

学习/培训文档

西门子自动化教育合作项目 (SCE) | 从 V14 SP1 开始

博途 (TIA Portal) 模块 051-201 使用 SCL 和 SIMATIC S7-1200 的 高级语言编程

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使用 SCL 和 SIMATIC S7-1200 的高级语言 编程

1 目标

在本章中您将学习到高级语言 SCL 的基本功能。此外,还将了解排除逻辑性编程错误的测试功能。可以使用第 3 章所列的 SIMATIC S7 控制器。

2 前提条件

本章的基础是 SIMATIC S7-1200 的硬件配置。只要是包含数字量输入/输出卡的硬件配置,都可实现本章所讲述的内容。学习本章内容时,可以参考以下项目:

" SCE_EN_011_101_Hardwarekonfiguration_CPU1214C.....zap14"

此外应掌握高级语言编程,例如 Pascal 的基础知识。

3 所需的硬件和软件

- 1 工程组态站点:对硬件和操作系统有要求 (其他相关信息,参见博途 (TIA Portal) 安装 DVD 上的 Readme/自述文件)
- 2 博途 (TIA Portal) 中的软件 SIMATIC STEP 7 Basic V14 SP1 及以上版本
- 3 控制器 SIMATIC S7-1200,例如 CPU 1214C DC/DC/DC 固件 V4.2.1 及以上版本
- 4 工程组态站点和控制器之间通过以太网连接





2 SIMATIC STEP 7 Basic (TIA Portal) V14 SP1 及以上版本

3 控制器 SIMATIC S7-1200

4 理论

4.1 编程语言 SCL

SCL (Structured Control Language) 是一种更高级的编程语言,以 Pascal 为基础,能实现结构化的编程。该语言符合标准 DIN EN-61131-3 (IEC 61131-3) 中规定的编程语言 ST "结构性文本"的特点。 你们高级语言元素外,SCL 还包含典型的 PLC 语言元素,如输入、输出、时间、位存储器、程序块调用等。它支持 STEP 7 的程序块方案,因此除了梯形图 (LAD)和功能图 (FBD)之外,还能实现符合标准的程序块编程。即 SCL 是编程软件 STEP 7 及其编程语言 LAD 和 FBD 的补充和扩展。它不必自己创建任何功能,而是使用预制程序块,如中央处理器模块的操作系统中现有的系统功能或系统功能块。

利用 SCL 编程的程序块可以与 LAD 和 FBD 块混合使用。也就是说,利用 SCL 编程的程序块可以 调用 LAD 或 FBD 中编程的其他程序块。相应地,也可以在 LAD 和 FBD 程序中调用 SCL 块。

SCL 网络同样可纳入 LAD 或 FBD 块中。

在编译过程的情况下, SCL 的测试功能可进行逻辑编程错误的查找。

4.2 SCL 开发环境

为了更好地运用 SCL,开发环境不仅要与 SCL 的特有属性相匹配,也要与 STEP 7 相匹配。该开 发环境由编辑器/编译器和调试器构成。



编辑器/编译器

SCL 编辑器是一种可以编辑任意文本的文本编辑器。它主要用来创建和编辑用于 STEP 7 程序的 程序块。在输入过程中即可进行基本的语法检查,从而简化准确无误的编程过程。语法错误将以不 同颜色显示。

编辑器具备以下功能:

- 用 SCL 语言编写 S7 程序块
- 通过拖放操作快捷地插入语言元素并调用程序块
- 在编程过程中直接检查语法
- 根据自己的要求设置编辑器,例如按照语法为各个语言元素上色
- 通过编译检查编写完成的程序块
- 显示编译时出现的所有错误和警告
- 在程序块中定位出错的位置,排除错误时可选择显示错误描述和说明

调试器

SCL 调试器可按照程序在自动化系统 (AS) 中的流程对程序进行检查,从而找到可能的逻辑性错误。

SCL 为此提供两种不同的测试模式:

- 持续监控
- 逐步监控

通过"持续监控"可测试一个程序块内的指令组。测试过程中,变量和参数的值将按时间顺序显示 出来并在可行的情况下周期性更新。

"逐步监控"对逻辑性的程序流程进行追踪。您可以一条一条指令地逐步执行程序算法,并在结果 窗口监控编辑的变量内容在此过程中如何变化。

"逐步监控"可用与否,取决于所使用的 CPU。它必须支持使用停止点。本文档中使用的 CPU 不 支持停止点。

5 任务要求

5.1 储罐内容物示例任务

在第一部分中,应对储罐内容物的计算进行编程。

5.2 示例任务扩展

在第二部分中,应扩展任务,对错误评估进行编程。

6 规划

储罐形状为直立式圆柱体。储罐内容物的物位通过模拟传感器进行测量。进行第一次测试时,物位 值应以标准化的形式,单位为米,呈现。

全局参数,例如储罐直径和高度,应结构化地存储在全局数据块"Data_Tank"中。

用于内容物计算的程序应写入" Calculate_Volume" 功能中,且参数应以米或升为单位。

6.1 全局数据块" Data_Tank"

全局参数应以多种结构存储在全局数据块中。

名称	数据类型	初始值	注释
dimensions	STRUCT		
Height	REAL	12.0	单位为米
Diameter	REAL	3.5	单位为米
measured_data	STRUCT		
filling_leve_per	INT	0	值在 0 - 27648 之间
filling_level_scal	REAL	0.0	值在 0 - 12.0 之间
Volume	REAL	0.0	储罐容量,单位:升
fault_flags	STRUCT		
Calculate_Volume	BOOL		错误情形下 = TRUE
Scaling	BOOL		错误情形下 = TRUE

表 1: 数据块" Data_Tank" 中的参数

6.2 "Calculate_Volume"功能

该程序块以升为单位计算储罐内容物。

在第一步中,不对所传输参数的合理性进行检查。

针对该步骤需要以下参数:

输入	数据类型	注释
Diameter	REAL	圆柱形储罐直径,单位:米
Filling_level	REAL	储罐内容物物位,单位:米
输出		
Volume	REAL	圆柱形储罐内容物,单位:升

表 2: 第一步中用于" Calculate_Volume" 功能的参数

为了解决该任务,要使用以下公式计算直立式圆柱体容积。使用换算系数 **1000**,以升为单位计算 结果。

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

6.3 扩展" Calculate_Volume" 功能

第二步检查直径是否大于零。接下来, 应测试物位是否大于等于零或等于储罐高度。

在错误情况下,将新参数" er" 设为 TURE,参数" Volume" 获得值 -1。

为接口扩展参数" er" 和" Height"。

输入	数据类型	注释
Height	REAL	圆柱形储罐高度,单位:米
Diameter	REAL	圆柱形储罐直径,单位:米
Filling_level	REAL	储罐内容物物位,单位:米
输出		
er	BOOL	错误标记;出错时 = TURE
Volume	REAL	圆柱形储罐内容物,单位:升

表 3: 第二步中用于" Calculate_Volume" 功能的参数

7 结构化分步指导

以下是帮助您实现规划的引导指南。如果您已经掌握了相关的知识,只需要使用带标号的步骤标题 作为参考。否则,也可以简单地跟随指南中的图示一步步操作。

7.1 恢复现有项目

® 开始编程之前,您需要包含硬件配置的项目。

(例如 SCE_EN_011-101_Hardwarekonfiguration_CPU1214C_....zap14)。

恢复现有项目时必须在 ® 项目 (Project) ® 恢复 (Retrieve) 下的项目视图中找到相应文档。接着点击打开您的选择。(® 项目 (Project) ® 恢复 (Retrieve) ® 选择 .zap 存档 ® 打开)



® 接下来,您可以选择用来保存恢复项目的目标目录。点击"OK"确认选择。

(®项目 (Project) ® 另存为 (Save as...) ® OK)

7.2 将项目保存在新名称下

廖 将打开的项目保存在名称 051-201_SCL_S7-1200 下。(⑧ 项目 (Project) ⑧ 另存为 (Save as...) ⑧ 051-201_SCL_S7-1200 ⑧ 保存 (Save))



7.3 创建数据块" Data_Tank"

® 在项目视图中导航至 ® 程序块 (Program blocks),并通过双击 ® 创建新块 (Add new block) 添加新块。



new block				
ame: ata Tank			_	
-	Type:	Global DB		
OB	Language:	DB	-	
Organization block	Number:	1	4	
		🔘 Manual		
		 Automatic 		
FB	Description:			
unction block	Data blocks (D	Bs) save program data.		
	more			
Function				
DB				
Data block				

DB

® 接着,请输入如下指定的变量名称与数据类型、初始值和注释。

<i>\$</i> 7	Da	ta_	Ta	🛃 🗮 😤 Keepa	ctual values 🔒 S	napshot 🔤 🛤	Copysnap	oshots to start val	lues 🧝	- B-		E
		Na	me		Data type	Start value	Retain	Accessible f	Writa	Visible in	Setpoint	Comment
	-	•	St	atic								
2	-		•	dimensions	Struct]						
}	-0			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
	-		•	fault_flags	Struct							
0	-			calculate_volume	Bool	false						fault == true
1	-			scaling	Bool	false						fault == true

7.4 创建" Calculate_Volume" 功能

® 现在请添加功能,输入名称并选择语言。

(⑧ 添加新块 (Add new block) ⑧ Function ⑧ " Calculate_Volume" ⑧ SCL ⑧ OK)

Add new block					×
Name:					
Calculate_Volume					
Organization block	Language: Number:	SCL 1 Manual Automatic	• •		
Function block	Description: Functions are c	ode blocks or subrout	tines without dec	licated memory.	
Function					
Data block	more				
Additional Infe	indica.				
Additional info	mation				
Add new and open	n			ОК	Cancel

7.5 确定" Calculate_Volume" 功能的接口

® 在编程视图的上部找到功能的接口描述。

05	1_3	201	_SCL_S7-1200 → CPU_12	14C [CPU 1214C D	C/DC/DC] > Pro	gram blocks → Calculate_Volume [FC1]	_ ₽ ■ ×
-	1	**	🖻 ± 🐛 🚬 🖀 🖀 ± 😥	🕫 📞 🖉 🐨 👘	🥹 🖛 🗃 🗗	洋 ~ 1 ~ 1 ~ 1 ~ 1 ~ 1 ~ 1 ~ 1 ~ 1 ~ 1 ~	
	Ca	Icu	late_Volume				
		Na	ime	Data type	Default value	Comment	
1	-	-	Input				
2			<add new=""></add>				
3	-	-	Output				
4			<add new=""></add>				
5	-	-	InOut				
6			<add new=""></add>				
7	-00	•	Temp				
8			<add new=""></add>				
9		-	Constant				
10			<add new=""></add>				
11		•	Return				
12		•	Calculate_Volume	Void			
1	1		Internet Lineare I			laster of	
		F	CASE FOR WHILE (**) REGION				
			1				
-							
SNC							
12							

® 创建以下输入和输出参数。(® 名称 (Name) ® 数据类型 (Data type) ® 注释 (Comment))

05	51_3	201	_SCL_\$7-1200 > CPU_1	214C [CPU 1214C	DC/DC/DC] 🕨 Pr	ogram blocks 🕨 Calculate_Volume [FC1]	_ = = ×
1	1	6	🖻 ± 🐛 🖿 🗐 🖓 ± 😥	e 🕫 🖓 🖓		画 神 「 」 下 こ こ う う ち ち ち ち ち ち ち ち ち ち ち ち ち ち ち ち	
	Ca	Icu	late_Volume				
		Na	me	Data type	Default value	Comment	
1	-	-	Input				
2	-		Diameter	Real		diameter cylindric tank in meter	
З	-00		Filling_level	Real		filling level of liquid in meter	
4			<add new=""></add>				
5		-	Output				
6	-00		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 "Calculate_Volume" 功能的编程

® 输入如下程序。(® 输入程序)

/	-12	200) ► CPU_1214C [CPU 1214	IC DC/DC/DC] ► Pr	ogram blocks 🕨	🕨 Calculate_Volume [FC1] 🛛 🗕 🖬 🖬	iX
1	1	÷ [🖻 ± 🐛 🖿 🗃 🖀 ± 😥	🥙 💊 🖑 🗺 🗎	🤣 📢 🖬 🗄	[井 뉴 뉴 웨 아 아 아 타]	4
	Cal	cu	late_Volume				
		Na	me	Data type	Default value	Comment	
1	-	•	Input				^
2	-		Diameter	Real		diameter cylindric tank in meter	
3	-		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		>	>
	IF.	1	CASE FOR WHILE (**) REGION OF TO DO DO #Volume := SQR (#Diamet	er) / 4 * 3.14159	* #Filling_le	evel * 1000;	

oject tree		7	Com	Pile CPU_1214C [CPL	J 1214C DC/DC/DC] 🕨 Progi	ram blocks	 Calculate 	_Volume [FC1]	- 61		T	nstructions 🗐	B
Devices												0	ptions	
14 14		-SF	Sé I		+ 🞲 🍋 🖕 🛲	Qa 16 40	≥ (= →= -	en #1 _ %		(aa)	-	T	• 🗆 🔟	
-		-	alcu	late Volume	- [04] - 40 -								Envoritos	-
051 201 SCL \$7-1200	^		Na	me	Data type	De	efault value	Comment				É	n avointes	
Add new device		1	•	Input	31						~	Ľ	Basic instructions	-
B Devices & networks		2		Diameter	Real			diameter c	vlindric tank in mete	r		Na	ame	
▼ T CPU 1214C [CPU 1214C DC/DC/DC]		3		Filling level	Real			filling level	of liquid in meter		-	1	Bit logic operations	e.
Device configuration		4		<add new=""></add>				,				P	Imer operations	
Q Online & diagnostics		5	-	Output								1	+1 Counter operations	ł
- 🕞 Program blocks	-	6		Volume	Real			volume of l	iquid in the tank in l	iter	1	1	Comparator operat	.10
Add new block		7		<add new=""></add>							~	1	± Math functions	
- Main [OB1]			<			Ш					>	P	Move operations	
Telculate_Volume [FC1]				CASE EOR WHILE		in a la la						11	Conversion operation	or
Data_Tank [DB1]			IF	OF TO DO DO (**)	REGION							11	Program control op	er
Technology objects		S S	1	#Volume := SQR(#1	Diameter) / 4 * 3	8.14159 *	#Filling 1	level * 1000);			11	DB Word logic operatio	Ins
External source files		8	2				-					1	Shift and rotate	
PLC tags		문												
Cit PLC data types												E.		
Watch and force tables			<					> 100%				4.		
Online backups						Q Pro	operties	1 Info 🔒	B Diagnostics					
🕨 🔄 Traces		G	nora		ces Compile	Ener	ray Suite	Syntax	ĵ					
Device proxy data					ices compile	Life	igy suite	Jyntax				٩.,		
Program info		2		Show all messages	•									
PLC alarm text lists		Co	npilin	g finished (errors: 0; war	nings: 0)									
Local modules		1	Path		Description				Go to	?		<	Ш	
Ungrouped devices		0	-	Program blocks					7		0 ^	• >	Extended instructi	0
Common data		0		Calculate_Volume (FC1) Block was suc	cessfully co	mpiled.		~			5	Technology	1
Documentation settings		0			Compiling fini	shed (errors	: 0; warnings	:: 0)			-	1É	recimology	-
The second se	~										100	1>	Communication	

		Q Properties	🗓 Info 🔒	Diagnostics		78	•
General (1) Cross-references	Compile	Energy Suite					
🕄 🔔 🕕 Show all messages							
Compiling finished (errors: 0; warnings	: 0)						
! Path	Description			Go to	?		
Program blocks				7		0	~
Calculate_Volume (FC1)	Block was succe	ssfully compiled.		~			
O	Compiling finish	ed (errors: 0; warning	(s: 0)				=
							~
<		III				>	

7.7 组织块" Main [OB1]" 的编程

⑧ 在对组织块"Main [OB1]"进行编程之前,请将程序语言转换为FBD。为此需用鼠标左键点击"程序块"(Program blocks)文件夹中的"Main [OB1]"。

(® CPU_1214C[CPU 1214C DC/DC/DC] ® 程序块 (Program blocks) ® Main [OB1] ® 切 换程序语言 (Switch programming language) ® FBD)

Siemens - C:\Users\mde\Des	ktop\051_201_SCL_S7	-1200\051_201_50	CL_\$7-1200								-	
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CPU_1214C [CPU 1214	C DC/DC/DC]	Name		Data type	Default value	Comment				× Basic inst	ructions	
Device configuratio	n	1 🕣 🕶 Input							^	Vame	ructions	-
🖳 Online & diagnostic	cs	2 🕣 🖷 Diar	meter	Real		diameter cy	lindric tank in mete	r		Bit logic	onerations	-
 Program blocks 		3 🔩 🖷 Fillir	ng_level	Real		filling level	of liquid in meter			I Timer on	erations	
Add new block		4 🕣 🕶 Output								Counter	operations	
🖀 Main [OB1]	0	5 📶 🔹 Volu	me	Real		volume of li	iquid in the tank in li	ter		Compara	tor operation	;
Calculate_Volu	Open									• ± Math fun	ctions	
Data_Tank [DB1	X Cut	Ctrl+X	new>		101				Ť	Move op	erations	
Technology objects	Copy	Ctrl+C			ated hotoni					► 😽 Conversi	on operations	
External source file	A Paste	Ctrl+V	R WHILE (* *) REGION	4						Program	control operat	ti
PLC tags	X Delete	Del								Nord log	ic operations	
He FLC data types	Rename	F2	ume := SQR(#D1ame	ter) / 4 * 3,14	159 * #Filling_	level * 1000	;			🕨 😝 Shift and	rotate	
Coline backups	Compile	•										
Tracer	Download to device	•										
Device providata	💋 Go online	Ctrl+K	Ш			> 100%						
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🕨 🧃 Common data			(errors: 0; warnings:	0)								
Documentation settin	Cross-references	F11		Description			Go to	?		< 11		>
Languages & resource	Collistructure	imation Shitt+Fill	n blocks				~	C	> ^	> Extended	instructions	
Online access	Assignment list		ulate_Volume (FC1)	Block was success	fully compiled.		· · · ·			> Technolog	av	
Card Reader/USB memory			CT I	Compiling finished	(errors: 0; warning	s: 0)				> Communi	cation	1
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 Portal view 	📑 Print	Ctrl+P					🛋 😒	The project	t 051_	_201_SCL_S7-12	00 wa	

® 现在请双击打开组织块" Main [OB1]"。



® 在第一个网络中调用" Calculate_Volume"功能。分配网络标题、注释并连接参数。

(® 调用"Calculate_Volume" ® 分配网络标题 ® 写网络注释 ® 连接参数)



7.8 编译程序并加载

® 点击"程序块" (Program blocks) 文件夹,并编译整个程序。编译成功后请保存您的项目并加

载到控制器中。(® 🖥 🛛 🔒 Save project 🛞 🔃)

ect Edit View Insert Online Option	ns Tools	100051_201_201_202 Window Help 🕤 🚺 🔲 🚆 💭 💋 Go online 🖉 Go offline 🎄 🕞 🕞 🗶 🚽 🔟 <earch in="" projects="" th="" 🔒<=""><th>Totally</th><th>Integrated Automation PORT</th></earch>	Totally	Integrated Automation PORT
roject tree	□ ◀	.I_201_SCL_S7-1200 → CPU_1214C [CPU 1214C DC/DC/DC] → Program blocks → Main [OB1] 🛛 💻 🖬	Ξ×	Instructions 🛛 🗊 🔟
Devices		Download to device		Options

-				
51 051 201 SCI 57-1200				> Favorites
Add new device		a >=1 177 → -01 → -[=]		✓ Basic instructions
Bevices & networks				Name
CPU 1214C [CPU 1214C DC/DC/DC]		Block title: "Main Program Sweep (Cycle)"	^	General
Device configuration		Comment		Bit logic operations
Q. Online & diagnostics		Network 1: Call of function "Calculate Volume"		G Timer operations
Program blocks				Counter operations
Add new block	=	 Inis function calculates the volume of a liquid inside a tank. Diameter and filling, level have to be assigned in meter. 		Comparator operatio
Main [OB1]		The volume will be calculated in liter	=	Math functions
Calculate Volume [EC1]			-	Move operations
Data Tank (DB1)		%#C1		Conversion operation
Technology objects		"Calculate_Volume"		Program control oper
External source files		— EN		Word logic operation
PIC tags		"Data Tank"		Shift and rotate
PIC data tunes		dimensions.		
Watch and force tables		diameter — Diameter		
Online backups		"Data Tapl"		
Traces		"Data_Tank"measured_data.		
Revice proxy data		filing_levelVolumeVolumeliquid		
10 Program info		scalFilling_levelFNO	~	
PLC alarm text lists	. H	Ⅲ > 100% ▼	ũ	
I ocal modules		🔍 Properties 🚺 Info 👔 😨 Diagnostics 👘		< 11
Ungrouped devices		Conneral (1) Cross references Compile Energy Suite Suntay		> Extended instruction
Common data		General U cross-references compile chergy suite syntax		 Extended instruction
Documentation settings		3 🔥 🚺 Show all messages		> Technology
Languages & resources	~	Compiling finished (errors: 0; warnings: 0)		> Communication
Details view		Path Description Go to ?		> Optional packages

® 选择 PG/PC 接口 ® 选择子网 ® 启动搜索 (Start search) ® 加载 (Load)

	Device	Device type	Slot	Туре	Address	Subnet
	CPU_1214C	CPU 1214C DC/D	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:	Direct at s	lot '1 X1'	-
		1st gat	eway:	1		-
	Device	Device type	Interfa	ce type	Address	Target device
na — 1	Device CPU_1214C	Device type CPU 1214C DC/D	Interfa PN/IE	ce type	Address 192.168.0.1	Target device CPU_1214C
	Device CPU_1214C —	Device type CPU 1214C DC/D 	Interfa PN/IE PN/IE	ce 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	ce 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	ce 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	ce type	Address 192.168.0.1 Access address Display only error	Target device CPU_1214C Start se
Flash LED	Device CPU_1214C 	Device type CPU 1214C DC/D – th address 192.168.0.1.	Interfa PN/IE PN/IE	ce type	Address 192.168.0.1 Access address Display only error	Target device CPU_1214C <u>Start se</u> pr messages
Flash LED	Device CPU_1214C 	Device type CPU 1214C DC/D - th address 192.168.0.1. of 1 accessible devices fou	Interfa PN/IE PN/IE PN/IE	ce type	Address 192.168.0.1 Access address Display only error	Target device CPU_1214C <u>Start se</u> or messages
Flash LED	Device CPU_1214C 	Device type CPU 1214C DC/D - - th address 192.168.0.1. of 1 accessible devices fou	Interfa PN/IE PN/IE	ce type	Address 192.168.0.1 Access address Display only error	Target device CPU_1214C <u>Start se</u> or messages

® 需要时进行选择 ® 加载 (Load)

Status	1	Target	Message	Action		
+[]	2	▼ CPU_1214C	Ready for loading.			
	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	e. 🗹 Overwrite all		
	0	Text libraries	Download all alarm texts and text list texts	Consistent download		
			11			

® 完成 (Finish)



- 7.9 监控并测试组织块
 - 在打开的 OB1 中点击图标 ■,以监控组织块。



⑧ 其时将值写入数据块的变量"Filling_level_scal"中,以测试程序。
(⑧ 右击"Filling_level_scal" ®"控制"(Modify)菜单 ® 控制运算数 (Modify operand))

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The vo	lume	X Cut i Copy Paste	Ctrl+X Ctrl+C Ctrl+V										
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d	imen dia	insert network Insert STL network Insert SCL network	Ctrl+R	0.0									
*D meas	Data_	Properties	Shift+F5	"Data_Tar measured	k". _data.								

® 输入值 6.0 ® OK

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

® 检查结果的正确性。

051_201_SCL_S7-1200 + CPU_1214C [CPU 1214C DC/DC/DC] + Program blocks + Main [OB1]	_ # # X
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Block interface	
& >=1 [??] → -oI → -[=]	
▼ Block title: "Main Program Sweep (Cycle)"	^
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 %FC1 "Calculate_Volume" 	
3.5 "Data_Tank". dimensions. diameter — Diameter	
"Data_Tank". measured_data. filling_level	

7.10 " Calculate_Volume" 功能扩展

⑧ 打开" Calculate_Volume"并右击接口行, 在输出参数中添加一行。
 (⑧ 打开" Calculate_Volume" ⑧ 右击第5行⑧ 添加行 (Insert row))

P	**	D ± ≤ 2 2 ± (😥 🕫 🚱	C	\$ ⊊ ∃	亜 井 * * い い い
C	alc	ulate_Volume	Determ	-	Defeulture	Comment
	IN	lame	Data typ	e	Default va	Comment
4		Input				
<	•	Diameter	Real			diameter cylindric tank in meter
-	•	Filling_level	Real			filling level of liquid in meter
<		 Output 				
1		locat row				volume of liquid in the tank in liter
-	1	Add row				
	-	Add TOW				
	X	Cut	Ctrl+X			
		Сору	Ctrl+C			
		Paste	Ctrl+V			
	×	Delete	Del	* 3.14159	* #Fillin	g_level * 1000;
Ш		Rename	F2			
		Update interface				
4		Go to next point of use 0	trl+Shift+G			
		Go to definition C	trl+Shift+D			
•	x	Cross-references	F11			

® 输入参数"er"及其数据类型 BOOL 和注释。

	• (CPI	J_1214C [CPU 1214C DC/D	C/DC] • Program	blocks ▶ C	alculate_Volume [FC1] 🛛 🗕 🖬 🚍	×
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	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	
4	-	•	Output				
5	-		er	Bool	1	fault flag; fault == true	1
6	-		Volume	Real		volume of liquid in the tank in liter	

® 随后以相同方式添加变量"Height"及其数据类型 Real 和注释。

••••	F	CPU_1214	C [CPU 1214	C DC/DC/DC]	 Program b 	olocks 🕨 C	alculate_	Volume [F	FC1]	- 7	■×
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	Cal	culate_Vo	lume					1.			
		Name		Data ty	pe	Default va	Comment	i.			
1		 Input 									^
2	-	 Heig 	ht	Real			height cyl	indric tank i	in meter		
3	-	 Dian 	eter	Real			diameter	cylindric tar	nk in me	ter	
4	-	Fillin	g_level	Real			filling leve	el of liquid in	meter		
5		 Output 									
6	-	er er		Bool			fault flag;	fault == true	e		
7	-	 Volu 	me	Real			volume o	fliquid in th	e tank in	n liter	

® 然后在基础指令 (Basic instructions) 的"程序控制" (Program control operations) 找到控制结构" IF...THEN...ELSE"。

(⑧ 指令 (Instructions) ⑧ 基础指令 (Basic instructions) ⑧ 程序控制 (Program control operations) ⑧ " IF...THEN...ELSE")

In	structions 📑	D	Þ	
Op	otions			
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>	Favorites			ruct
~	Basic instructions			ions
Na	me		-	
+	Bit logic operations		^	U
	Timer operations			9
•	+1 Counter operations			est
+	Comparator operations		_	ing
+	1 Math functions		=	
+	Move operations			
+	Conversion operations			H
•	Program control operati			ask
	SCL IF THEN			S
	SCL IF THEN ELSE			m
	SCI IF THEN FLSIF			1
	Ste Croc Or			ibr
	SCL FOR TO DO			arie
	SCL FOR TO BY DO	·		S
	sci WHILE DO			
	SCL REPEAT UNTIL			
	SCL CONTINUE			
	SCL EXIT			

⑧ 接着通过拖放操作将检查结构" IF...THEN...ELSE "移动至程序第二行。
(⑧" IF...THEN...ELSE" ⑧ 拖放)

MA Siemens - C:\Users\mde\Desktop\051_201	_SCL	_\$7-1200\051_	_201_SCL_S7-1200				_		_ 🗆 X
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Devices							(Options	- 8
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2		Calculate_V	olume				5	Favorites	Tud
▼ 051_201_SCL_S7-1200	^	Name		Data type	Default va	Comment		Basic instructions	- ion
Add new device	1	📹 🔻 Input					^	lame	
Devices & networks	2	🕣 = Hei	ight	Real		height cylindric tank in meter	= 1	Bit logic operations	
CPU_1214C [CPU 1214C DC/D	≣ 3	🕣 🔹 Dia	meter	Real		diameter cylindric tank in meter		Timer operations	8
Device configuration	4	📲 🔹 Filli	ing_level	Real		filling level of liquid in meter		+1 Counter operations	Tes
S Online & diagnostics	5	🕣 🔻 Outpu	t					Comparator operations	tin
 Program blocks 	6	📲 er		Bool		fault flag; fault == true		1 Math functions	
Add new block	7	🕣 = Vol	ume	Real		volume of liquid in the tank in liter		Move operations	-
Main [OB1]	8	InOut ✓					Ť,	Conversion operations	
Calculate_Volume [FC1]				internation internation		1		Program control operati	as
Data_Tank [DB1]		IF CASE	OR WHILE (**) REGION					SCL IF THEN	
Technology objects		UF 1	0.00					SCL IF THEN ELSE	
External source files		1 #Vo	lume := SQR(#Diamet	ter) / 4 * 3.14159	* #Fillin	g_level * 1000;	-	SCL IF THEN ELSIF	- U
La PLC tags		2						SCL CASE OF	
PLC data types	Š	4						SCL FOR TO DO	In
Watch and force tables	⊻	-						SCL FOR TO BY DO	es
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✓ Details view								SCL REPEAT UNTIL	
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7-1	7-1200 + CPU_1214C [CPU 1214C DC/DC/DC] + Program blocks + Calculate_Volume [FC1] 🛛 🗕 🖬 🗮 🗙									
<u></u> ₩ 1	# # = = = = = = # != * (* 6 @ @ = # = * (* * * * * * * * * * * * * * * * *									
		Block interface								
	-									
i	IF CASE FOR WHILE (**) REGION									
	1	<pre>#Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000;</pre>								
	2 [PIF _condition_ THEN								
	3	// Statement section IF								
	4									
	5 ELSE 6 // Statement section ELSE 7 ; 8 END IF;									
SN 4	9									
9										
Ĕ.										
and a second										

● 选中数学公式,并将其拖放至 ELSE 前的分号处。(⑧ 选中 ℗ 拖放)

🖻 👻 🖶 🗄 🔚 🖀 ± 🔝 ピ 💊 🕮 웹 🐃 🍄 💶 🎞 🏥 🖕 🐂 이 신 🔗 🥨 🕻 Block interfa IF... CASE... FOR... WHILE.. (*...*) REGION 1 #Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000; 2 PIF condition THEN 3 // Statement section IF 4 ÷ 5 ELSE // Statement section ELSE 6 7 ; 8 END_IF; 9

7-	-1200	CPU_1214C [CPU 1214C DC/DC/DC] Program blocks Calculate_Volume [FC1] _ ■ ■ ■ ×
-	÷ 6) ± 🐛 🗄 웹 월 1월 🕐 😡 🕮 🗃 🤣 📭 🏛 🏥 🎽 🚺 🌒 🖑 😵 🔭 🗔
		Block interface
	IF 0	ASE FOR WHILE (**) REGION
	1	FIF condition THEN
	3	// Statement section IF #Volume := SOR(#Diameter) / 4 * 3.14159 * #Filling level * 1000:
	5	ELSE
	6	// Statement section ELSE
	7	
SNOI	9	LEND_IF;

◎ 将功能补充完整并通过编译检查程序。(⑧ 补充程序 ⑧ 1)

	-1200	CPU_1214C [CPU 1214C DC/DC/DC] Program blocks Calculate_Volume [FC1] _ ■ ■ ■ ×							
		* 🐛 🗄 웹 월 1 😥 🕫 😘 🐻 🐨 🕹 📢 🖬 🖶 😵 👘 📢 🖑 😵 🔭 🗔							
	60	Block interface							
	-	1 • 1 1990							
	IF 0	ASE FOR WHILE (**) REGION DF TO DO DO							
	1	<pre>]IF #Diameter > 0 AND #Filling_level >= 0 AND #Filling_level <= #Height THEN</pre>							
	2	// Statement section IF							
	3	<pre>#er := FALSE;</pre>							
	4 #Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000; 5 ELSE								
	6	6 // Statement section ELSE							
	7 der := TRIF:								
	8	#Volume := -1:							
<u>u</u> [9	END TF-							
GION	10								

 ⑧ 添加注释时,可以标上"(**)"作为块注释添加,以及标上"//"作为行注释添加。现在可以 通过添加注释来补充程序。

(®从第1行开始添加块注释 ®在第12行和第16行添加行注释)。

	/-12	200	▶ CPU_1214C [CPU 1214C DC/DC/DC] Program blocks Calculate_Volume [FC1] _							×																		
		· · · · · · · · · · · · · · · · · · ·									•	E																
	Cal	cula	ate_Volu	ime																								
		Nam	ne					Da	ta ty	pe		Def	ault	a	Cor	nm	nent											
1	-	-	Input																									^
2	-		Height	t				Re	al						hei	gh	t cyl	indr	ic ta	nk i	n m	eter	r					-
3	-		Diame	ter				Re	al						dia	me	eter	cyli	ndri	c tan	ık in	me	ter					_
4	-		Filling	level	Ĺ			Re	al						filli	ng	leve	lof	liqu	id in	me	eter						
5	-	-	Output																									
6	-		er				Bo	ool						fau	lt fl	lag;	faul	t ==	true	4								
7	-		Volume Real							vol	um	ie of	flig	uid i	n the	e ta	nk ir	n lite	er				~					
	<											10							_				_				>	
REGIONS		<pre>1 □ (* 2 This function calculates the volume of a liquid inside a tank. 3 Input-parameters #Height, #Filling_level and #Diameter have to be assigned in meter. 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. 7 An error occurs if the diameter is less than or equal 0 8 or the filling level is less than 0 or 9 the filling level is greater than the height of the tank. 10 [*) 11 □IF #Diameter > 0 AND #Filling_level >= 0 AND #Filling_level <= #Height THEN 12 // no fault 13 #er := FALSE; 14 #Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000; 15 ELSE 16 // fault 17 #er := TRUE; 18 #Volume := -1; </pre>																										
	<	20				Ľ									>	1	100	%								Ş		5

7.11 调整组织块

🔋 打开 OB1 并点击 😵 更新矛盾的程序块调用。(🔋 打开 OB1 🛚 😵)



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$\mathsf{SCE}_\mathsf{ZH}_\mathsf{051}\text{-}\mathsf{201} \text{ with } \mathsf{SCL} \ \mathsf{S7}\text{-}\mathsf{1200}_R1709.docx$

® 补充参数" er" 和" Height" 的连接。

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Image: Imag
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Doto_totk .

7.12 编译、保存并加载程序

● 点击"程序块" (Program blocks) 文件夹,编译并保存整个程序。编译和保存成功后将项目加

载到控制器中。(® 程序块 (Program blocks) ® 🖥 🛚 🕞 Save project 🛞 🛄)

Siemens - C:\Users\mde\Desktop\051_20	_SCL	\$7-1200\051_201_\$CL_\$7-1200		_ ¤ ×
Project Edit View Insert Online Optio	ns T	ols Window Help Totally In	tegrate	ed Automation
📑 🔁 🖬 Save project 📑 🐰 💷 🛅 🗙	" ℃ ±	(# ± 🖥 🗓 🕼 🚆 🠺 💋 Go online 🖉 Go offline 🕌 🌆 🖪 👫 🛃 🛄		PORTAL
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	1	·····································		• 🗆 🔟 🔤
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Add new device		a >=1 [??] → -01 → -[=]		Basic Instructio
Devices & networks				Caparal
CPU_1214C [CPU 1214C DC/DC/DC]		 Network 1: Call of function "Calculate_Volume" 		Bit logic operati
Device configuration		 This function calculates the volume of a liquid inside a tank. 		Timer operation
😧 Online & diagnostics		Diameter and filling_level have to be assigned in meter The volume will be calculated in liter	=	+1 Counter operati
 Program blocks 			- 1	Comparator ope
Add new block		%FC1		E Math functions
Main [OB1]		"Calculate_Volume"		Move operation
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Data_Tank [DB1]		"Data Tapli"		Program control
Technology objects		dimensions.		Word logic oper
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Watch and force tables	-	O Despection 1 Info (1) Discovertion		ari.
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Program info		Compiling finished (errors: 0; warnings: 0)		
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		📀 🔻 Program blocks 💦	-= >	Extended instru
	_	Calculate_Volume (FC1) Block was successfully compiled.		Technology
		📀 Main (OB1) Block was successfully compiled. 🎽 🥕		Communication
Name Details		Compiling finished (errors: 0; warnings: 0)	~	Communication
	0		> >	Optional packa
Portal view Overview		Data_Tank (🖅 Calculate_Vo 🐨 Main (OB1)	1 SCL S	7-1200 wa

7.13 监控并测试组织块

⑧ 在打开的 OB1 中点击图标 ¹¹,以监控组织块。



® 其时将值写入数据块的变量"Filling_level_scal"中,以测试程序。

(⑧ 右击" Filling_level_scal" ⑧ "控制" (Modify) 菜单 ⑧ 控制运算数 (Modify operand) ⑧ 输入值 6.0 ® OK ® 检查)



学习/培训文档 | 博途 (TIA Portal) 模块 051-201,版本 2018 | 数字工厂,DF FA

受限,可供培训或研发机构自由使用。© Siemens AG 2018。保留所有权利。 SCE_ZH_051-201 with SCL S7-1200_R1709.docx ® 之后将直径设为零,测试是否输出错误。

(⑧ 右击" diameter" ⑧ "控制" (Modify) 菜单 ⑧ 控制运算数 (Modify operand) ⑧ 输入值 0.0 ⑧ OK ⑧ 检查)

- 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 监控并测试" Calculate_Volume" 功能

⑧ 最后,右击功能,选择"打开并监控"(Open and monitor)菜单项,打开并监控
" Calculate_Volume"功能。(⑧ 右击功能 ⑧ 打开并监控 (Open and monitor))



⑧ 您可以点击黑色箭头 ▼,将 IF 询问各个变量的值显示出来。(⑧ ▼)

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



® 可以右击变量调整显示格式。

(® 右击变量 ® 显示格式 (Display format) ® 浮点 (Floating-point))

-	Result	FALSE	
	#Diameter	0.0	
	#Fillin	6.0	
	#Fillin	6.0	
	#Height	Display format 🕨	O Automatic
	#er	Expand all	O Decimal
•	#Volume	Collapse all	Hexadecimal
	#er	TRUE	
	#Volume	-1.0	

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

® 现在将 OB1 中的直径重新控制在 3.5 米,以测试 IF 分支的其他分路。
 (® 打开 OB1 ® 将直径控制在 3.5 ® 打开并监控功能)

	SCL_S7-1200 + CPU_1214C [CPU 1214C DC/DC/DC] + Program blocks + Calculate_1	/olun			1
0 9	▶± 씨, 분涸@,± ☞ 얀 60 08 08 18 약 68 38 38 년 14 10 9 9 9 9 9 9 10 1	y 00,			Ē
	Block interface				
Call pat	th: Main [OB1]				
IF CA	KSE FOR WHILE (**) REGION				
11 E	IF #Diameter > 0 AND #Filling_level >= 0 AND #Filling_level <= #Height THEN	-	Result	TRUE	
			#Diameter	3.5	
			#Filling_level	6.0	
			<pre>#Filling_level</pre>	6.0	
			#Height	12.0	
12	// no fault				
13	<pre>#er := FALSE;</pre>		#er	FALSE	
14	<pre>#Volume := SQR(#Diameter) / 4 * 3.14159 * #Filling_level * 1000;</pre>	•	#Volume	57726.71	
15	ELSE				
16	// fault				
17	<pre>#er := TRUE;</pre>		#er		
18	<pre>#Volume := -1;</pre>		#Volume		
19	END_IF;				
20					

7.15 项目归档

 ⑧ 最后我们要将整个项目归档。在菜单项中选择 ® "项目"(Project) ® "归档"(Archive...)。打开 归档项目的文件夹,并将项目保存为文件格式"TIA Portal project archive"。(⑧ 项目 (Project) ⑧ 归档 (Archive...) ⑧ TIA Portal project archive ⑧ 文件名: SCE_EN_051-201 SCL_S7-1200... ⑧ 归档)



8 检查清单

编号	描述	已检查
1	编译成功,无错误提示	
2	加载成功,无错误提示	
	控制运算数(Diameter = 0.0)	
3	结果: 变量 Volume = -1	
	结果: 变量" er" = TRUE	
	控制运算数(Diameter = 3.5 且 Filling_level_scal = 0)	
4	结果: Volume = 0	
	结果: 变量" er" = FALSE	
	控制运算数(Filling_level_scal = 6.0)	
5	结果: Volume = 57726.72	
	结果: 变量" er" = FALSE	
	控制运算数(Filling_level_scal = 12.0)	
6	结果: Volume = 115453.4	
	结果: 变量" er" = FALSE	
	控制运算数(Filling_level_scal = 14.0)	
7	结果: Volume = -1	
	结果: 变量" er" = TRUE	
8	项目成功归档	

9 练习

9.1 任务要求 - 练习

本练习中将对"定标"(Scaling)功能进行编程。该程序应对任何正模拟值普遍适用。在我们的示例任务"储罐"中,物位通过模拟传感器读取,并通过功能将定标后的物位保存在数据块中。

在错误情况下,该程序块应将错误标记" er" 设为 TRUE,并将参数" Analog_scal"结果设为零。 如果参数" mx" 小于或等于" mn",就会出错。

该功能必须包含以下参数。

输入	数据类型	注释
Analog_per	INT	外围设备模拟值,在 0 - 27648 之间
mx	REAL	新标尺的最大值
mn	REAL	新标尺的最小值
输出		
er	BOOL	错误标记,无错误=0,有错误=1
Analog_scal	REAL	模拟值在 mn - mx 之间定标 错误状态下 = 0

解决任务时用到以下公式:

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

本练习任务需要模拟信号。必须将为此使用的运算数输入到 PLC 变量表中。

名称	数据类型	地址	注释
B1	INT	%EW64	物位,在0-27648之间

9.2 规划

现在请自主执行任务!

9.3 检查清单 - 练习

编号	描述	已检查
1	已将运算数添加到 PLC 变量表中	
2	FC 功能:已创建" Scaling"	
3	已定义接口	
4	已编程功能	
5	已将" Scaling" 功能插入 OB1 网络 1 中	
6	已连接输入变量	
7	已连接输出变量	
8	编译成功,无错误提示	
9	加载成功,无错误提示	
	物位模拟值设为零	
10	结果: Filling_level_scal = 0	
	结果: er = FALSE	
	物位模拟值设为 27648	
11	结果: Filling_level_scal = 12.0	
	结果: er = FALSE	
	物位模拟值设为 13824	
12	结果: Filling_level_scal = 6.0	
	结果: er = FALSE	
	控制运算数(mx = 0.0)	
13	结果: Filling_level_scal = 0	
	结果: 变量 er = TRUE	
14	项目成功归档	

10 更多相关信息

为帮助您进行入门学习或深化学习,您可以找到更多指导信息作为辅助学习手段,例如:入门指南、视频、辅导材料、APP、手册、编程指南及试用版软件/固件,单击链接:

siemens.com/sce/s7-1200

预览"其它信息"

- 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

其它信息

西门子自动化教育合作项目

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SCE 学习/培训文档 siemens.com/sce/documents

SCE 培训包 siemens.com/sce/tp

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工业 4.0 siemens.com/ future-of-manufacturing

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