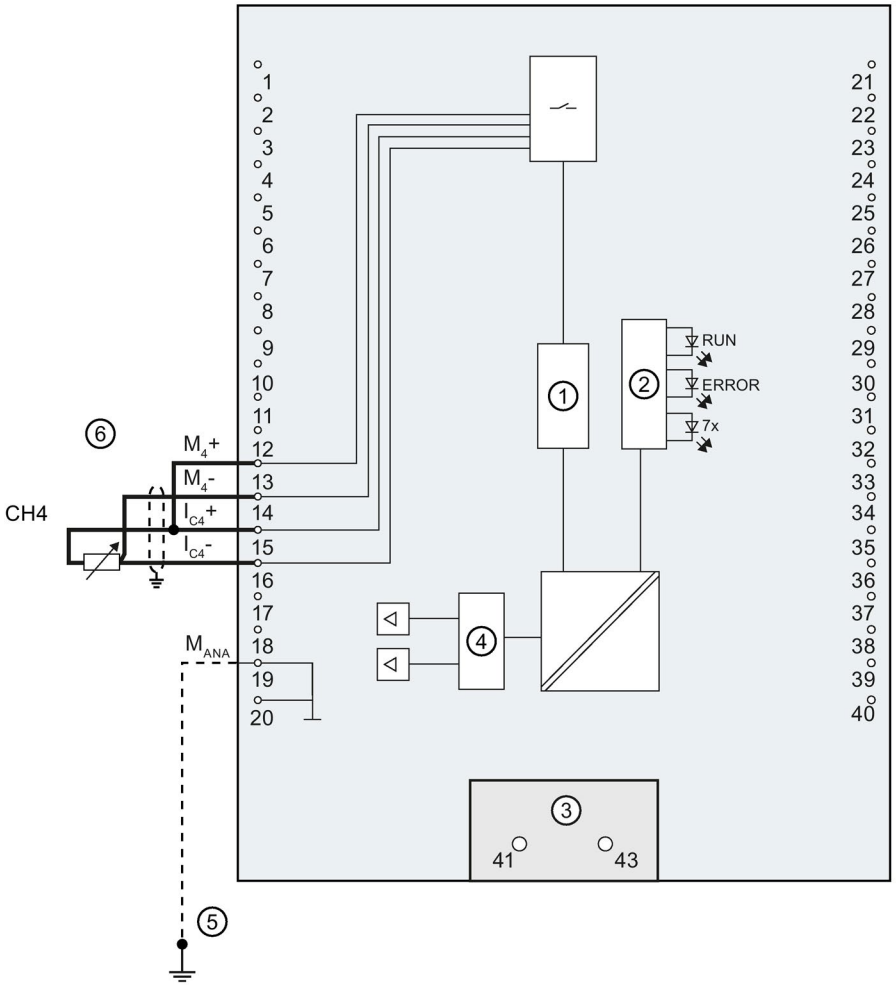
Wiring: 3-wire connection of resistance-type sensors or thermal resistors (RTD)

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

3-wire connection

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 4-7 Block diagram and terminal assignment for 3-wire connection

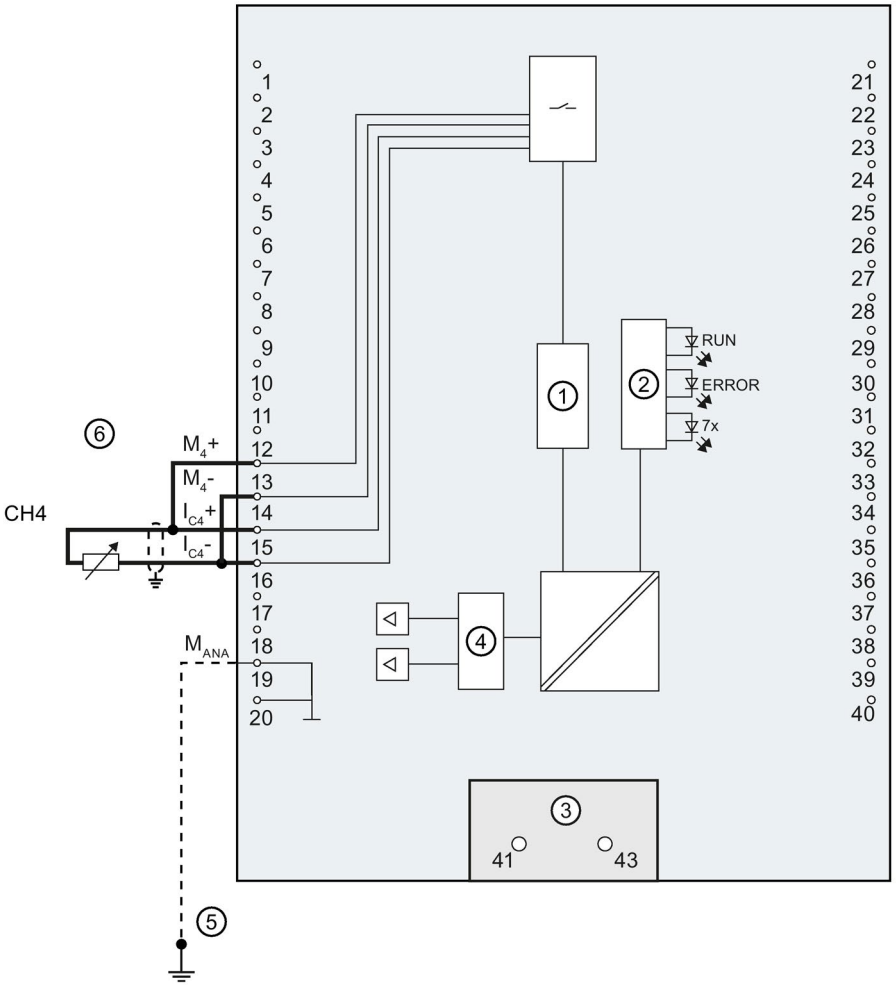
Wiring: 2-wire connection of resistance-type sensors or thermal resistors (RTD)

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

2-wire connection

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



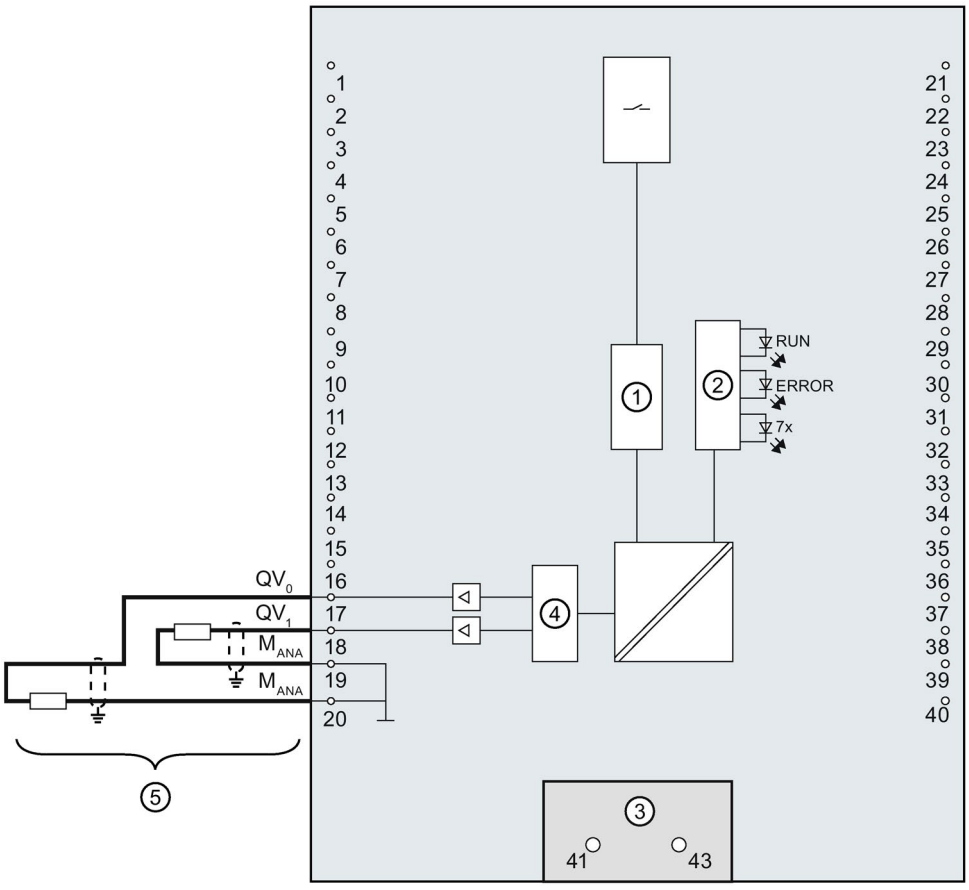
① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ Equipotential bonding cable (optional)
⑥ 2-wire connection

Figure 4-8 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 without 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

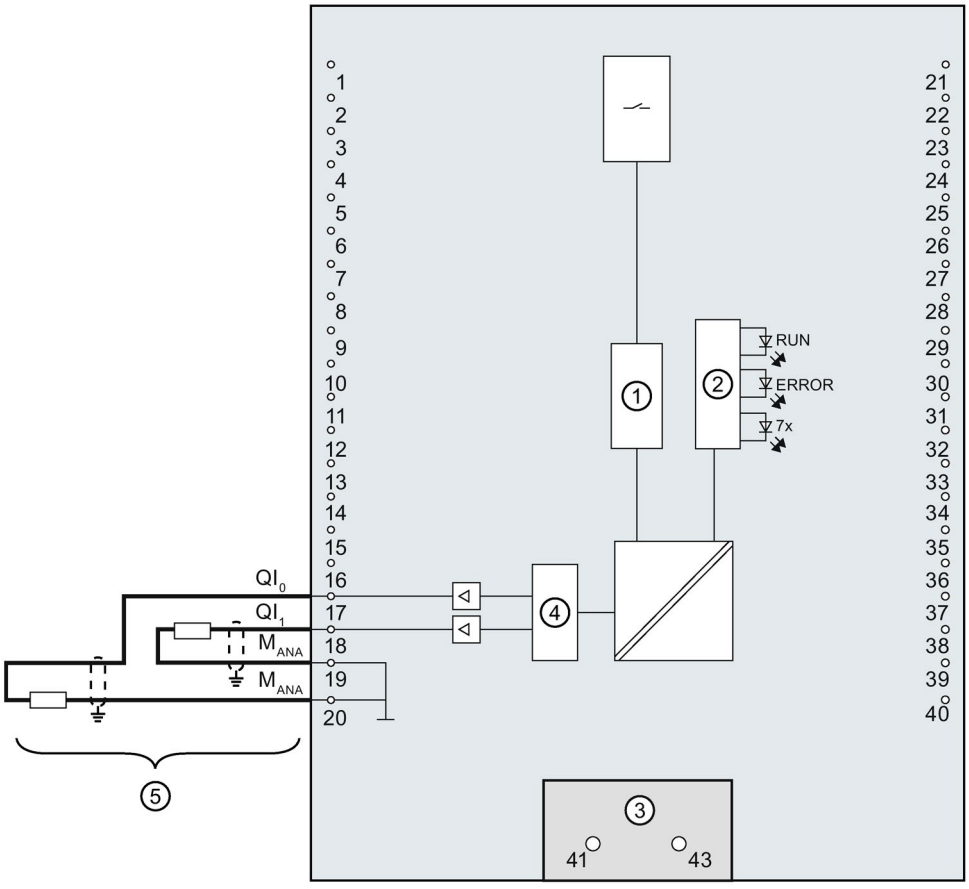
Figure 4-9 Block diagram and terminal assignment for voltage output

Note

M_{ANA} on terminals 19 and 20 is equivalent.

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 4-10 Block diagram and terminal assignment for current output

Note

M_{ANA} on terminals 19 and 20 is equivalent.

4.3.3 Wiring and block diagrams of the digital on-board I/O

This section contains the block diagram of the digital on-board I/O (X11) 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

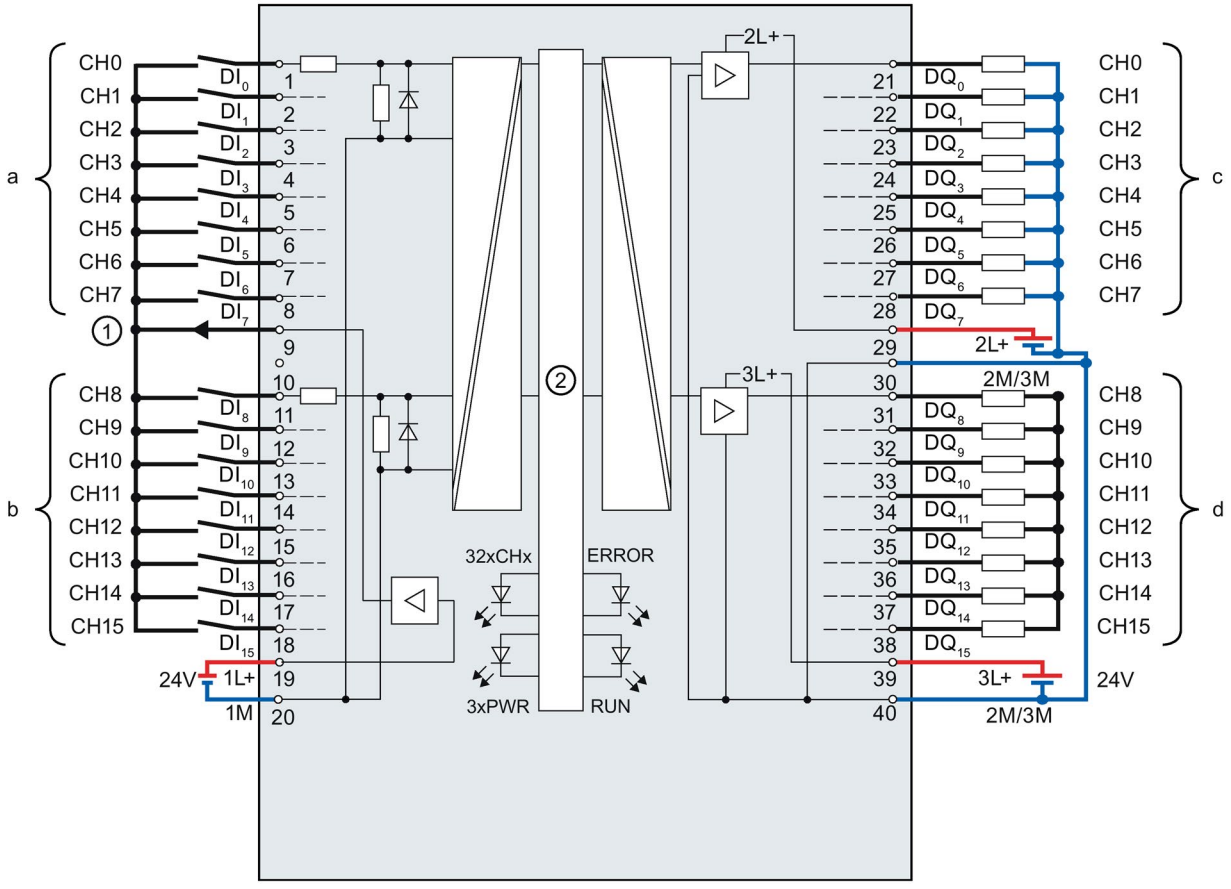
The infeed element is inserted on the front connector and serves to shield the digital on-board I/O.

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

The figure below shows you how to connect the digital on-board I/O 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

NOTICE
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.

Technical specifications

7

Technical specifications of the CPU 1511C-1 PN

	6ES7511-1CK00-0AB0
General information	
Product type designation	CPU 1511C-1 PN
Hardware functional status	FS03
Firmware version	V2.0
Engineering with	
STEP 7 TIA Portal can be configured/integrated as of version	V14
Configuration control	
Via data record	Yes
Display	
Screen diagonal (cm)	3.45 cm
Operator controls	
Number of keys	6
Mode selector	1
Supply voltage	
Type of supply voltage	24 V DC
Valid range, low limit (DC)	19.2 V; 20.4 V DC for supply of digital inputs/outputs
Valid range, high limit (DC)	28.8 V
Reverse polarity protection	Yes
Power and voltage failure backup	
Power/voltage failure backup time	5 ms; refers to the supply voltage at the CPU
Input current	
Current consumption (rated value)	0.8 A; digital on-board I/O is supplied separately
Inrush current, max.	1.9 A; rated value
I^2t	0.34 A^2s
Digital inputs	
From the load voltage L+ (no load), max.	20 mA; per group
Digital outputs	
From the load voltage L+, max.	30 mA; per group, without load
Output voltage	
Rated value (DC)	24 V

	6ES7511-1CK00-0AB0
Encoder supply	
Number of outputs	1; a common 24 V encoder supply
24 V encoder supply	
24 V	Yes; L+ (-0.8 V)
Short-circuit protection	Yes
Output current, max.	1 A
Power	
Power consumption from the backplane bus (balanced)	8.5 W
Incoming power to the backplane bus	10 W
Power loss	
Power loss, typ.	11.8 W
Memory	
SIMATIC memory card required	Yes
Work memory	
integrated (for program)	175 KB
integrated (for data)	1 MB
Load memory	
Plug-in (SIMATIC Memory Card), max.	32 GB
Buffering	
maintenance-free	Yes
CPU processing times	
for bit operations, typ.	60 ns
for word operations, typ.	72 ns
for fixed point arithmetic, typ.	96 ns
for floating point arithmetic, typ.	384 ns
CPU blocks	
Number of elements (total)	2000; blocks (OB/FB/FC/DB) and UDTs
DB	
Number range	1 ... 60 999; divided into: Number range that can be used by user: 1 ... 59 999 and number range for DBs generated by SFC 86: 60 000 ... 60 999
Size, max.	1 MB; the maximum size of the DB is 64 KB with non-optimized block access
FB	
Number range	0 ... 65 535
Size, max.	175 KB
FC	
Number range	0 ... 65 535
Size, max.	175 KB

	6ES7511-1CK00-0AB0
OB	
Size, max.	175 KB
Number of free cycle OBs	100
Number of time-of-day interrupt OBs	20
Number of time-delay interrupt OBs	20
Number of cyclic interrupt OBs	20; with minimum OB 3x cycle of 500 µs
Number of hardware interrupt OBs	50
Number of DPV1 interrupt OBs	3
Number of isochronous mode OBs	1
Number of technology synchronization interrupt OBs	2
Number of startup OBs	100
Number of asynchronous error OBs	4
Number of synchronous error OBs	2
Number of diagnostics interrupt OBs	1
Nesting depth	
per priority class	24
Counters, timers and their retentivity	
S7 counters	
Number	2048
Retentivity	
• can be set	Yes
IEC counters	
Number	Any (only limited by the work memory)
Retentivity	
• can be set	Yes
S7 timers	
Number	2048
Retentivity	
• can be set	Yes
IEC timers	
Number	Any (only limited by the work memory)
Retentivity	
• can be set	Yes
Data areas and their retentivity	
Retentive data area in total (incl. timers, counters, bit memory), max.	128 KB; in total; for bit memory, timers, counters, DBs and technological data (axes), usable retentive memory: 88 KB
Bit memory	
Number, max.	16 KB
Number of clock memory bits	8; there are 8 clock memory bits, grouped in one clock memory byte

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Data blocks	
Retentivity can be set	Yes
Retentivity preset	No
Local data	
per priority class, max.	64 KB; max. 16 KB per block
Address area	
Number of IO modules	1024; max. number of modules/submodules
I/O address area	
Inputs	32 KB; all inputs are within the process image
Outputs	32 KB; all outputs are within the process image
per integrated IO subsystem	
• Inputs (volume)	8 KB
• Outputs (volume)	8 KB
per CM/CP	
• Inputs (volume)	8 KB
• Outputs (volume)	8 KB
Process image partitions	
Number of process image partitions, max.	32
Hardware configuration	
Number of distributed IO systems	32; a distributed IO system is understood to mean the integration of distributed I/O via PROFINET or PROFIBUS communication modules as well as the connection of I/O via AS-i master modules or links (e.g. IE/PB link)
Number of DP masters	
via CM	4; a total of up to 4 CMs/CPs (PROFIBUS, PROFINET, Ethernet) can be inserted
Number of IO controllers	
integrated	1
via CM	4; a total of up to 4 CMs/CPs (PROFIBUS, PROFINET, Ethernet) can be inserted
Rack	
Modules per rack, max.	32; CPU + 31 modules
Number of rows, max.	1
PtP CM	
Number of PtP CMs	The number of connectable PtP CMs is only limited by the number of available slots

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Time	
Clock	
Type	Hardware clock
Backup duration	6 wk; at 40 °C ambient temperature, typ.
Deviation per day, max.	10 s; typ.: 2 s
Operating hours counter	
Number	16
Time of day synchronization	
supported	Yes
in AS, master	Yes
in AS, slave	Yes
on Ethernet via NTP	Yes
Digital inputs	
integrated channels (DI)	16
Configurable digital inputs	Yes
Sinking/sourcing input	Sinking input
Input characteristic curve acc. to IEC 61131, type 3	Yes
Digital input functions, configurable	
Gate start/stop	Yes
Capture	Yes
Synchronization	Yes
Input voltage	
Type of input voltage	DC
Rated value (DC)	24 V
for signal "0"	-3 ... +5 V
for signal "1"	+11 ... +30 V
Input current	
for signal "1", typ.	2.5 mA
Input delay (for rated value of input voltage)	
For standard inputs	
• Configurable	Yes; none / 0.05 / 0.1 / 0.4 / 1.6 / 3.2 / 12.8 / 20 ms
• at "0" to "1", min.	4 µs; with "none" configuration
• at "0" to "1", max.	20 ms
• at "1" to "0", min.	4 µs; with "none" configuration
• at "1" to "0", max.	20 ms
for interrupt inputs	
• Configurable	Yes; same as for standard inputs
for technological functions	
• Configurable	Yes; same as for standard inputs

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Cable length	
shielded, max.	1000 m; 600 m for technological functions; dependent on input frequency, encoder and cable quality; max. 50 m at 100 kHz
unshielded, max.	600 m; for technological functions: No
Digital outputs	
Type of digital output	Transistor
integrated channels (DQ)	16
Sourcing output	Yes; push-pull output
Short-circuit protection	Yes, electronic / thermal
• Response threshold, typ.	1.6 A with standard output; 0.5 A with high speed output; refer to manual for details
Limitation of inductive shutdown voltage to	-0.8 V
Activation of a digital input	Yes
Pulse duration accuracy	up to +-100 ppm +-2 µs with high-speed output; see manual for details
Minimum pulse duration	2 µs; with high-speed output, 50 µs or 5 ms with standard output; see manual for details
Digital output functions, configurable	
Switch at comparison values	Yes; as output signal of a high-speed counter
PWM output	Yes
• Number, max.	4
• Configurable cycle duration	Yes
• On-load factor, min.	0%
• On-load factor, max.	100%
• Resolution of the on-load factor	0.0036 %; with S7 analog format, min. 40 ns
Frequency output	Yes
Pulse train	Yes; including for pulse/direction interface
Switching capacity of outputs	
with resistive load, max.	0.5 A; 0.1 A at high-speed output, i.e. when a high-speed output is used; refer to manual for details
with lamp load, max.	5 W; 1 W with high-speed output, i.e. when a high-speed output is used; refer to manual for details
Load resistance range	
Low limit	48 W; 240 W with high-speed output, i.e. when a high-speed output is used; refer to manual for details
High limit	12 kΩ

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Output voltage	
Type of output voltage	DC
for signal "0", max.	1 V; with high-speed output, i.e. when a high-speed output is used; refer to manual for details
for signal "1", min.	23.2 V; L+ (-0.8 V)
Output current	
for signal "1" rated value	0.5 A; 0.1 A with high-speed output, i.e. when a high-speed output is used, observe derating; refer to manual for details
for signal "1" permissible range, min.	2 mA
for signal "1" permissible range, max.	0.6 A; 0.12 A with high-speed output, i.e. when a high-speed output is used; refer to manual for details
for signal "0" residual current, max.	0.5 mA
Output delay with resistive load	
"0" to "1", max.	100 µs
"1" to "0", max.	500 µs; load-dependent
for technological functions	
• "0" to "1", max.	5 µs; dependent on output used, see additional description in the manual
• "1" to "0", max.	5 µs; dependent on output used, see additional description in the manual
Parallel connection of two outputs	
For logic operations	Yes; For technological functions: No
For performance increase	No
For redundant activation of a load	Yes; For technological functions: No
Switching frequency	
with resistive load, max.	100 kHz; with high-speed output, 10 kHz with standard output
with inductive load, max.	0.5 Hz; acc. to IEC 60947-5-1, DC-13; observe derating curve
with lamp load, max.	10 Hz
Total current of the outputs	
Current per channel, max.	0.5 A; see additional description in the manual
Current per group, max.	8 A; see additional description in the manual
Current per power supply, max.	4 A; two power supplies per group, current per power supply max. 4 A, see additional description in the manual
for technological functions	
• Current per channel, max.	0.5 A; see additional description in the manual

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Cable length	
shielded, max.	1000 m; 600 m for technological functions; depending on output frequency, load and cable quality; max. 50 m at 100 kHz
unshielded, max.	600 m; for technological functions: No
Analog inputs	
Number of analog inputs	5; 4x for U/I, 1x for R/RTD
• for current measurement	4; max.
• for voltage measurement	4; max.
• for resistance/resistance thermometer measurement	1
permissible input voltage for voltage input (destruction limit), max.	28.8 V
permissible input current for current input (destruction limit), max.	40 mA
Cycle time (all channels), min.	1 ms; dependent on the configured interference frequency suppression, for details see Conversion method in the manual
Technical unit for temperature measurement, can be set	Yes; °C / °F / K
Input ranges (rated values), voltages	
0 to +10 V	Yes; physical measuring range: ±10 V
Input resistance (0 to 10 V)	100 kΩ
1 V to 5 V	Yes; physical measuring range: ±10 V
Input resistance (1 V to 5 V)	100 kΩ
-10 V to +10 V	Yes
Input resistance (-10 V to +10 V)	100 kΩ
-5 to +5 V	Yes; physical measuring range: ±10 V
Input resistance (-5 to +5 V)	100 kΩ
Input ranges (rated values), currents	
0 to 20 mA	Yes; physical measuring range: ±20 mA
Input resistance (0 to 20 mA)	50 Ω; plus approx. 55 ohm for overvoltage protection by PTC
-20 mA to +20 mA	Yes
Input resistance (-20 mA to +20 mA)	50 Ω; plus approx. 55 ohm for overvoltage protection by PTC
4 mA to 20 mA	Yes; physical measuring range: ±20 mA
Input resistance (4 mA to 20 mA)	50 Ω; plus approx. 55 ohm for overvoltage protection by PTC

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Input ranges (rated values), resistance-type thermometer	
Ni 100	Yes; standard/climate
Input resistance (Ni 100)	10 MΩ
Pt 100	Yes; standard/climate
Input resistance (Pt 100)	10 MΩ
Input ranges (rated values), resistances	
0 to 150 ohms	Yes; Physical measuring range: 0 to 600 ohms
Input resistance (0 to 150 ohms)	10 MΩ
0 to 300 ohms	Yes; Physical measuring range: 0 to 600 ohms
Input resistance (0 to 300 ohms)	10 MΩ
0 to 600 ohms	Yes
Input resistance (0 to 600 ohms)	10 MΩ
Cable length	
shielded, max.	800 m; with U/I, 200 m with R/RTD
Analog outputs	
Integrated channels (AQ)	2
Voltage output, short-circuit protection	Yes
Cycle time (all channels), min.	1 ms; dependent on the configured interference frequency suppression, for details see Conversion method in the manual
Output ranges, voltage	
0 to 10 V	Yes
1 V to 5 V	Yes
-10 V to +10 V	Yes
Output ranges, current	
0 to 20 mA	Yes
-20 mA to +20 mA	Yes
4 mA to 20 mA	Yes
Load resistance (in nominal range of the output)	
For voltage outputs, min.	1 kΩ
For voltage outputs, capacitive load, max.	100 nF
For current outputs, max.	500 Ω
For current outputs, inductive load, max.	1 mH
Cable length	
shielded, max.	200 m

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Analog value generation for the inputs	
Integration and conversion time/resolution per channel	
Resolution with overrange (bit including sign), max.	16 bits
Integration time configurable	Yes; 2.5 / 16.67 / 20 / 100 ms, acts on all channels
Interference voltage suppression for interference frequency f1 in Hz	400 / 60 / 50 / 10
Measured value smoothing	
Configurable	Yes
Setting: None	Yes
Setting: Weak	Yes
Setting: Medium	Yes
Setting: Strong	Yes
Analog value generation for the outputs	
Integration and conversion time/resolution per channel	
Resolution with overrange (bit including sign), max.	16 bits
Settling time	
For resistive load	1.5 ms
For capacitive load	2.5 ms
For inductive load	2.5 ms
Encoders	
Connection of the signal transmitters	
For voltage measurement	Yes
For current measurement as 4-wire transducer	Yes
For resistance measurement with two-wire connection	Yes
For resistance measurement with three-wire connection	Yes
For resistance measurement with four-wire connection	Yes
Connectable encoders	
2-wire sensor	Yes
• Permissible quiescent current (2-wire sensor), max.	1.5 mA
Encoder signals, incremental encoder (asymmetric)	
Input voltage	24 V
Input frequency, max.	100 kHz
Counting frequency, max.	400 kHz; with quadruple evaluation
Configurable signal filter	Yes
Incremental encoder with A/B tracks, 90° phase-shifted	Yes

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Incremental encoder with A/B tracks, 90° phase-shifted and zero track	Yes
Pulse encoder	Yes
Pulse encoder with direction	Yes
Pulse encoder with one pulse signal per count direction	Yes
Errors/accuracies	
Linearity error (relative to input range), (+/-)	0.1%
Temperature error (in relation to input range), (+/-)	0.005%/K
Crosstalk between the inputs, max.	-60 dB
Reproducibility in steady state condition at 25 °C (relative to input range), (+/-)	0.05%
Output ripple (relative to output range, bandwidth 0 to 50 kHz), (+/-)	0.02%
Linearity error (relative to output range), (+/-)	0.15%
Temperature error (in relation to output range), (+/-)	0.005%/K
Crosstalk between outputs, max.	-80 dB
Reproducibility in steady state condition at 25 °C (relative to output range), (+/-)	0.05%
Operational limit across the entire temperature range	
Voltage, relative to input range, (+/-)	0.3%
Current, relative to input range, (+/-)	0.3%
Resistance, relative to input range, (+/-)	0.3%
Resistance-type thermometer, relative to input range, (+/-)	Pt100 Standard: ±2 K, Pt100 Climatic: ±1 K, Ni100 Standard: ±1.2 K, Ni100 Climatic: ±1 K
Voltage, relative to output range, (+/-)	0.3%
Current, relative to output range, (+/-)	0.3%
Basic error limit (operational limit at 25 °C)	
Voltage, relative to input range, (+/-)	0.2%
Current, relative to input range, (+/-)	0.2%
Resistance, relative to input range, (+/-)	0.2%
Resistance-type thermometer, relative to input range, (+/-)	Pt100 Standard: ±1 K, Pt100 Climatic: ±0.5 K, Ni100 Standard: ±0.6 K, Ni100 Climatic: ±0.5 K
Voltage, relative to output range, (+/-)	0.2%
Current, relative to output range, (+/-)	0.2%
Interference voltage suppression for f = n x (f1 +/- 1%), f1 = interference frequency	
Series-mode interference (peak of the interference < rated value of the input range), min.	30 dB
Common mode voltage, max.	10 V
Common mode interference, min.	60 dB; at 400 Hz: 50 dB
Interfaces	
Number of PROFINET interfaces	1
1st interface	

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Interface hardware	
Number of ports	2
Integrated switch	Yes
RJ45 (Ethernet)	Yes; X1
Protocols	
PROFINET IO controller	Yes
PROFINET IO device	Yes
SIMATIC communication	Yes
Open IE communication	Yes
Web server	Yes
Media redundancy	Yes
PROFINET IO controller	
Services	
• PG/OP communication	Yes
• S7 routing	Yes
• Isochronous mode	Yes
• Open IE communication	Yes
• IRT	Yes
• MRP	Yes; as MRP redundancy manager and/or MRP client; max. number of devices in the ring: 50
• MRPD	Yes; requirement: IRT
• Prioritized startup	Yes; max. 32 PROFINET devices
• Number of connectable IO devices, max.	128; a maximum of 256 distributed I/O devices in total can be connected by means of AS-i, PROFIBUS or PROFINET
• of these, IO devices with IRT, max.	64
• Number of connectable IO devices for RT, max.	128
• of these in a line, max.	128
• Number of IO devices that can be enabled/disabled simultaneously, max.	8; in total over all interfaces
• Number of IO devices per tool, max.	8
• Update times	Minimum value of update time also depends on the communication allocation setting for PROFINET IO, the number of IO devices and the amount of configured user data

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Update time with IRT	
• with send clock of 250 µs	250 µs to 4 ms; note: with IRT with isochronous mode, the minimum update time of 625 µs of the isochronous OBs is crucial
• with send clock of 500 µs	500 µs to 8 ms; note: with IRT with isochronous mode, the minimum update time of 625 µs of the isochronous OBs is crucial
• with send clock of 1 ms	1 ms to 16 ms
• with send clock of 2 ms	2 ms to 32 ms
• with send clock of 4 ms	4 ms to 64 ms
• with IRT and "odd" send clock parameter assignment	Update time = set "odd" send clock (any multiple of 125 µs: 375 µs, 625 µs to 3 875 µs)
Update time with RT	
• with send clock of 250 µs	250 µs to 128 ms
• with send clock of 500 µs	500 µs to 256 ms
• with send clock of 1 ms	1 ms to 512 ms
• with send clock of 2 ms	2 ms to 512 ms
• with send clock of 4 ms	4 ms to 512 ms
PROFINET IO device	
Services	
• PG/OP communication	Yes
• S7 routing	Yes
• Isochronous mode	No
• Open IE communication	Yes
• IRT	Yes
• MRP	Yes
• MRPD	Yes; requirement: IRT
• PROFIenergy	Yes
• Shared device	Yes
• Number of IO controllers with shared device, max.	4
Interface hardware	
RJ 45 (Ethernet)	
100 Mbps	Yes
Autonegotiation	Yes
Autocrossing	Yes
Industrial Ethernet status LED	Yes

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Protocols	
Number of connections	
Number of connections, max.	96; via integrated interfaces of the CPU and connected CPs/CMs
Number of connections reserved for ES/HMI/Web	10
Number of connections via integrated interfaces	64
Number of S7 routing connections	16
PROFINET IO controller	
Services	
• PG/OP communication	Yes
• S7 routing	Yes
• Isochronous mode	Yes
• Open IE communication	Yes
• IRT	Yes
• MRP	Yes; as MRP redundancy manager and/or MRP client; max. number of devices in the ring: 50
• MRPD	Yes; requirement: IRT
• PROFIenergy	Yes
• Prioritized startup	Yes; max. 32 PROFINET devices
• Number of connectable IO devices, max.	128; a maximum of 256 distributed I/O devices in total can be connected by means of AS-i, PROFIBUS or PROFINET
• of these, IO devices with IRT, max.	64
• Number of connectable IO devices for RT, max.	128
• of these in a line, max.	128
• Number of IO devices that can be enabled/disabled simultaneously, max.	8; in total over all interfaces
• Number of IO devices per tool, max.	8
• Update times	Minimum value of update time also depends on the communication allocation setting for PROFINET IO, the number of IO devices and the amount of configured user data
SIMATIC communication	
S7 communication, as server	Yes
S7 communication, as client	Yes
User data per job, max.	See online help (S7 communication, user data size)

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Open IE communication	
TCP/IP	Yes
• Data length, max.	64 KB
• Multiple passive connections per port, supported	Yes
ISO-on-TCP (RFC1006)	Yes
• Data length, max.	64 KB
UDP	Yes
• Data length, max.	1472 bytes
DHCP	No
SNMP	Yes
DCP	Yes
LLDP	Yes
Web server	
HTTP	Yes; standard and user-defined sites
HTTPS	Yes; standard and user-defined sites
OPC UA	
OPC UA server	Yes; Data Access (Read, Write, Subscribe), Runtime license required
• Application authentication	Yes
• Security Policies	Available Security Policies: None, Basic128Rsa15, Basic256Rsa15, Basic256Sha256
• User authentication	"Anonymous" or with user name and password
Additional protocols	
MODBUS	Yes; MODBUS TCP
Media redundancy	
Failover time in the case of cable break, typ.	200 ms; with MRP; bumpless with MRPD
Number of devices in the ring, max.	50
Isochronous mode	
Isochronous operation (application synchronized up to terminal)	Yes; with minimum OB 6x cycle of 625 µs
Constant bus cycle	Yes
S7 alarm functions	
Number of stations that can log in for alarm functions, max.	32
Block-related alarms	Yes
Number of configurable interrupts, max.	5000
Number of simultaneously active interrupts in interrupt pool	
• Number of reserved user interrupts	300
• Number of reserved interrupts for system diagnostics	100
• Number of reserved interrupts for Motion Control technology objects	80

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Test - commissioning functions	
Joint commissioning (team engineering)	Yes; parallel online access possible for up to 5 engineering systems
Status block	Yes; up to 8 simultaneously (in total over all ES clients)
Single step	No
Status/modify	
Status/modify tag	Yes
Tags	Inputs/outputs, bit memory, DB, peripheral inputs/outputs, timers, counters
Number of tags, max.	
• of which status tags, max.	200; per job
• of which modify tags, max.	200; per job
Force	
Forcing, tags	Peripheral inputs/outputs
Number of tags, max.	200
Diagnostics buffer	
available	Yes
Number of entries, max.	1000
• of these protected against power failure	500
Traces	
Number of configurable traces	4; up to 512 KB data possible per trace
Interrupts/diagnostics/status information	
Interrupts	
Diagnostics interrupt	Yes
Hardware interrupt	Yes
Diagnostics alarms	
Monitoring of the supply voltage	Yes
Wire break	Yes; for analog inputs/outputs, see description in manual
Short-circuit	Yes; for analog outputs, see description in manual
A/B transition error with incremental encoder	Yes
Diagnostics display LED	
RUN/STOP LED	Yes
ERROR LED	Yes
MAINT LED	Yes
Monitoring of supply voltage (PWR LED)	Yes
Channel status display	Yes
For channel diagnostics	Yes; for analog inputs/outputs
Connection display LINK TX/RX	Yes

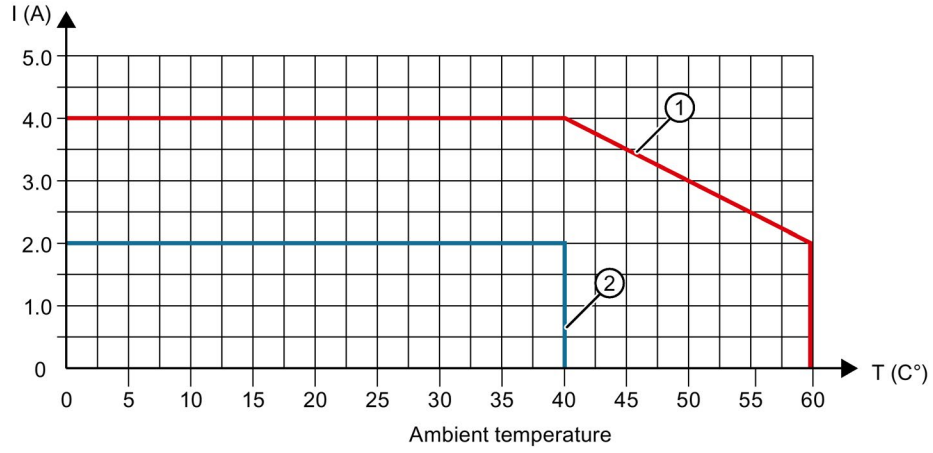
	6ES7511-1CK00-0AB0
Supported technology objects	
Motion Control	Yes; note: the number of axes affects the cycle time of the PLC program; selection guide via the TIA Selection Tool or SIZER
• Number of available motion control resources for technology objects (except cams)	800
• required Motion Control resources	
– per speed-controlled axis	40
– per positioning axis	80
– per synchronous axis	160
– per external encoder	80
– per output cam	20
– per cam track	160
– per measuring input	40
Controllers	
• PID_Compact	Yes; universal PID controller with integrated optimization
• PID_3Step	Yes; PID controller with integrated optimization for valves
• PID temp	Yes; PID controller with integrated optimization for temperature
Counting and measuring	
• High-speed counter	Yes
Integrated functions	
Number of counters	6; of which max. 4x A/B/N
Counting frequency (counter), max.	400 kHz; with quadruple evaluation
Counting functions	
Count continuously	Yes
Configurable counting behavior	Yes
Hardware gate via digital input	Yes
Software gate	Yes
Event-controlled stop	Yes
Synchronization via digital input	Yes
Configurable counting range	Yes
Comparator	
• Number of comparators	2; per counter channel; refer to manual for details
• Direction dependence	Yes
• Modifiable from user program	Yes

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Position detection	
Incremental detection	Yes
Suitable for S7-1500 Motion Control	Yes
Measuring functions	
Configurable measurement time	Yes
Dynamic measurement time configuration	Yes
Number of thresholds, configurable	2
Measuring range	
• Frequency measurement, min.	0.04 Hz
• Frequency measurement, max.	400 kHz; with quadruple evaluation
• Period measurement, min.	2.5 µs
• Period measurement, max.	25 s
Accuracy	
• Frequency measurement	100 ppm; dependent on measurement interval and signal evaluation
• Period measurement	100 ppm; dependent on measurement interval and signal evaluation
• Velocity measurement	100 ppm; dependent on measurement interval and signal evaluation
Electrical isolation	
Electrical isolation of digital inputs	
Between channels	No
Between channels, in groups of	16
Electrical isolation of digital outputs	
Between channels	No
Between channels, in groups of	16
Electrical isolation of channels	
Between the channels and backplane bus	Yes
Between the channels and load voltage L+	No
Insulation	
Insulation tested with	707 V DC (type test)
Standards, approvals, certificates	
Suitable for safety functions	No
Ambient conditions	
Ambient temperature in operation	
Horizontal installation, min.	0 °C
Horizontal installation, max.	60 °C; Note derating information for on-board I/O in the manual; Display: 50 °C, at an operating temperature of typically 50 °C, the display is switched off
Vertical installation, min.	0 °C
Vertical installation, max.	40 °C; Note derating information for on-board I/O in the manual; Display: 40 °C, at an operating temperature of typically 40 °C, the display is switched off

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Configuring	
Programming	
Programming language	
• LAD	Yes
• FBD	Yes
• STL	Yes
• SCL	Yes
• GRAPH	Yes
Know-how protection	
User program protection	Yes
Copy protection	Yes
Block protection	Yes
Access protection	
Password for display	Yes
Protection level: Write protection	Yes
Protection level: Write/read protection	Yes
Protection level: Complete protection	Yes
Cycle time monitoring	
Low limit	Configurable minimum cycle time
High limit	Configurable maximum cycle time
Dimensions	
Width	85 mm
Height	147 mm
Depth	129 mm
Weights	
Weight, approx.	1050 g

Power reduction (derating) to total current of digital outputs (per power supply)

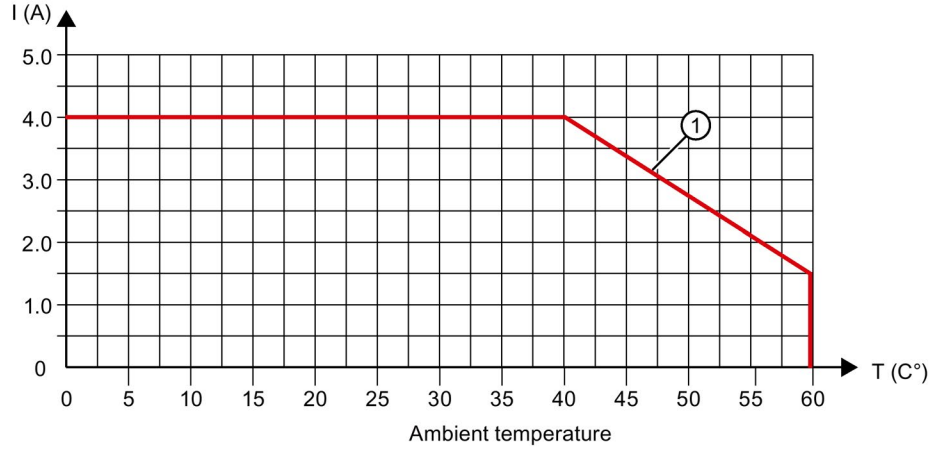
The following figure shows the load rating of the digital outputs in relation to the mounting position and the ambient temperature.



① Horizontal mounting position
② Vertical mounting position

Figure 7-1 Loading capacity of the digital outputs per mounting position

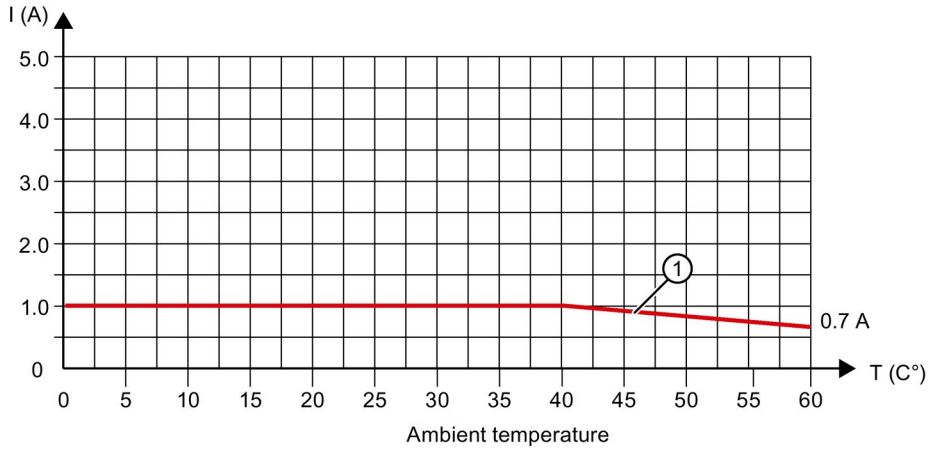
The following trends shows the load rating of the digital outputs when technology functions are used in dependence on the ambient temperature.



① Horizontal mounting position

Figure 7-2 Load rating of the digital outputs when technology functions are used

The following figure shows the load rating of the current for encoder supplies of digital inputs.



① Horizontal mounting position

Figure 7-3 Load rating of the current for encoder supplies of digital inputs when technology functions are used

Simultaneous operation of digital inputs per group

If the maximum voltage at the inputs is 24 V, all the digital inputs may be simultaneously at high level (corresponds to 100% of the digital inputs).

If the maximum voltage at the inputs is 30 V, only 12 digital inputs of 16 digital inputs of one group may be simultaneously at high level (corresponds to 75% of the digital inputs).

General technical specifications

For information on the general technical specifications, such as standards and approvals, electromagnetic compatibility, protection class, etc., refer to the S7-1500, ET 200MP system manual (http://support.automation.siemens.com/WW/view/en/59191792).

Dimension drawings

A

This appendix contains the dimension drawings of the compact CPU installed on a mounting rail. You must take the dimensions into consideration for installation in cabinets, control rooms, etc.

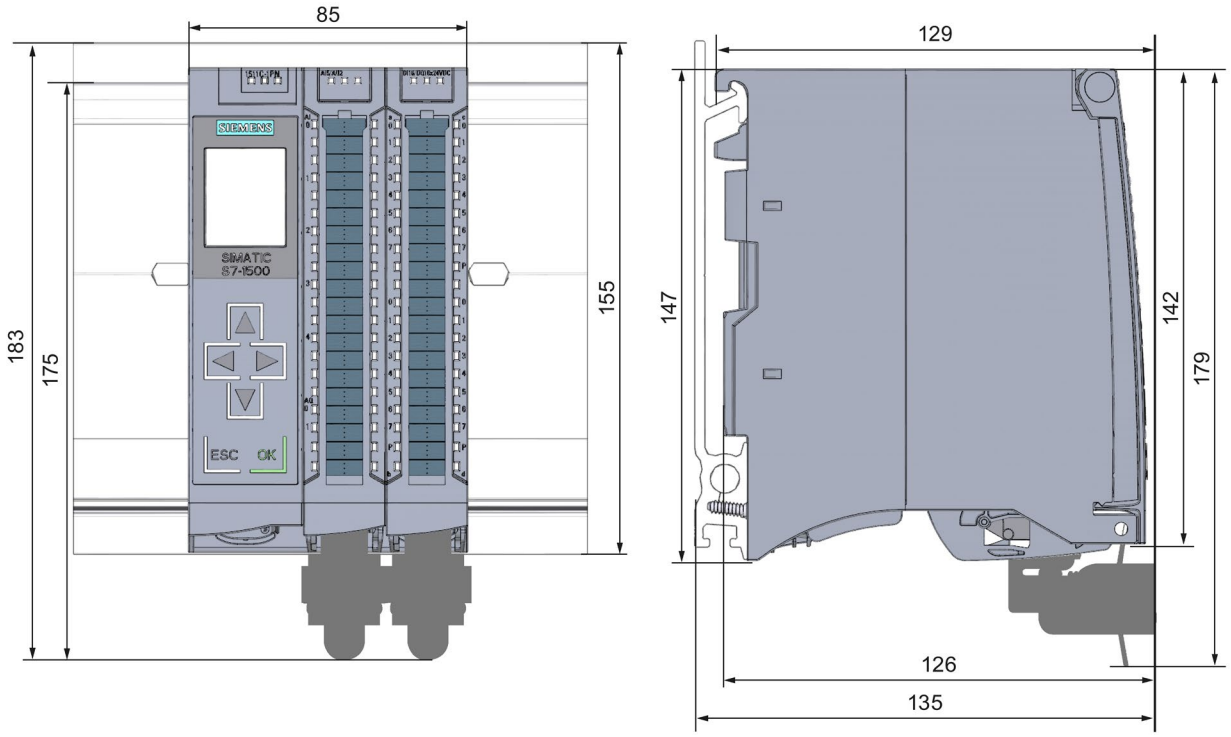


Figure A-1 Dimension drawing of CPU 1511C-1 PN – front and side views

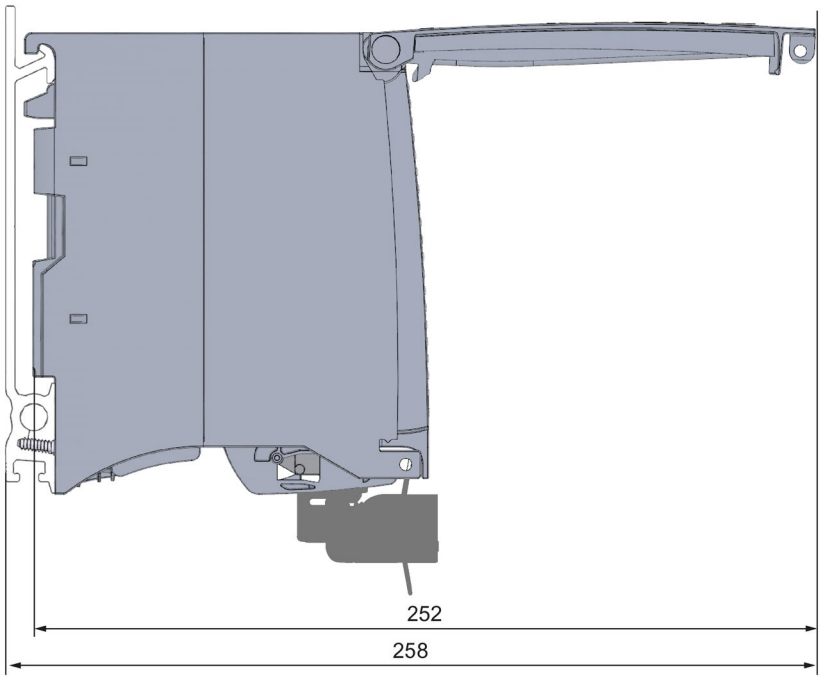


Figure A-2 Dimension drawing of CPU 1511C-1 PN – side view with front panel open