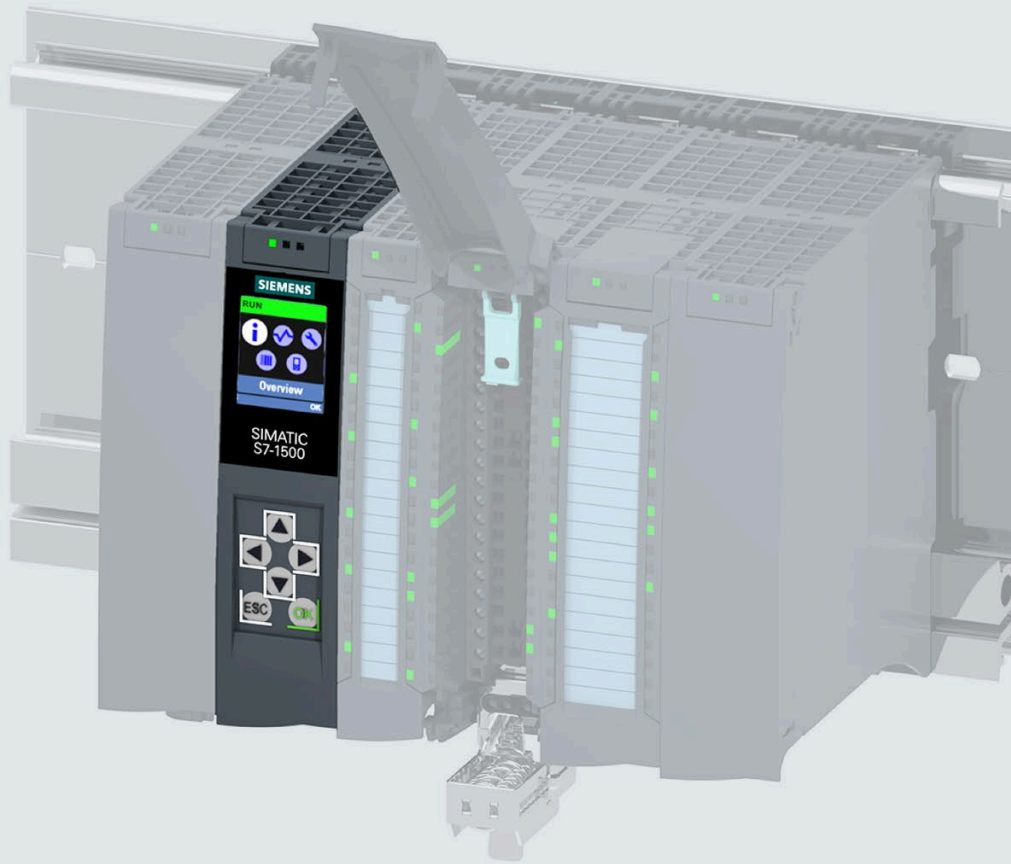# SIEMENS

**Manual**

# SIMATIC

## S7-1500

CPU 1511-1 PN (6ES7511-1AK02-0AB0)

Edition    05/2021

support.industry.siemens.com

# SIEMENS

## SIMATIC

## S7-1500
## CPU 1511-1 PN
## (6ES7511-1AK02-0AB0)

**Equipment Manual**

**05/2021**
A5E40869673-AB

# Legal information

## Warning notice system

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

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

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

> ⚠ **CAUTION**
>
> indicates that minor personal injury can result if proper precautions are not taken.

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

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

## Qualified Personnel

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

## Proper use of Siemens products

Note the following:

> ⚠ **WARNING**
>
> Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

## Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

## Disclaimer of Liability

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

# 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. All system-spanning functions are described in the function manuals.

The information provided in this manual and the system manual enables you to commission the CPU 1511-1 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**

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit (https://www.siemens.com/industrialsecurity).

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customers' exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed visit (https://www.siemens.com/industrialsecurity).

## Siemens Industry Online Support

You can find current information on the following topics quickly and easily here:

- **Product support**

  All the information and extensive know-how on your product, technical specifications, FAQs, certificates, downloads, and manuals.

- **Application examples**

  Tools and examples to solve your automation tasks – as well as function blocks, performance information and videos.

- **Services**

  Information about Industry Services, Field Services, Technical Support, spare parts and training offers.

- **Forums**

  For answers and solutions concerning automation technology.

- **mySupport**

  Your personal working area in Industry Online Support for messages, support queries, and configurable documents.

This information is provided by the Siemens Industry Online Support in the Internet (https://support.industry.siemens.com).

## Industry Mall

The Industry Mall is the catalog and order system of Siemens AG for automation and drive solutions on the basis of Totally Integrated Automation (TIA) and Totally Integrated Power (TIP).

Catalogs for all the products in automation and drives are available on the Internet (https://mall.industry.siemens.com).

# Table of contents

# S7-1500 / ET 200MP Documentation Guide

<span style="float:right; font-size:3em">1</span>

The documentation for the SIMATIC S7-1500 automation system and the SIMATIC ET 200MP distributed I/O system is arranged into three areas.
This arrangement enables you to access the specific content you require.
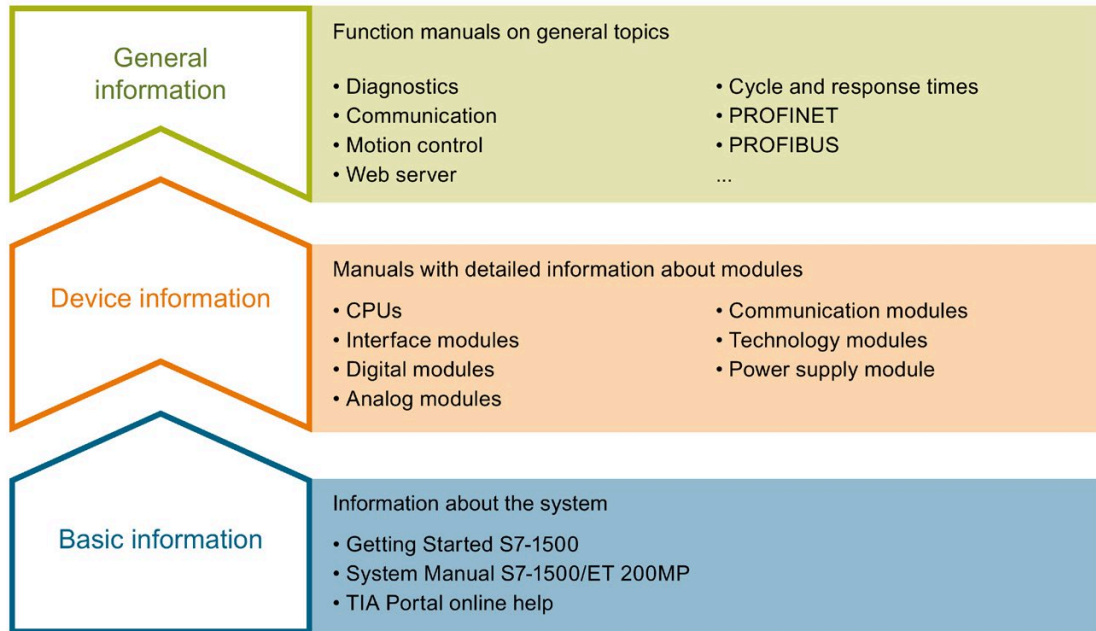


## Basic information

The System Manual and Getting Started describe in detail the configuration, installation, wiring and commissioning of the SIMATIC S7-1500 and ET 200MP systems. The STEP 7 online help supports you in the configuration and programming.

## Device information

Product manuals contain a compact description of the module-specific information, such as properties, wiring diagrams, characteristics and technical specifications.

## General information

The function manuals contain detailed descriptions on general topics regarding the SIMATIC S7-1500 and ET 200MP systems, e.g. diagnostics, communication, motion control, Web server, OPC UA.

You can download the documentation free of charge from the Internet (https://support.industry.siemens.com/cs/ww/en/view/109742691).

Changes and supplements to the manuals are documented in a Product Information.

You can download the product information free of charge from the Internet (https://support.industry.siemens.com/cs/us/en/view/68052815).

## Manual Collection S7-1500/ET 200MP

The Manual Collection contains the complete documentation on the SIMATIC S7-1500 automation system and the ET 200MP distributed I/O system gathered together in one file.

You can find the Manual Collection on the Internet (https://support.industry.siemens.com/cs/ww/en/view/86140384).

## SIMATIC S7-1500 comparison list for programming languages

The comparison list contains an overview of which instructions and functions you can use for which controller families.

You can find the comparison list on the Internet (https://support.industry.siemens.com/cs/ww/en/view/86630375).

## "mySupport"

With "mySupport", your personal workspace, you make the best out of your Industry Online Support.

In "mySupport", you can save filters, favorites and tags, request CAx data and compile your personal library in the Documentation area. In addition, your data is already filled out in support requests and you can get an overview of your current requests at any time.

You must register once to use the full functionality of "mySupport".

You can find "mySupport" on the Internet (https://support.industry.siemens.com/My/ww/en).

## Application examples

The application examples support you with various tools and examples for solving your automation tasks. Solutions are shown in interplay with multiple components in the system - separated from the focus on individual products.

You will find the application examples on the Internet (https://support.industry.siemens.com/cs/ww/en/ps/ae).

# Product overview

# 2

## 2.1 New functions

**New functions of the CPU in firmware version V2.9**

The following table provides an overview of the most important new functions of the CPU with firmware version V2.9.

| New functions | Applications | Customer benefits | Where can I find information? |
|---|---|---|---|
| **Communication of the CPU** | | | |
| Secure PG/HMI communication | With STEP 7 and WinCC as of Version V17, SIMATIC S7-1500 CPUs and ET 200 CPUs from firmware version 2.9 support innovated and standardized secure PG/PC and HMI communication – referred to as Secure PG/HMI communication for short. | Secure and standardized creation or assignment of PLC communication certificates | Communication function manual (https://support.industry.siemens.com/cs/ww/en/view/59192925) |
| Protection of confidential configuration data | You have the option of assigning a password for protecting confidential configuration data of the respective CPU. This refers to data such as private keys that are required for the proper functioning of certificate-based protocols. | Additional password protection of confidential configuration data | |
| OPC UA: Alarms & Conditions | OPC UA clients from any manufacturer can subscribe to alarms of the CPU via OPC UA Alarms & Conditions. | Without further measures, alarms created once via OPC UA are available as events and alarms. The alarms can be displayed by any display device with corresponding OPC UA client functionality. | |
| OPC UA: Certificate management via Global Discovery Server (GDS) | Via GDS push management functions:<br>• Automated update of OPC UA certificates of an S7-1500 CPU<br>• Transfer of updated certificates and lists in RUN operating state of the CPU | The automation of the certificate management eliminates any manual work required for reconfiguring the CPU, for example, after a certificate has expired, and a new download to the CPU. | |

| New functions | Applications | Customer benefits | Where can I find information? |
|---|---|---|---|
| DHCP (Dynamic Host Configuration Protocol) | The CPU can use the DHCP communication protocol to assign the network configuration via a DHCP server. The CPU uses a client ID for identification on the DHCP server. The following parameters can be obtained:<br>• IP Suite<br>• DNS server<br>• NTP server<br>The CPU can also send its host name to the DHCP server. | With DHCP, you can integrate the CPU into an existing IT network without having to make additional changes to the PROFINET interface. | Communication function manual (https://support.industry.siemens.com/cs/ww/en/view/59192925) |
| MRP interconnection in PROFINET networks | The MRP interconnection procedure is an extension of MRP. MRP interconnection enables the redundant coupling of two or more rings with MRP in PROFINET networks. | There is no limit to the maximum number of 50 devices in a ring when setting up redundant network topologies. Monitoring of larger topologies with ring redundancy | PROFINET function manual (https://support.industry.siemens.com/cs/ww/en/view/49948856) |
| **Web server of the CPU** | | | |
| Web applications that can be loaded by the user | Additional methods to manage web applications via Web API. You can use all available Web API methods within the web application | Web applications are also available in STOP mode of the CPU. Reduced development times of web server user pages | Web server function manual (https://support.industry.siemens.com/cs/ww/en/view/59193560) |
| New Web API methods | Reading and changing the CPU operating state via Web API. Ticket methods for transferring large amounts of data outside of the JSON RPC protocol | Additional applications for the web server | |
| Diagnostic information on motion control | Diagnostic information is available for all technology objects. Improved display and grouping of the tags | Comprehensive diagnostic options by means of motion control applications are possible via the web server. | |
| Optimizations to the DNS (Domain Name System) functionality with OPC UA/Open User Communication and on the web server | The feedback messages of the OPC UA server with the "Application Name" can be sent via DNS. The NTP client of the CPU can address its relevant NTP servers via DNS. The Web server can be consistently reached via DNS addressing. DNS is taken into account during certificate handling. | A pool of NTP servers can be addressed. | Communication function manual (https://support.industry.siemens.com/cs/ww/en/view/59192925) Web server function manual (https://support.industry.siemens.com/cs/ww/en/view/59193560) |
| **Technology functions of the CPU** | | | |
| Axis functions | • Backlash compensation<br>• Linear motor | The repeat accuracy of a movement is increased by compensation for the mechanical play of the real axis. Easier control of highly dynamic linear motors. | S7-1500T Motion Control function manuals (https://support.industry.siemens.com/cs/ww/en/view/109751049) |

**Reference**

You can find an overview of all new functions, improvements and revisions in the respective firmware versions on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109478459).

## 2.2 Area of application of the SIMATIC S7-1500 CPUs

**Area of application**

SIMATIC S7-1500 is the modular control system for a wide variety of automation applications in discrete automation.

SIMATIC S7-1500 is the cost-effective and convenient solution for a broad range of tasks and offers the following advantages:

- Modular, fanless design
- Simple realization of distributed structures
- User-friendly handling

Areas of application of the SIMATIC S7-1500 automation system include, for example:

- Special-purpose machines
- Textile machinery
- Packaging machines
- General mechanical engineering
- Controller engineering
- Machine tool engineering
- Installation engineering
- Electrical industry and crafts
- Automobile engineering
- Water/waste water
- Food & Beverage

Areas of application of the SIMATIC S7-1500R/H redundant system include, for example:

- Tunnels
- Airports (e.g. baggage conveyors)
- Subways
- Shipbuilding
- Wastewater treatment plants
- High-bay warehouses

Areas of application of the SIMATIC S7-1500T automation system for advanced motion control applications include, for example:

- Packaging machines
- Converting applications
- Assembly automation
- Pick-and-place automation
- Palletizers

You can choose between CPUs with various levels of performance and a comprehensive range of modules with many convenient functions. Fail-safe CPUs enable use in fail-safe applications. The modular design allows you to use only the modules that you need for your application. The controller can be retrofitted with additional modules at any time to expand its range of tasks.

High industrial suitability due to the high resistance to EMC, shock and vibration enable universal use of the SIMATIC S7-1500, S7-1500R/H and S7-1500T automation systems.

**Performance segments of the CPUs**

The CPUs can be used for smaller and mid-range applications, as well as for the high-end range of machine and plant automation.

Table 2- 1     Standard CPUs

| CPU | Performance segment | PROFIBUS interfaces | PROFINET IO RT/IRT interfaces | PROFINET IO RT interface | Basic PROFINET functionality | Work memory | Processing time for bit operations |
|---|---|---|---|---|---|---|---|
| CPU 1511-1 PN | Standard CPU for small to mid-range applications | -- | 1 | -- | -- | 1.15 MB | 60 ns |
| CPU 1513-1 PN | Standard CPU for mid-range applications | -- | 1 | -- | -- | 1.8 MB | 40 ns |
| CPU 1515-2 PN | Standard CPU for mid-range to large applications | -- | 1 | 1 | -- | 3.5 MB | 30 ns |
| CPU 1516-3 PN/DP | Standard CPU for demanding applications and communication tasks | 1 | 1 | 1 | -- | 6 MB | 10 ns |
| CPU 1517-3 PN/DP | Standard CPU for demanding applications and communication tasks | 1 | 1 | 1 | -- | 10 MB | 2 ns |

| CPU | Performance segment | PROFIBUS interfaces | PROFINET IO RT/IRT interfaces | PROFINET IO RT interface | Basic PROFINET functionality | Work memory | Processing time for bit operations |
|---|---|---|---|---|---|---|---|
| CPU 1518-4 PN/DP | Standard CPU for high-performance applications, demanding communication tasks and very short reaction times | 1 | 1 | 1 | 1 | 24 MB | 1 ns |
| CPU 1518-4 PN/DP MFP | Standard CPU for high-performance applications, demanding communication tasks, very short reaction times and C/C++ blocks for the user program | 1 | 1 | 1 | 1 | 74* MB | 1 ns |

* 50 MB of the integrated work memory is reserved for the function library of CPU runtime

Table 2- 2    Redundant CPUs

| CPU | Performance segment | PROFIBUS interfaces | PROFINET IO RT/IRT interfaces | PROFINET IO RT interface | Basic PROFINET functionality | Work memory | Processing time for bit operations |
|---|---|---|---|---|---|---|---|
| CPU 1513R-1 PN | Redundant CPU for smaller to mid-range applications | -- | 1 | -- | -- | 1.8 MB | 80 ns |
| CPU 1515R-2 PN | Redundant CPU for mid-range to large applications | -- | 1 | -- | 1 | 3.5 MB | 60 ns |
| CPU 1517H-3 PN | Redundant CPU for demanding applications and communication tasks | -- | 1 | -- | 1 | 10 MB | 4 ns |
| CPU 1518HF-4 PN | Fail-safe and redundant CPU for demanding applications and communication tasks | -- | 1 | -- | 2 | 69 MB | 4 ns |

Table 2- 3    Compact CPUs

| CPU | Performance segment | PROFIBUS interfaces | PROFINET IO RT/IRT interfaces | PROFINET IO RT interface | Basic PROFINET functional-ity | Work memory | Pro-cessing time for bit oper-ations |
|---|---|---|---|---|---|---|---|
| CPU 1511C-1 PN | Compact CPU for small to mid-range applica-tions | -- | 1 | -- | -- | 1.175 MB | 60 ns |
| CPU 1512C-1 PN | Compact CPU for mid-range applications | -- | 1 | -- | -- | 1.25 MB | 48 ns |

Table 2- 4    Fail-safe CPUs

| CPU | Performance segment | PROFIBUS interfaces | PROFINET IO RT/IRT interfaces | PROFINET IO RT interface | Basic PROFINET functional-ity | Work memory | Pro-cessing time for bit oper-ations |
|---|---|---|---|---|---|---|---|
| CPU 1511F-1 PN | Fail-safe CPU for small to mid-range applica-tions | -- | 1 | -- | -- | 1.225 MB | 60 ns |
| CPU 1511TF-1 PN | Fail-safe technology CPU for small to mid-range applications | -- | 1 | -- | -- | 1.225 MB | 60 ns |
| CPU 1513F-1 PN | Fail-safe CPU for mid-range applications | -- | 1 | -- | -- | 1.95 MB | 40 ns |
| CPU 1515F-2 PN | Fail-safe CPU for mid-range to large applica-tions | -- | 1 | 1 | -- | 3.75 MB | 30 ns |
| CPU 1515TF-2 PN | Fail-safe technology CPU for demanding applications and com-munication tasks | -- | 1 | 1 | -- | 3.75 MB | 30 ns |
| CPU 1516F-3 PN/DP | Fail-safe CPU for de-manding applications and communication tasks | 1 | 1 | 1 | -- | 6.5 MB | 10 ns |
| CPU 1516TF-3 PN/DP | Fail-safe technology CPU for demanding applications and com-munication tasks | 1 | 1 | 1 | -- | 6.5 MB | 10 ns |
| CPU 1517F-3 PN/DP | Fail-safe CPU for de-manding applications and communication tasks | 1 | 1 | 1 | -- | 11 MB | 2 ns |
| CPU 1517TF-3 PN/DP | Fail-safe technology CPU for demanding applications and com-munication tasks | 1 | 1 | 1 | -- | 11 MB | 2 ns |

| CPU | Performance segment | PROFIBUS interfaces | PROFINET IO RT/IRT interfaces | PROFINET IO RT interface | Basic PROFINET functionality | Work memory | Processing time for bit operations |
|---|---|---|---|---|---|---|---|
| CPU 1518F-4 PN/DP | Fail-safe CPU for high-performance applications, demanding communication tasks and very short reaction times | 1 | 1 | 1 | 1 | 26 MB | 1 ns |
| CPU 1518F-4 PN/DP MFP | Fail-safe CPU for high-performance applications, demanding communication tasks, very short reaction times and C/C++ blocks for the user program | 1 | 1 | 1 | 1 | 76* MB | 1 ns |
| CPU 1518TF-4 PN/DP | Technology CPU for high-performance motion control applications with large quantities, demanding communication tasks and very short reaction times | 1 | 1 | 1 | 1 | 69 MB | 1 ns |

* 50 MB of the integrated work memory is reserved for the function library of CPU runtime

Table 2- 5     Technology CPUs

| CPU | Performance segment | PROFIBUS interfaces | PROFINET IO RT/IRT interfaces | PROFINET IO RT interface | Basic PROFINET functionality | Work memory | Processing time for bit operations |
|---|---|---|---|---|---|---|---|
| CPU 1511T-1 PN | Technology CPU for small to mid-range applications | -- | 1 | -- | -- | 1.225 MB | 60 ns |
| CPU 1515T-2 PN | Technology CPU for mid-range to large applications | -- | 1 | 1 | -- | 3.75 MB | 30 ns |
| CPU 1516T-3 PN /DP | Technology CPU for high-end applications and communication tasks | 1 | 1 | 1 | -- | 6.5 MB | 10 ns |
| CPU 1517T-3 PN/DP | Technology CPU for complex applications and communication tasks | 1 | 1 | 1 | -- | 11 MB | 2 ns |

| CPU | Performance segment | PROFIBUS interfaces | PROFINET IO RT/IRT interfaces | PROFINET IO RT interface | Basic PROFINET functionality | Work memory | Processing time for bit operations |
|---|---|---|---|---|---|---|---|
| CPU 1518T-4 PN/DP | Technology CPU for high-performance motion control applications with large quantities, demanding communication tasks and very short reaction times | 1 | 1 | 1 | 1 | 69 MB | 1 ns |
| CPU 1511TF-1 PN<br>CPU 1515TF-2 PN<br>CPU 1516TF-3 PN/DP<br>CPU 1517TF-3 PN/DP<br>CPU 1518TF-4 PN/DP | These CPUs are described in the fail-safe CPUs | | | | | | |

## Performance segments of compact CPUs

The compact CPUs can be used for smaller to mid-range applications and have an integrated analog and digital on-board I/O as well as integrated technology functions. The following table shows the specific properties of the Compact CPUs.

| | CPU 1511C-1 PN | CPU 1512C-1 PN |
|---|---|---|
| Integrated analog inputs/outputs | 5 inputs/2 outputs | 5 inputs/2 outputs |
| Integrated digital inputs/outputs | 16 inputs/16 outputs | 32 inputs/32 outputs |
| High-speed counters | 6 | 6 |
| Frequency meters | 6 (max. 100 kHz) | 6 (max. 100 kHz) |
| Period duration measurement | 6 channels | 6 channels |
| Pulse width modulation (PWM output) | Max. 4 (up to 100 kHz) | Max. 4 (up to 100 kHz) |
| Pulse Train Output (PTO output) | Max. 4 (up to 100 kHz) | Max. 4 (up to 100 kHz) |
| Frequency output | Up to 100 kHz | Up to 100 kHz |

## Integrated Motion Control technology functions

**All CPUs of the SIMATIC S7-1500 automation system** support motion control technology functions. STEP 7 provides PLCopen-standardized Motion Control instructions for configuring and connecting a drive to the CPU.

S7-1500 Motion Control supports the following technology objects:

- Speed-controlled axes

- Positioning axes

- Synchronous axes

- External encoders

- Cam

- Cam track

- Measuring input

**The technology CPUs of the SIMATIC S7-1500-automation system** offer enhanced Motion Control functions:

- Advanced synchronization functions

  – Synchronization with specification of the synchronous position

  – Actual value coupling

  – Shifting of the master value at the following axis

  – Camming

- Up to 4 encoder or measuring systems as actual position for position control

- Cam

- Kinematics for control of:

  – Cartesian portals

  – Roller pickers

  – Jointed-arm robots

  – Delta pickers

  – SCARA robots

Due to the supported technology functions, the S7-1500T CPUs are suitable for controlling packaging machines, converting applications, assembly automation, etc.

## Additional integrated technology functions

For effective commissioning, diagnostics and fast optimization of drives and controls, the SIMATIC S7-1500 controller series offers extensive trace functions for all CPU tags.

In addition to drive integration, the SIMATIC S7-1500 controller series has a PID compact closed-loop controller; easy-to-configure blocks allow automatic optimization of the controller parameters for optimum control quality.

## Other technology functions

Technology modules also implement functions such as high-speed counting, position detection, measuring functions and pulse generators (PTO, PWM and frequency output). With the CPU 1511C-1 PN and CPU 1512C-1 PN compact CPUs, these functions are already integrated and can be implemented without additional technology modules.

SIWAREX is a versatile and flexible weighing module which you can use as a static scale for operation.

## Redundant CPUs

The CPUs of the S7-1500R/H redundant system offer a high degree of reliability and system availability. A redundant configuration of the most important automation components reduces the likelihood of production downtimes and the consequences of component errors.

The higher the risks and costs of a production downtime, the more worthwhile the use of a redundant system. The avoidance of production downtimes compensates for the generally higher investment costs.

## Security Integrated

In conjunction with STEP 7, each CPU offers password-based know-how protection against unauthorized reading out or modification of the program blocks.

Copy protection provides reliable protection against unauthorized reproduction of program blocks. With copy protection, individual blocks on the SIMATIC memory card can be tied to its serial number so that the block can only be run if the configured memory card is inserted into the CPU.

In addition, you can assign various access rights to different user groups in the controller using four different authorization levels.

Improved manipulation protection allows changed or unauthorized transfers of engineering data to be detected by the controller.

The use of an Ethernet CP (CP 1543-1) provides you with additional access protection through a firewall or possibilities to establish secure VPN connections.

## Safety Integrated

The fail-safe CPUs are intended for users who want to implement demanding standard and fail-safe applications both centrally and decentrally.

These fail-safe CPUs allow the processing of standard and safety programs on a single CPU. This allows fail-safe data to be evaluated in the standard user program. The integration also provides the system advantages and the extensive functionality of SIMATIC for fail-safe applications.

The fail-safe CPUs are certified for use in safety mode up to:

- Safety class (Safety Integrity Level) SIL 3 according to IEC 61508:2010

- Performance Level (PL) e and Category 4 according to ISO 13849-1:2015 or EN ISO 13849-1:2015

Additional password protection for F-configuration and F-program is set up for IT security.

## Design and handling

All CPUs of the SIMATIC S7-1500 product series feature a display with plain text information. The display provides the user with information on the order numbers, firmware version, and serial number of all connected modules. In addition, the IP address of the CPU and other network settings can be adapted locally without a programming device. Error messages are shown on the display directly in plain text. When performing servicing, you can minimize plant downtimes by quickly accessing the diagnostics alarms. Detailed information about this and a multitude of other display functions is available in the SIMATIC S7-1500 Display Simulator (https://support.industry.siemens.com/cs/ww/en/view/109761758).

Uniform front connectors for all modules and integrated potential jumpers for flexible formation of potential groups simplify storage. Additional components such as circuit breakers, relays, etc., can be installed quickly and easily, since a DIN rail is implemented in the rail of the SIMATIC S7-1500. The CPUs of the SIMATIC S7-1500 product series can be expanded centrally and in a modular fashion with signal modules. Space-saving expansion enables flexible adaptation to each application.

The system cabling for digital signal modules enables fast and clear connection to sensors and actuators from the field (fully modular connection consisting of front connector modules, connection cables and I/O modules), as well as easy wiring inside the control cabinet (flexible connection consisting of front connectors with assembled single conductors).

## System diagnostics and alarms

Integrated system diagnostics is activated by default for the CPUs. The different types of diagnostics are configured instead of programmed. System diagnostics information and alarms from the drives are displayed consistently and in plain text:

- On the CPU display

- In STEP 7

- On the HMI

- On the Web server

This information is available in RUN mode, but also in STOP mode of the CPU. The diagnostic information is updated automatically when you configure new hardware components.

The CPU is available as a central interrupt server in up to three project languages. The HMI takes over the display in the project languages defined for the CPU. If you require alarm texts in additional languages, you can load them into your HMI via the configured connection. The CPU, STEP 7 and your HMI ensure data consistency without additional engineering steps. The maintenance work is easier.

## 2.3 Hardware properties

**Article number**

6ES7511-1AK02-0AB0

**View of the module**

The following figure shows a CPU 1511-1 PN.



Figure 2-1     CPU 1511-1 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

CPU 1511-1 PN has the following technical properties:

| Property | Description | Additional information |
|---|---|---|
| **CPU display** | All CPUs of the SIMATIC S7-1500 product series feature a display with plain text information. The display provides information on order numbers, firmware version and serial numbers of all connected modules. In addition, you can set the IP address of the CPU and carry out further network settings. The display shows occurring error messages directly in plain text.<br><br>In addition to the functions listed here, a multitude of other functions that are described in the SIMATIC S7-1500 Display Simulator are shown on the display. | • S7-1500, ET 200MP system manual (http://support.automation.siemens.com/WW/view/en/59191792)<br>• SIMATIC S7-1500 Display Simulator (https://support.industry.siemens.com/cs/ww/en/view/109761758) |
| **Supply voltage** | The 24 V DC supply voltage is fed in via a 4-pin plug located at the bottom of the CPU. | • Chapter Connecting up (Page 30)<br>• S7-1500, ET 200MP system manual (http://support.automation.siemens.com/WW/view/en/59191792) |
| **PROFINET IO** | | |
| PROFINET interface (X1 P1 R and X1 P2 R) | The interface has two ports. In addition to basic PROFINET functionality, its also supports PROFINET IO RT (real time) and IRT (isochronous real time). | PROFINET function manual (https://support.industry.siemens.com/cs/ww/en/view/49948856) |
| Operation of the CPU as<br>• IO controller<br>• I-device | • **IO controller:**<br>As an IO controller the CPU addresses the connected IO devices<br>• **I-device:**<br>As an I-device (intelligent IO device) the CPU is assigned to a higher-level IO controller and is used in the process as an intelligent pre-processing unit of sub-processes | |

## Accessories

You can find information on "Accessories/spare parts" in the S7-1500, ET 200MP system manual (http://support.automation.siemens.com/WW/view/en/59191792).

## 2.4 Firmware functions

**Functions**

The CPU 1511-1 PN supports the following firmware functions:

| Function | Description | Additional information |
|---|---|---|
| **Integrated system diagnostics** | The system automatically generates the messages for the system diagnostics and outputs these messages via a programming device/PC, HMI device, the Web server or the integrated display. System diagnostics information is also available when the CPU is in STOP mode. | Diagnostics function manual (https://support.industry.siemens.com/cs/ww/en/view/59192926) |
| **Integrated Web server** | The Web server lets you access the CPU data by means of a network. Evaluations, diagnostics, and modifications are thus possible over long distances. Monitoring and evaluation is possible without STEP 7; all you need is a Web browser. Make sure that you take appropriate measures (e.g. limiting network access, using firewalls) to protect the CPU from being compromised. | • Web server function manual (https://support.industry.siemens.com/cs/ww/en/view/59193560) <br><br>• Security with SIMATIC S7 controllers system manual (https://support.industry.siemens.com/cs/ww/en/view/90885010) |
| **Integrated trace functionality** | Trace functionality supports you in troubleshooting and/or optimizing the user program. <br><br>You record device tags and evaluate the recordings with the trace and logic analyzer function. Tags are, for example, drive parameters or system and user tags of a CPU. <br><br>The device saves the recordings. You can read out and permanently save the recordings with the configuration system (ES), if required. The trace and logic analyzer function is therefore suitable for monitoring highly dynamic processes. <br><br>The trace record can also be displayed through the Web server. | Using the trace and logic analyzer function function manual (https://support.industry.siemens.com/cs/ww/en/view/64897128) |
| **OPC UA** | With OPC UA, you can exchange data via an open and manufacturer-neutral communication protocol. The CPU can act as OPC UA server. The CPU as OPC UA server can communicate with OPC UA clients. <br><br>The OPC UA Companion Specification allows methods to be specified uniformly and independently of the manufacturer. Using these specified methods, you can easily integrate devices from various manufacturers into your plants and production processes. | Communication function manual (https://support.industry.siemens.com/cs/ww/en/view/59192925) |
| **Configuration control** | You can use configuration control to operate different real hardware configurations with a configured maximum configuration of the S7-1500 automation system/ET 200MP distributed I/O system. This means that, in series machine manufacturing in particular, you have the option of operating/configuring different configuration variants of a machine with a single project. | S7-1500, ET 200MP system manual (https://support.industry.siemens.com/cs/ww/en/view/59191792) |

| Function | Description | Additional information |
|---|---|---|
| **PROFINET IO** | | |
| RT (real time) | RT prioritizes PROFINET IO telegrams over standard telegrams. This ensures the required determinism in the automation technology. In this process the data is transferred via prioritized Ethernet telegrams. | PROFINET function manual (https://support.industry.siemens.com/cs/ww/en/view/49948856) |
| IRT (isochronous real time) | A reserved bandwidth within the send clock is available for IRT data. The reserved bandwidth ensures that the IRT data can be transmitted in time-synchronized intervals, unaffected by other high network loading (e.g. TCP/IP communication or additional real-time communication). Update times with maximum determinism can be realized through IRT. Isochronous applications are possible with IRT. | |
| Isochronous mode | The Isochronous mode system property acquires measured values and process data and processes the signals in a fixed system clock. Isochronous mode thus contributes to high control quality and hence to greater manufacturing precision. Isochronous mode reduces possible fluctuations of the process reaction times to a minimum. Time-assured processing makes higher machine cycles possible. | |
| MRP (Media Redundancy Protocol) | It is possible to establish redundant networks via the Media Redundancy Protocol. Redundant transmission links (ring topology) ensure that an alternative communication path is made available if a transmission link fails. The PROFINET devices that are part of this redundant network form an MRP domain.<br><br>RT operation is possible with the use of MRP. | |
| MRPD (Media Redundancy with Planned Duplication) | The advantage of the MRP extension MRPD is that, in the event of a failure of a device or a line in the ring, all other devices continue to be supplied with IO data without interruption and with short update times.<br><br>MRPD is based on IRT and MRP. To realize media redundancy with short update times, the PROFINET devices participating in the ring send their data in both directions. The devices receive this data at both ring ports so that there is no reconfiguration time. | |
| Shared device | The "Shared device" function allows you to divide the modules or submodules of an IO device up among different IO controllers. Numerous IO controllers are often used in larger or widely distributed systems. Without the "Shared device" function, each I/O module of an IO device is assigned to the same IO controller. If sensors that are physically close to each other must provide data to different IO controllers, several IO devices are required. The "Shared device" function allows the modules or submodules of an IO device to be divided up among different IO controllers, thus allowing flexible automation concepts. You can, for example, combine I/O modules that are physically close to each other in one IO device. | |
| PROFIenergy | PROFIenergy is a PROFINET-based data interface for switching off consumers centrally and with full coordination during pause times regardless of the manufacturer or device type. Through this, the process should only be provided with the energy that is absolutely required. The majority of the energy is saved by the process; the PROFINET device itself only contributes a few watts of savings potential. | |

| Function | Description | Additional information |
|---|---|---|
| **Integrated technology** | | |
| Motion Control | S7-1500 CPUs support the controlled positioning and traveling of axes via S7-1500 Motion Control functions by means of the following technology objects:<br><br>Speed-controlled axes, positioning axes, synchronized axes, external encoders, cams, cam tracks and measuring inputs.<br><br>• Speed-controlled axis for controlling a drive with speed specification<br><br>• Positioning axis for position-controlled positioning of a drive<br><br>• Synchronous axis to interconnect with a master value. The axis is synchronized to the master axis position.<br><br>• External encoder for detecting the actual position of an encoder and its use as a master value for synchronous operation<br><br>• Cams, cam track for position-dependent generation of switching signals<br><br>• Measuring input for fast, accurate and event-dependent sensing of actual positions | S7-1500T Motion Control function manuals (https://support.industry.siemens.com/cs/ww/en/view/109751049) |
| Integrated closed-loop control functionality | • PID Compact (continuous PID controller)<br><br>• PID 3Step (step controller for integrating actuators)<br><br>• PID Temp (temperature controller for heating and cooling with two separate actuators) | PID control function manual (https://support.industry.siemens.com/cs/ww/en/view/108210036) |

| Function | Description | Additional information |
|---|---|---|
| **Integrated safety** | | |
| Know-how protection | The know-how protection protects user blocks against unauthorized access and modifications. | S7-1500, ET 200MP system manual (https://support.industry.siemens.com/cs/ww/en/view/59191792) |
| 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. | |
| Access protection | You can use authorization levels to assign separate rights to different users. | |
| Integrity protection | The CPUs dispose of integrity protection by default. Integrity protection identifies possible manipulations of engineering data on the SIMATIC memory card or during data transfer between TIA Portal and CPU. Integrity protection also checks the communication from a SIMATIC HMI system to the CPU for possible manipulations of engineering data. If integrity protection identifies the manipulation of engineering data, the user receives a corresponding message. | |
| Password provider | As an alternative to manual password input you can connect a password provider to STEP 7. A password provider offers the following advantages: <br>• Convenient handling of passwords. STEP 7 reads the password automatically for the blocks. This saves you time. <br>• Optimum block protection because the users do not know the password itself. | |

## 2.5 Operating and display elements

### 2.5.1 Front view of the CPU with closed front panel

The following figure shows the front view of the CPU 1511-1 PN.
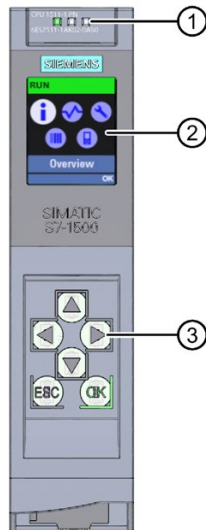


① LEDs for the current operating mode and diagnostics status of the CPU
② Display
③ Operator control buttons

Figure 2-2    View of the CPU 1511-1 PN (with front panel) - 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, 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 38).

---

**Removing and fitting the front panel or display**

You can remove and fit the front panel or the display during operation.

| ⚠ 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 remove or fit the front panel, always switch off the power supply to the S7-1500 automation system in hazardous area zone 2. |

**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 diameter of 3 mm to the front panel.
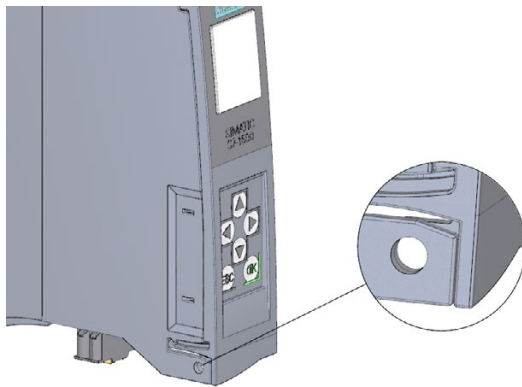


Figure 2-3      Locking latch on the CPU

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. You can find additional information on the display, configurable protection levels and local locks in 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 (https://support.industry.siemens.com/cs/ww/en/view/109761758).

## 2.5.2 Front view of the CPU without front panel and view from below

The following figure shows the operator controls and connection elements of the CPU 1511-1 PN.
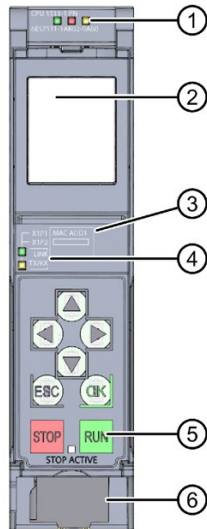


| ① | LEDs for the current operating mode and diagnostic status of the CPU |
| ② | Display |
| ③ | MAC address |
| ④ | LED displays for the 2 ports of the PROFINET interface X1 |
| ⑤ | Operating modes with "STOP ACTIVE" LED |
| ⑥ | Connector for power supply |

Figure 2-4    View of the CPU 1511-1 PN (without front panel) – front

---

**Note**

**Removing the display**

Only remove the display if it is faulty.

You can find information on removing and replacing displays in the S7-1500, ET 200MP system manual (https://support.industry.siemens.com/cs/ww/en/view/59191792).

---
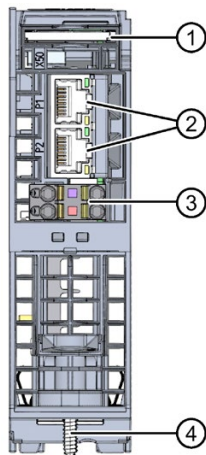
| ① | Slot for the SIMATIC memory card |
|---|---|
| ② | PROFINET IO interface (X1) with 2 ports |
| ③ | Connection for supply voltage |
| ④ | Fixing screw |

Figure 2-5    View of the CPU 1511-1 PN – bottom

### 2.5.3    Rear view of the CPU

The following figure shows the connection elements on the back of the CPU 1511-1 PN.
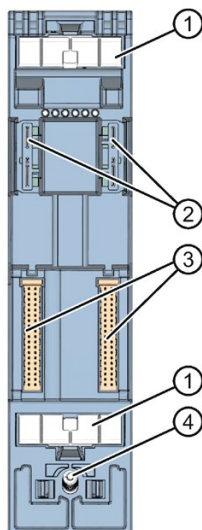


| ① | Shield contact surface |
|---|---|
| ② | Plug-in connection for power supply |
| ③ | Plug-in connection for backplane bus |
| ④ | Fastening screw |

Figure 2-6    View of the CPU 1511-1 PN - rear

## 2.6     Operating mode buttons

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

The following table shows the meaning of the corresponding operation of the operating mode buttons.

Table 2- 6     Meaning of the operating mode buttons

| Operation of the operating mode buttons | Meaning | Explanation |
|---|---|---|
| RUN | RUN mode | The CPU is executing the user program. |
| STOP | STOP mode | The user program is not being executed. (STOP ACTIVE LED lights up). |
| MRES<br><br>1. Press the operating mode button STOP.<br><br>    Result: The RUN/STOP LED lights up yellow.<br>2. Press the operating mode button STOP until the RUN/STOP LED lights up for the 2nd time and remains continuously lit (this takes three seconds). After this, release the button.<br>3. Press the operating mode button STOP again within the next three seconds. | Manual memory reset (with inserted SIMATIC memory card) or Reset to factory settings (without inserted SIMATIC memory card): | The CPU executes memory reset.<br><br><br>or<br>The CPU is reset to its factory settings.<br>You can find additional information in the S7-1500/ET 200MP system manual (https://support.industry.siemens.com/cs/ww/den/view/59191792). |

# Connecting up

# 3

This section provides information on the terminal assignment of the individual interfaces and the block diagram of the CPU 1511-1 PN.

## 24 V DC supply voltage (X80)

The connector for the power supply is plugged in when the CPU ships from the factory.

The following table shows the signal names and the descriptions of the pin assignment of the 24 V DC supply voltage.

Table 3- 1   Pin assignment 24 V DC supply voltage

| View | | Signal name [1] | | Description |
|---|---|---|---|---|
| **Connector** | | | | |
| | 1 | | 1L+ | + 24 V DC of the supply voltage |
| | 2 | | 1M | Ground of the supply voltage |
| | 3 | | 2M | Ground of the supply voltage for loop-through [2] |
| | 4 | | 2L+ | + 24 V DC of the supply voltage for loop-through [2] |

[1]   1L+ and 2L+ as well as 1M and 2M are bridged internally

[2]   Maximum 10 A permitted

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

## 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).
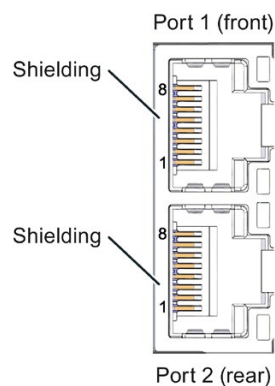


Figure 3-1      PROFINET ports

**Note**

You need a screwdriver (max. blade width 2.5 mm) to remove the PROFINET plug.

## Remove display

You can find a description of how to remove and replace the display in the S7-1500, ET 200MP (http://support.automation.siemens.com/WW/view/en/59191792) system manual.

## Reference

You can find additional information on the topics of "Connecting the CPU" and "Accessories/spare parts" in the S7-1500, ET 200MP (http://support.automation.siemens.com/WW/view/en/59191792) system manual.

## Assignment of the MAC addresses

The CPU 1511-1 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 1511-1 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 sequential. The first and last MAC address are lasered on the rating plate on the right side of each CPU 1511-1 PN.

The table below shows how the MAC addresses are assigned.

Table 3- 2    Assignment of the MAC addresses

|  | Assignment | Labeling |
|---|---|---|
| **MAC address 1** | PROFINET interface X1 (visible in STEP 7 for accessible devices) | • Front, lasered<br>• 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<br>• Right side, lasered (end of number range) |

**Block diagram**

The following figure shows the block diagram of the CPU 1511-1 PN.
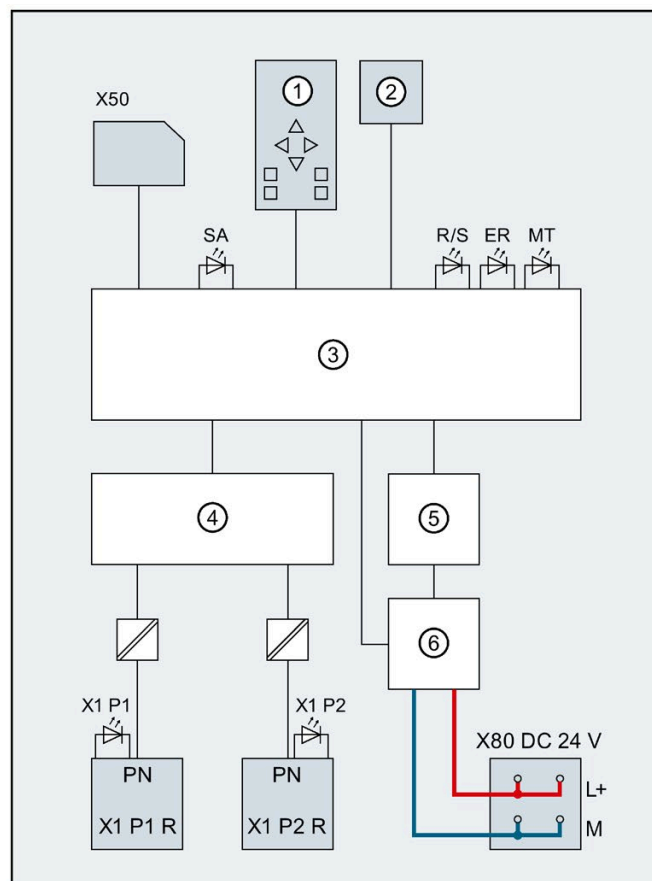


| ① | CPU with control and operating mode buttons | X80 24 V DC | Infeed of supply voltage |
| --- | --- | --- | --- |
| ② | Display | L+ | 24 V DC supply voltage |
| ③ | Electronics | M | Ground |
| ④ | PROFINET 2-port switch | SF | STOP ACTIVE LED (yellow) |
| ⑤ | Backplane bus interface | R/S | RUN/STOP LED (yellow/green) |
| ⑥ | Internal supply voltage | ER | ERROR LED (red) |
| PN X1 P1 R | PROFINET interface X1 Port 1 | MT | MAINT LED (yellow) |
| PN X1 P2 R | PROFINET interface X1 Port 2 | X1 P1, X1 P2 | LED Link TX/RX |
| X50 | SIMATIC memory card | | |

Figure 3-2    Block diagram CPU 1511-1 PN

# Interrupts, error messages, diagnostics and system alarms

# 4

The status and error displays of the CPU 1511-1 PN are described below.

You will find additional information on "Interrupts" in the STEP 7 online help.

You can find additional information on the topics of "Diagnostics" and "System alarms" in the Diagnostics (http://support.automation.siemens.com/WW/view/en/59192926) function manual.

## 4.1        Status and error display of the CPU

**LED display**

The figure below shows the LED display of the CPU 1511-1 PN.
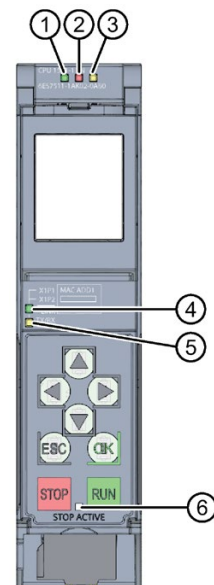


| ① | RUN/STOP LED (yellow/green LED) |
|---|---|
| ② | ERROR LED (red LED) |
| ③ | MAINT LED (yellow LED) |
| ④ | LINK RX/TX LED for port X1 P1 (yellow/green LED) |
| ⑤ | LINK RX/TX LED for port X1 P2 (yellow/green LED) |
| ⑥ | STOP ACTIVE-LED (yellow LED) |

Figure 4-1        LED display of the CPU 1511-1 PN (without front panel)

## Meaning of the RUN/STOP, ERROR and MAINT LEDs

The CPU 1511-1 PN has three LEDs to signal the current operating status and diagnostics status. The following table shows the meaning of the various combinations of colors for the RUN/STOP, ERROR and MAINT LEDs.

Table 4- 1     Meaning of the LEDs

| RUN/STOP LED | ERROR LED | MAINT LED | Meaning |
|---|---|---|---|
| □<br>LED off | □<br>LED off | □<br>LED off | Missing or insufficient power supply on the CPU. |
| □<br>LED off | ☀<br>LED flashes red | □<br>LED off | An error has occurred. |
| ■<br>LED lit green | □<br>LED off | □<br>LED off | CPU is in RUN mode. |
| ■<br>LED lit green | ☀<br>LED flashes red | □<br>LED off | A diagnostics event is pending. |
| ■<br>LED lit green | □<br>LED off | ■<br>LED lit yellow | Maintenance demanded for the plant.<br>The affected hardware must be checked/replaced within a short period of time.<br>Active Force job |
| ■<br>LED lit green | □<br>LED off | ☀<br>LED flashes yellow | Bad configuration |
| ■<br>LED lit yellow | ☀<br>LED flashes red | □<br>LED off | A diagnostics event is pending. |
| ■<br>LED lit yellow | □<br>LED off | ☀<br>LED flashes yellow | Firmware update successfully completed. |
| ■<br>LED lit yellow | □<br>LED off | □<br>LED off | CPU is in STOP mode. |
| ■<br>LED lit yellow | ☀<br>LED flashes red | ☀<br>LED flashes yellow | The program on the SIMATIC memory card is causing an error.<br>Firmware update using SIMATIC memory card has failed.<br>The CPU has detected an error state. Additional information is available via the CPU diagnostic buffer. |
| ☀<br>LED flashes yellow | □<br>LED off | □<br>LED off | CPU is performing internal activities during STOP, e.g. startup after STOP.<br>Download of the user program from the SIMATIC memory card<br>CPU carries out a program with active breakpoint. |
| ☀<br>LED flashes yellow/green | □<br>LED off | □<br>LED off | Startup (transition from STOP → RUN) |
| ☀<br>LED flashes yellow/green | ☀<br>LED flashes red | ☀<br>LED flashes yellow | Startup (CPU booting)<br>Test of LEDs during startup, inserting a module.<br>LED flashing test |

**Meaning of LINK RX/TX LED**

Each port has a LINK RX/TX LED. The table below shows the various "LED scenarios" of the ports for the CPU 1511-1 PN.

Table 4- 2     Meaning of the LEDs

| LINK TX/RX LED | Meaning |
|---|---|
| 🟨<br>LED off | There is no Ethernet connection between the PROFINET interface of the PROFINET device and the communication partner.<br>No data is currently being sent/received via the PROFINET interface.<br>There is no LINK connection. |
| ☼<br>LED flashes green | The "LED flashing test" is being performed. |
| ▪<br>LED lit green | There is an Ethernet connection between the PROFINET interface of your PROFINET device and a communication partner. |
| ☼<br>LED flashes yellow/green | Data is currently being received from or sent to a communications partner on Ethernet via the PROFINET interface of the PROFINET device. |

**Note**

**"LED" instruction**

You can read the status (e.g. "On" or "Off") of LEDs of a CPU or a module using the "LED" instruction. Note, however, that it is not possible to read the LED status of the LINK RX/TX LEDs on all S7-1500 CPUs.

You can find additional information on the "LED" instruction in the STEP 7 online help.

**Meaning of the STOP ACTIVE LED**

The following table shows the meaning of the STOP ACTIVE LED for the CPU 1511-1 PN.

Table 4- 3     Meaning of the LEDs

| STOP ACTIVE LED | Meaning |
|---|---|
| ■<br>LED lit yellow | The CPU is switched to "STOP" mode using the STOP button.<br><br>• As long as the STOP ACTIVE LED is lit up, switching the CPU to RUN mode is only possible using the RUN button.<br><br>• The CPU can then no longer be set to RUN mode via the display operation or via online functions. The state of the buttons is retained at power-off. If the CPU does not start up automatically after a power-on, you have to keep the STOP button pressed during start-up until the STOP ACTIVE LED is activated.<br><br>• If an automatic start-up is to be reliably prevented after a power-up, the STOP button has to be kept pressed during the start-up of the CPU until the STOP ACTIVE LED is activated. |
| □<br>LED off | • The CPU is set to "STOP" mode using the display or programming device and not with the STOP button on the device.<br><br>• The CPU is in RUN mode. |

# Technical specifications

# 5

The following table shows the technical specifications as of 05/2021. You will find a data sheet including daily updated technical specifications on the Internet (https://support.industry.siemens.com/cs/ww/en/pv/6ES7511-1AK02-0AB0/td?dl=en).

| Article number | 6ES7511-1AK02-0AB0 |
|---|---|
| **General information** | |
| Product type designation | CPU 1511-1 PN |
| HW functional status | FS03 |
| Firmware version | V2.9 |
| **Product function** | |
| • I&M data | Yes; I&M0 to I&M3 |
| • Isochronous mode | Yes; Distributed and central; with minimum OB 6x cycle of 625 µs (distributed) and 1 ms (central) |
| **Engineering with** | |
| • STEP 7 TIA Portal configurable/integrated from version | V17 (FW V2.9) / V15 (FW V2.5) or higher; with older TIA Portal versions configurable as 6ES7511-1AK01-0AB0 |
| **Configuration control** | |
| via dataset | Yes |
| **Display** | |
| Screen diagonal [cm] | 3.45 cm |
| **Control elements** | |
| Number of keys | 8 |
| Mode buttons | 2 |
| **Supply voltage** | |
| Type of supply voltage | 24 V DC |
| permissible range, lower limit (DC) | 19.2 V |
| permissible range, upper limit (DC) | 28.8 V |
| Reverse polarity protection | Yes |
| **Mains buffering** | |
| • Mains/voltage failure stored energy time | 5 ms |
| • Repeat rate, min. | 1/s |
| **Input current** | |
| Current consumption (rated value) | 0.7 A |
| Current consumption, max. | 0.95 A |
| Inrush current, max. | 1.9 A; Rated value |
| $I^2t$ | 0.02 A²·s |
| **Power** | |
| Infeed power to the backplane bus | 10 W |
| Power consumption from the backplane bus (balanced) | 5.5 W |
| **Power loss** | |
| Power loss, typ. | 5.7 W |

| Article number | 6ES7511-1AK02-0AB0 |
|---|---|
| **Memory** | |
| Number of slots for SIMATIC memory card | 1 |
| SIMATIC memory card required | Yes |
| **Work memory** | |
| • integrated (for program) | 150 kbyte |
| • integrated (for data) | 1 Mbyte |
| **Load memory** | |
| • Plug-in (SIMATIC Memory Card), max. | 32 Gbyte |
| **Backup** | |
| • 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) | 4 000; Blocks (OB, FB, FC, DB) and UDTs |
| **DB** | |
| • Number range | 1 ... 60 999; subdivided into: number range that can be used by the user: 1 ... 59 999, and number range of DBs created via SFC 86: 60 000 ... 60 999 |
| • Size, max. | 1 Mbyte; For DBs with absolute addressing, the max. size is 64 KB |
| **FB** | |
| • Number range | 0 ... 65 535 |
| • Size, max. | 150 kbyte |
| **FC** | |
| • Number range | 0 ... 65 535 |
| • Size, max. | 150 kbyte |
| **OB** | |
| • Size, max. | 150 kbyte |
| • Number of free cycle OBs | 100 |
| • Number of time alarm OBs | 20 |
| • Number of delay alarm OBs | 20 |
| • Number of cyclic interrupt OBs | 20; With minimum OB 3x cycle of 500 µs |
| • Number of process alarm OBs | 50 |
| • Number of DPV1 alarm OBs | 3 |
| • Number of isochronous mode OBs | 2 |
| • Number of technology synchronous alarm OBs | 2 |
| • Number of startup OBs | 100 |

| Article number | 6ES7511-1AK02-0AB0 |
|---|---|
| • Number of asynchronous error OBs | 4 |
| • Number of synchronous error OBs | 2 |
| • Number of diagnostic alarm OBs | 1 |
| **Nesting depth** | |
| • per priority class | 24 |
| **Counters, timers and their retentivity** | |
| **S7 counter** | |
| • Number | 2 048 |
| **Retentivity** | |
| – adjustable | Yes |
| **IEC counter** | |
| • Number | Any (only limited by the main memory) |
| **Retentivity** | |
| – adjustable | Yes |
| **S7 times** | |
| • Number | 2 048 |
| **Retentivity** | |
| – adjustable | Yes |
| **IEC timer** | |
| • Number | Any (only limited by the main memory) |
| **Retentivity** | |
| – adjustable | Yes |
| **Data areas and their retentivity** | |
| Retentive data area (incl. timers, counters, flags), max. | 128 kbyte; In total; available retentive memory for bit memories, timers, counters, DBs, and technology data (axes): 88 KB |
| Extended retentive data area (incl. timers, counters, flags), max. | 1 Mbyte; When using PS 6 0W 24/48/60 V DC HF |
| **Flag** | |
| • Size, max. | 16 kbyte |
| • Number of clock memories | 8; 8 clock memory bit, grouped into one clock memory byte |
| **Data blocks** | |
| • Retentivity adjustable | Yes |
| • Retentivity preset | No |
| **Local data** | |
| • per priority class, max. | 64 kbyte; max. 16 KB per block |
| **Address area** | |
| Number of IO modules | 1 024; max. number of modules / submodules |

| Article number | 6ES7511-1AK02-0AB0 |
|---|---|
| **I/O address area** | |
| • Inputs | 32 kbyte; All inputs are in the process image |
| • Outputs | 32 kbyte; All outputs are in the process image |
| **per integrated IO subsystem** | |
| – Inputs (volume) | 8 kbyte |
| – Outputs (volume) | 8 kbyte |
| **per CM/CP** | |
| – Inputs (volume) | 8 kbyte |
| – Outputs (volume) | 8 kbyte |
| **Subprocess images** | |
| • Number of subprocess images, max. | 32 |
| **Hardware configuration** | |
| Number of distributed IO systems | 32; A distributed I/O system is characterized not only by the integration of distributed I/O via PROFINET or PROFIBUS communication modules, but also by 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 maximum of 4 CMs/CPs (PROFIBUS, PROFINET, Ethernet) can be inserted in total |
| **Number of IO Controllers** | |
| • integrated | 1 |
| • Via CM | 4; A maximum of 4 CMs/CPs (PROFIBUS, PROFINET, Ethernet) can be inserted in total |
| **Rack** | |
| • Modules per rack, max. | 32; CPU + 31 modules |
| • Number of lines, max. | 1 |
| **PtP CM** | |
| • Number of PtP CMs | the number of connectable PtP CMs is only limited by the number of available slots |
| **Time of day** | |
| **Clock** | |
| • Type | Hardware clock |
| • Backup time | 6 wk; At 40 °C ambient temperature, typically |
| • Deviation per day, max. | 10 s; Typ.: 2 s |
| **Operating hours counter** | |
| • Number | 16 |
| **Clock synchronization** | |
| • supported | Yes |
| • in AS, master | Yes |
| • in AS, slave | Yes |
| • on Ethernet via NTP | Yes |

| Article number | 6ES7511-1AK02-0AB0 |
|---|---|
| **Interfaces** | |
| Number of PROFINET interfaces | 1 |
| **1. Interface** | |
| **Interface types** | |
| • RJ 45 (Ethernet) | Yes; X1 |
| • Number of ports | 2 |
| • integrated switch | Yes |
| **Protocols** | |
| • IP protocol | Yes; IPv4 |
| • PROFINET IO Controller | Yes |
| • PROFINET IO Device | Yes |
| • SIMATIC communication | Yes |
| • Open IE communication | Yes; Optionally also encrypted |
| • Web server | Yes |
| • Media redundancy | Yes |
| **PROFINET IO Controller** **Services** | |
| – PG/OP communication | Yes |
| – Isochronous mode | Yes |
| – Direct data exchange | Yes; Requirement: IRT and isochronous mode (MRPD optional) |
| – IRT | Yes |
| – PROFIenergy | Yes; per user program |
| – Prioritized startup | Yes; Max. 32 PROFINET devices |
| – Number of connectable IO Devices, max. | 128; In total, up to 256 distributed I/O devices can be connected via AS-i, PROFIBUS or PROFINET |
| – Of which IO devices with IRT, max. | 64 |
| – Number of connectable IO Devices for RT, max. | 128 |
| – of which in line, max. | 128 |
| – Number of IO Devices that can be simultaneously activated/deactivated, max. | 8; in total across all interfaces |
| – Number of IO Devices per tool, max. | 8 |
| – Updating times | The minimum value of the update time also depends on communication share set for PROFINET IO, on the number of IO devices, and on the quantity of configured user data |

| Article number | 6ES7511-1AK02-0AB0 |
| --- | --- |
| **Update time for IRT** | |
| – for send cycle of 250 µs | 250 µs to 4 ms; Note: In the case of IRT with isochronous mode, the minimum update time of 625 µs of the isochronous OB is decisive |
| – for send cycle of 500 µs | 500 µs to 8 ms; Note: In the case of IRT with isochronous mode, the minimum update time of 625 µs of the isochronous OB is decisive |
| – for send cycle of 1 ms | 1 ms to 16 ms |
| – for send cycle of 2 ms | 2 ms to 32 ms |
| – for send cycle of 4 ms | 4 ms to 64 ms |
| – With IRT and parameterization of "odd" send cycles | Update time = set "odd" send clock (any multiple of 125 µs: 375 µs, 625 µs ... 3 875 µs) |
| **Update time for RT** | |
| – for send cycle of 250 µs | 250 µs to 128 ms |
| – for send cycle of 500 µs | 500 µs to 256 ms |
| – for send cycle of 1 ms | 1 ms to 512 ms |
| – for send cycle of 2 ms | 2 ms to 512 ms |
| – for send cycle of 4 ms | 4 ms to 512 ms |
| **PROFINET IO Device** | |
| **Services** | |
| – PG/OP communication | Yes |
| – Isochronous mode | No |
| – IRT | Yes |
| – PROFIenergy | Yes; per user program |
| – Shared device | Yes |
| – Number of IO Controllers with shared device, max. | 4 |
| – activation/deactivation of I-devices | Yes; per user program |
| – Asset management record | Yes; per user program |
| **Interface types** | |
| **RJ 45 (Ethernet)** | |
| • 100 Mbps | Yes |
| • Autonegotiation | Yes |
| • Autocrossing | Yes |
| • Industrial Ethernet status LED | Yes |
| **Protocols** | |

| Article number | 6ES7511-1AK02-0AB0 |
| --- | --- |
| **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 paths | 16 |
| **Redundancy mode** | |
| • H-Sync forwarding | Yes |
| **Media redundancy** | |
| – Media redundancy | only via 1st interface (X1) |
| – MRP | Yes |
| – MRP interconnection, supported | Yes; as MRP ring node according to IEC 62439-2 Edition 3.0 |
| – MRPD | Yes; Requirement: IRT |
| – Switchover time on line break, typ. | 200 ms; For MRP, bumpless for MRPD |
| – Number of stations in the ring, max. | 50 |
| **SIMATIC communication** | |
| • PG/OP communication | Yes; encryption with TLS V1.3 pre-selected |
| • S7 routing | Yes |
| • S7 communication, as server | Yes |
| • S7 communication, as client | Yes |
| • User data per job, max. | See online help (S7 communication, user data size) |
| **Open IE communication** | |
| • TCP/IP | Yes |
| – Data length, max. | 64 kbyte |
| – several passive connections per port, supported | Yes |
| • ISO-on-TCP (RFC1006) | Yes |
| – Data length, max. | 64 kbyte |
| • UDP | Yes |
| – Data length, max. | 2 kbyte; 1 472 bytes for UDP broadcast |
| – UDP multicast | Yes; Max. 5 multicast circuits |
| • DHCP | Yes |
| • DNS | Yes |
| • SNMP | Yes |
| • DCP | Yes |

| Article number | 6ES7511-1AK02-0AB0 |
| --- | --- |
| • LLDP | Yes |
| • Encryption | Yes; Optional |
| **Web server** | |
| • HTTP | Yes; Standard and user pages |
| • HTTPS | Yes; Standard and user pages |
| **OPC UA** | |
| • Runtime license required | Yes; "Small" license required |
| • OPC UA Client | Yes |
| – Application authentication | Yes |
| – Security policies | Available security policies: None, Basic128Rsa15, Basic256Rsa15, Basic256Sha256 |
| – User authentication | "anonymous" or by user name & password |
| – Number of connections, max. | 4 |
| – Number of nodes of the client interfaces, max. | 1 000 |
| – Number of elements for one call of OPC_UA_NodeGetHandleList/OPC_UA_ReadList/OPC_UA_WriteList, max. | 300 |
| – Number of elements for one call of OPC_UA_NameSpaceGetIndexList, max. | 20 |
| – Number of elements for one call of OPC_UA_MethodGetHandleList, max. | 100 |
| – Number of simultaneous calls of the client instructions per connection (except OPC_UA_ReadList,OPC_UA_WriteList,OPC_UA_MethodCall), max. | 1 |
| – Number of simultaneous calls of the client instructions OPC_UA_ReadList,OPC_UA_WriteList and OPC_UA_MethodCall, max. | 5 |
| – Number of registerable nodes, max. | 5 000 |
| – Number of registerable method calls of OPC_UA_MethodCall, max. | 100 |
| – Number of inputs/outputs when calling OPC_UA_MethodCall, max. | 20 |
| • OPC UA Server | Yes; Data access (read, write, subscribe), method call, custom address space |
| – Application authentication | Yes |
| – Security policies | Available security policies: None, Basic128Rsa15, Basic256Rsa15, Basic256Sha256 |
| – User authentication | "anonymous" or by user name & password |
| – GDS support (certificate management) | Yes |

| Article number | 6ES7511-1AK02-0AB0 |
|---|---|
| – Number of sessions, max. | 32 |
| – Number of accessible variables, max. | 50 000 |
| – Number of registerable nodes, max. | 10 000 |
| – Number of subscriptions per session, max. | 20 |
| – Sampling interval, min. | 100 ms |
| – Publishing interval, min. | 500 ms |
| – Number of server methods, max. | 20 |
| – Number of inputs/outputs per server method, max. | 20 |
| – Number of monitored items, max. | 1 000; for 1 s sampling interval and 1 s send interval |
| – Number of nodes for user-defined server interfaces, max. | 1 000 |
| • Alarms and Conditions | Yes |
| – Number of program alarms | 100 |
| – Number of alarms for system diagnostics | 50 |
| **Further protocols** | |
| • MODBUS | Yes; MODBUS TCP |
| **Isochronous mode** | |
| Equidistance | Yes |
| **S7 message functions** | |
| Number of login stations for message functions, max. | 32 |
| Program alarms | Yes |
| Number of configurable program messages, max. | 5 000; Program messages are generated by the "Program_Alarm" block, ProDiag or GRAPH |
| Number of loadable program messages in RUN, max. | 2 500 |
| Number of simultaneously active program alarms | |
| • Number of program alarms | 600 |
| • Number of alarms for system diagnostics | 100 |
| • Number of alarms for motion technology objects | 80 |
| **Test commissioning functions** | |
| Joint commission (Team Engineering) | Yes; Parallel online access possible for up to 5 engineering systems |
| Status block | Yes; Up to 8 simultaneously (in total across all ES clients) |
| Single step | No |
| Number of breakpoints | 8 |

| Article number | 6ES7511-1AK02-0AB0 |
|---|---|
| **Status/control** | |
| • Status/control variable | Yes |
| • Variables | Inputs/outputs, memory bits, DBs, distributed I/Os, timers, counters |
| • Number of variables, max. | |
| – of which status variables, max. | 200; per job |
| – of which control variables, max. | 200; per job |
| **Forcing** | |
| • Forcing | Yes |
| • Forcing, variables | Peripheral inputs/outputs |
| • Number of variables, max. | 200 |
| **Diagnostic buffer** | |
| • present | Yes |
| • Number of entries, max. | 1 000 |
| – of which powerfail-proof | 500 |
| **Traces** | |
| • Number of configurable Traces | 4; Up to 512 KB of data per trace are possible |
| **Interrupts/diagnostics/status information** | |
| **Diagnostics indication LED** | |
| • RUN/STOP LED | Yes |
| • ERROR LED | Yes |
| • MAINT LED | Yes |
| • STOP ACTIVE LED | Yes |
| • Connection display LINK TX/RX | Yes |
| **Supported technology objects** | |
| Motion Control | Yes; Note: The number of technology objects affects the cycle time of the PLC program; selection guide via the TIA Selection Tool |
| • Number of available Motion Control resources for technology objects | 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 probe | 40 |

| Article number | 6ES7511-1AK02-0AB0 |
|---|---|
| • Positioning axis | |
|    – Number of positioning axes at motion control cycle of 4 ms (typical value) | 5 |
|    – Number of positioning axes at motion control cycle of 8 ms (typical value) | 10 |
| Controller | |
| • 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 |
| **Standards, approvals, certificates** | |
| Suitable for safety functions | No |
| **Ambient conditions** | |
| **Ambient temperature during operation** | |
| • horizontal installation, min. | -25 °C; No condensation |
| • horizontal installation, max. | 60 °C; Display: 50 °C, at an operating temperature of typically 50 °C, the display is switched off |
| • vertical installation, min. | -25 °C; No condensation |
| • vertical installation, max. | 40 °C; Display: 40 °C, at an operating temperature of typically 40 °C, the display is switched off |
| **Ambient temperature during storage/transportation** | |
| • min. | -40 °C |
| • max. | 70 °C |
| **Altitude during operation relating to sea level** | |
| • Installation altitude above sea level, max. | 5 000 m; Restrictions for installation altitudes > 2 000 m, see manual |
| **Configuration** | |
| **Programming** | |
| **Programming language** | |
|    – LAD | Yes |
|    – FBD | Yes |
|    – STL | Yes |
|    – SCL | Yes |
|    – GRAPH | Yes |

| Article number | 6ES7511-1AK02-0AB0 |
|---|---|
| **Know-how protection** | |
| • User program protection/password protection | Yes |
| • Copy protection | Yes |
| • Block protection | Yes |
| **Access protection** | |
| • protection of confidential configuration data | Yes |
| • Password for display | Yes |
| • Protection level: Write protection | Yes |
| • Protection level: Read/write protection | Yes |
| • Protection level: Complete protection | Yes |
| **Cycle time monitoring** | |
| • lower limit | adjustable minimum cycle time |
| • upper limit | adjustable maximum cycle time |
| **Dimensions** | |
| Width | 35 mm |
| Height | 147 mm |
| Depth | 129 mm |
| **Weights** | |
| Weight, approx. | 405 g |

## General technical specifications

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

# Dimensional drawing

# A

This section includes a dimensional drawing of the module on a mounting rail and a dimensional drawing with the front panel open. Always observe the specified dimensions for installation in cabinets, control rooms, etc.

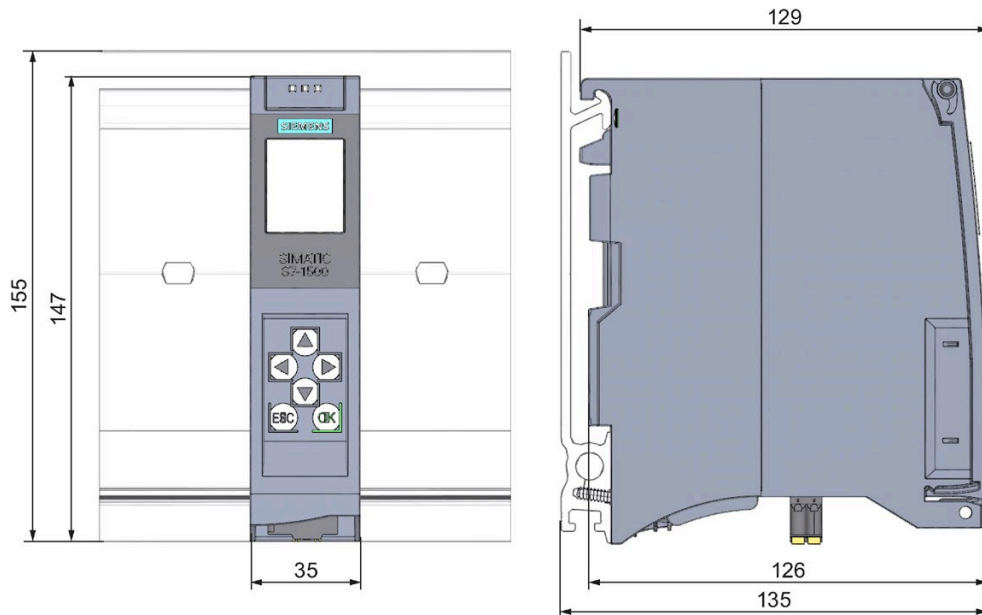**Dimensional drawings for CPU 1511-1 PN**



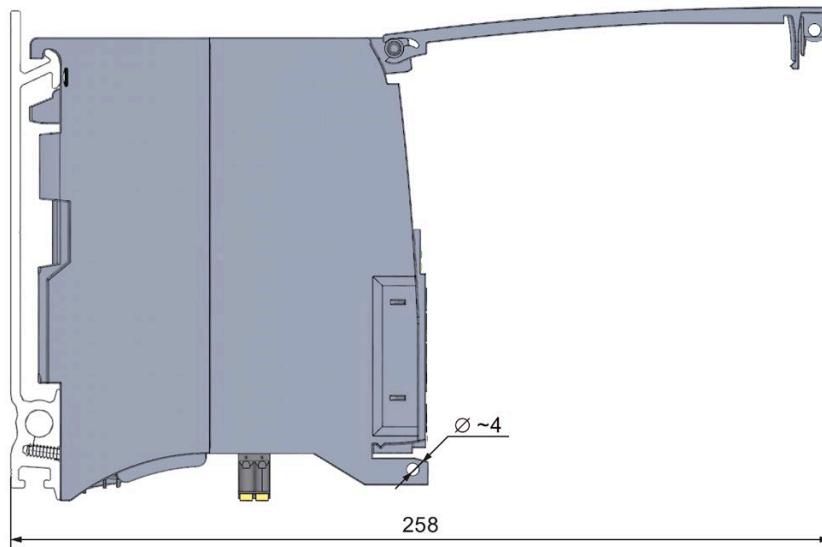Figure A-1    Dimensional drawing of CPU 1511-1 PN, front and side views

Figure A-2    Dimensional drawing of CPU 1511-1 PN, side view with front panel open