SIEMENS

SIMATIC

S7-1500, ET 200SP, ET 200pro

Structure and Use of the CPU Memory

Function manual

Edition 09/2016

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A5E03461664-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:

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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.

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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.

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Preface

Purpose of the documentation

This documentation describes the various memory areas of the S7-1500 CPUs, ET 200SP CPUs and the ET 200pro CPU 1516pro-2 PN, and shows how you can optimally use these memory areas.

Additionally this manual shows how you can free work memory by using recipes and data logs.

Basic knowledge required

The following knowledge is required in order to understand the documentation:

- General knowledge of automation technology
- Knowledge of the SIMATIC industrial automation system
- Knowledge about the use of computers
- Knowledge of working with the TIA Portal and STEP 7

Conventions

Please also observe notes marked as follows:

Note

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

Scope of the documentation

This documentation is valid for all CPUs of the product families S7-1500 and ET 200SP and for the ET 200pro CPU 1516pro-2 PN.

What's new compared to the previous version of the function manual (01/2013 edition)

What's new?		What are the customer benefits?	Where can I find information?
New contents	Analyzing memory requirements and memory usage	You have various options for analyzing the memory requirements and the memory usage of the CPU: • with STEP 7 • with the display of the CPU • with the Web server of the CPU	Section Memory requirements and memory usage (Page 16)
	Memory behavior in load memory when loading software changes	When loading software changes to the SIMATIC memory card, the files in question are only deleted after creation of the new files. For this reason, the CPU requires adequate free memory space on the SIMATIC memory card. You have various options for creating memory space; these will be explained.	Section Memory behavior in load memory when loading software changes (Page 26)
	Service life of SIMATIC memory cards	Using calculation examples of the service life of a SIMATIC memory card, you can estimate which SIMATIC memory card is required for your automation task.	Section Service life of the SIMATIC memory card (Page 51)
Changed contents	Scope of the function manual expanded to include the CPUs of the distributed I/O system ET 200SP and the CPU 1516pro-2 PN	Functions that you will be familiar with from the SIMATIC S7-1500 CPUs are implemented in CPUs in other designs (ET 200SP) and in the CPU 1516pro-2 PN (degree of protection IP65, IP66 and IP67).	Manual CPU 1510SP-1 PN (https://support.industry.siemens.com/cs/ww/en/view/90157130) Manual CPU 1512SP-1 PN (https://support.industry.siemens.com/cs/ww/en/view/90157013) Operating instructions CPU 1516pro-2 PN (https://support.industry.siemens.com/cs/ww/en/view/109482416)

See also

SIMATIC Portal (http://www.siemens.com/simatic-tech-doku-portal)

Catalog (www.siemens.com/industrymall)

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 only form one element of such a concept.

Customer is responsible to prevent unauthorized access to its plants, systems, machines and networks. Systems, machines and components should only be connected to the enterprise network or the internet if and to the extent necessary and with appropriate security measures (e.g. use of firewalls and network segmentation) in place.

Additionally, Siemens' guidance on appropriate security measures should be taken into account. For more information about industrial security, please visit (http://www.siemens.com/industrialsecurity).

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

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under (http://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 (http://www.siemens.com/automation/service&support).

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.

See also

Industry Mall (https://mall.industry.siemens.com)

Table of contents

Documentation guide

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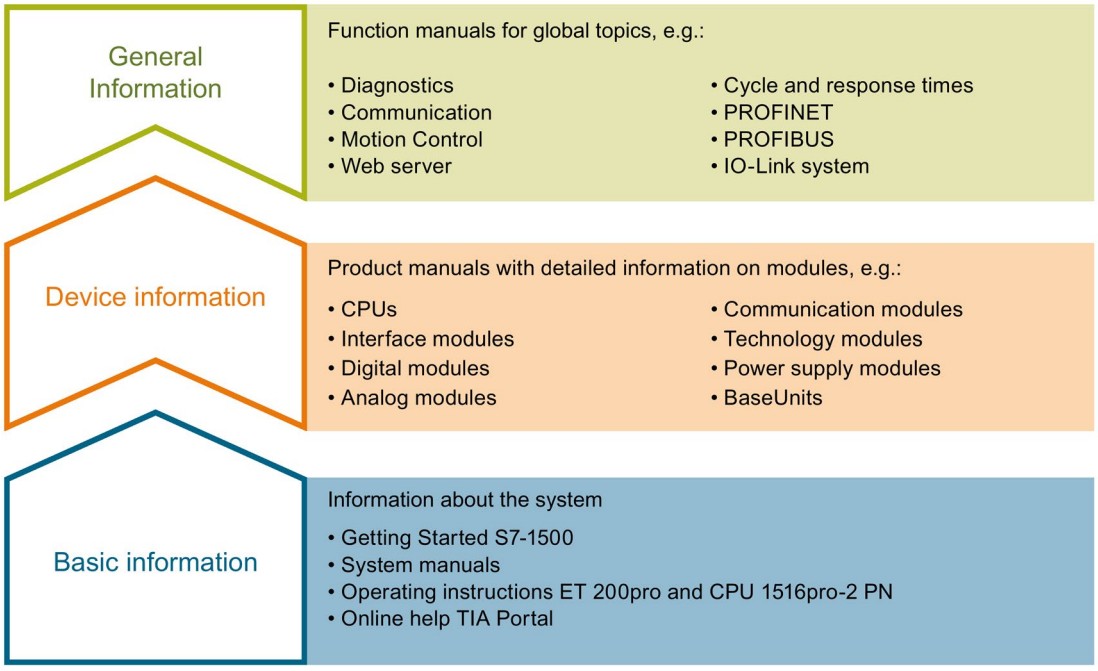
The documentation for the SIMATIC S7-1500 automation system, for CPU 1516pro-2 PN based on SIMATIC S7-1500, and for the distributed I/O systems SIMATIC ET 200MP, ET 200SP and ET 200AL is divided into three areas.
This division allows you easier access to the specific information you require.



Basic information

System manuals and Getting Started manuals describe in detail the configuration, installation, wiring and commissioning of the SIMATIC S7-1500, ET 200MP, ET 200SP and ET 200AL systems; use the corresponding operating instructions for CPU 1516pro-2 PN. The STEP 7 online help supports you in configuration and programming.

Device information

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

General information

The function manuals contain detailed descriptions on general topics such as diagnostics, communication, Motion Control, Web server, OPC UA.

You can download the documentation free of charge from the Internet (http://w3.siemens.com/mcms/industrial-automation-systems-simatic/en/manual-overview/Pages/Default.aspx).

Changes and additions to the manuals are documented in product information sheets.

You will find the product information on the Internet:

- S7-1500/ET 200MP (https://support.industry.siemens.com/cs/us/en/view/68052815)
- ET 200SP (https://support.industry.siemens.com/cs/us/en/view/73021864)
- ET 200AL (https://support.industry.siemens.com/cs/us/en/view/99494757)

Manual Collections

The Manual Collections contain the complete documentation of the systems put together in one file.

You will find the Manual Collections on the Internet:

- S7-1500/ET 200MP (https://support.industry.siemens.com/cs/ww/en/view/86140384)
- ET 200SP (https://support.industry.siemens.com/cs/ww/en/view/84133942)
- ET 200AL (https://support.industry.siemens.com/cs/ww/en/view/95242965)

"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).

"mySupport" - Documentation

In the Documentation area in "mySupport" you can combine entire manuals or only parts of these to your own manual.
You can export the manual as PDF file or in a format that can be edited later.

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

"mySupport" - CAx data

In the CAx data area in "mySupport", you can access the current product data for your CAx or CAe system.

You configure your own download package with a few clicks.

In doing so you can select:

- Product images, 2D dimension drawings, 3D models, internal circuit diagrams, EPLAN macro files
- Manuals, characteristics, operating manuals, certificates
- Product master data

You can find "mySupport" - CAx data on the Internet (http://support.industry.siemens.com/my/ww/en/CAxOnline).

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/sc/ww/en/sc/2054).

TIA Selection Tool

With the TIA Selection Tool, you can select, configure and order devices for Totally Integrated Automation (TIA).
This tool is the successor of the SIMATIC Selection Tool and combines the known configurators for automation technology into one tool.
With the TIA Selection Tool, you can generate a complete order list from your product selection or product configuration.

You can find the TIA Selection Tool on the Internet (http://w3.siemens.com/mcms/topics/en/simatic/tia-selection-tool).

SIMATIC Automation Tool

You can use the SIMATIC Automation Tool to run commissioning and maintenance activities simultaneously on different SIMATIC S7 stations as a bulk operation, independently of the TIA Portal.

The SIMATIC automation tool provides a variety of functions:

- Scanning of a PROFINET/Ethernet plant network and identification of all connected CPUs
- Address assignment (IP, subnet, gateway) and station name (PROFINET device) to a CPU
- Transfer of the date and programming device/PC time converted to UTC time to the module
- Program download to CPU
- Operating mode switchover RUN/STOP
- CPU localization by means of LED flashing
- Reading out CPU error information
- Reading of CPU diagnostic buffer
- Reset to factory settings
- Updating the firmware of the CPU and connected modules

You can find the SIMATIC Automation Tool on the Internet (https://support.industry.siemens.com/cs/ww/en/view/98161300).

PRONETA

With SIEMENS PRONETA (PROFINET network analysis), you analyze the plant network during commissioning. PRONETA features two core functions:

- The topology overview independently scans PROFINET and all connected components.
- The IO check is a fast test of the wiring and the module configuration of a plant.

You can find SIEMENS PRONETA on the Internet (https://support.industry.siemens.com/cs/ww/en/view/67460624).

Memory areas and retentive memory

2

Memory areas

The automation data is located in the automation system in different memory areas.

The offline data of the project created in STEP 7 is located on the hard disk of the programming device. The online data of the project is located in the load memory on the SIMATIC memory card. In addition, the work memory, retentive memory and other memory areas are located on the CPU.

The following figure shows an overview of the memory areas of the S7-1500 and ET 200SP CPUs and the ET 200pro CPU 1516pro-2 PN.

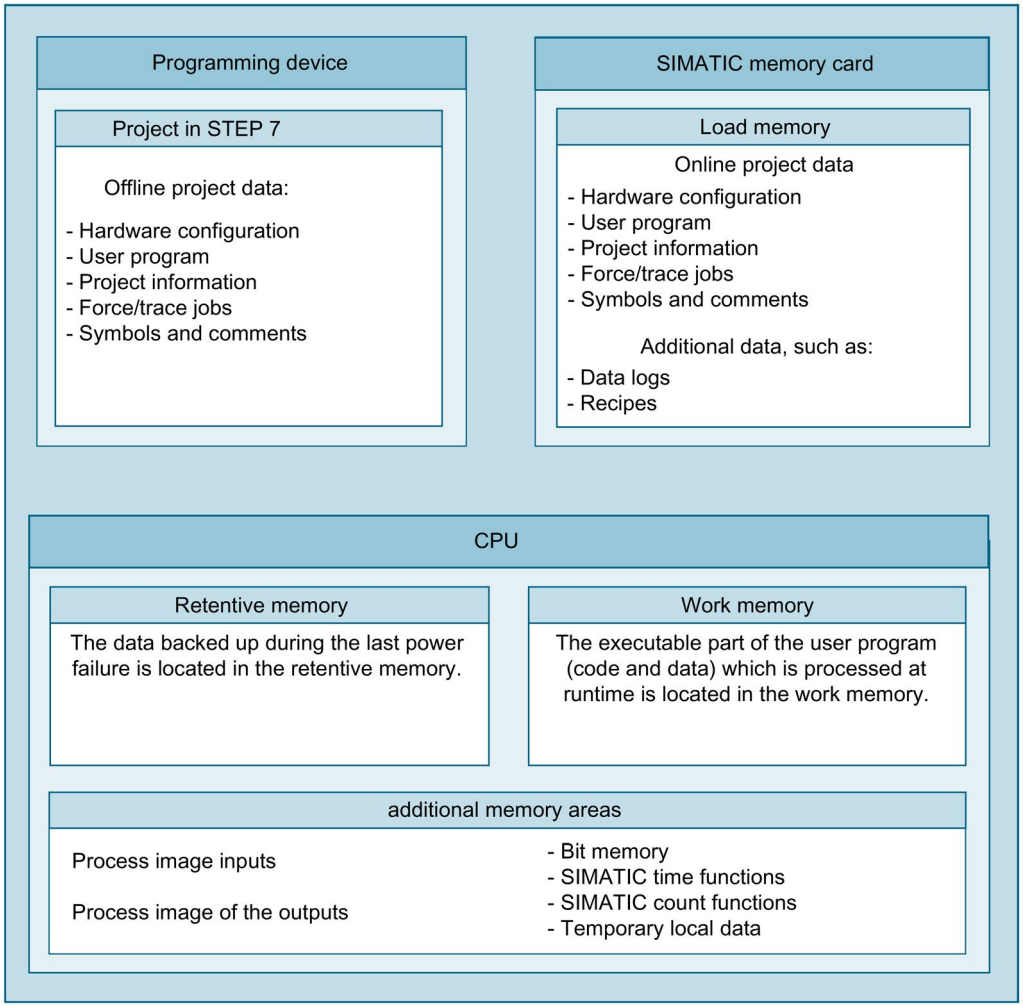


Figure 2-1 Memory areas

Load memory

Load memory is non-volatile memory for code blocks, data blocks, technology objects and the hardware configuration. The load memory is located on the SIMATIC memory card. STEP 7 transfers the project data from the programming device to the load memory.

If you have copied additional data (e.g. HMI backups or other files) via the CPU Web server or Explorer to the SIMATIC memory card, this data is also located in the load memory of the SIMATIC memory card.

Note

An inserted SIMATIC memory card is required to operate the CPU.

Work memory

The work memory is volatile memory that contains the code and data blocks. The work memory is integrated into the CPU and cannot be extended. The work memory is only used in operation of the CPU.

In the CPUs, the work memory is divided into two areas:

- Code work memory: The code work memory contains runtime-relevant parts of the program code.
- Data work memory: The data work memory contains the runtime-relevant parts of the data blocks and technology objects. At the operating mode transitions POWER ON to startup and STOP to startup, tags from global data blocks, instance data blocks and technology objects are initialized with their start values; retentive tags retain their actual values as saved in the retentive memory.

Retentive memory

The retentive memory is non-volatile memory for saving a limited amount of data in the event of power failure.

The following actions delete the content of the retentive memory:

- Memory reset
- Reset to factory settings

You can find additional information on memory reset and resetting to factory settings in the S7-1500 Automation system, ET 200MP (http://support.automation.siemens.com/WW/view/en/59191792) system manual, the ET 200MP distributed I/O system (http://support.automation.siemens.com/WW/view/en/58649293) system manual and the ET 200pro CPU 1516pro-2 PN (https://support.industry.siemens.com/cs/ww/en/view/109482416) operating instructions.

Additional memory areas

Besides the memory areas that have been described for the user program and data, the CPU has additional memory areas available.

The additional memory areas include the following:

- Process images
- Temporary local data

The CPU-specific sizes can be found in the technical specifications for the respective CPU.

2.1 Memory requirements and memory usage

In STEP 7, you can retrieve information about the memory areas of the CPU on the display of the CPU (only applies to the S7-1500 CPUs) and via the Web server.

Memory requirements of the program in the offline project

The display of the memory usage in the program information of STEP 7 is intended to determine whether the project is becoming too big for a particular CPU or a particular memory card already during the creation or modification of a project. You can find this information under "Program information" in the project tree, for example. In the "Resources" tab you can find information about the total size of the memory areas of the respective CPU project (in the figure below in the line "Total"), and about the memory requirements of the program elements (blocks, data types, objects for motion control and PLC tags) and their percentages in the respective memory area of the offline project (in the figure below in the line "Used:"). In the overview table you can also find information about the assigned inputs and outputs.

For a CPU, you can select the total size of the load memory in a drop-down list. Select the size of the load memory in accordance with the size of the SIMATIC memory card you are using. The percentage shown in the Load memory column depends on the selected size of the load memory. As soon as the memory size exceeds the size of the load memory of the memory card you are using, the sizes indicated turn red. The drop-down list therefore only serves as a visual aid.

The following figure shows an overview of the usage of the different memory areas of the "Resources tab:

	Objects	Load memory	Code work-memory	Data work-memory	Retain memory
1		19 %	1 %	8 %	23 %
2					
3	Total:	0 kB	1048576 bytes	5242880 bytes	484000 bytes
4	Used:	0 kB	15293 bytes	411034 bytes	110592 bytes
5	Details	2 MB			
6	OB	4 MB	469 bytes		
7	FC	12 MB	410 bytes		
8	FB	24 MB	14414 bytes		
9	DB	256 MB		411034 bytes	110592 bytes
10	Data types	2 GB 6681 bytes	-		
11	PLC tags	32 GB			0 bytes

Figure 2-2 Display of the usage of the different memory areas

Note

Display of memory usage under "Program information"

The display of the memory usage in the program information is an offline display in STEP 7 and only shows the memory requirements of the program in the project. The program on the memory card of the CPU may vary, however, e.g.:

- if it is more recent
- if it contains blocks created via other projects
- if it contains blocks generated on the CPU

See the FAQ "How do you estimate the memory requirements of your user program in the load memory of an S7-1500 CPU and an ET 200SP CPU (Open Controller)?" on the Internet (https://support.industry.siemens.com/cs/ww/en/view/97553417).

Data on the SIMATIC memory card

In addition to the program and the associated program elements (blocks, data types, objects for motion control and PLC tags), the following data is stored:

- Hardware configuration
- Project information
- Force/trace jobs
- Symbols and comments

The following further data may also be found on the memory card:

- Recipes, data logs and HMI backups
- Non-SIMATIC files which were copied to the memory card via the Web server of the CPU or offline via the Explorer (e.g. PDF files etc.)

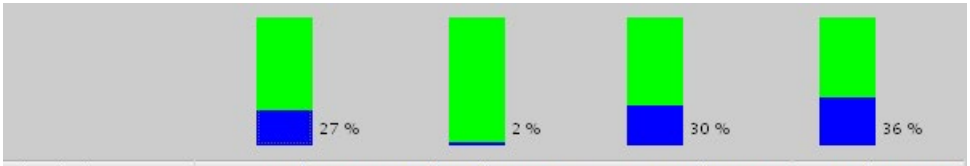
Display of the memory usage of the CPU

In online mode, the online function "Memory" provides you with the following up-to-date memory information:

- Size of the total free and already allocated load memory on the SIMATIC memory card.
- Size of the total free and already allocated work memory, separated by code and data.
- Size of the total free and already allocated retentive memory.

The online function "Memory" can be found in Online & Diagnostics under "Diagnostics > Memory". You can access the functions under Online & Diagnostics in various ways:

- In the project tree under every configured CPU.
- In the project tree under Online access > Accessible devices, to display the usage of CPUs which were not configured in the project.
- In all views of the device configuration (topology view, network view, device view) by selecting a CPU with the right mouse button.



Sizes in bytes	Load memory	Code work-memory	Data work-memory	Retain memory
Free:	6291456	1048576	5242880	524288
In use:	2316997	17355	2299642	301234
Total:	8608453	1065931	7542522	825522

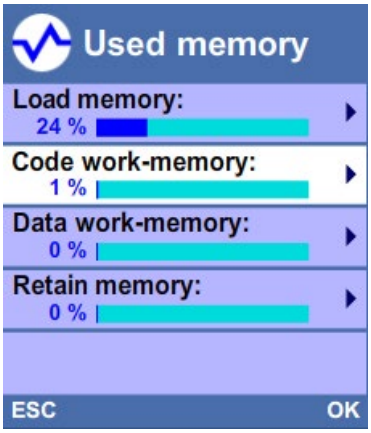
Figure 2-3 "Memory" online function

Display of the memory usage in the display of the CPU

To obtain information about the available memory via the display, proceed as follows:

- Select the "Diagnostics" menu on the display with the help of the arrow keys.
- Select the "Memory" command from the "Diagnostics" menu.

Under the "Memory" command you can find information about the usage of the various memory areas (see following figure). Please note that the memory allocation is queried at the time of the call and is not continuously updated.



To find out details about the respective memory areas (e.g. code work memory), select the required memory area with the help of the arrow keys (see following figure).

In the detail view, e.g. of the code work memory, the display provides you with the following information:

- Memory space which is still available in the code work memory.
- Memory space which is already allocated in the code work memory.
- Total available memory space in the code work memory.

Display of the memory usage in the Web server

On the Web server, you can find information about the current usage of the individual memory areas on the Web page "Diagnostics" in the "Memory" tab.

Detailed information about the use of the Web server can be found in the S7-1500 Web server (https://support.industry.siemens.com/cs/ww/en/view/59193560) function manual.

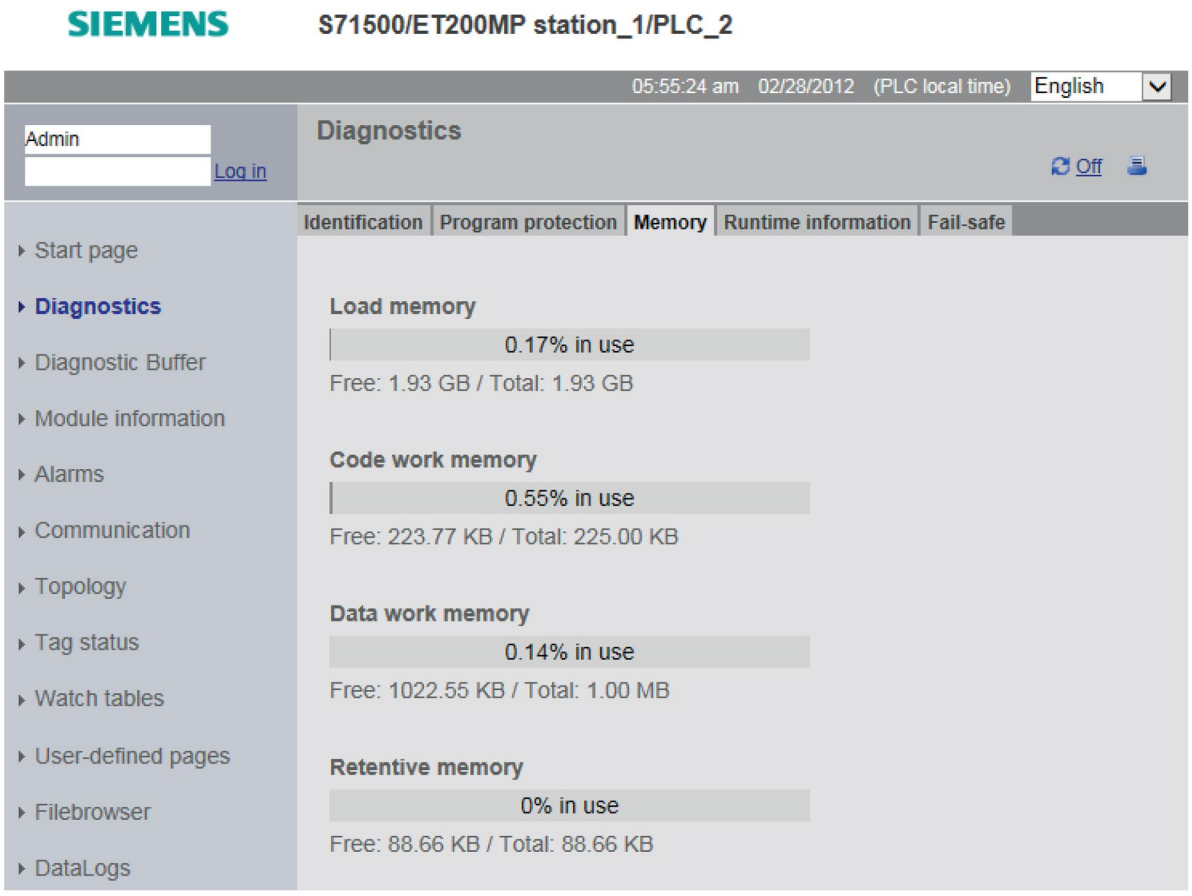


Figure 2-4 Display of the memory usage in the Web server

2.2 Retentive memory areas

Introduction

The CPUs have memory available for storing retentive data at POWER-OFF. Details about the size of the retentive memory can be found in the technical specifications for the respective CPU.

In STEP 7, you can find the configured CPU's retentive memory utilization offline at "Program information > Resources" or online at Online & Diagnostics under "Diagnostics > Memory".

If you define data as retentive, its content is retained beyond program startup after STOP or a power failure.

You can define the following data and objects as retentive:

- Tags of global data blocks
- Tags of instance data blocks of a function block
- Bit memories, timers and counters

Tags of technology objects are always retentive, for example, adjustment values of absolute encoders. The volume of retentive data of technology objects therefore is also included in the volume of retentive data which you can define as retentive in your project.

Tags of a global data block

In a global data block, you can define either individual tags from a block or all of its tags collectively as retentive, depending on the setting for the "Optimized block access" attribute:

- "Optimized block access" activated: In the declaration table of the data block, you can define individual tags as retentive.

	Name	Data type	Start value	Retain	Visible in HMI	Comment
1	Static			☐	☐	
2	var1	Bool	false	☑	☑	
3	var2	Bool	false	☐	☑	
4	var3	Bool	false	☑	☑	
5	var4	Bool	false	☐	☑	
6	var5	Bool	false	☑	☑	

Figure 2-5 Retentivity setting "Optimized block access" activated

- "Optimized block access" not activated: In the declaration table of the data block, you can only define the retentivity of all tags collectively.

	Name	Data type	Offset	Start value	Retain	Visible in HMI	Comment
1	Static				☐	☐	
2	var6	Bool	...	false	☑	☑	
3	var7	Bool	...	false	☑	☑	
4	var8	Bool	...	false	☑	☑	
5	var9	Bool	...	false	☑	☑	
6	var10	Bool	...	false	☑	☑	

Figure 2-6 Retentivity setting "Optimized block access" not activated

You can find additional information on optimized and non-optimized data blocks in the Programming guideline for S7-1200/S7-1500 (https://support.industry.siemens.com/cs/de/de/view/90885040/en).

Tags of an instance data block of a function block

In STEP 7, you can define the tags from the instance data block of a function block as retentive. Depending on the setting for the "Optimized block access" attribute, you can define retentivity either for individual tags from a block or for all of its tags collectively:

- "Optimized block access" activated: In the interface of the function block, you can define individual tags as retentive.
- "Optimized block access" not activated: In the instance data block, you can only define the retentivity of all tags collectively.

Creation of a data block in the user program

The instruction "CREATE_DB" is used to create a new data block in the load and/or work memory. For data blocks which you create in the load memory, depending on the selection for the ATTRIB parameter, the generated data block either has the property "retentive" or the property "non-retentive". Setting the retentivity for individual tags is not possible here. The "Optimized block access" attribute is disabled.

You can find additional information on the "CREATE_DB" instruction in the STEP 7 online help under "PLC programming > Instructions > Extended instructions > Data block functions > CREATE_DB Create data block".

Tags of technology objects

Tags of technology objects are retentive, for example adjustment values of absolute encoders. STEP 7 automatically manages the retentivity of the tags of technology objects so that you do not have to configure any retentivity.

The retentive tags of technology objects are unaffected by a memory reset. They can only be deleted by resetting to factory settings.

Bit memories, timers and counters

In STEP 7, you can define the number of retentive bit memories, times and counters in the PLC tag table using the "Retentive memory" button.

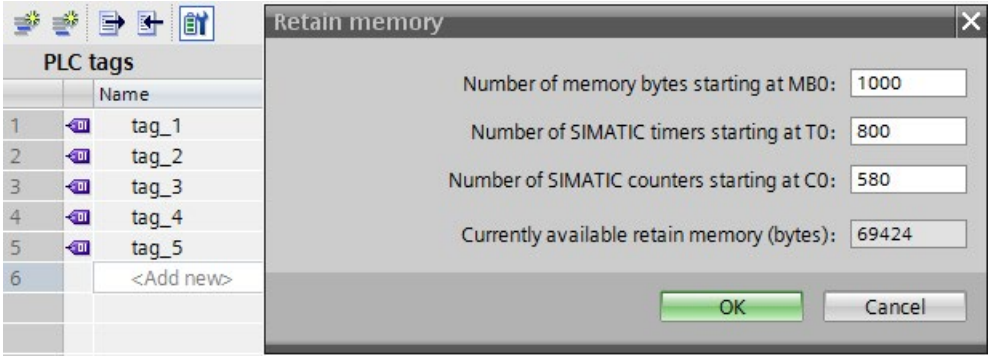


Figure 2-7 Definition of the number of retentive bit memories, timers and counters (beginning at 0, continuing without gaps) using the "Retentive memory" button

Reference

You can find additional information on configuring retentivity in the STEP 7 online help.

2.3 Summary of retentive behavior

Retentive behavior of the memory objects

This section gives an overview of the retentive behavior of memory objects for the CPUs. In addition to the retentive memory areas described, there are other objects with retentive characteristics, for example, the diagnostics buffer. These objects do not occupy any storage space in the retentive memory.

The following table shows the retentive behavior of the memory objects at the operating mode transitions STOP to startup and POWER ON to startup, as well as the memory-influencing functions "Memory reset" and "Reset to factory settings".

Table 2- 1 Retentive behavior of the memory objects

Memory object	Operating mode transitions		Memory reset	Reset to factory settings
	STOP → STARTUP	POWER ON → STARTUP		
Actual values of the data blocks, instance data blocks	Can be set in the Properties of the DB in STEP 7.[1].		-	-
Bit memories, timers and counters - configured as retentive	x	x	-	-
Bit memories, timers and counters - configured as non-retentive	-	-	-	-
Retentive tags of technology objects (e.g. adjustment values of absolute encoders)	x	x	x	-
Diagnostics buffer entries (retentive area)	x	x	x	-
Diagnostics buffer entries (non-retentive area)	x	-	-	-
Operating hours counter	x	x	x	-
Clock time	x	x	x	-
x = content is retained – = object is initialized				

1) For DBs with optimized access the retentive behavior is configurable for specific tags.

Diagnostics buffer

With the CPUs, a portion of the diagnostics buffer is retentive. The number of retentive diagnostics buffer entries depends on the type of CPU. The latest entries in the diagnostics buffer are retained after power failure, and are not affected by a memory reset. The retentive portion of the diagnostics buffer can only be deleted by resetting to factory settings. The entries in the diagnostics buffer do not occupy any storage space in the retentive memory.

Operating hours counter

The operating hours counters of the CPUs are retentive and are not affected by a memory reset. By resetting to factory settings, the operating hours counters are set to zero.

Clock time

The clock time of the CPUs is retentive and is not affected by a memory reset. By resetting to factory settings, the clock time is reset.

Reference

You can find additional information on memory reset and resetting to factory settings in the S7-1500 Automation system, ET 200MP (http://support.automation.siemens.com/WW/view/en/59191792) system manual, the ET 200MP distributed I/O system (http://support.automation.siemens.com/WW/view/en/58649293) system manual and the ET 200pro CPU 1516pro-2 PN (https://support.industry.siemens.com/cs/ww/en/view/109482416) operating instructions.

2.4 Memory behavior when loading software changes

Introduction

In the STOP and RUN modes of the CPU, you can load changes to the software without this affecting the actual values of tags already loaded.

In STEP 7, you load changes to the software (in the project tree and with selected PLC station) under "Download to device > Software (only changes)".

Impact of software changes on PLC tags

You can load the following software changes without affecting the actual values of PLC tags that have already been loaded:

- Name change
- Comment change
- Addition of new tags
- Deletion of tags
- Change of retentivity settings for Retentive memory areas (Page 21)

The actual values are affected by loading the following software changes:

- Data type change
- Address change

Memory reserve of global DBs and instance DBs

Each function block or data block with the "Optimized block access" attribute activated contains, by default, a memory reserve which you can use for subsequent interface changes. The memory reserve is initially not used. When you have compiled and loaded the block, and then observe that you want to reload interface changes, activate the memory reserve. All tags that you subsequently declare will be placed in the memory reserve. During the next load, the new tags are then initialized to their start values. Tags which have already been loaded are not reinitialized.

The setting for memory reserve can be found in STEP 7 in the data block properties in the category "Download without reinitialization".

Impacts of software changes on data blocks without memory reserve

If you are not using memory reserve, you can load the following software changes without this reinitializing the actual values of DB tags that have already been loaded:

- Change of initial value
- Comment change

Impacts of software changes on data blocks with memory reserve

If you are using memory reserve for data blocks ("Optimized block access" attribute and "Download without reinitialization" button activated), you can load the following software changes without this reinitializing the actual values of DB tags which have already been loaded:

- Change of initial value
- Comment change
- Addition of new tags

If the button "Enable download without reinitialization for retentive tags" is deactivated, then all actual values of the data block are reinitialized on the next loading of the following software changes:

- Name change
- Data type change
- Retentivity change
- Deletion of tags
- Changes to the memory reserve settings

Reference

You can find additional information on setting and activating the memory reserve, and on loading block changes, in the online help for STEP 7 under "PLC programming > Compile and download blocks > Download blocks for S7-1200/1500 > Download block extensions without reinitialization".

2.5 Memory behavior in load memory when loading software changes

Memory requirements in RUN mode

For the consistent and atomic handling of the entire load procedure, the CPU requires adequate free memory space on the SIMATIC memory card. The files affected by loading the software changes to the CPU are only deleted after the new files have been created. This SIMATIC memory card therefore requires memory space corresponding approximately to the space required for all program objects to be loaded on the memory card.

If this amount of memory is not available on your SIMATIC memory card, the following message is displayed in STEP 7 during the load procedure in the CPU: "There is insufficient memory on the memory card for this amount of data."

In order to still enable the loading of changes to the CPU in such a case, we recommend one or more of the following options:

- Load in RUN mode
  - Delete any files no longer required (e.g. CSV files, panel backups, etc.) on the memory card using the Web server.
  - If possible, load extensive changes in RUN mode in several steps, or load after every modification step.
- Load in STOP mode
  - If loading in several steps is not possible, load extensive changes in STOP mode. Please note that when loading in STOP mode, the actual values of non-retentive data are not initialized.
- Use a larger memory card
  - In order to perform extensive load processes in RUN mode of the CPU, use a larger memory card. A description of how to change the memory card can be found in the section "Changing the memory card without losing retained data".

Impact of minor program changes on the load procedure

There are dependencies between the objects of a program, e.g. of code blocks to called code blocks, of code blocks to data blocks and of data blocks to data types (PLC data types, FB types). This means that the load procedure for a minor change may be very time-consuming if the change affects a large number of dependent objects.

Example:

A STEP 7 program contains an organization block (OB), 20 functions (FC) and a data block (DB). The OB calls the 20 FCs and all FCs access the DB. If you change the program code in one of the FCs, the following load procedure only contains the changed FC. If you change the data type of a tag in the DB, however, the following load procedure then changes all the FCs and the DB.

The following figure shows the objects in the load procedure in a preview.

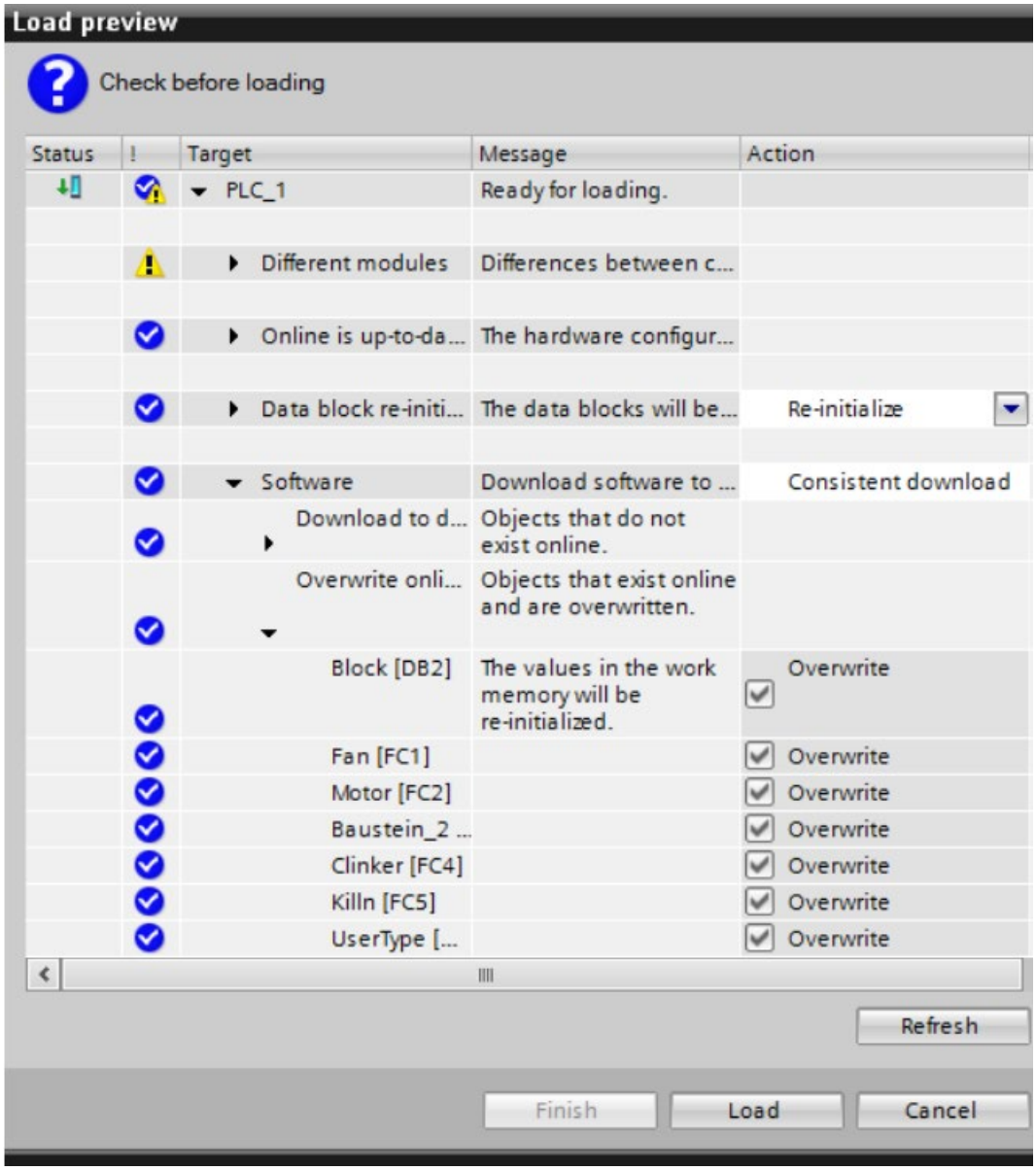


Figure 2-8 Preview for loading

To find the interdependencies of the individual objects, double-click in the project tree on "Program information" and in the dialog "Program information" change to the "Dependency structure" tab.

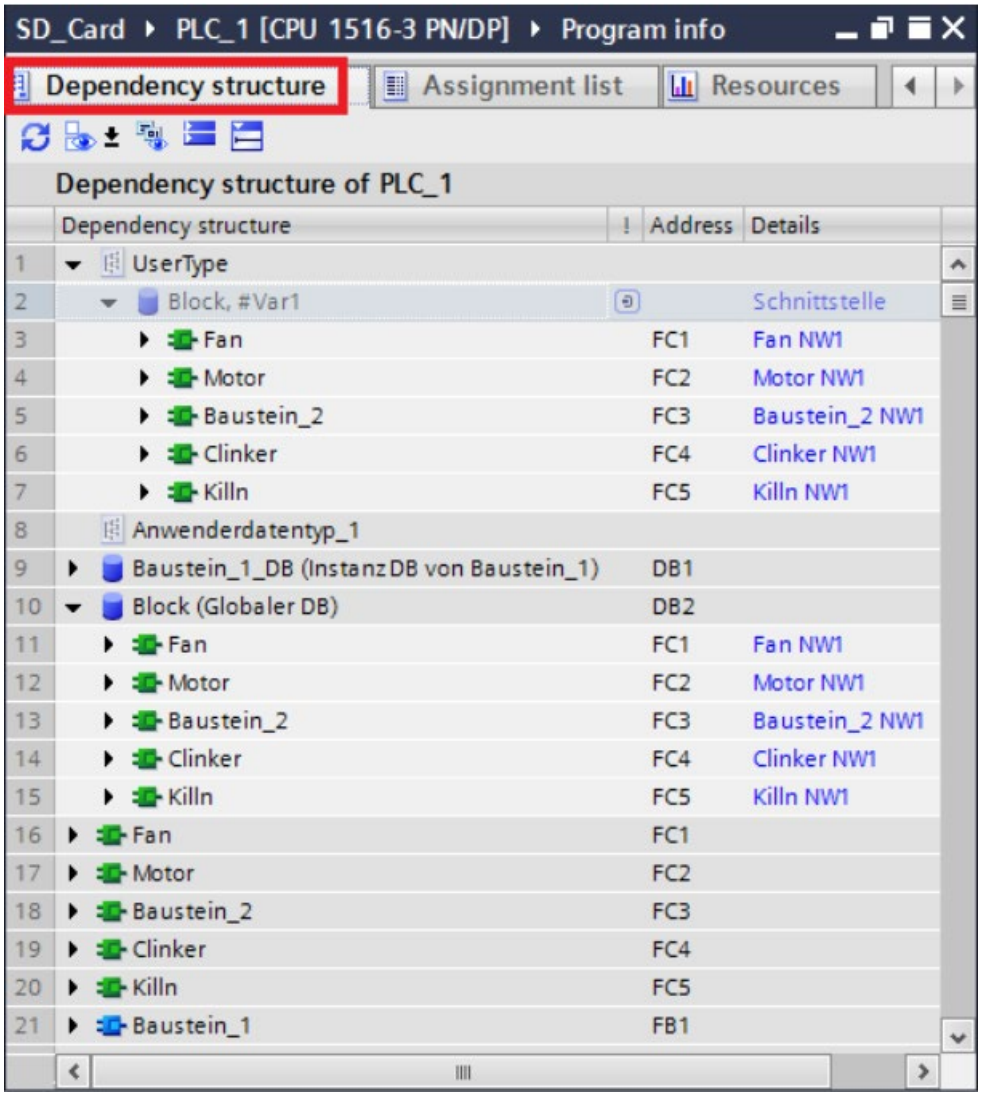


Figure 2-9 Dependency structure

Memory requirements for saving trace recordings

The "Save measurements on device (memory card)" function allows you to save trace recordings on your SIMATIC memory card.

Response when number reached

The parameter "Deactivate recording" repeats the measurements until the configured "Number of measurements" has been reached.

The parameter "Overwrite oldest recording" replaces the oldest measurement with the latest measurement when the configured "Number of measurements" has been reached. Keep in mind, however, that writing data to the SIMATIC memory card continuously will shorten its service life.

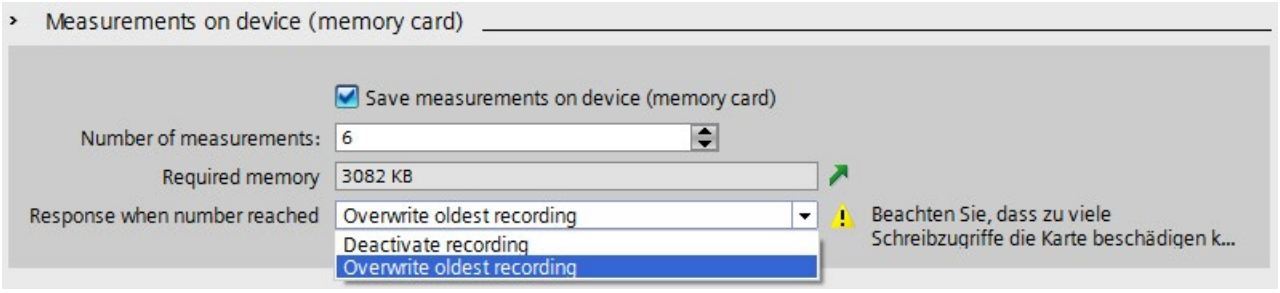


Figure 2-10 Dialog of settings for saving measurements on the memory card in STEP 7

Number of measurements

The CPU supports a maximum of 999 measurements. While the CPU writes the trace recordings to the load memory of the memory card, it pauses monitoring of the trigger conditions for the trace job. Once the CPU has finished saving the trace recordings, it resumes checking the trigger conditions.

NOTICE
Memory required on the SIMATIC memory card Keep in mind that the "Save measurements on device (memory card)" function requires free memory of more than 1024 KB on your SIMATIC memory card. This required memory is independent of the card size of the SIMATIC memory card you are using. If this space is no longer available, the CPU stops storing measurements on the memory card and writes a corresponding entry to the diagnostic buffer. Make sure that sufficient memory is available on the SIMATIC memory card before you execute the "Save measurements on device (memory card)" function. Delete any trace recordings no longer required from the SIMATIC memory card.

You can find additional information on trace recordings in the Using the trace and logic analyzer function (http://support.automation.siemens.com/WW/view/en/64897128) function manual, in the Web server (http://support.automation.siemens.com/WW/view/en/59193560) function manual and in the STEP 7 online help.

Memory requirements in STOP mode

Even when downloading in STOP mode a certain amount of reserve memory is required, because your memory card needs sufficient free memory for consistent downloading of individual data blocks. The files affected by loading the data blocks are only deleted after the new files have been created. Therefore, for the modifications you must have available at least the memory requirement of the largest data block.

Contrary to downloading in RUN mode, when downloading in STOP mode, modified code blocks in the CPU are deleted first prior to downloading of the modified code block. For this reason, when downloading code blocks in STOP mode, no additional memory is required on the memory card.

If insufficient reserve memory is available in your SIMATIC memory card when loading in STOP mode, the following message is displayed in STEP 7 during the load procedure: "There is insufficient memory on the memory card for this amount of data."

In order to still enable the loading of changes to the CPU in such a case, we recommend one or more of the following options:

- Delete any files no longer required (e.g. CSV files, panel backups, etc.) from the memory card using the Web server.
- Use a larger memory card. A description of how to change the memory card can be found in the section "Changing the memory card without losing retained data".

Note

Please note that retained data and possibly also project data is lost with the following three options. Therefore only use the following options described if the two options described previously did not lead to the desired result.

- In STEP 7, load your program with the menu command "Online > Download and reset PLC program" into the CPU.
- Remove the memory card from the slot of the CPU and delete the content of the memory card you no longer need with your programming device.
- Delete the entire contents, e.g. by formatting the memory card. A description of how to format the memory card can be found in the section "Formatting a SIMATIC memory card".

Also refer to the FAQ "When downloading to the S7-1500 CPU, why is the message "There is insufficient memory on the memory card for this amount of data" displayed although there is still enough memory available?" on the Internet (https://support.industry.siemens.com/cs/ww/en/view/107108015).

Changing the memory card without losing retained data

You can change or use a larger SIMATIC memory card without losing the retained data. When you switch off the CPU, the retained data is backed up in the retentive memory of the CPU. While the CPU is switched off, you can remove the memory card and copy the contents to a larger memory card. After switching on the CPU, data backed up in the CPU when switched off is restored.

Formatting a SIMATIC memory card

To create storage space on your SIMATIC memory card, you can format the SIMATIC memory card. During formatting, the entire content of the memory card with the exception of the IP address is deleted.

The SIMATIC memory card may only be formatted in the CPU. With a SIMATIC memory card inserted, follow these steps:

Formatting with STEP 7:

- Establish an online connection.
- Double-click "Online & diagnostics" in the project tree.
- In the dialog window select "Functions > Format memory card" and then select the "Format" button.

Formatting via the display of the CPU

- In the display of the CPU, select the menu "Settings" > "Card functions" > "Format card" and confirm with OK.

NOTICE
Format the SIMATIC memory card Do **not** format the memory card with Windows tools. Formatting with Windows makes the memory card unusable for use in a CPU of the S7-1500 product family. If you have inadvertently formatted the card with Windows tools, you can restore the functioning of the card by reformatting the card in the CPU in SIMATIC format.

Memory usage and application examples 3

3.1 Memory usage for recipes

Introduction

A recipe represents a collection of parameter records with the same structure. These recipe data records are located in a non-runtime-relevant data block in the load memory, and do not occupy any storage space in the work memory. You have the option of reading individual recipe data records into a data block in the work memory and accessing the data in the user program. You can write a recipe data record that has been changed in the user program back to the recipe data block.

Recipes contain, for example, the related data of a specific batch in production. You can export recipe data records of a recipe DB as csv file. A Web browser can read data using the Web server in the CPU, even when the CPU is in STOP mode. You can also access the data directly on the SIMATIC memory card with a card reader on the programming device.

Processing sequence

- **Saving a recipe in load memory**

  STEP 7 stores the individual data records of a recipe in a non-runtime-relevant DB and loads it to the CPU. To configure a non-runtime-relevant DB, you must activate the "Only store in load memory" block attribute. The recipes then only use storage space in the load memory, and not in the work memory.

- **Working with recipe data in the user program**

  You can use the "READ_DBL" instruction to copy a data record belonging to the current recipe from the DB in the load memory to a runtime-relevant DB in the work memory. As a result, the work memory only has to accommodate the data for the currently required recipe data record. The user program can now access the data of the current data record.

- **Saving back changed recipe data records**

  You can use the "WRIT_DBL" instruction to write new or changed data records of a recipe from the user program back to the load memory. The data written to the load memory is portable and not affected by a memory reset. To back up changed data records (recipes), you have to upload the data blocks and back them up on the PG/PC. You can find information on uploading data blocks in the online help for STEP 7 under "PLC programming > Compile and download blocks > Download blocks for S7-1200/1500 > Download blocks from a memory card".

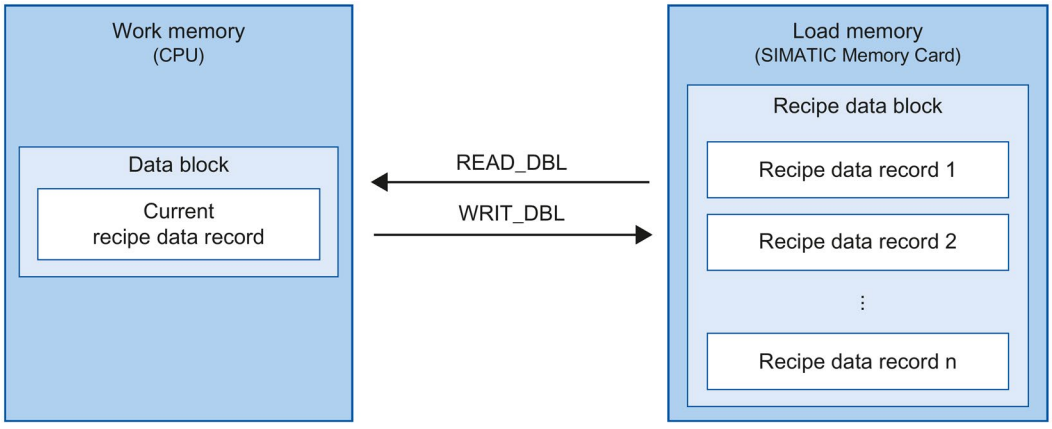


Figure 3-1 Processing sequence with "READ_DBL" and "WRIT_DBL"

Also see the FAQ "In STEP 7 (TIA Portal) how do you configure data blocks with the "Only store in load memory" attribute?" on the Internet (https://support.industry.siemens.com/cs/ww/en/view/53034113).

Note

Instructions that access the SIMATIC memory card have a lower performance than instructions that access the work memory. The associated blocks (e.g. READ_DBL and WRIT_DBL) are therefore asynchronous. Their execution extends if necessary over several cycles.

NOTICE

Service life of the SIMATIC memory card

Only a limited number of delete and write operations are possible on the SIMATIC memory card. After expiration of the service life, there is a risk that the card can no longer be used. Therefore, use a SIMATIC memory card with sufficient memory for your particular purposes.

Additional information on the service life of the SIMATIC memory card can be found in the section Service life of the SIMATIC memory card (Page 51).

Import and export of recipe data

You have the option of exporting a recipe DB's recipe data records as a CSV file, and of importing them from a CSV file into a DB. The csv file is located in the "\recipes" directory on the SIMATIC memory card. You can open and process this file further with a spreadsheet program, e.g. Microsoft Excel.

You can easily manage the csv files on the SIMATIC memory card using the CPU's Web server (e.g. rename, save to hard disk, delete, etc.). In order to prevent unwanted tampering, configure the access privileges for the Web server in STEP 7. Additional information on the Web server can be found in the Web server (http://support.automation.siemens.com/WW/view/en/59193560) function manual, in the File browser section.

- **Export of recipe data**

  The "RecipeExport" instruction exports all of a recipe DB's recipe data records from the load memory to a csv file on the SIMATIC memory card. The csv file has the same name as the DB's recipe. The csv file is stored in the "\recipes" directory on the SIMATIC memory card.

  The "RecipeExport" instruction only exports valid and unencrypted recipe data records.

- **Import of recipe data**

  The "RecipeImport" instruction imports all recipe data records from the csv file into the recipe DB in the load memory. The name of the csv file must match the name of the recipe DB.

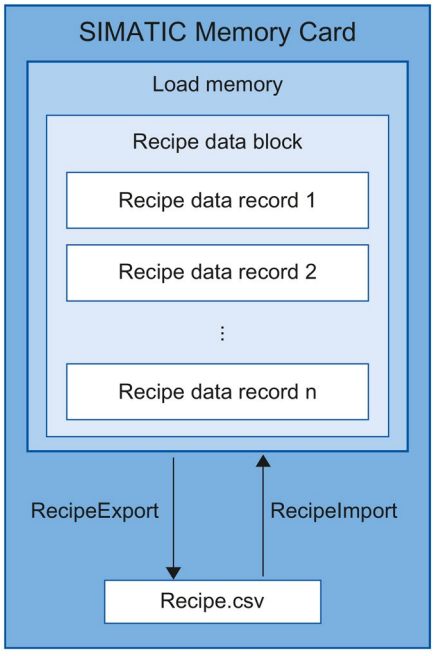


Figure 3-2 Import and export of recipe data

Note

Asynchronous instructions

Please note that the "RecipeExport" and "RecipeImport" instructions are asynchronous instructions.

In contrast to synchronous instructions, this means the execution of an asynchronous instruction can extend over multiple calls before execution is completed. The CPU processes asynchronous instructions in parallel with the cyclic user program.

A CPU can process several asynchronous instruction jobs in parallel. The CPU can process a maximum of 10 jobs of the instructions listed in parallel.

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

Reference

You can find additional information on the instructions for recipes in the online help for STEP 7 under "PLC programming > Instructions > Instructions (S7-1200, S7-1500) > Extended instructions > Recipes and data logging > Recipe functions".

Also see the FAQ "Using Recipe Functions for persistent Data with SIMATIC S7-1200 and S7-1500" on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109479727).

3.2 Memory usage for data logging

3.2.1 Overview of data logging

With data logging, you save selected process values from the user program in a file, the data log. The data logs are saved on the SIMATIC memory card in csv format and stored in the "\datalogs" directory. A Web browser can read data using the Web server in the CPU, even when the CPU is in STOP mode. You can also access the data directly on the SIMATIC memory card with a card reader on the programming device.

NOTICE
Service life of the SIMATIC memory card Only a limited number of delete and write operations are possible on the SIMATIC memory card. Cyclic write operations via the user program to the SIMATIC memory card reduce the service life of the SIMATIC memory card. After expiration of the service life, there is a risk that the card can no longer be used. Therefore, use a SIMATIC memory card with sufficient memory for your particular purposes. Information on the service life of the SIMATIC memory card can be found in the section Service life of the SIMATIC memory card (Page 51).

The "data logging" instructions may be used in your program to create, open, write, and close data logs. You decide which tags are logged by creating a data block that defines a single data log data record. Your data block is used as temporary storage for a new data log data record. New current values for the tags must be transferred into the data block during runtime by means of user program instructions. If all tag values have been updated, you can execute the "DataLogWrite" instruction, in order to transfer data from the data block into the data log.

You manage your data logs using the integrated Web server. On the standard "File browser" web page, you can download or delete data logs. After you have transferred a data log to your PC, you can analyze the data using popular spreadsheet programs, e.g. Microsoft Excel.

The following figure shows the basic sequence for creating a data log:

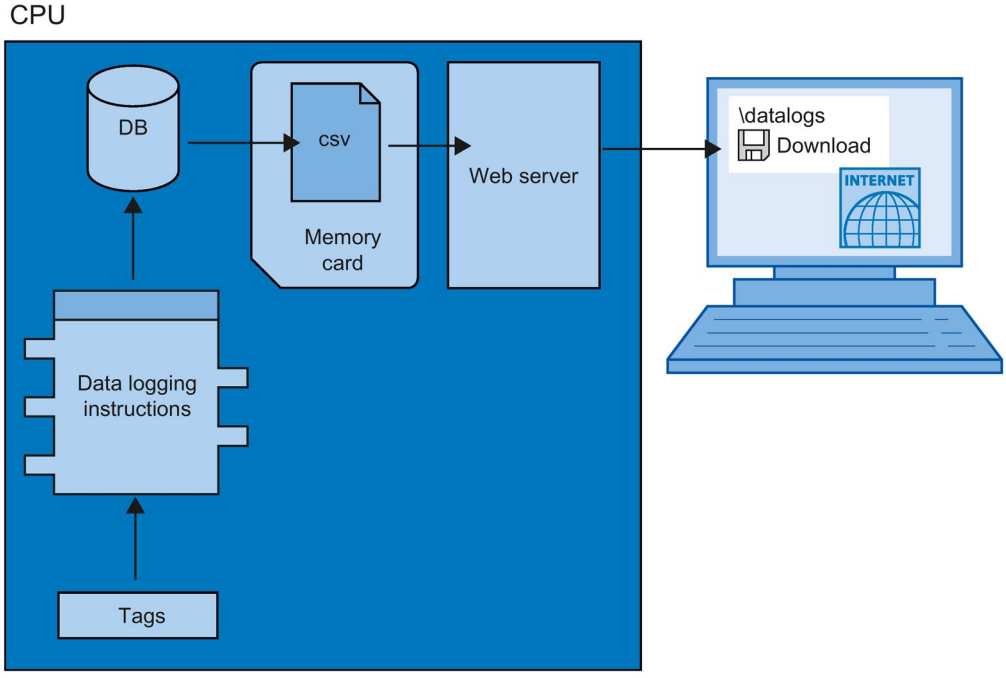


Figure 3-3 Basic sequence during the creation of a data log

3.2.2 Data structure of the data logs

Introduction

You use the "DataLogCreate" instruction to create a data log in STEP 7. The NAME parameter assigns the data log a name. The DATA and HEADER parameters specify the data type of all data elements in a data log data record, and the header line of the data log. The RECORDS parameter indicates the maximum number of records in the data log.

NAME parameter for the "DataLogCreate" instruction

You use the NAME parameter to assign a name for the data log. This is the name under which the data log is saved in the "\datalogs" directory of the SIMATIC memory card.

DATA parameter for the "DataLogCreate" instruction

The DATA block parameter specifies the structure of the data log's records. The columns and data types of a data record in the data log are determined by the elements of the structure declaration or array declaration of this data buffer. Each element of a structure or array corresponds to a column in a row in the data log.

HEADER parameter for the "DataLogCreate" instruction

Using the HEADER block parameter, you can assign a heading in the header row to each column in the data log.

RECORDS parameter for the "DataLogCreate" instruction

The RECORDS parameter specifies the maximum number of records that can be stored in a data log. If the specified maximum number of records in a data log is reached, the next write operation overwrites the oldest data record.

3.2.3 Instructions for data logging

Overview

The following table gives an overview of the instructions for data logging. You will find the data logging instructions in "STEP 7" in the "Instructions" task card, under "Extended instructions > Recipe and data logging > Data Logging".

Table 3- 1 Overview of the data logging instructions

Name of the instruction	Description
"DataLogCreate": Create data log	With the "DataLogCreate" instruction you create a data log. The data log is saved on the SIMATIC memory card in the "\datalogs" directory. You can use the data logging instructions to save process data. The amount of data that can be stored in a data log depends on the available storage space on the SIMATIC memory card.
"DataLogOpen": Open data log	With the "DataLogOpen" instruction, you open an existing data log on the SIMATIC memory card. A data log must be open before you can write new data records to it. The data log is automatically opened when the "DataLogCreate" and "DataLogNewFile" instructions are executed. A maximum of 10 data logs can be open at any one time. The data log to be opened can be selected using the ID or name of the data log. The maximum file size of data logs is 2 GB. A maximum number of 1000 data log files is possible with firmware version V2.0.
DataLogWrite": Write data log	With the "DataLogWrite" instruction you write a data record into an existing data log. Use the ID parameter to select the data log to which the data record is to be written. To write a new data record, the data log must be open.
DataLogClose": Close data log	With the "DataLogClose" instruction, you close an open data log. You select the data log using the ID parameter. At switch to STOP operating state, all open data logs are closed.
DataLogNewFile": Data log in new file	With the "DataLogNewFile" instruction you create a new data log with the same properties as an already existing data log. By creating a new data log, you prevent cyclic overwriting of existing data records. When the instruction is called it creates a new data log on the SIMATIC memory card using the name defined in the NAME parameter. You use the ID parameter to specify the ID of the old data log whose properties you want to apply to the new data log. The ID of the new data log is then output at the ID parameter.
DataLogClear": Clear data log	The "DataLogClear" instruction deletes all data records in an existing data log. The header of the data log is not deleted (see the description of the parameter Data structure of the data logs (Page 39)).
DataLogDelete": Delete data log	The "DataLogDelete" instruction is used to delete a data log from the SIMATIC memory card. Select the data log to be deleted using the NAME and ID parameters.

Note

Asynchronous instructions

Please note that the instructions listed in the table are asynchronous instructions.

In contrast to synchronous instructions, this means the execution of an asynchronous instruction can extend over multiple calls before execution is completed. The CPU processes asynchronous instructions in parallel with the cyclic user program.

A CPU can process several asynchronous instruction jobs in parallel. The CPU can process a maximum of 10 jobs of the instructions listed in the table in parallel.

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

3.2.4 Example program for data logging

This example program shows the storing of 3 process values for counter state, temperature, and pressure in a data log.

The example shows the basic functioning of the instructions for data logs. The complete program logic is not shown.

Note

General use of data logs

- Data logs are automatically opened after execution of the "DataLogCreate" and "DataLogNewFile" instructions.
- Data logs are automatically closed at a change of CPU from RUN to STOP, or during a restart of the CPU.
- A data log must be open in order to be able to write data to the data log with the "DataLogWrite" instruction.
- A maximum of 10 data logs can be open at any one time, even when more than 10 data logs exist.

Tags of the data block

The following figure shows the tags of the "My_Datalog_Vars" data block. These tags are used by the "Data logging" instructions "DataLogCreate" and "DataLogNewFile". The "MyDataLogName" and "MyNEWDataLogName" tags are called in the NAME block parameter, and give the data logs a name. The "MyData" structure is called in the DATA block parameter and specifies the structure of the csv file. The three MyData tags temporarily store new values. The tag values at these DB addresses are transferred to a data log using the "DataLogWrite" instruction. The "MyDataLogHeaders" tag is called in the HEADER block parameter and specifies a header for the data log.

My_Datalog_Vars

	Name	Data type	Start value
1	Static		
2	MyNEWDataLogName	String	'MyNEWDataLog'
3	MyDataLogName	String	'MyDataLog'
4	MyDataLogID	DWord	0
5	MyDataLogHeaders	String	'Count,Temperature,Pressure'
6	MyData	Struct	
7	MyCount	Int	0
8	MyTemperature	Real	0.0
9	MyPressure	Real	0.0

Figure 3-4 Declaration table with the data block's tags

Network 1

A rising edge at REQ starts the creation of the data log.

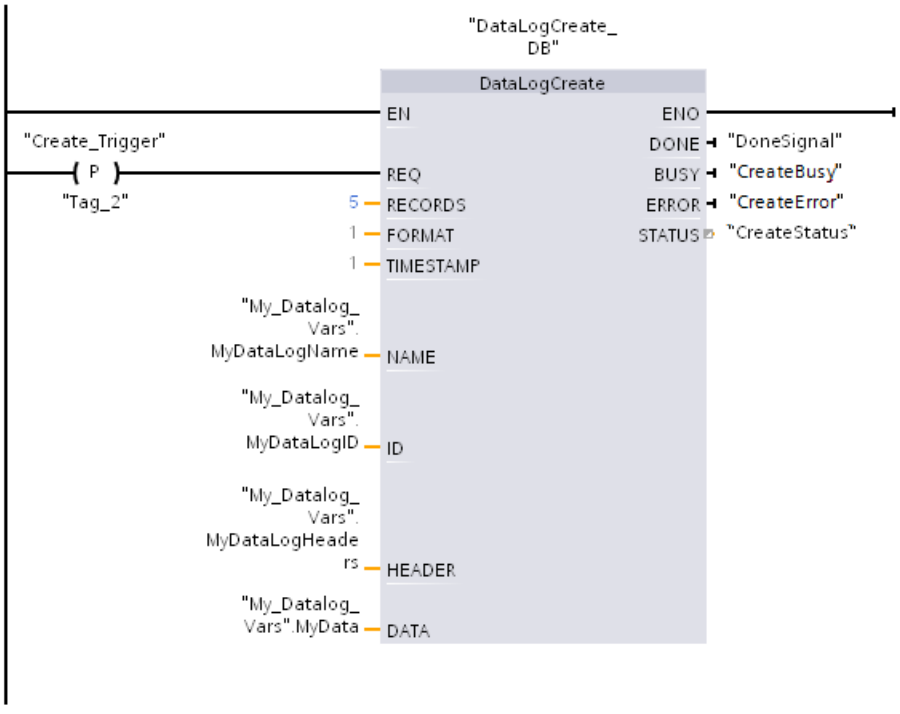


Figure 3-5 Network 1

Network 2

Detect the output DONE of "DataLogCreate", because after the execution of "DataLogCreate" it is only set to 1 for one cycle.

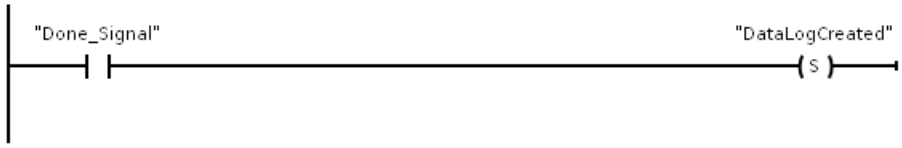


Figure 3-6 Network 2

Network 3

A rising edge triggers the point in time at which new process values are stored in the MyData structure.

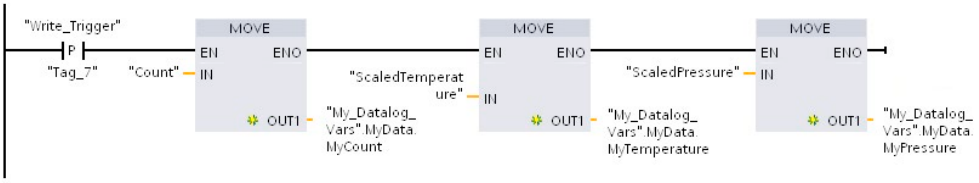


Figure 3-7 Network 3

Network 4

The state of the input EN is based on the point in time at which the execution of "DataLogCreate" was completed. One execution of "DataLogCreate" extends over multiple cycles, and must be completed before a write operation is executed. The rising edge at input REQ is the event that triggers an activated write operation.

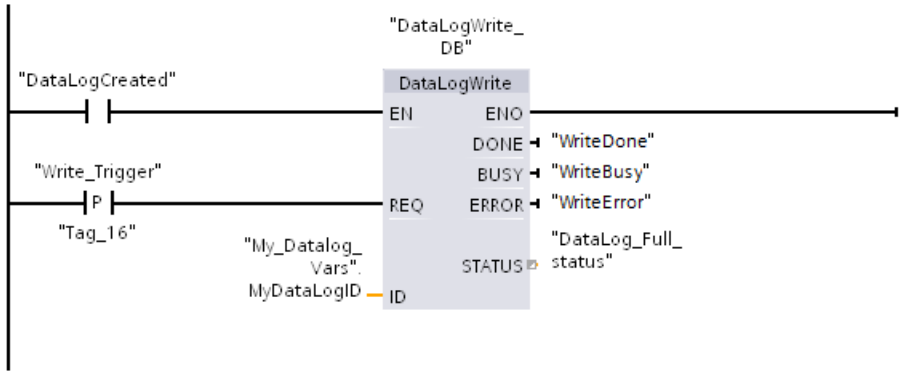


Figure 3-8 Network 4

Network 5

Close the data log after the last data record has been written. After execution of the "DataLogWrite" instruction, which writes the last data record, the STATUS output is set to "1".

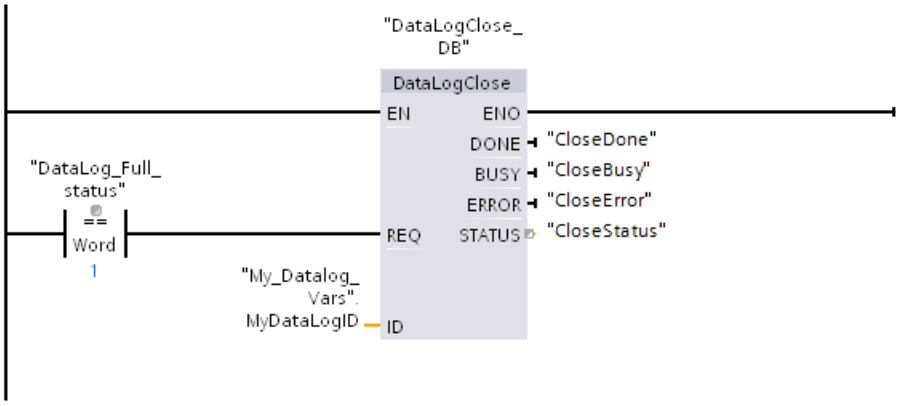


Figure 3-9 Network 5

Network 6

A rising edge at the input REQ of the instruction "DataLogOpen" simulates that the user presses a button on an HMI device, which opens a data log. If you open a data log in which all records are occupied by process data, then the next execution of the "DataLogWrite" instruction overwrites the oldest data record. You can however also preserve the old data log, and create a new data log instead. This is shown in network 7.

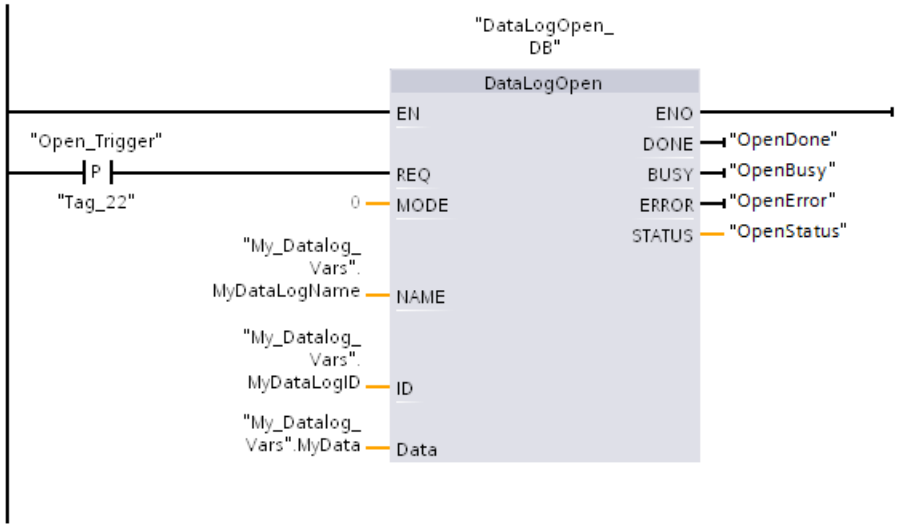


Figure 3-10 Network 6

Network 7

The ID parameter is an IN/OUT type. First you indicate the ID value of the existing data log whose structure you want to copy. After the "DataLogNewFile" instruction has been executed, a new and unique ID value for the new data log is written back into the address of the ID reference. The required detection DONE bit = TRUE is not shown. An example for the logic of the DONE bit can be found in networks 1, 2 and 4.

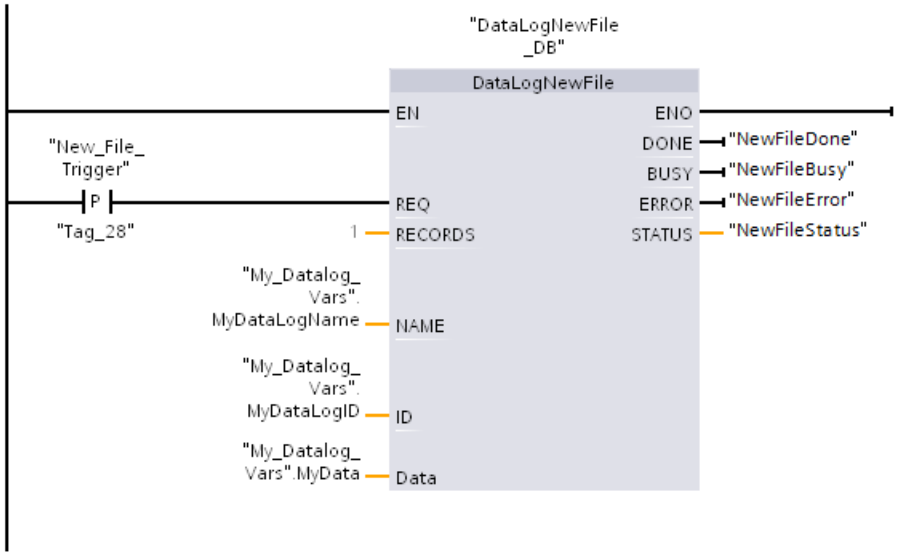


Figure 3-11 Network 7

The data logs created in the example program can be found on the CPU Web server's standard "File browser" Web page in the "\datalogs" folder.

The following figure shows the standard Web page of the Web server using the example of the CPU 1516-3 PN/DP.

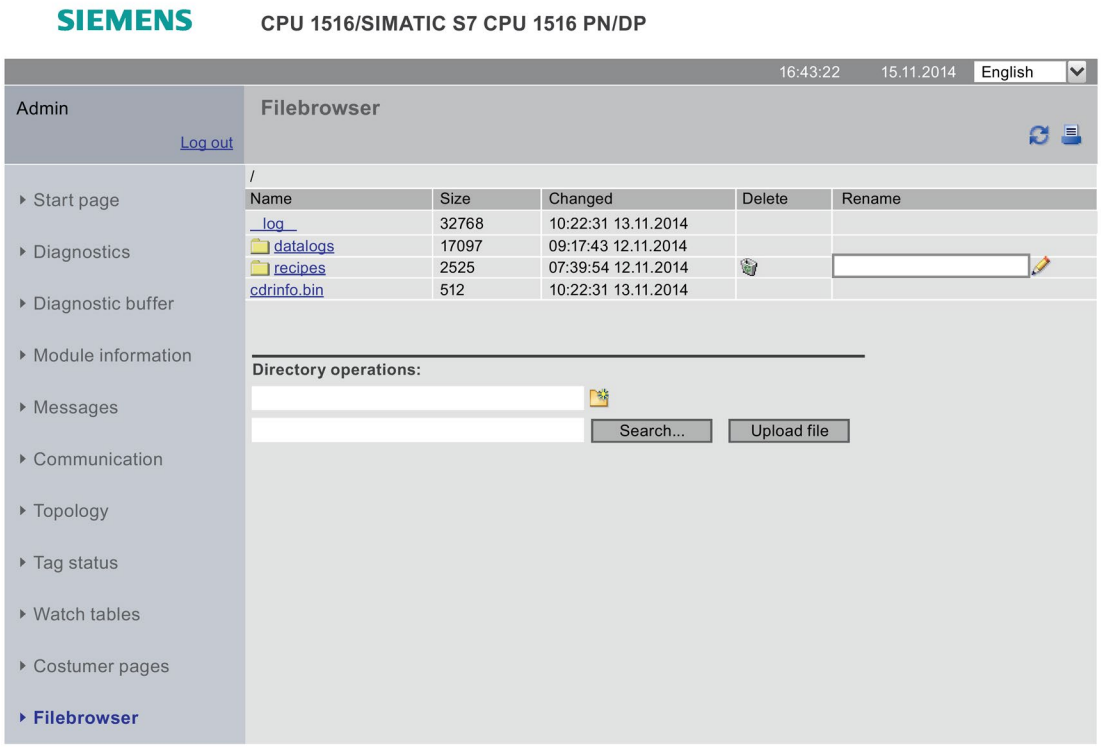


Figure 3-12 Standard "File browser" web page of the Web server

In the file browser, you can download the data logs created in the example program. It is not possible to delete or rename the data logs in the Web server. To delete a data log you either use the DataLogDelete instruction or you format the SIMATIC memory card.

On the DataLogs web page, you can have all the data logs that you created displayed. You can call and empty the relevant data log file by clicking the icon .

Note

Manipulation of the data logs using a card reader

Do not delete or change the data logs using a card reader on the PG/PC. You can copy the data logs on the SIMATIC memory card, however, using a card reader on the PG/PC.

The recommended medium for viewing, downloading (copying) and deleting data logs is the file browser of the Web server, however. Direct file access via the Windows Explorer carries a risk of the inadvertent deletion of or modification of data logs or system files. This may result, however, in files being damaged or the SIMATIC memory card becoming unusable.

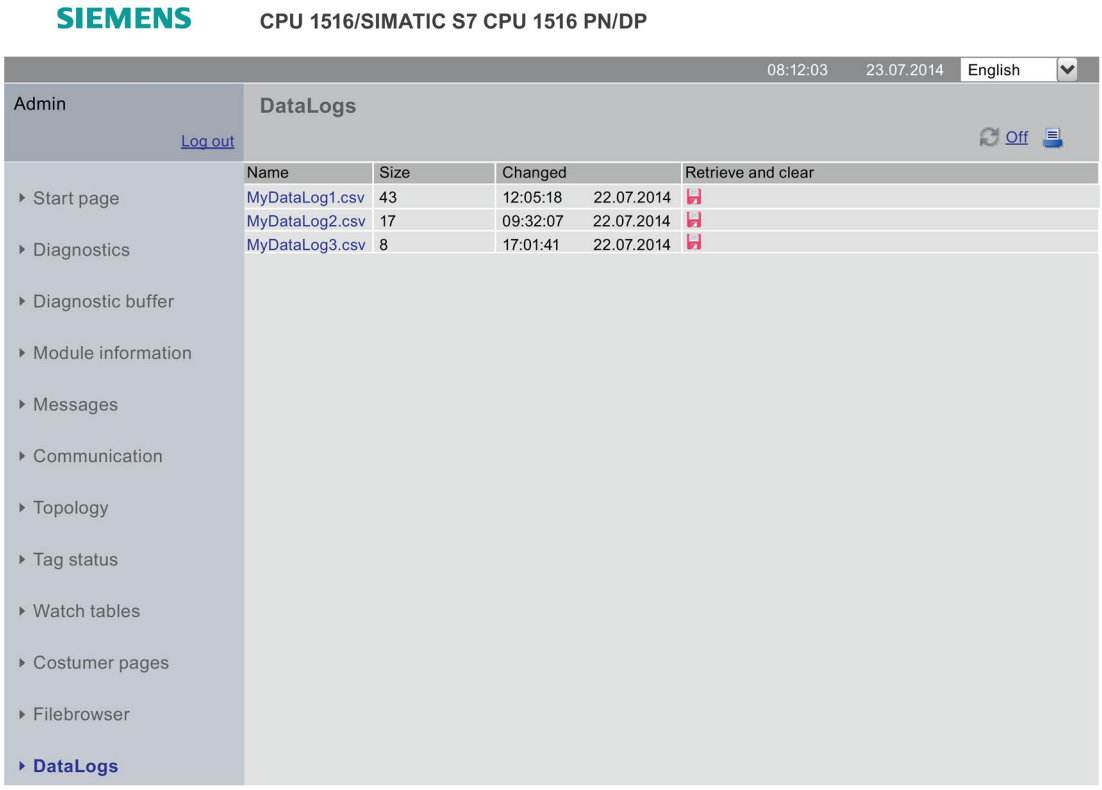
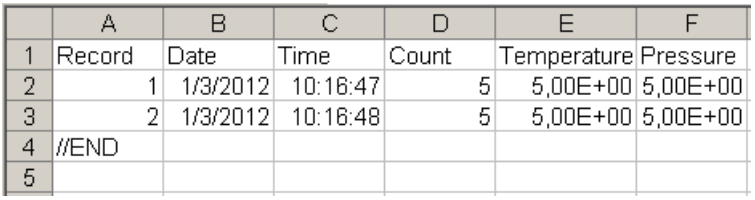
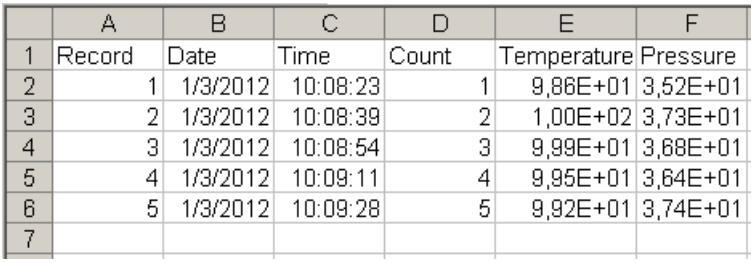
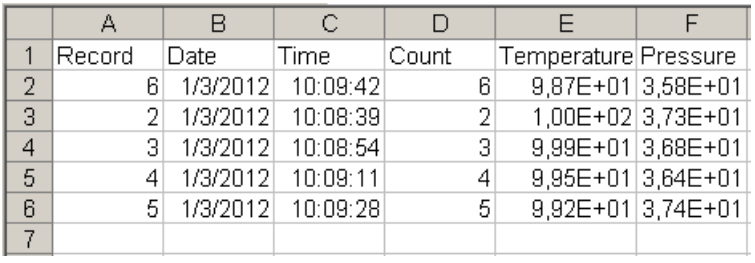


Figure 3-13 Example - Data logs in the folder "\datalogs" of the file browser

Table 3- 2 Downloaded examples of data logs displayed in Microsoft Excel

Two data records written in a data log which contains a maximum of five data records.	
Five data records written in a data log which contains a maximum of five data records.	
After another data record has been written, the 6th write operation overwrites the oldest data record (record 1) with data record 6. Another write operation overwrites data record 2 with data record 7, etc.	

3.2.5 Calculation of the data log size

The maximum memory size is allocated when you create the data log. In addition to the size required for all data records, you must take into consideration the memory required for a data log header (if used), a time stamp header (if used), a data record index header and the minimum block size for memory allocation.

The formula below represents a method to help you determine the estimated size of your data log. Make sure that you observe the rule for the maximum size.

Data bytes of the data log = ((data bytes in a data record + time stamp bytes + 12 bytes) * number of data records)

Header

Header bytes of the data log = header character bytes + 2 bytes

Header character bytes

- No data header and no time stamp = 7 bytes
- No data header and time stamp (with time stamp header) = 21 bytes
- Data header and no time stamp = Number of character bytes in all column headers including separating commas
- Data header and time stamp (with time stamp header) = Number of character bytes in all column headers including separating commas + 21 bytes

Data

Data bytes of the data log = ((data bytes in a data record + time stamp bytes + 12 bytes) * number of data records)

Data bytes in a data record

The DATA parameter of the "DataLogCreate" instruction points to a structure that assigns the number of data fields and the data type of each data field for a data log data record.

Multiply the number of the respective data type with the number of bytes required for this data type. Repeat the procedure for each data type in a data record and add all data bytes for the sum of all data elements in a data record.

Size of the individual data types

The data in data logs is saved as character bytes in csv format (comma separated values). The table below shows the number of bytes that are required to save each data type.

Data type	Bytes
Any	10
Bool	1
Byte	4
Char	1
Date	10
DInt	12
DTL	31
DWord	11
Int	7
LDT	31
LReal	25
Real	16
Sint	5
String	**Example 1:** MyString String[10] The maximum character string size is specified with 10 characters. • Text character + automatic filling with spaces = 10 bytes • Quotation marks at the start and end + comma character = 3 bytes 10 + 3 = 13 bytes total **Example 2:** Mystring2 String If no size is specified in square brackets, 254 bytes are assigned by default. • Text character + automatic filling with spaces = 254 bytes • Quotation marks at the start and end + comma character = 3 bytes 254 + 3 = 257 bytes total
Time	14
Tod	12
UDInt	12
UInt	7
USInt	5
WChar	1
Word	6

Number of data records in a data log

The RECORDS parameter of the "DataLogCreate" instruction specifies the maximum number of data records that can be stored in a data log.

Time stamp bytes in a data record

- No time stamp = 0 bytes
- Time stamp = 22 bytes

Example for size of a CSV file

The figure "Open CSV file" shows a CSV file opened in a spreadsheet program with five written data records in one data log.

The figure "Size of the header and the data records" shows the size of the header used in the CSV file and the size of the individual data records on the SIMATIC memory card.

The figure "Column size" shows the size of the respective columns depending on the data type used.

Open CSV file

	A	B	C	D	E	F
1						
2	Record	Date	UTC Time	Count	Temperature	Pressure
3	1	9/30/2010	20:26:56	1	9.86E+01	3.52E+01
4	2	9/30/2010	20:28:43	2	1.00E+02	3.73E+01
5	3	9/30/2010	20:29:03	3	9.99E+01	3.68E+01
6	4	9/30/2010	20:29:21	4	9.95E+01	3.64E+01
7	5	9/30/2010	20:30:19	5	9.92E+01	3.74E+01
8						

Size of the header and the data records

G
49 (42 characters + 5 commas + 2 line ending)
79 (72 + 5 commas + 2 line ending)
79 (72 + 5 commas + 2 line ending)
79 (72 + 5 commas + 2 line ending)
79 (72 + 5 commas + 2 line ending)
77 (72 + 5 commas)
Total = 442

Column size

9	Size of each column:					
10	index	Date	Time	int	real	real
11	11	10	12	7	16	16

As the example shows, each data record also consists of a separating comma (1 byte each) which must be taken into account when calculating the total size of the column.

Keep in mind that the calculation for the size of the header, the data records and the columns is not part of the opened CSV file. The size information was added manually to illustrate the elements that make up the size of a data log. You can display the total size of a data log you have created as CSV file in the Web server on the "DataLogs" website.

3.3 Service life of the SIMATIC memory card

Calculation of the theoretical service life of a SIMATIC memory serves as a decision aid for selecting which card you need for your automation task. The following examples only return a guide value, however. A precise calculation of the service life is not possible due to the fact that the description cannot cover all the theoretically possible scenarios.

Influences on the service life

You can influence the service life of SIMATIC memory cards by the following factors:

- Size of card
- Number and type of write operations

  The number of physical write operations to the memory blocks of the card results from the number and type of write operations from the application.

Structure of a SIMATIC memory card

The internal flash memory of the SIMATIC memory card is organized in memory blocks. A memory block is a memory area of a fixed size. A write operation always addresses entire memory blocks on the SIMATIC memory card. When a memory block has been written once it must be deleted before it can be written again. The number of delete/write operations per memory block is limited. The service life of the SIMATIC memory card is measured by the maximum number of supported delete or write operations per memory block.

In contrast to delete or write operations, read operations have a negligible impact on the service life. The influence of the read operations is reduced with progressive memory technology, so that the influence by read operations is not included in this calculation. A very high number of read operations can, however, influence the service life to a small extent.

Max. number of write/delete operations

In order to be able to carry out as many write operations as possible on the SIMATIC memory card, the internal controller of the memory card ensures that the available memory blocks are evenly used. Internal algorithms distribute the write accesses to the same logical memory area over changing physical memory areas in order to use the memory blocks evenly.

The following table shows the number of maximum possible write/delete operations based on the SIMATIC memory card. The number of maximum write/delete operations of the respective SIMATIC memory card is also available online in the technical specifications of the respective SIMATIC memory card.

Memory size of the SIMATIC memory card *	Article number	Max. number of write/delete operations per memory block
4 MB	6ES7954-8LCxx-0AA0	500 000
12 MB	6ES7954-8LExx-0AA0	500 000
24 MB	6ES7954-8LFxx-0AA0	500 000
256 MB	6ES7954-8LL02-0AA0	200 000
2 GB	6ES7954-8LP01-0AA0	100 000
2 GB	6ES7954-8LP02-0AA0	60 000
32 GB	6ES7954-8LT02-0AA0	50 000

* The memory size figures named in the table are theoretical values. The actual existing memory size in practice is below the theoretical value. The reason for this is that the internal controller of the card and the file system reserve part of the existing memory for internal memory management.

Note

Write or delete operations

Write or delete operations, particularly cyclic write/delete operations via the user program, to the SIMATIC memory card reduces its life.

Cyclic execution of the following instructions reduces the service life of the memory card depending on the number of write operations and data:

- "CREATE_DB" (with ATTRIB "Create DB in load memory")
- "DataLogWrite"
- "RecipeExport"
- "RecipeImport" (if target DB in load memory)
- "SET_TIMEZONE"

Please also note that, in addition to the cyclic write/delete operations, writing or deleting very large amounts of data also has a negative impact on the service life of the SIMATIC memory card.

Guaranteed data retention time

If you do not use your SIMATIC memory card for a longer period of time, there is the risk that data contained on the memory card may no longer be readable after a certain amount of time.

With proper storage, the guaranteed data retention time of a SIMATIC memory card is 10 years on delivery. With a number of ≤ 10% of the maximum write/delete operations, the data stored on the card has a retention time of 10 years.

Please note that increasing numbers of write/delete operations to the card reduces its data retention time. If 90% of the maximum write/delete operations is reached, the guaranteed data retention time is reduced to 1 year. If 100% of the maximum write/delete operations is reached, the retention time of the saved data can no longer be guaranteed.

Determining the current consumption status of a SIMATIC memory card in STEP 7

When you activate the "Aging of the SIMATIC memory card" option, you enter a threshold value as a percentage in the text box below. As soon as the service life of the SIMATIC memory card has reached the threshold value (e.g. 80%), the CPU outputs a diagnostics alarm.

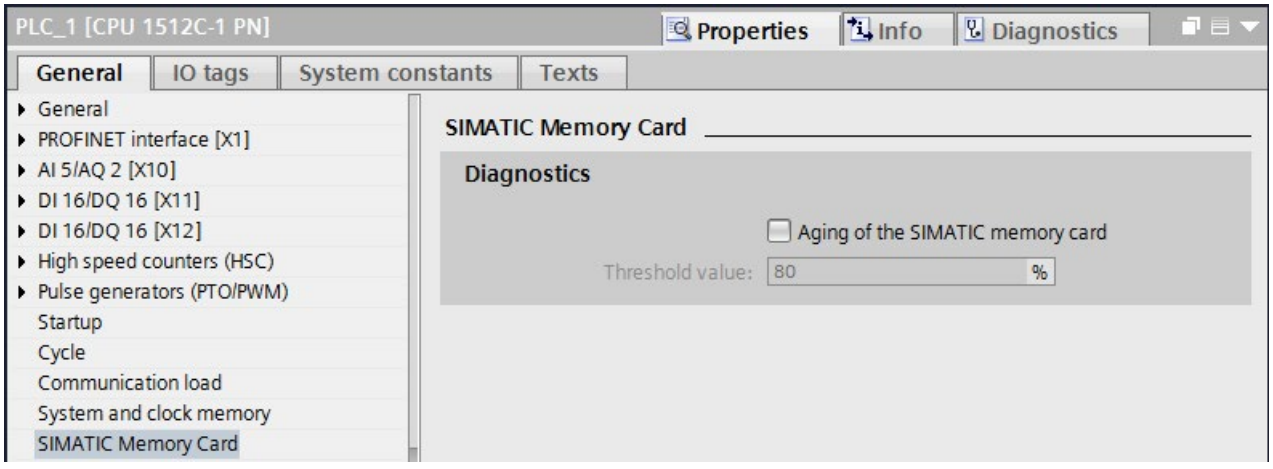


Figure 3-14 Enabled option "Aging of the SIMATIC memory card"

Calculation of the theoretical service life of a SIMATIC memory card

We will use the following example as a basis for calculation:

The user uses a new **256** MB memory card. In accordance with the table, this memory card type supports **200000** write operations. After parameter changes, the user would like to write **200** data blocks of **5** KB each to the SIMATIC memory card with a frequency of **50** times per day using the "RecipeExport" instruction.

Step 1: Calculating the write operations

First use the following formula to calculate the service life of the SIMATIC memory card:

$$\text{Write operations} = \frac{\text{Size of the memory card} \ * \ \text{Maximum number of write operations}}{\text{Number of written bytes}}$$

We first use the sizes from the example in the formula "Write operations" as a basis for calculating the service life:

- Size of the memory card: **256** MB = **268435456** byte
- Maximum number of write operations: **200000**
- Number of written bytes: **1024000** byte (**200** x **5** KB)

If we use the sizes from the example in the formula, we obtain the following result:

$$\text{Write operations} = \frac{268\,435\,456 \text{ byte} \ * \ 200\,000}{1\,024\,000 \text{ byte}} = 52\,428\,800 \text{ write operations}$$

Step 2: Calculating the service life

Use the following formula to calculate the service life in years:

$$\text{Service life} = \frac{\frac{\text{Write operations}}{\text{Write operations per day}}}{365 \text{ days}} : \text{Net-gross factor} = \text{years}$$

Note

Net-gross factor

With every write operation, internal data (metadata) is also written to the SIMATIC memory card. Due to this additional data, include the net-gross factor **10** when calculating the service life.

If we use the sizes from the example in the formula, we obtain the following result:

$$\text{Service life} = \frac{\frac{52\,428\,800}{50}}{365 \text{ days}} : 10 = 287 \text{ years}$$

Calculation with more frequent write accesses and a higher number of bytes written

If the frequency of write accesses and the number of bytes written per day increases, the service life of the SIMATIC memory card is reduced.

Using empirical values, the following table shows how the service life of a SIMATIC memory card with a size of 256 MB is reduced.

Write accesses per day	Number of bytes written per instruction	Service life of the SIMATIC memory card in years
50	1024000	287
100	1024000	143
400	1024000	36
400	2048000	18
400	4096000	9

The following table shows how the same values impact the service life of a SIMATIC memory card with a size of 2 GB (6ES7954-8LP01-0AA0).

Write accesses per day	Number of bytes written per instruction	Service life of the SIMATIC memory card in years
50	1024000	1149
100	1024000	575
400	1024000	144
400	2048000	72
400	4096000	36

The result shows that a high number of write accesses together with a high number of written bytes significantly shortens the service life of the SIMATIC memory card.

Reference

An alternative method for calculating the service life of a SIMATIC memory card is available in an FAQ on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109482591).

Glossary

Bit memory

Bit memory is a memory area of the CPU that can be addressed from any code block (FC, FB, OB). You have read/write access to this memory area. The bit memory area can be used to store temporary results, for example.

Counters

In STEP 7, counting tasks are performed using counters. You can modify the contents of the "counter cells" using STEP 7 instructions (for example, count up/down).

Data block

Data blocks store information for the program. They can be defined either in such a way that all code blocks can access them (global data block) or that they are assigned to a specific FB or SFB (instance data block).

Data log

Data logs are csv files for the storage of tag values. The data logs are saved on the SIMATIC memory card in the "\datalogs" directory. Data records of tag values are written to a data log by means of instructions in the user program.

Global data block (DB)

Every function block, every function, and every organization block can read the data from a global data block, or write its own data to a global data block. This data is retained in the data block, even when the data block is exited.

Instance data block (IDB)

A data block is assigned to each call of a function block in the STEP 7 user program. The instance data block stores the values of input, output and in/out parameters, as well as local block data.

Local data

This memory area accepts the temporary local data of a block for the duration of processing.

Memory reset

During memory reset the CPU is set to the configured initial state.

Optimized block access

Data blocks with optimized access have no fixed structure. In the declaration, the data elements only receive a symbolic name, and no fixed address within the block. The elements are automatically arranged in the block's available memory area in such a way that its capacity is optimally exploited.

In these data blocks, you can only address tags symbolically. For example, you would access the "FillState" tag in the "Data" DB as follows:

"Data".FillState

Optimized access offers the following advantages:

- The data is structured and saved in a manner that is optimal for the CPU used. This allows you to increase CPU performance.
- Access errors, e.g. from the HMI, are not possible.
- You can selectively define individual tags as retentive.

Process images (I/O)

The CPU transfers the values from the input and output modules in this memory area. At the start of the cyclic program, the signal states of the input modules are transmitted to the process image input. At the end of the cyclic program, the process image output is transmitted as signal state to the output modules.

Reset to factory setting

Resetting to factory settings restores the CPU settings to the delivery state.

Restart

Restart occurs at the transitions from STOP to STARTUP, and POWER ON to STARTUP. Before the cyclic program processing, the CPU first processes the startup OB or OBs.

Restart has the following effects on the memory areas of the CPU:

- The process images are deleted.
- The retentive tags of data blocks retain the values saved in retentive memory.
- All retentive bit memories, timers, and counters retain the values saved in retentive memory.
- All non-retentive user data is initialized:
  - Data blocks receive their start value
  - Bit memories, timers, and counters with "0"

SIMATIC memory card

Memory for the user program for programmable modules and communication processors. You can also use the SIMATIC memory card for changing user software and user data.

Standard access

Data blocks with standard access have a fixed structure. In the declaration, the data elements contain both a symbolic name and a fixed address within the block. The address is displayed in the "Offset" column.

In these data blocks, you can address tags both symbolically and absolutely:

"Data".FillState

DB1.DBW2

Timers

In STEP 7, programmed time processes are performed using timers. The content of timer cells is automatically updated by the operating system, asynchronously to the user program. STEP 7 instructions are used to define the precise function of the timer cell (for example, on-delay time) and to trigger its execution (for example, start).

User program

The user program contains all instructions, declarations and data for signal processing required to control a plant or a process. The user program is assigned to a programmable module (for example, CPU, CM) and can be structured in smaller units.

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