

SCE Training Curriculum

Siemens Automation Cooperates with Education | 05/2017

TIA Portal Module 032-410 Basics of Diagnostics with SIMATIC S7-1500



Matching SCE trainer packages for these training curriculums

SIMATIC Controllers

- SIMATIC ET 200SP Open Controller CPU 1515SP PC F and HMI RT SW Order no.: 6ES7677-2FA41-4AB1
- SIMATIC ET 200SP Distributed Controller CPU 1512SP F-1 PN Safety Order no.: 6ES7512-1SK00-4AB2
- SIMATIC CPU 1516F PN/DP Safety Order no.: 6ES7516-3FN00-4AB2
- SIMATIC S7 CPU 1516-3 PN/DP Order no.: 6ES7516-3AN00-4AB3
- SIMATIC CPU 1512C PN with Software and PM 1507 Order no.: 6ES7512-1CK00-4AB1
- SIMATIC CPU 1512C PN with Software, PM 1507 and CP 1542-5 (PROFIBUS) Order no.: 6ES7512-1CK00-4AB2
- SIMATIC CPU 1512C PN with Software Order no.: 6ES7512-1CK00-4AB6
- SIMATIC CPU 1512C PN with Software and CP 1542-5 (PROFIBUS) Order no.: 6ES7512-1CK00-4AB7

SIMATIC STEP 7 Software for Training

- SIMATIC STEP 7 Professional V14 SP1 Single license Order no.: 6ES7822-1AA04-4YA5
- SIMATIC STEP 7 Professional V14 SP1- Classroom license (up to 6 users) Order no.: 6ES7822-1BA04-4YA5
- SIMATIC STEP 7 Professional V14 SP1 Upgrade license (up to 6 users) Order no.: 6ES7822-1AA04-4YE5
- SIMATIC STEP 7 Professional V14 SP1 Student license (up to 20 users) Order no.: 6ES7822-1AC04-4YA5

Note that these trainer packages are replaced with successor packages when necessary. An overview of the currently available SCE packages is provided at: <u>siemens.com/sce/tp</u>

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Additional information regarding SCE

siemens.com/sce

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We wish to thank the TU Dresden, especially Prof. Dr.-Ing. Leon Urbas, the Michael Dziallas Engineering Corporation and all other involved persons for their support during the preparation of this training curriculum.

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BASICS OF DIAGNOSTIC FUNCTIONS

1 Goal

In this module, the reader will become acquainted with the tools that support troubleshooting.

This module will present diagnostic functions that, for example, you can test with the TIA project from the SCE_EN_032-100_FC-Programming with SIMATIC S7-1500 module.

The SIMATIC S7 controllers listed in Chapter 3 can be used.

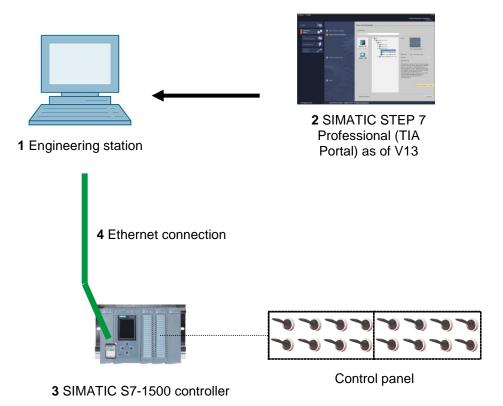
2 Prerequisite

This chapter builds on the hardware configuration of SIMATIC S7 CPU1516F-3 PN/DP. However, other hardware configurations that have digital input and output cards can be used. You can use the following project for this chapter, for example:

SCE_EN_032_100_FC-Programming_R1503.zap13

3 Required hardware and software

- 1 Engineering station: requirements include hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVDs)
- 2 SIMATIC STEP 7 Professional software in TIA Portal as of V13
- SIMATIC S7-1500/S7-1200/S7-300 controller, e.g. CPU 1516F-3 PN/DP Firmware as of V1.6 with memory card and 16DI/16DO and 2AI/1AO Note: The digital inputs should be fed out to a control panel.
- 4 Ethernet connection between engineering station and controller



4 Theory

4.1 Fault diagnostics and hardware faults

Faults can be caused by a variety of things.

Two error patterns can be distinguished for faults that occur after a transition to RUN.

1. The CPU goes to or stays in STOP mode. The yellow STOP LED lights up, and other indicator LEDs light up on the CPU, power supply unit, IO modules or bus modules.

A CPU fault has occurred in this case. For example, a module in the AS might be defective or have an incorrect parameter assignment, or a bus system fault might be present.

An interruption analysis will be performed in this instance by evaluating the hardware diagnostics and by reading the module status in the diagnostic buffer of the CPU.

2. The CPU is in faulty RUN mode. The green RUN LED lights up and other indicator LEDs light up or flash on the CPU, power supply unit, IO modules or bus modules.

In this case, a fault may have occurred in the IO devices or power supply. A visual check is performed initially to narrow down the fault area. The indicator LEDs on the CPU and IO devices are evaluated. The diagnostic data of the faulty IO and bus modules are read from the hardware diagnostics. In addition, a fault analysis can be performed using a watch table on the programming device.

4.2 Hardware diagnostics

The device view in online mode of the TIA Portal provides you a quick overview of the configuration and system status of the automation system.

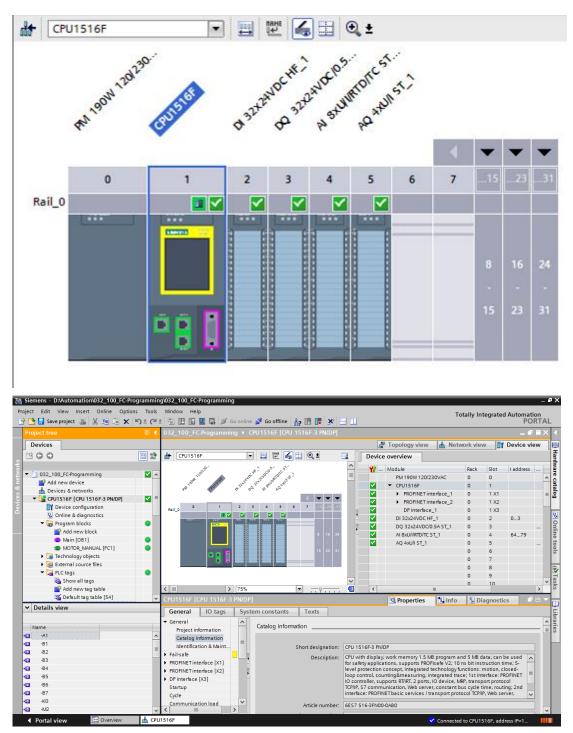


Figure 1: Online view of device configuration

4.3 Diagnostics for program blocks

The project tree window of the TIA Portal in online mode provides you an overview of the programmed blocks of the user program. With the help diagnostic symbols, a comparison of the program blocks used offline and online is displayed.

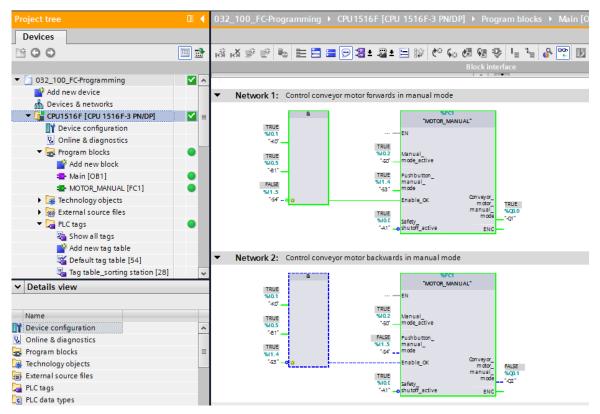


Figure 2: Online view of the Main [OB1] block

5 Task

The following diagnostic functions will be shown and tested in this chapter:

- Diagnostic symbols in the online view of the TIA Portal
- Device diagnostics with module status
- Offline/online comparison
- Monitoring and modifying tags
- Forcing tags

6 Planning

The diagnostic functions will be performed using a finished project as an example.

A project in the TIA Portal that was previously downloaded to the controller should be open for this.

In our case, after starting the TIA Portal, a previously created project will be retrieved from the archive and downloaded to the associated controller.

Afterwards, you can start implementing the diagnostic functions in the TIA Portal.

6.1 Online interface

Online diagnostics are only possible when the correct communication connection to the CPU has been set up beforehand. Here, we are connected via Ethernet/PROFINET.

When connecting online, you must therefore set the appropriate interfaces for your automation system.

Extended download to o	device		_				>
	Configured access node	es of "CPU1516F"					
	Device	Device type	Slot	Туре	Address	Subn	et
	CPU1516F	CPU 1516F-3 PN/	1 X3	PROFIBUS	2		
		CPU 1516F-3 PN/		PN/IE	192.168.0.111	PN/IE	_1
		CPU 1516F-3 PN/	1 X2	PN/IE	192.168.1.1		
	τ	ype of the PG/PC inte	rface:	PN/IE			•
		PG/PC inte	rface:	💹 Dell Wirele	ss 1901 802.11a/b/g/r	n (2.4GHz an	- 🖲 🖸
	Conne	ction to interface/su	bnet:	PN/IE_1			- 💎
		1st gate	eway:				- 🖲
	Compatible devices in t	arget subnet:			Show all compa	tible devices	
	Device	Device type	Туре		Address	Target de	vice
in 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 19	CPU1516F	CPU 1516F-3 PN/	PN/IE		192.168.0.111	CPU1516	F
	-	-	PN/IE		Access address	-	
°E (
Flash LED							
						<u>S</u> ta	rt search
Online status information:							
Retrieving device info	rmation						~
🗹 Scan and information	retrieval completed.						-
Display only error mes							*
Display only error mes	sages						
					Ŀ	ad	<u>C</u> ancel

Figure 3: Go online

7 Structured step-by-step instructions

You can find instructions on how to carry out planning below. If you already have a good understanding of everything, it will be sufficient to focus on the numbered steps. Otherwise, simply follow the detailed steps in the instructions.

7.1 Retrieve an existing project

→ Before we can start the diagnostic functions, we need a project with programming and a hardware configuration.

(e.g., SCE_EN_032-100_FC-Programming....zap).

To retrieve an existing project that has been archived, you must select the relevant

archive with \rightarrow Project \rightarrow Retrieve in the project view.

Confirm your selection with "Open".

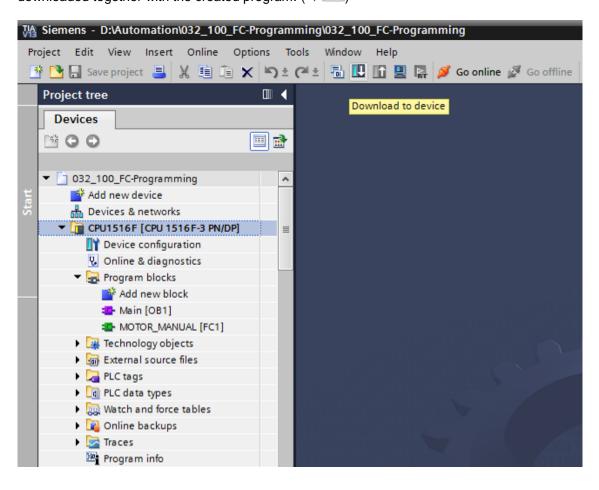
 $(\rightarrow \text{Project} \rightarrow \text{Retrieve} \rightarrow \text{Select a .zap archive} \rightarrow \text{Open})$

Project Edit View	Insert	Online	Options					
予 Open Migrate project			Ctrl+O					
Close			Ctrl+W					
Save			Ctrl+S					
Save as	Ctrl	+Shift+S						
Delete project Archive								
Retrieve								
Card Reader/USB m Memory card file	emory		;					
Upgrade								
D:lAutomation\013 D:lAutomation\012 D:lVorlagenprojekt D:l\032-200_FB-Pr D:lAutomatisi\012	_10\012 Webserv. ogrammi	_101_CPU ITank_V1 erung_S7-	1516F 3_SP1 314					
Exit								

→ The next step is to select the target directory where the retrieved project will be stored. Confirm your selection with "OK". (→ Target directory \rightarrow OK)

7.2 Download the program

→ After the project has been successfully retrieved, the controller can be selected and downloaded together with the created program. (→ □□)



→ Select the correct interfaces and click "Start search". (→ "PN/IE" → Selection of the network adapter of the PG/PC → Direct at slot '1 X1'→ "Start search")

Extended download to	device		_				
	Configured access n	odes of "CPU1516F"					
	Device	Device type	Slot	Туре	Address	Subn	et
	CPU1516F	CPU 1516F-3 PN/	1 X3	PROFIBUS	2		
		CPU 1516F-3 PN/	1 X1	PN/IE	192.168.0.111	PN/IE	1
		CPU 1516F-3 PN/	1 X2	PN/IE	192.168.1.1		
				-			_
		Type of the PG/PC inte		PN/IE			-
		PG/PC inte		Dell Wireles	s 1901 802.11a/b/g/n (:	2.4GHz an	- 🖲 🖻
	Co	nnection to interface/su	bnet:	PN/IE_1			- 💎
		1st gate	eway:				- 💎
	Compatible devices	in target subnet:			Show all compatil	ole devices	
	Device	Device type	Туре	A	ddress	Target de	vice
	CPU1516F	CPU 1516F-3 PN/	. PN/IE	1	92.168.0.111	CPU1516	F
	-	-	PN/IE	A	ccess address	-	
* E I							
Flash LED							
						<u>S</u> ta	rt search
Online status information	1:						
Retrieving device inf	ormation						^
🗹 Scan and informatio	n retrieval completed.						
							~
Display only error me	essages						
							Cancel
					Load		

Once "Scan and information retrieval completed" appears, click "Load". (\rightarrow "Load")

→ Before downloading can be started, other actions may have to be set (highlighted in pink). Click "Load" again. (\rightarrow "Load").

Status	!	Target CPU1516F	Message Reads for local line	Action
*0	`	• Cruisior	Ready for loading.	
	0	 Online is up-to-da 	. The hardware configuration will not be loaded, because the onlin	
	0	Software	Download software to device	Consistent download
	0	Text libraries	Download all alarm texts and text list texts	Consistent download
<			101	

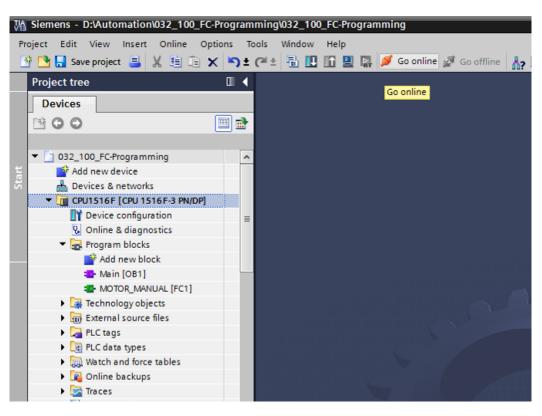
 \rightarrow After loading, first select the "Start all" check box under Action.

Click "Finish". (\rightarrow select check box \rightarrow "Finish")

Load res	sults			×
? s	tatus	and actions after downloa	ding to device	
Status	1	Target	Message	Action
tî.	%	▼ CPU1516F	Downloading to device completed without error.	
		Start modules	Start modules after downloading to device.	Start all
	4	 start modules 	start modules after downloading to device.	Start an
۲.			III	>
			Finish	Load Cancel

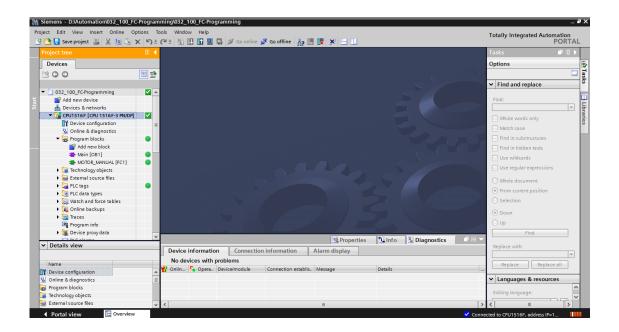
7.3 Go online

→ To get started with the diagnostic functions, we will select our controller ("PLC_1") and click "Go online". (\rightarrow PLC_1 \rightarrow Go online)



 \rightarrow Once the online connection to the "PLC_1" controller is established, the CPU can be

started or stopped with the following buttons Diagnostic information in the form of symbols will already be available in the project tree and in the diagnostics window.



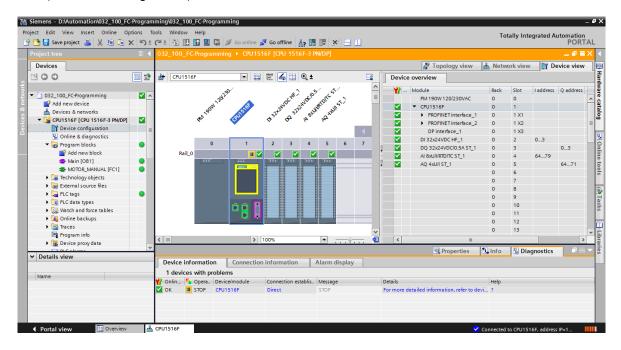
Symbols for the comparison status in the project tree

→ The diagnostic symbols in the project tree show a comparison status representing the online/offline comparison of the project structure.

Symbol	Meaning
0	Folder contains objects whose online and offline versions are different (only in the project tree)
•	Online and offline versions of the object are different
0	Object only exists online
•	Object only exists offline
	Online and offline versions of the object are the same

 \rightarrow Double-click "Device configuration".

 $(\rightarrow \text{Device configuration})$



Operating state symbols for CPUs and CPs

→ The graphical representation and device information window show the various operating states of the CPU or communication processors (CPs).

Symbol	Operating state
	RUN
	STOP
	STARTUP
<u> "</u>	HOLD
X	DEFECT
14	Unknown operating state
16	The configured module does not support display of the operating state.

Diagnostic symbols for modules and devices in the device overview

→ The graphical representation and Device overview window display the operating states of the various modules, CPU, or communication processors (CPs) using the following symbols.

Symbol	Meaning
* .57	The connection to a CPU is currently being established.
E S	The CPU is not accessible at the set address.
P.	The type of CPU configured and type of CPU actually present are incompatible.
2	During the establishment of the online connection to a protected CPU, the password dialog was terminated without input of the correct password.
>	No fault
2	Maintenance required
	Maintenance demanded
Ŷ	Fault
۵	The module or device is deactivated.
La	The module or device cannot be accessed from the CPU (valid for modules and devices below a CPU).
B !	Diagnostic data is not available because the current online configuration data differs from the offline configuration data.
1	The configured module or device and the module or device actually present are incompatible (valid for modules or devices below a CPU).
! ?	The configured module does not support display of the diagnostic status (valid for modules below a CPU).
?	The connection has been established, but the state of the module is currently still being determined.
0	The configured module does not support display of the diagnostic status.
0	Error in lower-level component: A error is present in at least one lower-level hardware component.

Color coding of ports and Ethernet cables

- → The status of ports and Ethernet cables can be diagnosed in the Network view and Topology view.
- \rightarrow The following table shows the possible colors and their respective meaning.

Color	Meaning
	No fault or maintenance required
-	Maintenance demanded
	Communication error

7.4 Online & diagnostics of the SIMATIC S7 controller

- \rightarrow Double-click "Online & diagnostics" in the project tree.
 - $(\rightarrow \text{Online \& diagnostics})$
- \rightarrow A CPU operator panel, the cycle time and the memory utilization are displayed in the Online tools on the right side. Switch the CPU to RUN here. (\rightarrow RUN)

Pro	Siemens - D:Vautomation/032_100_FC-Progra oject Edit View Insert Online Options 🔁 🔒 Save project 🚇 🐰 🗐 👔 🗙 🍋	Tools Window Help	online 🖉 Go offline 🛔 🖪 🖪 🤰	< ⊒ Ш		Totally Integrated Auto	mation PORTAL	
		032_100_FC-Programming >	CPU1516F [CPU 1516F-3 PN/DP]		.∎≡×	Online tools		
	Devices					Options		
stic	O O		Article number: Hardware: Firmware:			CPU operator panel CPU1516F [CPU 1516F-3 P RUN / STOP RROR STOP		📑 Tasks
	Wein (DB1) Wein (DB1) Technology objects Jig Technology objects Jig Technology objects Jig Technology objects Jig Technology object		Rack: 0 Slot: 1 Module information			✓ Cycle time	ms =	Libraries
	Signature Marces Marces Marces Marces Marces Program info Signature Prove proxy data V Details view Name		Module name: Plant designation: Location ID: Installation date: Additional information:	CPUISI6F Thursday , February 19 , 2015 12 : 39 *		Shortest: 1 ms Currentllast: 1 ms V Memory Load memory Free	99 %	
	Portal view	CPU1516F 😵 Online & dia	Manufacturer information Manufacturer description:	SIEMENS AG ③ Properties 1 Info 1 Diagnostics		Work memory Work memory code Free:	99.98 %	

 \rightarrow The working area window contains general information about the CPU. (\rightarrow General)

100_FC-Programming >	CPU1516F [CPU 1516F-3 PN/DP]	_ I
ne access	1	
nostics	General	
eneral iagnostic status	Module	
iagnostics buffer	Short designation:	CPU 1516F-3 PN/DP
ycle time	Article number:	6ES7 516-3FN00-0AB0
lemory		
isplay	Hardware:	2
ROFINET interface [X1]	Firmware:	V 1.6.0
ROFINET interface [X2]		
tions	Rack: 0	
	Slot: 1	
•	Module information	
	Device name:	
	Module name:	CPU1516F
	Plant designation:	
	-	
	Location ID:	
	Installation date:	Thursday, February 19, 2015 12:39
	Additional information:	
	Manufacturer information	
	Manufacturer description:	SIEMENS AG
	Serial number:	S C-EDSB09372014
	Profile:	16#0000
	Profile details:	16#0000
	Profile details:	16#0000

- \rightarrow If diagnostic information is available, it is displayed in Diagnostic status.
 - $(\rightarrow \text{Diagnostic status})$

032_100_FC-Programming	32_100_FC-Programming CPU1516F [CPU 1516F-3 PN/DP]		
Online access			
 Diagnostics 	Diagnostic status		
General			
Diagnostic status	Module exists.		
Diagnostics buffer	ОК		
Cycle time			
Memory			
Display			
PROFINET interface[X1]			
PROFINET interface[X2]			
Functions			

 \rightarrow Detailed Information on the individual events is displayed in Diagnostics buffer.

 $(\rightarrow \text{Diagnostics buffer})$

032_100_FC-Programming >	CPU1516F [CPU 1516F-3 PN/DP]	ĸ
Online access • Diagnostics	Diagnostics buffer	^
General	Events	
Diagnostic status		
Diagnostics buffer	Display CPU Time Stamps in PG/PC local time	
Cycle time	No. Date and time Event	
Memory	1 1/1/2012 10:24:02.493 Communication initiated request: STOP - CPU changes fro	
Display	2 1/1/2012 10:16:29.689 Communication initiated request: WARM RESTART - CPU ch	
 PROFINET interface[X1] 	3 1/1/2012 10:16:29.676 Communication initiated request: WARM RESTART - CPU ch	
PROFINET interface[X2]	4 1/1/2012 10:13:01.755 System initiated session termination	
Functions	5 1/1/2012 10:11:44.894 Communication initiated request: STOP - CPU changes fro	
	6 1/1/2012 9:43:10.209 AM Communication initiated request: WARM RESTART - CPU ch	
	7 1/1/2012 9:43:10.188 AM Communication initiated request: WARM RESTART - CPU ch	
	8 1/1/2012 1:00:06.092 AM Follow-on operating mode change - CPU changes from ST	
	Freeze display	
	Details on event	
	Details on event: 1 of 10	
	Description: CPU info: Communication initiated request: STOP	
	Pending startup inhibit(s):	
	- No startup inhibit set	
	CPU changes from RUN to STOP mode	
	CPU1516F	
	Time stamp: 1/1/2012 10:24:02.493 AM	
	Module: CPU1516F	
	Rack/slot: Rack 0 / Slot 1	
	Plant designation:	
	Location identifier	v
	K III	

 \rightarrow Next you receive information about the cycle time of the executed program.

 $(\rightarrow$ Cycle time)

032_100_FC-Programming)	CPU1516F [CPU 1516F-3 PN/DP]	_ ⊫∎×
Online access		
 Diagnostics 	Cycle time	
General	Cycle time diagram	
Diagnostic status		
Diagnostics buffer		
Cycle time		
Memory		
Display		
PROFINET interface[X1]	150 ms	
PROFINET interface[X2]	1 150	
Functions		

 \rightarrow The memory utilization can be seen here in detail. (\rightarrow Memory)

032_100_FC-Programmi	ing CPU1516F [CPU 1]	516F-3 PN/DP]			_ 12 = >
Online access					
 Diagnostics 	Memory				
General					
Diagnostic status					_
Diagnostics buffer					
Cycle time					
Memory					
Display		1 96	0.02%	0 %	0 %
PROFINET interfac	Sizes in bytes	Load memory	Code work-memory	Data work-mem	Retain memor
PROFINET interfac	Free:	24879616	1546977	5242880	48400
Functions	In use:	296448	287	0	
	Total:	25176064	1547264	5242880	48400

 \rightarrow Information about the display is also available for the CPU 1516F. (\rightarrow Display)

032_100_FC-Programmi	ing 🔸 CPU1516F [CPU 1516F-3 PN	¶/DP] IE ■ >
Online access	Disalau	
 Diagnostics 	Display	
General	Module	
Diagnostic status		
Diagnostics buffer	Article number:	6ES7 591-1BA00-0AA0
Cycle time	Hardware:	98
Memory		
Display	Firm ware :	V 1.6.0
PROFINET interfac	Manufacturer description:	SIEMENS AG
PROFINET interfac	Serial number:	S C-ENSJ6715
Functions		

→ The network settings and the status of the PROFINET interfaces [X1] and [X2] can also be displayed.

032_100_FC-Programmi	ng CPU1516F [CPU 1516F-3 PN/DP]	_ ∎∎×
Online access Diagnostics General Diagnostic status Diagnostics buffer Cycle time Memory	PROFINET interface[X1] Ethernet address Network connection	
Display PROFINET interfac Ethernet address Ports	MAC address: 28-63-36-86-59-82	
Communicatio Domain PROFINET interfac Functions	IP address: 192.168.0.111 Subnet mask: 255.255.0 Default router: 192.168.0.111 IP settings: IP setting time: IP setting time: Ports Ports	
	Name Status Settings Mode Port 1 (X1P OK Automatically TP 100 Mbps Image: Setting set	

 $(\rightarrow \text{PROFINET} \text{ interface [X1] or } \rightarrow \text{PROFINET} \text{ interface [X2]})$

 \rightarrow In "Assign IP address" under Functions, you can assign the IP address to a controller. However, this is only possible when no hardware has been downloaded to the CPU.

 $(\rightarrow$ Functions \rightarrow Assign IP address)

ng 🕨 CPU1516F [CPU 1516F-	3 PN/DP]		_ ⊫ ■ ×
Analog ID address			
Assign iF address			
MAC address:	00 - 00 - 00 - 00 - 00 - 00	Accessible devices	
IP address:	192 . 168 . 0 . 111		
Subnet mask:	255 . 255 . 255 . 0		
	O		
	Use router		
Router address:	192.168.0.111		
	Assign IP address		
	Assign IP address MAC address: IP address: Subnet mask:	g ▶ CPU1516F [CPU 1516F-3 PN/DP] Assign IP address MAC address: 00 -00 -00 -00 -00 -00 IP address: 192 . 168 . 0 . 111 Subnet mask: 255 . 255 . 0 Use router Router address: 192 . 168 . 0 . 111 Assign IP address	Assign IP address

 \rightarrow Under "Set time", you can set the time of the CPU.

 $(\rightarrow$ Functions \rightarrow Set time)

032_100_FC-Programmi	ng CPU1516F [CPU 1516F-3 PN/DP]	_ ⊫∎×
Online access	Cat there	
Diagnostics	Set time	
▼ Functions		
Assign IP address		
Set time		
Firmware update	PG/PC time:	
Assign name	(UTC+01:00) Amsterdam, Berlin, Bern, Rom, Stockholm, Wien 🔻	
Reset to factory se		
Format memory card	March 17, 2015 💌 09:02:24 PM 🖨	
Save service data		
	Module time PG/PC date	
	January 01 , 2012 💌 10 : 33 : 28 AM 🖨	
	Take from PG/PC Apply	

 \rightarrow Under "Firmware update", you can update the firmware of the PLC or the display.

 $(\rightarrow$ Functions \rightarrow Firmware update)

032_100_FC-Programmi	ing 🔸 CPU1516F [CPU 1516F-3	PN/DP]	_ ⊫ ■ ×
Online access Diagnostics Functions			
Assign IP address	> PLC		
Set time	Online data		
Firmware update			
Assign name	Article number:	6ES7 516-3FN00-0AB0	
Reset to factory se	Firmware:	V 1.6.0	
Format memory card	Name:	CPU1516F	
Save service data	Rack:		
	Slot:		
	3101.	1	
	Firmware loader		
	Firmware file:	•	Browse
	Firmware version:		
	Suitable for modules with:		
	Sutable for modules with.	Article number Firmware versio	n and higher
		< III	>
	Status:		
	Status:		
		🗸 Run firmware after update	*

→ Under "Assign name", you can assign a PROFINET device name to the configured field devices on PROFINET. The device name of the CPU cannot be changed here. It can only be changed by downloading a modified hardware configuration.

2_100_FC-Programmi	ng 🔸 CPU1516F [CPU 1	1516F-3 PN/DP]				_ IB
Online access	Assign name					
Diagnostics	Assign name					
Functions						
Assign IP address						
Set time		Configured PROFI	NET devi	ce		
Firmware update		PROFINET device	name:	cpu1516f.profinet interfac	e 1 💌	
Assign name				· · ·	··	
Reset to factory se		Devic	e type:	CPU 1516F-3 PN/DP		
Format memory card		Online access				
Save service data		Type of the PG/PC int	erface:	PN/IE	•	
		PG/PC int	erface:	Dell Wirelers 1001 802	.11a/b/g/n (2.4GHz an 💌 🖲 🛙	31
		- Cincinn	choce.	weben wheless 1901 002.	Transgin (2.4 driž an	
		Device filter		e same type bad parameter settings		
	Accessible dev	Only show do	evices with	out names		
	IP address	MAC address	Device type	PROFINET device name	Status	
	٢					>

 $(\rightarrow$ Functions \rightarrow Assign name)

→ Under "Reset to factory settings", you can restore the factory settings for the CPU. After restoring the factory settings, the CPU configuration and the program must be imported again from the inserted memory card. Therefore, the memory card must be formatted before the restoring the factory settings.

 $(\rightarrow$ Format memory card \rightarrow Format \rightarrow Reset to factory settings \rightarrow Retain or delete IP address \rightarrow Reset)

032_100_FC-Programmi	ng CPU1516F [CPU 1516F-3 PN/DP]	_ ⊫∎×
Online access	Baasta fatan astilara	
Diagnostics	Reset to factory settings	
 Functions 		
Assign IP address		
Set time		
Firmware update	IP address: 192 . 168 . 0 . 111	
Assign name	PROFINET device name: cpu1516f.profinet interface_1	
Reset to factory se	PROFINEL device name	
Format memory card		
Save service data	Retain IP address	
	O Delete IP address	
	Reset	

 \rightarrow Finally, the service data can be saved under Functions.

 $(\rightarrow$ Functions \rightarrow Save service data)

032_100_FC-Programmir	ıg → CPU1516F [CPU 1516F-3 PN/DP]	_ ∎∎×
Online access	Save service data	
Diagnostics		
▼ Functions	Online data	
Assign IP address		
Set time	Article number: 6ES7 591-18A00-0AA0	
Firmware update	Firmware: V1.6.0	
Assign name	Module name: CPU1516F	
Reset to factory se	would name. Croision	
Format memory card		
Save service data	Rack: 0	
	Slot: 1	
	Save service data	
-	Path C:\Users\Sven\Documents	
-	Save service data	

 \rightarrow The online connection should be disconnected again before the next chapter.

 $(\rightarrow \text{Online access} \rightarrow \text{Disconnect online connection})$

032_100_FC-Programmi	ng > CPU1516F [CPU 1516F-3 PN/DP]		_ II = ×
Online access			
Diagnostics	Online access		
 Functions 	Status		
Assign IP address			
Set time			
Firmware update	Online		
Assign name			
Reset to factory se		132	
Format memory card			
Save service data		Flash LED	
	Online access		
	Type of the PG/PC interface:	PN/IE	
	PG/PC interface:	🔤 Dell Wireless 1901 802.11a/b/g/n (2.4GHz an 💌 🐑 🔍	
	Connection to interface/subnet:	PN/IE_1	
	1st gateway:	· · · · · · · · · · · · · · · · · · ·	
	Device address:	192.168.0.111	
		🖉 Go offline	

→ The TIA Portal is now back in offline mode. The orange-colored bars and the diagnostic symbols are no longer displayed.

7.5 Online/offline comparison

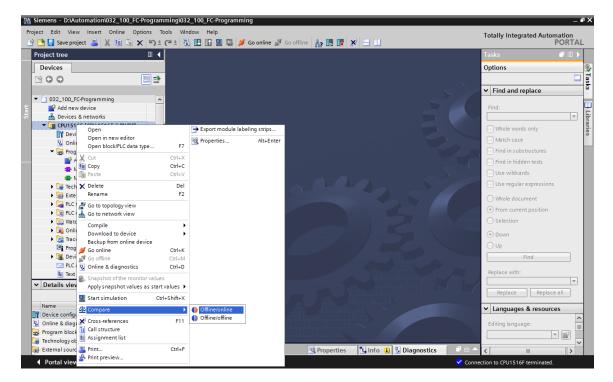
→ It is often important to know whether the saved data matches the data loaded in the controller. First, remove the negation from the "Safety_shutoff_active" tag at the AND function in the "MOTOR_MANUAL [FC1]" block.

Save the "MOTOR_MANUAL [FC1]" block, but do NOT download it to the controller.

Close the "MOTOR_MANUAL [FC1]" block again.

→ To compare, right-click the "PLC_1" controller and select "Compare", "Offline/online".

 $(\rightarrow \text{Select controller} \rightarrow \text{Compare} \rightarrow \text{Offline/online})$



 \rightarrow The Compare editor online opens.

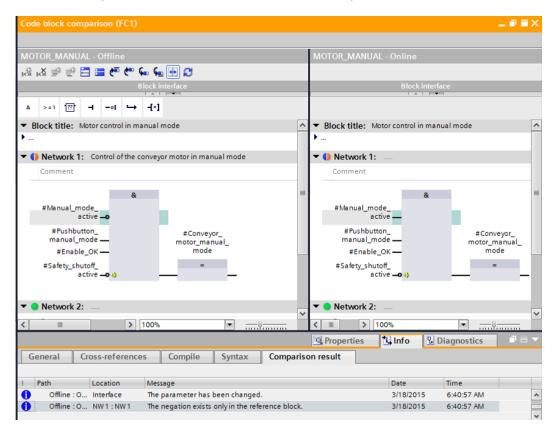
Com	pare editor online													Ξ×
() 🔭 ± 📑 🗉	8 8	2											
								53						
"032_	100_FC-Programming	g: CPU151	6F"	_	_	_	-			"Online PLC"	_	_		_
Name		Address	Туре	Time	Time stamp	code	Status	Action		Name	Туре	Time	Time stamp code	
-	CPU1516F						•	<u> </u>	-	CPU1516F				
•	🛃 Program blocks						•	U.						
	🏭 Main [OB1]	OB1	OB	3/17/	3/17/2015 -	20:48:2				💶 Main [OB1]	OB	3/17/	3/17/2015 - 20:48:24.9844	4933
	MOTOR_MA	FC1	FC	3/8/2	3/18/2015 -	06:37:3		11		MOTOR_MANUAL [FC1]	FC			
	🙀 Technology obj													
	PLC tags									0				
	🛅 PLC data types													
<						>				<		Ш		>
Comp	arison result: No deta	ailed prop	erty co	mparison	available.				_					
				-	-							1		
					_			U						
				CPU	U1516F						CPU151	I 6F		

→ If, for example, block differences are indicated , first select the block involved. You can then click the button to "Start detailed comparison".

 $(\rightarrow MOTOR_MANUAL \rightarrow Start detailed comparison).$

Compare editor online											_ = ×
🍤 🌗 🥐 ± 📑 🗄	ê 🕄	4									3
	Start	detaile	ed compa	arison	-	<u> </u>	1				
"032_100_FC-Programming	g: CPU151	6F"					ľ	"Online PLC"			
Name	Address	Туре	Time	Time stamp code	Status	Action	-	Name	Туре	Time	Time stamp code
👻 🛅 CPU1516F					•	II		CPU1516F			
🔻 🛃 Program blocks					•	11					
🛥 Main [OB1]	OB1	OB	3/17/	3/17/2015 - 20:48:2			1	💶 Main [OB1]	OB	3/17/	3/17/2015 - 20:48:24.9844933
MOTOR_MA	FC1	FC	3/8/2	3/18/2015 - 06:37:3	•	11	-	- MOTOR_MANUAL [FC1]	FC		-
🙀 Technology obj											
PLC tags								0			
PLC data types											

→ The selected offline/online block will be compared in the code block comparison. A detailed description of the difference is shown in the comparison result.



 \rightarrow Close the window of the code block comparison.

 \rightarrow An action can be selected for the block involved in the Compare editor.

Either the "MOTOR_MANUAL" block will be downloaded from the programming device to the controller and overwritten there or the "MOTOR_MANUAL" block will be imported from the controller and overwritten in the TIA Portal.

Select the "Upload from device" action. (← Upload from device)

Compare editor onlin									_ • • • >
🌢 🛛 🏞 ± 🖪 🕯	ቆ ₿ ₫	2							
					<u> </u>				
032_100_FC-Programmin	g: CPU1516F					"Online PLC"			
Name	Address	Туре	Time st	Status	Action	Name	Address	Туре	Time st.
CPU1516F				•	11	Tepu1516F			
🔻 🛃 Program blocks				•	11				
🏩 Main [OB1]	OB1	OB	3/17/20			💶 Main [OB1]	OB1	OB	3/17/20
MOTOR_MA	FC1	FC	3/8/201		11	MOTOR_MANUAL [FC1]	FC1	FC	3/8/201
🙀 Technology obj					II No act	ion			
\sub PLC tags					🔶 Upload	from device			
📑 PLC data types					→ Downl	oad to device			

 \rightarrow Click the "Execute actions" button 2. (\rightarrow Execute actions)

Compare editor online									
🍤 🕩 💏 🗉 🚺	🔒 🚨 🗄	2							-
		Execute a	actions		<u> </u>				
032_100_FC-Programmin	g: CPU1516F					"Online PLC"			
Name	Address	Туре	Time st	Status	Action	Name	Address	Туре	Time st
 CPU1516F 				0	+	1 CPU1516F			
🔻 🛃 Program blocks				•	+				
🖀 Main [OB1]	OB1	OB	3/17/20			💶 Main [OB1]	OB1	OB	3/17/20.
MOTOR_MA	FC1	FC	3/8/201		+	MOTOR_MANUAL [FC1]	FC1	FC	3/8/201.
🙀 Technology obj									
浸 PLC tags						0			
PLC data types									

 \rightarrow Confirm "Upload from device". (\rightarrow Upload from device)

pload ? c		preconditions for uploa	ad from device	
Status	1	Target	Message	Action
t]	<u> </u>	▼ CPU1516F	Ready for loading.	
	4	 Conflicts 	Conflicts occurred during loading.	Overwrite
<			III	
				Refresh
				Upload from device Cancel

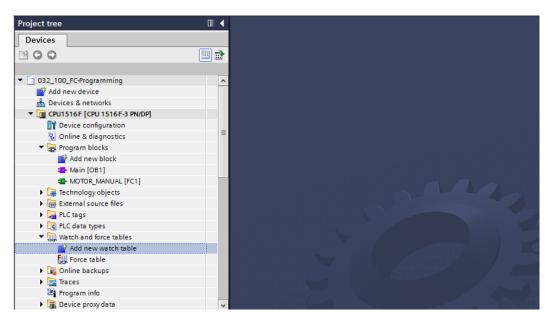
→ After the upload, there are no more differences. You should now save your project again and close the online connection.

7.6 Monitor and modify tags

 \rightarrow To monitor and modify tags, you need a watch table.

Double-click "Add new watch table" in the project tree.

 $(\rightarrow \text{Add new watch table})$



- \rightarrow Open the newly created "Watch_table_1" by double-clicking it. (\rightarrow "Watch_table_1")
- \rightarrow You can enter individual tags in the table or you can select the

"Tag_table_sorting_station" and the tags to be monitored, and drag them from the Details view to the watch table.

 $(\rightarrow \text{Default tag table})$

Project tree			032_	100_FC-Progran		F [CPU 1516F-3 PN	/DP] 🕨 Watch ar	d force tables 🕨	
Devices									
				🖗 🖉 🕹 🖗 1	% \$ ²⁰ ¹⁰⁰ 1				
			i	Name	Address	Display format	Monitor value	Modify value	1
📑 Add new d	evice	^	1	"-S0"	%10.2	Bool			
nh Devices & I	networks		2	"-S3"	%11.4	Bool			
🔻 🗖 CPU1516F	[CPU 1516F-3 PN/DP]		з	"-K0"	%IO.1	Bool			
🕎 Device	configuration		4	"-B1"	%10.5	Bool			
😵 Online i	& diagnostics		5	"-S4"	%11.5	Bool			
🔻 🛃 Progran			6	"-A1"	%10.0	Bool			
📑 Add	new block		7	"-Q1"	%Q0.0	Bool			
💶 Mair	n [OB1]		8		Add new>				
	OR_MANUAL [FC1]								
🕨 🙀 Technol									
🕨 🔚 Externa									
🔻 浸 PLC tag									
	w all tags								
	new tag table								
	ult tag table [54]								
	table_sorting station [28]	~							
Details view	a types	~	-						
• Details view									
Name	Data type Details								
-Q1	Bool III %Q0.0								
• -Q2	Bool %Q0.1								
• -Q3	Bool %Q0.2								
an -so	Bool %I0.2								

To have all monitoring and modifying functions available for selection, the following \rightarrow columns can be displayed:

'All modify columns' is and 'All expanded mode columns'

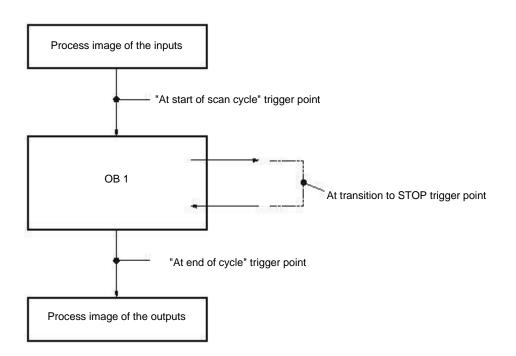
Continue by selecting the trigger timing for the monitoring.

 $(\rightarrow \text{Permanent})$

÷ *	1 1 10 1	R 27 🚏 º	1						
i	Name	Address	Display form	Monitor valu	Monitor with trig	Modify with trigge	Modify value	9	Comment
	"-SO"	%I0.2	Bool		Permanent	Permanent			
	"-S3"	%11.4	Bool		Permanent	Permanent			
	"-КО"	%I0.1	Bool		Permanent	Permanent			
	"-81"	%I0.5	Bool		Permanent	Permanent			
	"-S4"	%11.5	Bool		Permanent	Permanent			
	"-A1"	%IO.0	Bool		Permanent	Permanent			
	"-Q1"	🗉 %Q0.0	Bool 💌	1	Permanent 👻	Permanent 🔹			
		<add new=""></add>			Permanent				
					Permanently, at sta				
					Once only, at start				
					Permanently, at en Once only, at end o				
					Permanently, at tra	Instant cycle			
					Once only, at trans				

The following monitoring and modifying modes are available:

- Permanent (in this mode, the inputs are monitored/modified at the start of the cycle and the outputs at the end.)
- Once only, at start of scan cycle
- Once only, at end of scan cycle
- Permanently, at start of scan cycle
- Permanently, at end of scan cycle
- Once only, at transition to STOP
- Permanently, at transition to STOP



 \rightarrow Next, click "Monitor all values once and now" \square or "Monitor all values according to

DON

trigger	settings"	· 🔝. (> 🔝 Mo	onitor all)					
∌ ₹	1 lo 91 1	ð 🛷 📭 🕫	ת 1						
i	Name	Address	Display form	Monitor valu	Monitor with trig	Modify with trigge	Modify value	4	Comment
1	"-SO"	%10.2	Bool	FALSE	Permanent	Permanent			
2	"-S3"	%11.4	Bool	FALSE	Permanent	Permanent			
3	"-ко"	%I0.1	Bool	FALSE	Permanent	Permanent			
4	"-B1"	%10.5	Bool	FALSE	Permanent	Permanent			
5	"-S4"	%11.5	Bool	FALSE	Permanent	Permanent			
6	"-A1"	%10.0	Bool	FALSE	Permanent	Permanent			
7	"-Q1"	%Q0.0	Bool 💌	FALSE	Permanent 💌	Permanent 💌			
8		<add new=""></add>							

→ To modify tags, enter the desired "Modify values". Next, click ¹ to "Modify all activated values once and now" or ¹ to "Modify all activated values by Modify with trigger condition".

 $(\rightarrow \text{TRUE} \rightarrow \overset{\textcircled{}}{\longrightarrow} \text{modifies all activated values by "Modify with trigger condition"})$

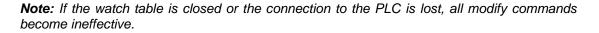
i	i	Name	All active value	ues will be mod	ified by modify	with trigger". trig	Modify with trigge	Modify value	9	Comment
1		*-SO*	%IU.2	8001	TALSE	rermanent	Permanent			
2		"-53"	%11.4	Bool	FALSE	Permanent	Permanent			
3		*-КО*	%IO.1	Bool	FALSE	Permanent	Permanent			
4		"-B1"	%10.5	Bool	FALSE	Permanent	Permanent			
5		"-S4"	%11.5	Bool	FALSE	Permanent	Permanent			
6		"-A1"	%10.0	Bool	FALSE	Permanent	Permanent			
7		*-Q1*	%Q0.0	Bool	FALSE	Permanent 💌	Permanent 💌	TRUE	M /	
8			<add new=""></add>							

 \rightarrow Confirm the warning with **'Yes'.** (\rightarrow Yes)



 \rightarrow The output becomes active even though the programmed conditions are not met.

	i	Name	Address	Display form	Monitor valu	Monitor with trig	Modify with trigge	Modify value	4	Comment
1		*-S0*	%10.2	Bool	FALSE	Permanent	Permanent			
2		*-53*	%11.4	Bool	FALSE	Permanent	Permanent			
3		"-КО"	%IO.1	Bool	FALSE	Permanent	Permanent			
4		*-B1*	%10.5	Bool	FALSE	Permanent	Permanent			
5		*-54*	%11.5	Bool	FALSE	Permanent	Permanent			
6		*-A1*	%10.0	Bool	FALSE	Permanent	Permanent			
7	-	*-Q1*	%Q0.0	Bool	TRUE	Permanent	Permanent	TRUE		
8			Add new>							



7.7 Force tags

→ The "Force" function can be used to assign a fixed value to tags. Force values are specified in a similar way as for the "Modify tags" function but, in contrast, are retained after the CPU is stopped. The main differences between "Modify tags" and the "Force" function are as follows: In contrast with "Modify tags", the "Force" function does not allow you to assign values to data blocks, timers, counters and bit memory.

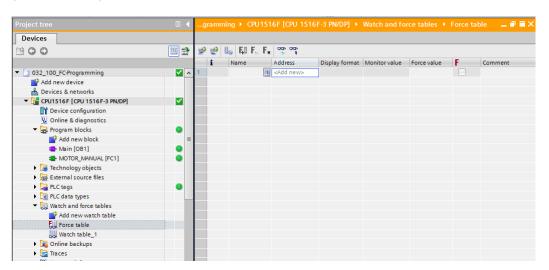
IO device inputs (e.g., IWxx:P) cannot be modified, although they can be pre-assigned by the "Force" function.

Unlike with the "Modify" function, values permanently assigned by the "Force" function cannot be overwritten by the user program.

If you close the force table, the force values are retained. This is not the case with the "Modify" function.

If the online connection to the CPU is interrupted, the tags assigned with the "Force" function retain their value.

 \rightarrow To force tags, you must first double-click the force table to open it.



$(\rightarrow$ Force table)

 \rightarrow Select the "Q1" operand with address %Q0.0 from the list. (\rightarrow Q1)

i	Name	Address	Display format	Monitor value	Force value	F	Comment
1		<add new=""></add>					
	- @ *-P7*		Bool	%Q1.3	displa	y cylinder	~
	-Q1"		Bool	%Q0.0	conve	yor motor	
	-Q2*		Bool	%Q0.1	conve	yor motor	
	-Q3"		Bool	%Q0.2	conve	yor motor	
	-so"		Bool	%10.2	mode	selector	
	-s1"		Bool	%10.3	pusht	outton aut	=
	- 3 *-S2*		Bool	%10.4	pusht	outton aut	
	······································		Bool	%11.4	pusht	outton ma	~

 \rightarrow With forcing, the operands are entered with direct IO access (%Q0.0:P).

	i	Name	Address	Display format	Monitor value	Force value	F	Comment
1		"-Q1":P	%Q0.0:P	Bool	0			
2		1	Add new>					

 \rightarrow Enter the desired force value and activate it \blacksquare .

Click "Start or replace forcing" I. The new force request is transferred to the CPU.

 $(\rightarrow \%Q0.0:P \rightarrow TRUE \rightarrow \square \rightarrow \blacksquare$ Start or replace forcing)

No.	🥩 🕐 🗓 FJ 🖡 F. 😤 😋									
	i	Name	Address	Display format	Monitor value	Force value	F	Comment		
1		"-Q1":P	%Q0.0:P	Bool	00	TRUE	M 🔺			
2			<add new=""></add>							

 \rightarrow Confirm the warning with **'Yes'.** (\rightarrow Yes)

Force all	(0710:001)	? ×
	Force all	
	CAUTION: Forcing with 'CPU1516F' !	
	Do you want to start "forcing" now?	
		Yes No

→ Forcing is activated and the yellow **MAINT LED** on the CPU lights up. In addition, an **F** on a red background is shown at the top right of the display of the S7-1500.

	Name	Address	Display format	Monitoryphus	Force value	E	Comment
--	------	---------	----------------	--------------	-------------	---	---------

Note: If the watch table is closed or the connection to the PLC is lost, **forcing remains active**, and the yellow **FRCE LED** on the CPU continues to be lit.

→ If you want to '**Stop forcing**', simply click "Stop forcing" ^[F], and confirm the next dialog with "Yes".

$T \rightarrow \blacksquare$ Stop forcing) ' Yes' (\rightarrow Yes)									
-	2	🗓 🖓 F. F.	00n 00n ⊳ 1						
	i	Name	Address	Display format	Monitor value	Force value	F	Comment	
1		"-Q1":P	%Q0.0:P	Bool	00	TRUE	M /		
2		[10]	<add new=""></add>						

Forcing is stopped and the yellow **MAINT LED** on the CPU goes out.

100

 \rightarrow If there is already a force request in the controller, this is indicated by the **E** symbol in the watch table.

n	n <mark>ming</mark>	• CPU1516F	[CPU 1516F	-3 PN/DP] 🕨	Watch and f	orce tables 🔸 Wa	atch table_1	-∎≡×
3)	4 10 <i>4 4</i>	5 🛷 📭 🕫	,				
-	- 10 1	Name	Address	Display form	Monitor valu	Monitor with trig	Modify with trigge	Modify v
1		"-SO"	%I0.2	Bool	FALSE	Permanent	Permanent	
2		"-53"	%11.4	Bool	FALSE	Permanent	Permanent	
3		"-ко"	%IO.1	Bool	FALSE	Permanent	Permanent	
4		"-B1"	%10.5	Bool	FALSE	Permanent	Permanent	
5		"-S4"	%11.5	Bool	FALSE	Permanent	Permanent	
6		"-A1"	%10.0	Bool	FALSE	Permanent	Permanent	
7	E	"-Q1"	%Q0.0	Bool	E FALSE	Permanent	Permanent	
8			<add new=""></add>				-]

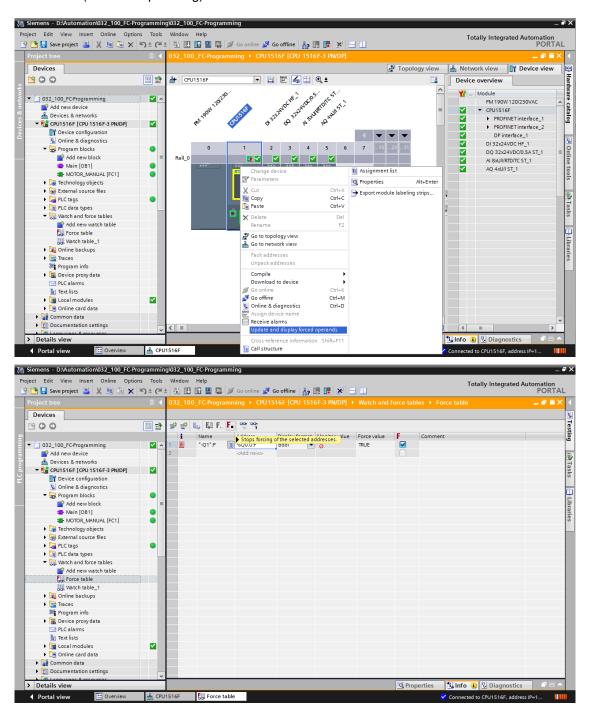
 \rightarrow If you now click **E**, additional information is displayed. (\rightarrow **E**)

101	1	19 10 9	1 2 2 00	1				
	i	Name	Address	Display form	Monitor valu	Monitor with trig	Modify with trigge	Modify v.
1		*-S0*	%10.2	Bool	FALSE	Permanent	Permanent	
2		"-S3"	%11.4	Bool	FALSE	Permanent	Permanent	
3		"-K0"	%10.1	Bool	FALSE	Permanent	Permanent	
k.		"-B1"	%10.5	Bool	FALSE	Permanent	Permanent	
5		*-S4*	%11.5	Bool	FALSE	Permanent	Permanent	
5		"-A1"	%10.0	Bool	FALSE	Permanent	Permanent	
7.	En	"-01"	%Q0.0	Bool	EN FALSE	Permanent	Permanent	

→ If there is already a force request in the controller, it can also be displayed and stopped via the online device view. For this, you need to right-click the CPU in online mode of the device view and select "Update and display forced operands".

 $(\rightarrow$ right-click the CPU \rightarrow Update and display forced operands")

 \rightarrow The force table with the current force requests will now be displayed and you can stop



these. (\rightarrow **Stop forcing**)

7.8 Checklist

No.	Description	Completed
1	Project 032-100_FB-programming successfully retrieved.	
2	CPU 1516F from project 032-100_FB-Programming successfully downloaded.	
3	CPU 1516F connected online.	
4	Status of the CPU 1516F checked with Online & diagnostics.	
5	Offline/online comparison of blocks in the CPU 1516F performed.	
6	Watch_table_1 created.	
7	Tags (-S0 / -S3 / -K0 / -B1 / -S4 / -A1 / -Q1) entered in watch table.	
8	Switch on conveyor motor forwards by modifying the output $(-Q1 = 1)$ in watch table.	
9	Switch off conveyor motor forwards by modifying the output $(-Q1 = 0)$ in watch table.	
10	Open force table	
11	Tag (-Q1:P) entered in force table.	
12	Switch on conveyor motor forwards by forcing the output $(-Q1 = 1)$ in force table.	
13	Force output -Q1 to switch off again.	

8 Exercise

8.1 Task – Exercise

In this exercise, the MOTOR_AUTO [FB1] function block from chapter SCE_EN_032-200_FB-Programming is to be tested.

The problem here is that the cylinder is in the front end position and thus the enable conditions for switching on the conveyor are not OK.

Using a watch table, the cylinder is to be moved to its rear end position so that the enable conditions for the MOTOR_AUTO [FB1] block become OK.

8.2 Planning

Plan the implementation of the task independently using the step-by-instructions as an aid.

8.3 Checklist – Exercise

No.	Description	Completed
1	Project 032-200_FB-Programming successfully retrieved.	
2	CPU 1516F from project 032-200_FB-Programming successfully downloaded.	
3	Watch table created and renamed as "Watch_table_cylinder".	
4	Tags (-B1 / -B2 / -M2) entered in watch table.	
5	Retract cylinder by modifying the output $(-M2 = 1)$ in watch table.	
6	Cylinder retracted (-B1 = 1)	
7	Reset output for Retract cylinder in watch table again $(-M2 = 0)$.	

9 Additional information

You can find additional information as an orientation aid for initial and advanced training, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software/firmware, at the following link:

www.siemens.com/sce/s7-1500