

Learn-/Training Document

Siemens Automation Cooperates with Education (SCE) | From Version V14 SP1

TIA Portal Module 051-201 High-Level Language Programming with SCL and SIMATIC S7-1200

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- SIMATIC S7-1200 AC/DC/RELAY (set of 6) "TIA Portal" Order no.: 6ES7214-1BE30-4AB3
- SIMATIC S7-1200 DC/DC/DC (set of 6) "TIA Portal" Order no.: 6ES7214-1AE30-4AB3
- Upgrade SIMATIC STEP 7 BASIC V14 SP1 (for S7-1200) (set of 6) "TIA Portal" Order no.: 6ES7822-0AA04-4YE5

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High-Level Language Programming with SCL and S7-1200

1 Objective

In this section, you will become familiar with the basic functions of the SCL high-level language. Test functions for eliminating logical programming errors will also be presented.

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

2 Requirements

This section builds on the hardware configuration of a SIMATIC S7-1200. It can be implemented with any hardware configurations that have digital input and output cards. To implement this section, you can use the following project, for example:

"SCE_EN_011_101_Hardware_Configuration_CPU1214C.....zap14"

You should also be familiar with high-level language programming, such as Pascal.

3 Hardware and software required

- 1 Engineering Station: The requirements are hardware and operating system (for additional information, see Readme on the TIA Portal Installation DVD)
- 2 SIMATIC STEP 7 Basic software in the TIA Portal as of V14 SP1
- 3 SIMATIC S7-1200 controller, e.g. CPU 1214C DC/DC/DC Firmware V4.2.1 or higher
- 4 Ethernet connection between the engineering station and controller



1 Engineering station





2 SIMATIC STEP 7 Basic (TIA Portal) as of V14 SP1

3 SIMATIC S7-1200 controller

4 Theory

4.1 SCL programming language

SCL (Structured Control Language) is a high-level, Pascal-based programming language that enables structured programming. The language corresponds to the "Structured Text" (ST) programming language specified in DIN EN-61131-3 (IEC 61131-3). In addition to high-level language elements, SCL contains typical elements of the PLC as language elements such as inputs, outputs, timers, block calls, etc. It supports the STEP 7 block concept and enables block programming in compliance with standards in addition to programming with Ladder Logic (LAD) and Function Block Diagram (FBD). This means SCL supplements and expands the STEP 7 programming software with its LAD and FBD programming languages.

You do not have to create every function yourself but can use pre-compiled blocks, such as system functions and system function blocks that are present in the CPU's operating system.

Blocks that are programmed with SCL can be mixed with LAD and FBD blocks. This means that a block programmed with SCL can call another block that is programmed in LAD or FBD. Accordingly, SCL blocks can also be called in LAD and FBD programs.

SCL networks can also be inserted in LAD and FBD blocks.

The SCL test functions can be used to find logical programming errors in an error-free compilation.

4.2 SCL development environment

There is a development environment that is tailored to the specific properties of both SCL and STEP 7 for use and application of SCL. This development environment consists of an editor/compiler and a debugger.



Editor/compiler

The SCL editor is a text editor that can be used to edit any text. The main task of the SCL editor is the creation and editing of blocks for STEP 7 programs. A basic syntax check is performed during the input which makes it easier to avoid errors during programming. Syntax errors are displayed in different colors.

The editor offers the following options:

- Programming of an S7 block in the SCL language
- Convenient insertion of language elements and block calls using drag & drop
- Direct syntax check during programming
- Customization of the editor to meet your needs, e.g. color-coding for the different language elements according to syntax
- Checking of the finished block through compiling
- Display of all errors and warnings that occur during compiling
- Localization of error locations in the block, optionally with error description and information on troubleshooting

Debugger

The SCL debugger enables you to check a program while it is running in the automation system (AS) and thus find potential logical errors.

SCL provides two different test modes:

- Continuous monitoring
- Step-by-step monitoring

With "Continuous monitoring" you can test a group of instructions within a block. During the test, the values of the tags and parameters are displayed in chronological order and – if possible – updated cyclically.

With "Step-by-step monitoring" the logical program sequence is followed. You can run the program algorithm instruction-by-instruction and observe how the contents of the processed tags change in a result window.

The type of CPU you are using determines whether or not you can use "Step-by-step monitoring". The CPU must support the use of breakpoints. The CPU used in this document does not support breakpoints.

5 Task

5.1 Example task – Tank volume

In the first part, you are to program the calculation of the tank volume.

5.2 Expansion of the sample task

In the second part, the task is expanded and you are to program an error evaluation.

6 Planning

The tank is in the shape of a vertical cylinder. The filling level is measured with an analog sensor. For the first test, the filling level value should be available as a scaled value (in meters).

Global parameters, such as the diameter and height of the tank, are to be stored in a structured manner in a global data block "Data_Tank".

The program for calculation of the volume should be written in a "Calculate_Volume" function and the parameters are to use the unit 'meter' or 'liter'.

6.1 Global data block "Data_Tank"

The global parameters are stored in multiple structures in a global data block.

Name	Data type	Start value	Comment
Dimensions	STRUCT		
Height	REAL	12.0	in meter
Diameter	REAL	3.5	in meter
measured_data	STRUCT		
filling_level_per	INT	0	value between 027648
filling_level_scal	REAL	0.0	range 012.0.
Volume	REAL	0.0	Volume of tank in liter
fault_flags	STRUCT		
calculate_volume	BOOL		fault == true
Scaling	BOOL		fault == true

Table 1: Parameters in the "Data_Tank" data block

6.2 "Calculate_Volume" function

This block calculates the volume of the tank in liters.

In the first step, there is to be no check of the transferred parameters for reasonableness.

The following parameters are required for this step:

Input	Data type	Comment
Diameter	REAL	Diameter of cylindric tank in meter
Filling_level	REAL	Filling level of liquid in meter
Output		
Volume	REAL	Volume of liquid in the tank in liter

Table 2: Parameters for "Calculate_Volume" function in the first step

The formula for calculating the volume of a vertical cylinder is used to solve the task. The conversion factor 1000 is used to calculate the result in liters.

$$V = \frac{d^2}{4} \cdot \rho \cdot h \qquad = > \qquad \# \text{Volume} = \frac{\# \text{Diameter}}{4} \cdot 3.14159 \cdot \# \text{Filling_le vel} \cdot 1000$$

6.3 Expansion of the "Calculate_Volume" function

The second step checks whether the diameter is greater than zero. In addition, a test is to be performed to determine whether the filling level is greater than or equal to zero and less than or equal to the height of the tank.

In case of an error, the new parameter "er" is set to TRUE, and the "Volume" parameter is set to the value -1.

Input Data type		Comment
Height	REAL	Height of cylindric tank in meter
Diameter	REAL	Diameter of cylindric tank in meter
Filling_level	REAL	Filling level of liquid in meter
Output		
er	BOOL	fault flag; fault == true
Volume	REAL	Volume of liquid in the tank in liter

For this purpose, add the "er" and "Height" parameters to the interface.

Table 3: Parameters for "Calculate_Volume" function in the second step

7 Structured step-by-step instructions

You can find instructions on how to implement the planning below. If you already have a good understanding of everything, it is sufficient to focus on the numbered steps. Otherwise, simply follow the steps of the instructions explained below.

7.1 Retrieving an existing project

Before you can start programming, you need a project with a hardware configuration.
 (e.g. SCE EN 011-101 Hardware Configuration CPU1214Czap14).

To retrieve an existing project, you must select the respective archive from the Project view under

Project

Retrieve. Confirm your selection with "Open".

(® Project ® Retrieve ® Selection of a .zap archive ® Open)



® Next you can select the target directory to which you want to save the retrieved project. Confirm your selection with "OK". (® Project ® Save as... ® OK)

7.2 Saving the project under a new name

Project ® Save as ... ® 051-201_SCL_S7-1200.
 (® Project ® Save as ... ® 051-201_SCL_S7-1200 ® Save)



7.3 Creating the "Data_Tank" data block

In the Project view, navigate to
 the program blocks and create a new block by doubleclicking
 Add new block.

TIA Siemens - C:\Users\mde\Desktop\051_20	1_SCL_S7-1200\051_201_SCL_S7-1200
Project Edit View Insert Online Optio	ns Tools Window Help うと(チェ 🖥 🗓 🖺 🚆 🐺 🖋 Goonline 🖨 Gooffline 🕌 🌆 📑 🗰
Project tree	
Devices	
▼051_201_SCL_S7-1200	
Add new device	
の Devices & networks	
▼ [] CPU_1214C [CPU 1214C DC/DC/DC]	
III Device configuration	
S Online & diagnostics	
 Program blocks 	
Add new block	
Hain [OB1]	
Technology objects	
External source files	
PLC tags	
PLC data types	
Watch and force tables	
Online backups	
🕨 🔄 Traces	

® Now select a data block and enter the name.

(® Data block ® "Da	ata_Tank" ® O	K)			
Add new block Name: Data_Tank					×
Organization block	Type: Language: Number:	Global DB DB 1 Manual	▼ ▼ \$		
Function block	Description: Data blocks (DI more	Automatic Bs) save program data.			
Function					
Data block					
Additional info	n			ОК	Cancel

Next, enter the names of the tags listed below with data type, start value and comment. R

*	Da	ta	٦ Ta	🛃 📰 🤓 Keep a	ctual values 🛛 🔒	Snapshot 🔤 i	Copy sna	oshots <mark>t</mark> o start va	lues 🖁	· B- •		8
		Na	me		Data type	Start value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
	-	•	St	atic								
			•	dimensions	Struct							
	-			height	Real	12.0						in meter
	-			diameter	Real	3.5						in meter
	-		•	measured_data	Struct							
				filling_level_per	Int	0						range 027648
	-			filling_level_scal	Real	0.0						range 012.0
	-			volume_liquid	Real	0.0						in liter
	-00		•	fault_flags	Struct							
0	-			calculate_volume	Bool	false						fault == true
1	-00			scaling	Bool	false						fault == true

Creating the "Calculate_Volume" function 7.4

- ® Next, add a function, enter the name and select the language.
- (
 Add new block
 Function
 R "Calculate_Volume"
 SCL
 OK) Add new block X Name: Calculate_Volume SCL -Language: \$ Number: OR Manual Organization block Automatic Description: Functions are code blocks or subroutines without dedicated memory. Function block Function DB Data block more... > Additional information Add new and open OK Cancel

7.5 Specifying the interface of the "Calculate_Volume" function

® The top section of your programming view shows the interface description of your function.

05	1_2	201	1_SCL_S7-1200 → CPU_12	14C [CPU 1214C DO	DC/DC] > Pro	gram blocks 🔸 Calculate_Volume [FC1]	_ = = ×
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	Ca	Icu	late_Volume				
		Na	ame	Data type	Default value	Comment	
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2			<add new=""></add>				
3	-	•	Output				
4			<add new=""></add>				
5		•	InOut				
6			<add new=""></add>				
7	-	•	Temp				
8			<add new=""></add>				
9		•	Constant				
10			<add new=""></add>				
11	-0	•	Return				
12		•	Calculate_Volume	Void			
	1		Internet Later and Internet.				
	B	F	CASE FOR WHILE OF TO DO DO (**) REGION				
	-		1				
		1					
5							
ō							

® Create the following input and output parameters.

(
 Name
 Data type
 Comment)

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	Ca	lcu	late_Volume				
		Na	me	Data type	Default value	Comment	
1		•	Input				
2	-		Diameter	Real		diameter cylindric tank in meter	
З	-		Filling_level	Real		filling level of liquid in meter	
4			<add new=""></add>				
5		•	Output				
6			Volume	Real]	volume of liquid in the tank in liter	
7			<add new=""></add>				
8		•	InOut				
9			<add new=""></add>				
10		•	Temp				
11			<add new=""></add>				
12		•	Constant				
13			<add new=""></add>				
14	-	•	Return				
15	-		Calculate_Volume	Void			

7.6 **Programming the "Calculate_Volume" function**

® Enter the program shown below. (® Enter program)

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	Ca	cu	late_Volume				
-		Na	ime	Data type	Default value	Comment	
1	-	-	Input				^
2			Diameter	Real		diameter cylindric tank in meter	=
З	-		Filling_level	Real		filling level of liquid in meter	
4			<add new=""></add>				
5	-	•	Output				
6	-		Volume	Real]	volume of liquid in the tank in liter	~
	<			1			>
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	IF		CASE FOR WHILE (**) REGION				
	-		#Volume := SOP (#Diamet	(ar) / 4 + 3 - 14150	* #Filling le	vel * 1000.	
			- HADIGINE - Der(HDIGINE)	JCI) / 4 J.141JJ	"TITITIG_IC		
		1					

® Now compile your program and check it for syntax errors. These are displayed in the Inspector window below the programming. Correct any errors and compile the program again.

Then save your pr	ogram. (®	🔠 ® Eliminate	e errors ®	Save project	1	
iemens - C:\Users\mde\Desktop\051_201	_SCL_S7-1200\051_201_	SCL_\$7-1200				-
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-	Calculate	Volume				> Equaritan
051 201 SCI \$7-1200	A Name	Data type	Default value	Comment		Pavontes
Add new device		boto type	Deradit volue	comment	~	✓ Basic instructions
Devices & networks	2 - 0 - 0	iameter Beal		diameter cylindric tank in meter		Name
▼ T CPU 1214C [CPU 1214C DC/DC/DC]	3 6 1 F	lling level Beal		filling level of liquid in meter	=	Bit logic operations
Device configuration	4 4 0	Add new>				O Timer operations
V. Online & diagnostics	5 🕣 🔻 Outr	ut				H1 Counter operations
Program blocks	- 6 - CI = V	olume Real		volume of liquid in the tank in liter		Comparator operatio
Add new block	7	Add new>			~	the functions
Main [OB1]	<		Ш		>	Move operations
Calculate_Volume [FC1]	CALE		hurved hurrent			Conversion operation
Data_Tank [DB1]	IF OF	TO DO., DO (**) REGION				Program control oper
Technology objects	2 1 #V	olume := SOB(#Diameter) / 4 *	3.14159 * #Filling	level * 1000:		Word logic operations
External source files	2					Shift and rotate
PLC tags	ž,					
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Watch and force tables	<	III.		> 100%		
Online backups			Properties	Linfo 🗓 🛚 Diagnostics		
🕨 🔄 Traces	General (Cross references Compile	Enormy Suito	Suntax		
Device proxy data		Compile	Lifergy Suite	Jyntax		
Program info	😂 🔺 🚺 sł	iow all messages				
PLC alarm text lists	Compiling finis	hed (errors: 0; warnings: 0)				
Local modules	! Path	Description		Go to ?		< III
Ingrouped devices	📀 🔻 Prog	ram blocks		~	0 ^	> Extended instruction
Common data	O (alculate_Volume (FC1) Block was su	ccessfully compiled.	× .		> Technology
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Canquages & resources	~				~	Communication
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			R Properties	🗓 Info 🔒	& Diagnostics			
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Ο	A Show all messages	•						
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0	Calculate_Volume (FC1)) Block was succe	essfully compiled.		×			
0		Compiling finish	ed (errors: 0; warning	gs: 0)				
								~
<			III				>	

7.7 Programming the "Main [OB1]" organization block

Before programming the "Main [OB1]" organization block, switch the programming language to FBD. To do this, click on "Main [OB1]" in the "Program blocks" folder.
 (® CPU_1214C[CPU 1214C DC/DC/DC] ® Program blocks ® Main [OB1] ® Switch programming language ® FBD)

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🔻 🛃 Program blocks		3 🕣 🖷	Fillin	g_level	Real		filling level of li	quid in meter		1		stiens
Add new block		4 🕣 🕶	Output								Counter oper	auons
🏰 Main (OB1)		5 47 8	Volu	me	Real		volume of liqui	d in the tank in liter			Comparate	or operation
Telculate_Volu	Open										Math funct	tions
🗧 Data_Tank [DB1	X Cut		Ctrl+X	new>						× (Move oper	rations
🕨 🙀 Technology objects	Copy		Ctrl+C			111 111			>	- 1	Conversion	noneration
External source file	Paste		Ctrl+V	K WHILE. (A A) DECID							ad Program c	ontrol operation
PLC tags	X Delete		Del	DO DO () REGIO	n						Mord Logic	operations
PLC data types	Rename		F2	me := SQR(#Diame	ter) / 4 * 3.1415	9 * #Filling_1	level * 1000;				Shift and n	otate
Watch and force ta	Compile										- Shine and h	otote
Online backups	Download to device		- 1									
Traces	o online		Ctrl+K			1	100%	-				
Device proxy data	Go offline		Ctrl+M					()()				
Program info	AD Quick compare				G	Properties	Li Info 追 📱	Diagnostics		M.		
PLC alarm text lists	on Quick compare			Cross-references	Compile	Energy Suite	Syntax					
Local modules	Search in project		Ctrl+F	all manage								
La Ungrouped devices	Generate source fro	m blocks		an messages	-							
Common data	Y Cross-references		E11	(errors: 0; warnings	: 0)							_
Cocumentation settin	X Cross-reference info	mation Shi	ift+F11		Description			Go to ?		<		
Languages & resource	Call structure			DIOCKS	ni - i	la service the st			0	<u></u> 2	Extended in	nstruction
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Caro Reader/USB memory	Switch programmin	o language		STL	compliing finished (e	mors: 0, warnings					Communica	ation
Details view	sincerprogrammin	grangauge		LAD						× .	0.11	

® Now double-click the "Main [OB1]" organization block to open it.



® Call the "Calculate_Volume" function in the first network. Assign network title, comment and connect the parameters. (® Call "Calculate_Volume" ® Assign network title ® Write network comment ® Connect parameters)



Compiling and downloading the program 7.8

® Click the "Program blocks" folder and compile the entire program. After successful compilation, save your project and download it to the controller.

iamans - C:WsarsImda/Daskton/051 201 S	CI \$7.1200051 201 \$CI \$7.1200	
ect Edit View Insert Online Options	Tools Window Help Totali	v Integrated Automation
🔁 🖬 Save project 昌 🐰 🏥 🗎 🗙 🖺	🗈 (🛎 🖥 🛄 🌆 🚆 🙀 🂋 Go online 🖉 Go offine 🛔 🌆 🖪 🗱 🗶 🖃 🛄 - Search in projects - 🙀	PORTA
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Devices	Download to device	Options
		• •
	DIOCK INTELTACE	> Favorites
051_201_SCL_S7-1200		✓ Basic instructions
Paulses & patworks		Name
Devices & networks	Block title: *Main Program Sweep (Cycle)*	🕨 🛅 General
Device confouration	Comment	Bit logic operations
Device configuration	Notwork 1. Call offunction "Calculate Volume"	Timer operations
Program blocks	• Network 1: Californitation Calculate_volume	Counter operations
Add paw black	This function calculates the volume of a liquid inside a tank.	Comparator operation
Add new block	The volume will be calculated in liter	▶ 主 Math functions
Calculate Volume (EC1)		Move operations
Data Task (DP1)	%FC1	🕨 🄄 Conversion operation
	"Calculate_Volume"	Program control operation
External course fles		Word logic operations
Pictor		🕨 😝 Shift and rotate
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Watch and force tabler	diameter Diameter	
Opline backups	Then Table	
Tracer	"Data_Tank". Data_tank. measured data.	
Device providata	filling_level	
10 Program info	scal Filling level FNO	1
PIC alarm text lists	< III > 100% •	
I ocal modules	🔍 Properties 👘 Info 🚯 😯 Diagnostics 📰 🖃 🔽	<
Lingrouped devices	Committee Committee Committee Committee Committee	> Extended instruction
Common data	General Cross-references Compile Energy Suite Syntax	 Extended instruction
Documentation settings	Show all messages	> Technology
Languages & resources	Compiling finished (errors: 0; warnings: 0)	> Communication
	I Path Description Co.to 2	

® Select PG/PC interface ® Select subnet ® Start search ® Load

	-		-			
	Device	Device type	Slot	Туре	Address	Subnet
–	CPU_1214C	CPU 1214C DCD	1 X1	PN/IE	192.168.0.1	PN/IE_1
		Type of the PG/PC inte	face:	PN/IE		•
		PG/PC inte	face:	Intel(R)	Ethernet Connection (4) I	219-LM 💌 🖲
	,	Connection to interface/su	bnet:	Directats	slot '1 X1'	- •
		1st gate	wav:	-		
			and the second			
	Device	Device type	Interfa	ace type	Address	Target device
	Device CPU_1214C 	CPU 1214C DC/D	Interfa PN/IE PN/IE	ice type	Address 192.168.0.1 Access address	Target device CPU_1214C
₩	CPU_1214C	Device type CPU 1214C DC/D -	Interfa PN/IE PN/IE	ice type	Address 192.168.0.1 Access address	Target device CPU_1214C
Flash LED	Device CPU_1214C -	Device type CPU 1214C DC/D —	Interfa PN/IE PN/IE	sce type	Address 192.168.0.1 Access address	Target device CPU_1214C -
Flash LED	Device CPU_1214C 	Device type CPU 1214C DC/D —	Interfa PN/IE PN/IE	ice type	Address 192.168.0.1 Access address	Target device CPU_1214C
Flash LED	Device CPU_1214C 	Device type CPU 1214C DC/D —	Interfi PN/IE PN/IE	ice type	Address 192.168.0.1 Access address Display only error	Target device CPU_1214C <u>Start searc</u> or messages
Flash LED	tion:	Device type CPU 1214C DC/D. - th address 192.168.0.1. f1 accessible devices for	Interfa	ice type	Address 192.168.0.1 Access address Display only erre	Target device CPU_1214C <u>Start searc</u> or messages
Flash LED	tion: 1 compatible devices of information	Device type CPU 1214C DC/D — th address 192.168.0.1. of 1 accessible devices fou	Interfa	ice type	Address 192.168.0.1 Access address Display only em	Target device CPU_1214C <u>Start searc</u> or messages

® Make a selection, if necessary ® Load

Status	1	Target ▼ CPU_1214C	Message Ready for loading.	Action
	4	 Protection 	Protection from unauthorized access	
	0	Stop modules	The modules are stopped for downloading to device.	Stop all
	0	Device configurati	. Delete and replace system data in target	Download to device
	0	Software	Download software to device	Consistent download
	0	 Additional inform 	There are differences between the settings for the project and the	Verwrite all
	0	Text libraries	Download all alarm texts and text list texts	Consistent download
:			m	

R Finish

Status	1	Target	Message	Action
1	2	▼ CPU_1214C	Downloading to device completed without error.	
	٨	Start modules	Start modules after downloading to device.	Start all
c				

7.9 Monitoring and testing the organization block

- _ 7 = 🕸 14 후 한 🐛 🖿 🚍 🗁 웹 ± 웹 ± 텔 🌮 10 등 60 등 68 등 🗣 🐂 🐓 🐮 象 🔛 🕷 Monitoring or & >=1 [??] -1 --01 → -[=] Network 1: Call of function "Calculate_Volume" ~ This function calculates the volume of a liquid inside a tank. Diameter and filling_level have to be assigned in meter The volume will be calculated in liter "Calculate_Volume" EN 3.5 "Data_Tank". dimensions. diameter Diameter 0.0 "Data_Tank". asured_data. filling_level_ 0.0 "Data_Tank". measured_data. volume_liquid Volu Filling_level ENO 100% -
- In the open OB1, click the icon to monitor the block.

Test your program by writing a value to the "Filling_level_scal" tag in the data block.
 (® Right-click on "Filling_level_scal" ® "Modify" menu ® Modify operand)

Modify Modify Modify Modify to 0 Ctrl+F3 Monitor Display format Modify operand Ctrl+F2 Modify operand Ctrl+Shift+2 Network Define tag Ctrl+Shift+1 Modify operand Ctrl+Shift+2 This function Diameter a The volume Ctrl - Shift+P Mc V Cut Ctrl+Shift+P nk. V Cut Ctrl+V Copy Ctrl+C Paste Ctrl+V Delete Del Go to Cross-reference information Shift+F11 Cross-reference information Shift+F11 O.0 "Data dimendia Insert STL network Ctrl+F5 O.0 "Data Insert SCL network Shift+F5 D.0 "Data Thiset empty box Shift+F5 D.0	н R	ă ⊉ ⊉	8.		± 🖀 ± 😫 ± 🗄		¢0	6 0 🖑	6	₽	¢≡	I =	″≣	G	¢I	•	-	8	
Network Define tag Ctrl+Shift+I This functio Rename tag Ctrl+Shift+P Diameter a Cut Ctrl+Shift+P Ime volume Cut Ctrl+X Copy Ctrl+C Paste Copy Ctrl+V X Delete Delete Del Go to Y Cross-reference information Shift+F11 Insert network Ctrl+R Insert STL network Insert SCL network Insert SCL network Shift+F5 *Data Insert empty box	8	>=1 ??		Modify Monitor Display format	۶ ۱		Modify to Modify to Modify o	o 0 o 1 perano	I	Ctrl-	Ctrl+ Ctrl+ Shift	F3 F2 +2							
Diameter a The volume Rewire tag Ctrl+Shift+P X Cut Ctrl+X Image: Copy Ctrl+C Paste Ctrl+V X Delete Go to Image: Cross-reference information Shift+F11 dimendia Insert network Ctrl+STL network Ctrl+R Insert STL network Shift+F5 *Data Minsert structure *Data Shift+F5	•	Network ' This functio		Define tag Rename tag	Ctrl+Shift+I Ctrl+Shift+T	nk.													[
Paste Ctrl+V X Delete Del Go to Cross-reference information Shift+F11 dimen dia Insert network Ctrl+R Insert STL network Insert SCL network Insert SCL network Insert empty box Shift+F5 "Data "Data		Diameter a The volume	X	Cut Copy	Ctrl+Shift+P Ctrl+X Ctrl+C														
*Data_ *Data_				Paste Delete	Ctrl+V Del														
dimen dia insert STL network Insert STL network Insert SCL network Insert empty box Shift+F5 Data_Tank*. measured data		"Data_		Go to Cross-reference informa	tion Shift+F11														
*Data		dimen dia	ку Ку	Insert network Insert STL network	Ctrl+R														
		"Data_	<u> ??</u>	Insert empty box	Shift+F5	0	.0 Data_Tar	k".											

® Enter value 6.0 ® OK

Modify			×
Operand:	"Data_Tank".measured_data.filling	Data type:	Real
Modify value:	6.0	Format:	Floating-point number
			OK Cancel

Check the result for correctness.



7.10 Expansion of the "Calculate_Volume" function

 Open the "Calculate_Volume" function, and insert a row in the output parameters by right-clicking the row in the interface.

1	ര	Open "	Calculate	Volume"®	Pight-click	on row	5 @	Incort	row	۱
l	w.	Open			TAIGHT-CHCK		J	moen	1000	,

••••	• 0	PU_1214C [CPU 1214C	DC/DC/DC] 🕨	Program I	blocks 🕨 C	alculate_Volume [FC1]	_ • • •	×
1	e	} ± 4, ≿ 22	± 😰 ৫০ ፍሪ	· (= •= -=	1 3 4 € 3	目田田市「同名」	ti 🕨 🖬	
	Calo	culate_Volume						
	1	Name	Data typ	e	Default va	Comment		
1		▼ Input						^
2		 Diameter 	Real			diameter cylindric tank in met	er	-
3		Filling_level	Real			filling level of liquid in meter		
4	-	 Output 						
5	5	Insert row] 🔲		volume of liquid in the tank in	liter	
6		Add row						~
7	-	1	e. 1. v.				>	
-	3	Cut	Ctrl+X					-
		Deste	Ctrl+C					
	-	Braste	Ctil+V					
	×	(Delete	Del	* 3.14159	* #Fillin	g_level * 1000;		
		Rename	F2					
		Update interface						
SN	-	Go to next point of use	Ctrl+Shift+G					
60		Go to definition	Ctrl+Shift+D					
RE	×	Cross-references	F11					
	X	Cross-reference informati	on Shift+F11					

® Enter the parameter "er" with data type BOOL and comment.

•••) (CPL	J_1214C [CPU 1214C DC/D	C/DC] 🕨 Program I	blocks 🕨 C	alculate_Volume [FC1] 🛛 🗕 🗖 🗖	iX
1	-		∋± 4, E 3 2±10	ද ා ද ₀ ද≣ ⊊≣ *≣	- 0 ≱ (⊊ = =	■ em 部 년 16 10 64 ek ト E	d
	Cal	lcu	late_Volume				
		Na	me	Data type	Default va	Comment	
1	-	•	Input				^
2	-		Diameter	Real		diameter cylindric tank in meter	-
З	-		Filling_level	Real		filling level of liquid in meter	1000
4	-	•	Output				
5	-		er	Bool		fault flag; fault == true	1
6	-		Volume	Real		volume of liquid in the tank in liter	~

® Follow the same steps to add the "Height" tag with data type Real and comment.

	F	CPU_1214C [CPU 1214C DC/D	C/DC] • Program t	olocks 🕨 C	alculate_Volume [FC1] 🛛 🗖 🖬	×
-	1	🕴 🕞 ± 🐛 🖿 🗐 🖓 ± 😥	C° 60 🖑 🗺 🖷	\$ €= →	■ 🖽 井 📲 👘 🖬 🖉 🕇 🗄	4
	Cal	Iculate_Volume				
		Name	Data type	Default va	Comment	
1		🔽 Input				~
2	-	I = Height	Real		height cylindric tank in meter	
3	-	Diameter	Real		diameter cylindric tank in meter	=
4	-	Filling_level	Real		filling level of liquid in meter	-
5	-	🗸 🔻 Output				
6	-	a er	Bool		fault flag; fault == true	
7	-	I Volume	Real		volume of liquid in the tank in liter	

® Then go to the "IF...THEN...ELSE" control statement from the "Program control operations" folder of Basic instructions.

(® Instructions ® Basic instructions ® Program control operations ® "IF...THEN...ELSE")

In	structions 📑	D	Þ	
O	ptions	1 7	=	
>	Favorites			structi
~	Basic instructions		_	ons
Na	me			1
+	🗐 Bit logic operations		^	
	Timer operations			1
•	+1 Counter operations			est
•	Comparator operations			ing
+	🛨 Math functions		=	
•	🔁 Move operations			
•	Section Operations			H
•	Program control operati			ask
	SCL IF THEN			S
	SCL IF THEN ELSE			m
	Branch conditionally			Lib
	SCL FOR TO DO			rar
	SCL FOR TO BY DO			les
	SCL WHILE DO			
	SCL REPEAT UNTIL			
	SCL EXIT			

Then drag the "IF...THEN...ELSE" control statement to the second row of the program.
 (® "IF...THEN...ELSE" @ drag & drop)

roject tree			CPU_1	214C [CPU 1214C DC/I	DC/DC] 🕨 Program b	locks 🕨 Calcu	ilate_Volume [FC1] 🛛 🗖 🗖	×	Instructions 🛛 🗊 🔳
Devices									Options
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			Calcu	late Volume				-	> Eavorites
051 201 SCL S7-1200	^	_	N	ame	Data type	Default va.,	Comment		
Add new device		1	- m	Input				~	 Basic instructions
Devices & networks		2	-	Height	Real		beight cylindric tank in meter	T	Name .
▼ CPU 1214C [CPU 1214C DC/D		3	-	Diameter	Real		diameter cylindric tank in meter	-	Bit logic operations
Device configuration		4	-	Filling level	Real		filling level of liquid in meter		Timer operations
Q Online & diagnostics		5	-	Output			,		Lounter operations
Program blocks	-	6	-	er	Bool		fault flag; fault == true	1	Comparator operations
Add new block		7	-	Volume	Real		volume of liquid in the tank in liter		Math functions
Amain [OB1]		8	-	InOut				~	Move operations
Calculate_Volume [FC1]			<			-	>		Conversion operations
Data_Tank [DB1]				CASE FOR WHILE					Frogram control operati
Technology objects			IF	OF TO DO DO (**)	REGION				SCLIF THEN
External source files				1 #Volume := SQR(#D	iameter) / 4 * 3.14	159 * #Fillir	ng_level * 1000;		SCLIF IHEN ELSE
PLC tags				2					SEL IF IHEN ELSIF
PLC data types		2	-						SEE CASE OF
Watch and force tables	~	ŏ	-						SCI FOR 10 DO
· · · · ·	>	SEG	•						SEL FOR 10 BY DO
Datalla view			-						SEE WHILE DO
Details view	_								SCI REFERI UNITE
									SEL CONTINUE
			1	m		\$ 100%			50 0000
Name Address	1					100%			<
					S. Properti	es Li Info	Diagnostics	М	> Extended instructions
			Gener	al 追 Cross-referen	ces Compile	Energy Suite	e Syntax		> Technology
		C		Show all messages					> Communication
		-							Communication

	200	CPU_1214C [CPU 1214C DC/DC/DC] Program blocks Calculate_Volume [FC1] _ ■ ■ ■ ×
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		Block interface
1		
15	CA	ASE FOR WHILE (**) REGION
	1	
	1	<pre>#Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000;</pre>
	2 8	PIF _condition_ THEN
	3	// Statement section IF
	4	
	5	ELSE
	6	// Statement section ELSE
	7	
	8	END IF;
SN N	9	
9		
Ĕ.		
1000 - C		

- B Highlight the mathematical formula and move it onto the semicolon in front of the ELSE using drag & drop.
 - (® Select ® drag & drop)

7-12	00	► CP	י_U	1214	C [C	PU	1214	C D	CIDO)DC])	Pro	ogra	n bl	ock	s 🕨	Ca	cula	ate_	Volu	ıme	[FC	1]	_ 7	∎×
<u>–</u>		t i	1 ₁	E	8	2.	: 199	60	60	1	G	*	₽	Ç ≣	+	•	井	1_	٩.		S.	¢.	0		
	1						-				Blo	ock i	nterfa	ice									ŧ.		
	-	-		-	-	-						A	•												1
IF.		ASE F	OR 0 DO.	WHILI	. (*	.*) 5	REGION																		
	1	#Vol	lume	:=	SQR (#D:	iamet	er)	/ 4	*	3.14	159	* #	Fill	ing_	lev	rel	* 10	000;						
	2 [IF	COL	diti	on	THE	EN																		
	3		11	Stat	emen	t s	secti	on	EF																
	4		-																						
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7-12	00	CPU_1214C [CPU 1214C DC/DC/DC] Program blocks Calculate_Volume [FC1] □ □ □ □ □ □ □ □ □ □ □
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	i.	Block interface
	-	
1F.	- CA	ASE FOR WHILE (**) REGION DF TO DO DO (**) REGION
	1	
	21	
	3	// Statement Section if
	4	<pre>#Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000;</pre>
	5	ELSE
	6	// Statement section ELSE
	7	;
	8	END_IF;
I NO	9	

- ® Complete the function and check your program by compiling it.
 - (
 Complete program
 ®

Image: Section ELSE 6 7 8 9 END_IF;	7-1200 CPU_1214C [CPU 1214C DC/DC/DC] Program blocks Calculate_Volume [FC1]	⊢∎∎×
Image: Second		
Block interface IF CASE FOR WHILE (**) REGION 1 □ IF #Diameter > 0 AND #Filling_level >= 0 AND #Filling_level <= #Height THEN 2 // Statement section IF 3 #er := FALSE; 4 #Volume := SQR (#Diameter) / 4 * 3.14159 * #Filling_level * 1000; 5 ELSE 6 // Statement section ELSE 7 #er := TRUE; 8 #Volume := -1; 9 END_IF;	· · · · · · · · · · · · · · · · · · ·	e 🐨 🕻 📑
IF CASE FOR WHILE (**) REGION 1 FIF #Diameter > 0 AND #Filling_level >= 0 AND #Filling_level <= #Height THEN 2 // Statement section IF #er := FALSE; # #Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000; 5 ELSE 6 // Statement section ELSE #er := TRUE; # 8 #Volume := -1; 9 END_IF; END_IF; END_IF;	Block interface	
<pre> 1 □IF #Diameter > 0 AND #Filling_level >= 0 AND #Filling_level <= #Height THEN 2 // Statement section IF 3 #er := FALSE; 4 #Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000; 5 ELSE 6 // Statement section ELSE 7 #er := TRUE; 8 #Volume := -1; 9 END_IF; </pre>	IF CASE FOR WHILE (**) REGION	
	<pre>1 DIF #Diameter > 0 AND #Filling_level >= 0 AND #Filling_level <= #Height THEN 2 // Statement section IF 3 #er := FALSE; 4 #Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000; 5 ELSE 6 // Statement section ELSE 7 #er := TRUE; 8 #Volume := -1; 9 END_IF;</pre>	

Comments can be added with "(**)" as block comment and with "//" as row comment. You can
 now add comments to your program.

(® Insert block comment starting with row 1 ® Insert row comments in rows 12/16)

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	Cal	cula	ate_Volume	-1			
		Nan	ne	Data type	Default va	Comment	
1		-	Input				1
ż			Height	Real		height cylindric tank in meter	
3			Diameter	Real		diameter cylindric tank in meter	1
ţ			Filling level	Real		filling level of liquid in meter	
5		-	Output				
;	-		er	Bool		fault flag; fault == true	
ŧ	-		Volume	Real		volume of liquid in the tank in liter	
	-				00		<u>\</u>
_		-		1 🔺	hard and		•
		1 2 3 4	⊖(* This function calcula Input-parameters #Hei Output-parameter #Vol	ates the volume of ght, #Filling_leve ume will be calcul	a liquid i l and #Dia ated in li	nside a tank. meter have to be assigned in meter. ter.	
- I		1 2 3 4 5 6 7 8 9	(* This function calcula Input-parameters #Hei Output-parameter #Vol In case of an error t and the output-parame An error occurs if th or the filling level the filling level is	ates the volume of ght, #Filling_leve ume will be calcul the fault flag outp eter #Volume will b he diameter is less is less than 0 or greater than the h	a liquid i l and #Dia ated in li ut-paramet e -1. than or e eight of t	nside a tank. meter have to be assigned in meter. ter. er #er will be set TRUE qual 0 he tank.	
		1 2 3 4 5 6 7 8 9 10	<pre> (* This function calcula Input-parameters #Hei Output-parameter #Vol In case of an error t and the output-parame An error occurs if th or the filling level the filling level is *)</pre>	ates the volume of ght, #Filling_leve ume will be calcul the fault flag outp eter #Volume will b the diameter is less is less than 0 or greater than the h	a liquid i l and #Dia ated in li ut-paramet e -1. than or e eight of t	nside a tank. meter have to be assigned in meter. ter. er #er will be set TRUE qual 0 he tank.	
		1 2 3 4 5 6 7 8 9 10 11	<pre>E (* This function calcula Input-parameters #Hei Output-parameter #Vol In case of an error t and the output-parame An error occurs if th or the filling level the filling level is *) EIF #Diameter > 0 AND </pre>	ates the volume of ght, #Filling_leve ume will be calcul the fault flag outp eter #Volume will b the diameter is less is less than 0 or greater than the h #Filling_level >=	a liquid i l and #Dia ated in li ut-paramet e -1. than or e eight of t 0 AND #Fil	nside a tank. meter have to be assigned in meter. ter. er #er will be set TRUE qual 0 he tank. ling_level <= #Height THEN	
		1 2 3 4 5 6 7 8 9 10 11 12	<pre> (* This function calcula Input-parameters #Hei Output-parameter #Vol In case of an error t and the output-parame An error occurs if th or the filling level is *) EIF #Diameter > 0 AND</pre>	ates the volume of ght, #Filling_leve ume will be calcul the fault flag outp ter #Volume will b te diameter is less is less than 0 or greater than the h #Filling_level >=	a liquid i l and #Dia ated in li ut-paramet e -1. than or e eight of t 0 AND #Fil	nside a tank. meter have to be assigned in meter. ter. er #er will be set TRUE qual 0 he tank. ling_level <= #Height THEN	
		1 2 3 4 5 6 7 8 9 10 11 12 13	<pre> (* This function calcula Input-parameters #Hei Output-parameter #Vol In case of an error t and the output-parame An error occurs if th or the filling level is *) EIF #Diameter > 0 AND</pre>	ates the volume of ght, #Filling_leve ume will be calcul the fault flag outp tter #Volume will b te diameter is less is less than 0 or greater than the h #Filling_level >=	a liquid i l and #Dia ated in li ut-paramet e -1. than or e eight of t 0 AND #Fil	nside a tank. meter have to be assigned in meter. ter. er #er will be set TRUE qual 0 he tank. ling_level <= #Height THEN	
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	<pre> (* This function calcula Input-parameters #Hei Output-parameter #Vol In case of an error t and the output-parame An error occurs if th or the filling level the filling level is *) EIF #Diameter > 0 AND // no fault #er := FALSE; #Volume := SQR(#E) FLSE </pre>	ates the volume of ght, #Filling_leve ume will be calcul the fault flag outp tter #Volume will b te diameter is less is less than 0 or greater than the h #Filling_level >= Diameter) / 4 * 3.1	a liquid i l and #Dia ated in li ut-paramet e -1. than or e eight of t 0 AND #Fil 4159 * #Fi	nside a tank. meter have to be assigned in meter. ter. er #er will be set TRUE qual 0 he tank. ling_level <= #Height THEN lling_level * 1000;	
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	<pre> (* This function calcula Input-parameters #Hei Output-parameter #Vol In case of an error t and the output-parame An error occurs if th or the filling level the filling level is *) IF #Diameter > 0 AND // no fault #er := FALSE; #Volume := SQR(#E ELSE // fault</pre>	ates the volume of ght, #Filling_leve ume will be calcul the fault flag outp ter #Volume will b te diameter is less is less than 0 or greater than the h #Filling_level >= Diameter) / 4 * 3.1	a liquid i l and #Dia ated in li ut-paramet e -1. than or e eight of t 0 AND #Fil 4159 * #Fi	nside a tank. meter have to be assigned in meter. ter. er #er will be set TRUE qual 0 he tank. ling_level <= #Height THEN lling_level * 1000;	
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17	<pre> (* This function calcula Input-parameters #Hei Output-parameter #Vol In case of an error t and the output-parame An error occurs if th or the filling level the filling level is *) EIF #Diameter > 0 AND // no fault #er := FALSE; #Volume := SQR(#E ELSE // fault #er := TRUE:</pre>	ates the volume of ght, #Filling_leve ume will be calcul the fault flag outp eter #Volume will b te diameter is less is less than 0 or greater than the h #Filling_level >= Diameter) / 4 * 3.1	a liquid i l and #Dia ated in li ut-paramet e -1. than or e eight of t 0 AND #Fil 4159 * #Fi	nside a tank. meter have to be assigned in meter. ter. er #er will be set TRUE qual 0 he tank. ling_level <= #Height THEN lling_level * 1000;	
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	<pre> (* This function calcula Input-parameters #Hei Output-parameter #Vol In case of an error t and the output-parame An error occurs if th or the filling level the filling level is *) □IF #Diameter > 0 AND // no fault #er := FALSE; #Volume := SQR(#I ELSE // fault #er := TRUE; #Volume := -1; #Volume := -1; } </pre>	ates the volume of ght, #Filling_leve ume will be calcul the fault flag outp eter #Volume will b he diameter is less is less than 0 or greater than the h #Filling_level >= Diameter) / 4 * 3.1	a liquid i l and #Dia ated in li ut-paramet e -1. than or e eight of t 0 AND #Fil 4159 * #Fi	nside a tank. meter have to be assigned in meter. ter. er #er will be set TRUE qual 0 he tank. ling_level <= #Height THEN lling_level * 1000;	
		1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	<pre> (* This function calcula Input-parameters #Hei Output-parameter #Vol In case of an error t and the output-parame An error occurs if th or the filling level the filling level is *) □IF #Diameter > 0 AND // no fault #er := FALSE; #Volume := SQR(#I ELSE // fault #er := TRUE; #Volume := -1; END IF; </pre>	ates the volume of aght, #Filling_leve ume will be calcul the fault flag outp eter #Volume will b he diameter is less is less than 0 or greater than the h #Filling_level >= Diameter) / 4 * 3.1	a liquid i l and #Dia ated in li ut-paramet e -1. than or e eight of t 0 AND #Fil 4159 * #Fi	nside a tank. meter have to be assigned in meter. ter. er #er will be set TRUE qual 0 he tank. ling_level <= #Height THEN lling_level * 1000;	

7.11 Customizing the organization block

® Open OB1 and update the inconsistent block calls by clicking ¹/₂. (® Open OB1 ® ¹/₂)



® To do this, add the parameters "er" and "Height".

051_201_SCL_S7-1200 + CP	U_1214C [CPU 1214C	DC/DC/DC] > Pro	gram blocks 🕨 🖡	Aain [OB1]	_ 7	Ξ×
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	E	Block interface				
& >=1 1??[• Ⅰ →	-1=]					
▼ Block title: *Main Program Sw	veep (Cycle)*					~
Comment						
						- 1
 This function calculates the volume ter and filling_level hav The volume will be calculated EN "Data_Tank". dimensions. height 	ilume of a liquid inside a ta e to be assigned in meter in liter %FC1 Calculate_Volume"	*Data_Tank*.				=
"Data_Tank". dimensions. diameter Diamete "Data_Tank". measured_data. filling_level_ scal Filling_le	r er Volume evel ENO	fault_flags. calculate_ volume "Data_Tank". measured_data volume_liquid	100%			2

7.12 Compiling, saving and downloading the program

® Click the "Program blocks" folder, compile the entire program and then save it. After successful compilation and saving, download the project to the controller.
 (® Program blocks ®
 ® Save project ®

ct Edit View Insert Online Option 强 🗔 Saveproject 🚇 🐰 值 💼 🗙	Tools Window Help Totally	y Integrated Automation PORTA
oject tree [I201_SCL_SCL_SCL_SCL_1214C [CPU 1214C DC/DC/DC] Program blocks Main [OB1]	🖬 🖬 🗙 Instruc 🗊 🔟 I
Devices		Options
•	* * * * * * * * * * * * * * * * * * *	
-	Block interface	> Foundation
051 201 SCI \$7-1200		> Favorites
Add new device	a >=1 [??] → -ol → -[=]	✓ Basic instruct
Devices & networks		Name
CPU 1214C [CPU 1214C DC/DC/DC]	 Network 1: Call of function "Calculate_Volume" 	🛆 🕨 📴 General
Device configuration	This function calculates the volume of a liquid inside a tank.	🕨 🕨 🖬 Bit logic oper
Q Online & diagnostics	Diameter and filling_level have to be assigned in meter	Timer operat
Program blocks	The volume will be calculated in liter	- +1 Counter ope
Add new block		Comparator
Main [OB1]	78FC1	the second
Calculate_Volume [FC1]	Calculate_volume	Move operat
Data_Tank [DB1]	— EN	Conversion of
Technology objects	"Data_Tank".	Program con
External source files	dimensions.	Word logic op
PLC tags	"Data_Tapk"	Shift and rota
PLC data types	< III > 100% •	1111
Watch and force tables	🔍 Properties 🔛 Info 빐 🖳 Diagnostics	
Online backups	General (1) Cross-references Compile Energy Suite Syntax	
🕨 📴 Traces	Compile Energy Suite Syntax	
Device proxy data	Show all messages	
Program info	Compiling finished (errors: 0; warnings: 0)	
PLC alarm text lists	V I Path Description Go to ?	
Details view	🔮 👻 CPU_1214C 🧖	
	🔮 🔻 Program blocks 🧖	Extended ins
	Calculate_Volume (FC1) Block was successfully compiled.	> Technology
	Main (OB1) Block was successfully compiled.	> Communicati
Name Details	Compiling finished (errors: 0; warnings: 0)	A Ontional and

7.13 Monitoring and testing the organization block

In the open OB1, click the icon to monitor the block.

051	_201_	SCL_	\$7-1 2	200)	CPU	1214	C [CPU	12140	DC/DC/	DC] 🕨	Prog	ram bi	ocks	• 1	/lain	[OB1]		- 1	∎ × ≡ ∎
iối.	<mark>к</mark> й 学	⊒Š	ii,	E E		93	± 2	: 均 ±	=	CO 60		G 10	¢=	I _≡	1	si e	1 8	• 🐨 •	
									Block in	terface									
		1 22 1				3-1			1 - 1									Monitor	ing on/off
a	2.11	0	7	-01	-	1.1													
•	Netw	ork 1	: Ca	II of fu	nction	*Calcula	te_Volu	me"											^
	This fu	nction	calcu	lates t	the vol	ume of a	a liquid i	inside a	tank.										
	The vo	lume	will be	e calcu	lated i	e to be a in liter	ssigned	in mete	er										
					~	%F	C1		1										
				EN		alculate	_volum	e											
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	-	Data T	12.0 [ank"																=
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		h	leight	- He	ight				EAL	E.									
			3.5						"Da	ta_Tank"									
	"[Data_1	Tank".						faul	flags.									
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			0.0						0.0	a Tank"									
	meas	ured_	data.						mea	sured_c	lata.								
	fi	lling_l	evel_					Volum	e volu	me_liqu	id								
			scal	Fill	ing_le	vel		EN	0-										

Test your program by writing a value to the "Filling_level_scal" tag in the data block.
 (® Right-click on "Filling_level_scal" ® "Modify" menu ® Modify operand ® Enter value 6.0
 @ OK ® Check)



- Now test if an error is output by setting the diameter to zero.
 - (® Right-click on "Diameter" ® "Modify" menu ® Modify operand ® Enter value 0.0 ® OK
 - ® Check)
 - Network 1: Call of function "Calculate_Volume"
 - This function calculates the volume of a liquid inside a tank. Diameter and filling_level have to be assigned in meter The volume will be calculated in liter



7.14 Monitoring and testing the "Calculate_Volume" function

In Finally, open and monitor the "Calculate_Volume" function by right-clicking the function and selecting the "Open and monitor" menu command. (In Right-click on function In Open and monitor)



® You can show the values of the individual tags of the IF query by clicking the black arrow ▼. (® ▼)

-	Result	FALSE
	#Diameter	0.0
	#Fillin	6.0
	#Fillin	6.0
	#Height	12.0
	#er	
•	#Volume	
	#er	TRUE
	#Volume	-1.0

2	La Save projectX 10 10 X 10 2 C 10 10 10 10 10 10 10 10 10 10 10 10 10	ie 🖁	? 🖪 🖪 🗶 🖃 [~	Totally Integrated Automation PORTA
		e_vo	iume [rc1]			Testing D L
						Options
# 1	· · · · · · · · · · · · · · · · · · ·		oot qot ⊜e	3		
	Block interface					✓ CPU operator panel
G	Call path: Main [OB1]				11	
-				(CPU_1214C [CPU 1214C DC/DC/DC
	IF OF TO DO DO (**) REGION					RUN / STOP RUN
	1日(*			1	~	ERROR STOP
	2 This function calculates the volume of a liquid inside a tank.					
	3 Input-parameters #Height, #Filling_level and #Diameter have to be assigned	ir				MRES
	4 Output-parameter #Volume will be calculated in liter.					
	5 In case of an error the fault flag output-parameter #er will be set TRUE					<
	6 and the output-parameter #Volume will be -1.					× Call environment
	7 An error occurs if the diameter is less than or equal 0					
	8 or the filling level is less than 0 or					Call path: Main [OB1]
	9 the filling level is greater than the height of the tank.					Change
4						
	II HIF #Diameter > 0 AND #Filling_level >= 0 AND #Filling_level <= #Height InEN	-	ADiamatan	PALSE		
-			#Fillin	6.0	-	✓ Breakpoints
			#Fillin	6.0		🖏 ± 💞 🗣 🗣 🕅 🖓 🖓
			#Height	12.0		Enable output in run
	12 // no fault					This device does not support
	13 #er := FALSE;		#er			breakpoints.
	14 #Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000;	•	#Volume			
	15 ELSE					
	16 // fault					✓ Call hierarchy
	17 #er := TRUE;		#er	TRUE		
	18 #Volume := -1;		#Volume	-1.0	Constant State	Main IOB11-NW1
	19 [END_IF;				~	and the second sec
<	< III	> 1	100%	·		1
	O Descention		the cold Dise			1

Right-click the tag to adjust the display format. (
 Right-click tag
 Display format
 Floating point)

-	Result	FALSE	
	#Diameter	0.0	
	#Fillin	6.0	
	#Fillin	6.0	
	#Height	Display format	Automatic
	#er	Expand all	Decimal Decimal
-	#Volume	Collapse all	- Floating-point
	ior	TOILE	
	#Volume	-1.0	
	Result	FALSE	
	#Diameter	0.0	
	#Filling_level	6.0	
	<pre>#Filling_level</pre>	6.0	
	#Filling_level #Height	6.0 12.0	
	<pre>#Filling_level #Height #er</pre>	6.0 12.0	
	<pre>#Filling_level #Height #er #Volume</pre>	6.0 12.0	
	<pre>#Filling_level #Height #er #Volume</pre>	6.0 12.0	

® Now test the other branch of the IF branch by modifying the diameter in OB1 back to 3.5 meters. (® Open OB1 ® Modify diameter to 3.5 ® Open and monitor function)

201_SCL_S7-1200 + CPU_1214C [CPU 1214C DC/DC/DC] + Program blocks + Calculate_Volume [FC1]						
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	Block interface					
all a she to be to						
all path: Main	IORI					
F CASE FOR	R WHILE (**) REGION					
11 🖓 IF #D	liameter > 0 AND #Filling_level >= 0 AND #Filling_level <= #Height THEN	-	Result	TRUE		
			#Diameter	3.5		
			#Filling_level	6.0		
			#Filling_level	6.0		
			#Height	12.0		
12 /	/ no fault					
13 #	er := FALSE;		#er	FALSE		
14 #	<pre>Wolume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000;</pre>	•	#Volume	57726.71		
15 ELSE						
16 /	// fault					
17 #	er := TRUE;		#er			
18 #	Volume := -1;		#Volume			
19 END_I	F;					
20						

7.15 Archiving the project

® Finally, the complete project is to be archived. Select ® "Project" ® "Archive ..." in the menu. Open the folder in which you want to archive your project and save it as file type "TIA Portal Project archive". (® Project ® Archive ® TIA Portal Project archive ® File name: SCE_EN_051-201 SCL_S7-1200... ® Archive)



8 Checklist

No.	Description	Checked
1	Successful compilation without error message	
2	Successful download without error message	
3	Modify operand (Diameter = 0.0) Result tag Volume= -1 Result tag "er" = TRUE	
4	Modify operand (Diameter = 3.5 and Level_scal = 0) Result Volume = 0 Result tag "er" = FALSE	
5	Modify operand (Filling_level_scal= 6.0) Result Volume = 57726.72 Result tag "er" = FALSE	
6	Modify operand (Filling_level_scal= 12.0) Result Volume = 115453.4 Result tag "er" = FALSE	
7	Modify operand (Filling_level_scal= 14.0) Result Volume = -1 Result tag "er" = TRUE	
8	Project successfully archived	

9 Exercise

9.1 Task description – Exercise

In this exercise you are going to program a "Scaling" function. The program is to be generally applicable to any positive analog values. In our example task "Tank", the filling level is read by an analog sensor and stored as a scaled value in the data block using this function.

In case of an error, the block is to set the error flag "er" to TRUE and set the parameter "Analog_scal" to zero as a result. An error exists when the "mx" parameter is less than or equal to "mn".

Input	Data type	Comment
Analog_per	INT	Analog value of the IO between 027648
mx	REAL	Maximum of the new scale
mn	REAL	Minimum of the new scale
Output		
er	BOOL	Error flag, no error = 0, error = 1
Analog_scal	REAL	Analog value scaled between mnmx In case of an error = 0

The function must contain the following parameters.

The following formula is used to solve the task:

#Analog_sca l =
$$\frac{\text{#Analog_per}}{27648} \cdot (\text{# mx} - \text{# mn}) + \text{# mn}$$

An analog signal is required for this task. The operand used for this task must be entered in the PLC tag table.

Name	Data type	Address	Comment
B1	INT	%IW64	Filling level between 027648

9.2 Planning

Now solve this task on your own.

9.3 Checklist – Exercise

No.	Description	Checked
1	Operand added to PLC tag table	
2	Function FC: "Scaling" created	
3	Interface defined	
4	Function programmed	
5	"Scaling" function added to network 1 of OB1	
6	Input tags connected	
7	Output tags connected	
8	Successful compilation without error message	
9	Successful download without error message	
10	Analog value for filling level set to zero Result Filling_level_scal = 0 Result er = FALSE	
11	Analog value for filling level set to 27648 Result Filling_level_scal = 12.0 Result er = FALSE	
12	Analog value for filling level set to 13824 Result Filling_level_scal = 6.0 Result er = FALSE	
13	Modify operand (mx = 0.0) Result Filling_level_scal = 0 Result tag er = TRUE	
14	Project successfully archived	

10 Additional information

More information for further practice and consolidation is available as orientation, for example: Getting Started, videos, tutorials, apps, manuals, programming guidelines and trial software / firmware, under the following link:

siemens.com/sce/s7-1200

Preview "Additional information"

- Getting Started, Videos, Tutorials, Apps, Manuals, Trial-SW/Firmware
 - ↗ TIA Portal Videos
 - ↗ TIA Portal Tutorial Center
 - > Getting Started
 - ↗ Programming Guideline
 - ↗ Easy Entry in SIMATIC S7-1200
 - > Download Trial Software/Firmware
 - ↗ Technical Documentation SIMATIC Controller
 - ↗ Industry Online Support App
 - TIA Portal, SIMATIC S7-1200/1500 Overview
 - ↗ TIA Portal Website
 - ↗ SIMATIC S7-1200 Website
 - ↗ SIMATIC S7-1500 Website

Further information

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