

SIEMENS

SIMATIC

SIMATIC C7-621 Control System

First steps with STEP 7-Mini and ProTool/Lite

Guide

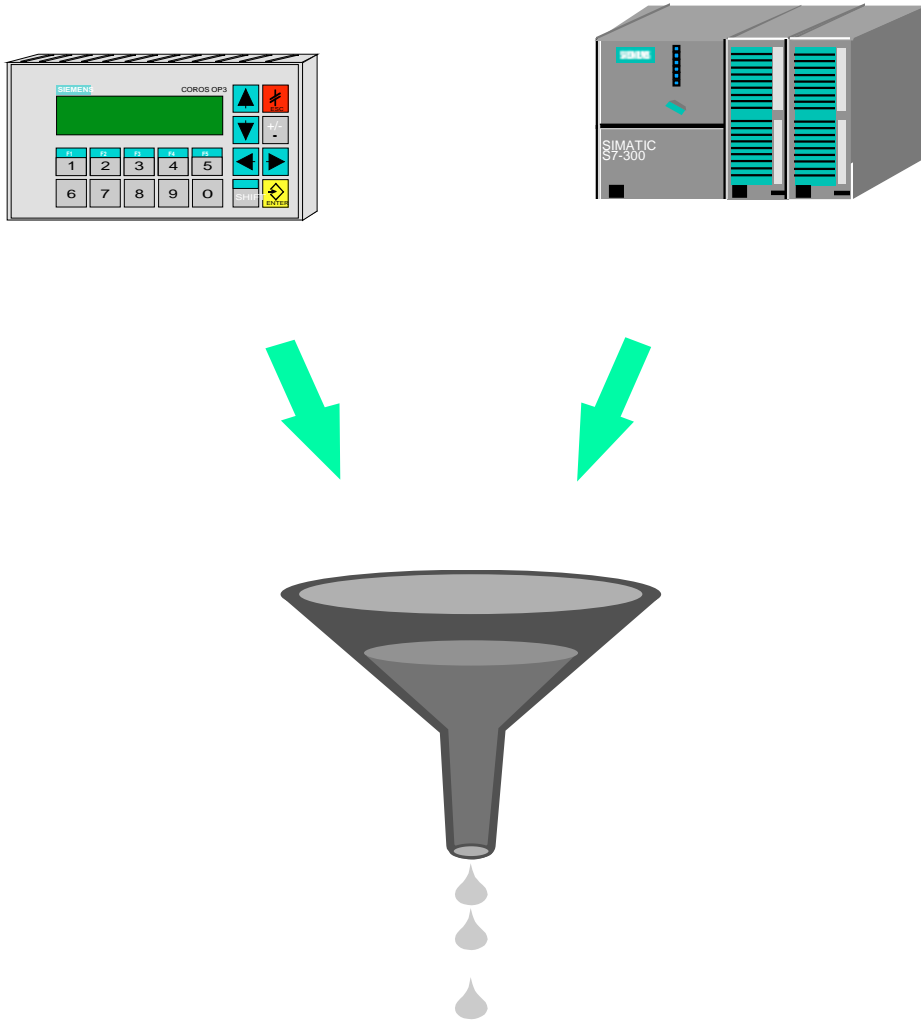
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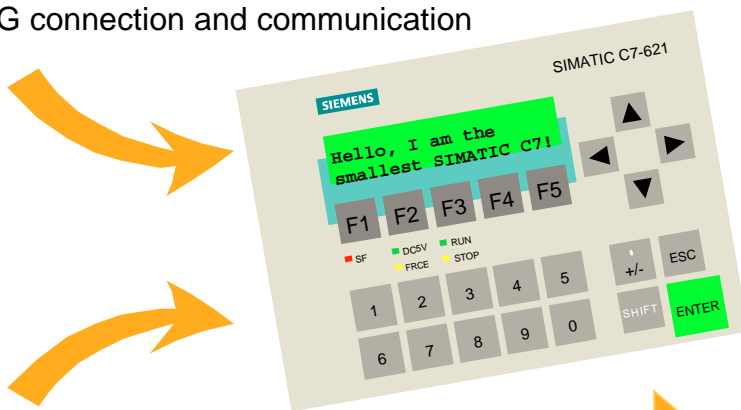
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MPI Interface

PG connection and communication



On-Board I/O

- 16 digital inputs
24 V DC
- 16 digital outputs
24 V DC

4 analog inputs
1 analog output

External I/O Expansion

Interface to connect an expansion rack

Introduction

The SIMATIC C7-621 provides you with a wide range of features to automate your process in a convenient, clearly structured system with a fully functional man-machine interface.



This booklet shows you just how easily and quickly you can create your own application for Windows 95 with the C7-621, the STEP 7 or STEP 7-Mini^{*)} programming software and the ProTool or ProTool/Lite^{**)} configuring software. Using a real-life solution as an example, we will guide you **step by step to your finished application**.

In self-contained chapters, we explain the main functions of the SIMATIC C7- 621, describe typical tasks on a sample machine, and provide you with some extra tips and tricks.

All Chapters are built on the same principle:

- First, the task is explained.
- Then we take you through the individual steps of the solution with illustrations of selected dialog boxes.
- Finally, we show you the result, so that you can check your own result after each programming and configuring step.

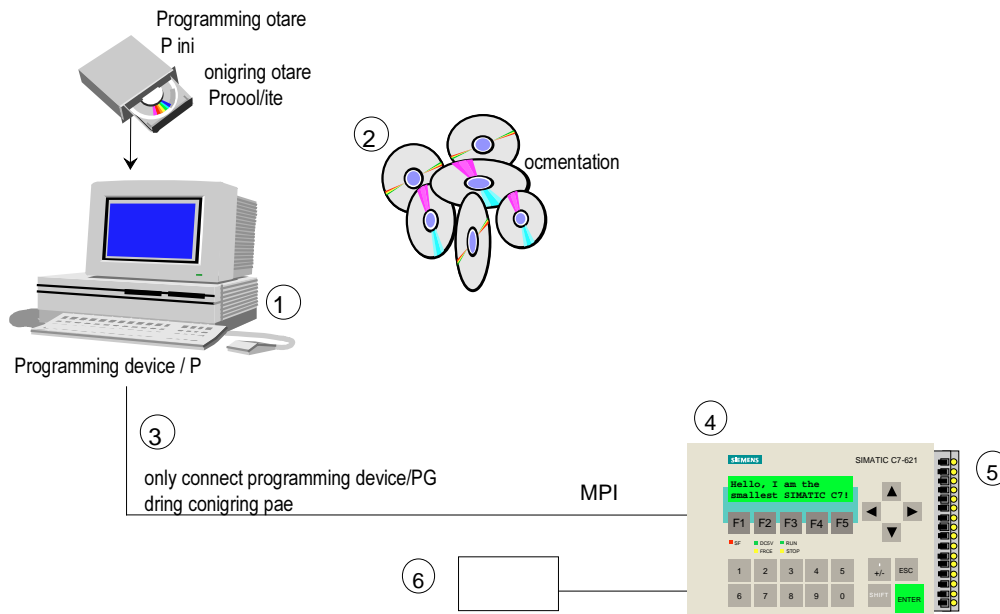
Conventions:

	The mouse indicates that you need to enter data on the PC/programming device.
	The hand indicates that you need to enter data/perform an operator action on the C7-621.
<code>quickmix.pdb</code>	Texts to be configured, program sections to be coded and inputs to be selected from a range of options are formatted in <i>Courier</i> .
<i>File → New</i>	Menus, menu items, dialog boxes and text in dialog boxes that you select are written in <i>italics</i> .

^{*)} Referred to below simply as STEP 7

^{**)} Referred to below simply as ProTool

Hardware



Checklist of components required:

	Components	Order No.	Included in starter kit
①	PC or programming device		No
	STEP 7-Mini programming software	6ES7 810-3CC04-0YX0	Yes
	ProTool/Lite configuring software	6AV6 580-3BX05-1AX0	Yes
	SIMATIC documentation on CD-ROM in 5 languages	6ES7 398-8AE00-8YE0	Yes
	PC/MPI cable	6ES7 972-0CA22-0XA0	Yes
	RS232 cable	6ES7 901-1BF00 0XA0	Yes
	SIMATIC C7-621 control system	6ES7 621-1AD01-0AE3	Yes
	C7-DI/DO simulator module	6ES7 620-0AA00-4AA0	Yes
	PS307+24V power supply	6ES7 307-1BA00-0AA0	No

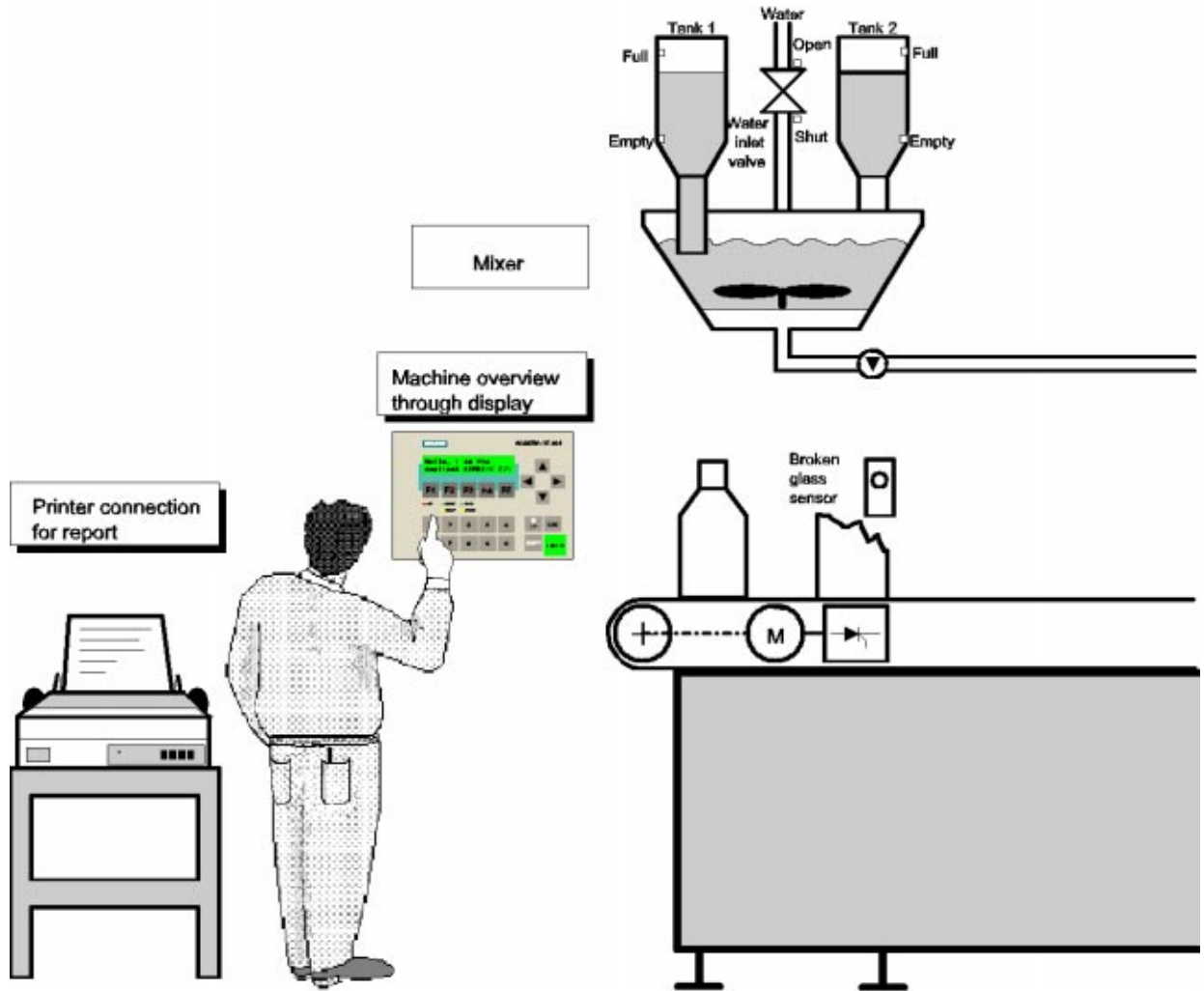
Checklist for startup

The following basic steps are necessary in order to start up the SIMATIC C7:

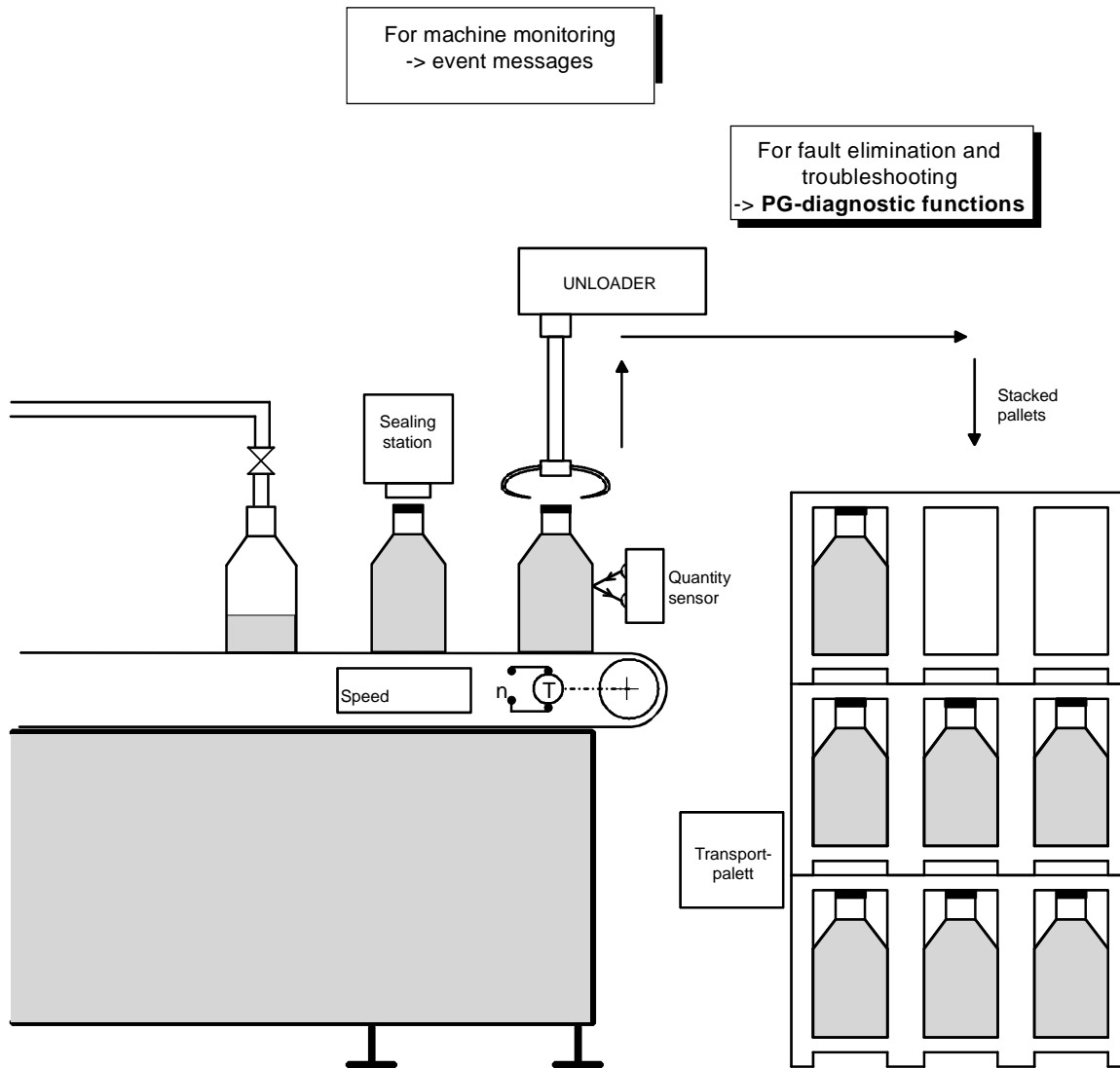
- Install STEP 7 or STEP 7-Mini on a PC/programming device
- Install ProTool or ProTool/Lite in STEP 7 or STEP 7-Mini on the PC/programming device
- Connect the PC/MPI cable (C7 ↔ PC/programming device)
- Connect the C7 to the power supply (+24V)
- Reset the memory on the C7-CPU and C7-OP
- Select STEP 7-Mini on the PC/programming device and create the PLC program
- Load the PLC program on the C7
- Select ProTool/Lite on the PC/programming device and create the OP configuration
- Load the configuration on the C7

Example machine: Quickmix

Quickmix is a mixing and filling plant which takes orange and mango concentrate from two separate tanks, mixes them with water to produce orange or mango juice and then bottles the finished product.



The diagram shows the configurable aspects of the example machine. We will develop a PLC program for this machine and get to know the steps involved in interfacing the integrated C7 operator panel.



Preparations for programming

Start STEP 7

- When you install STEP 7, an icon for the SIMATIC Manager appears on the Windows 95 desktop and the SIMATIC program group is included in the start menu. Like any Windows 95 application, you start the program by double-clicking the SIMATIC Manager icon or selecting *Start menu* → *SIMATIC* → *SIMATIC Manager*.
- If STEP 7 is started, cancel the STEP 7 Assistant: New Project.

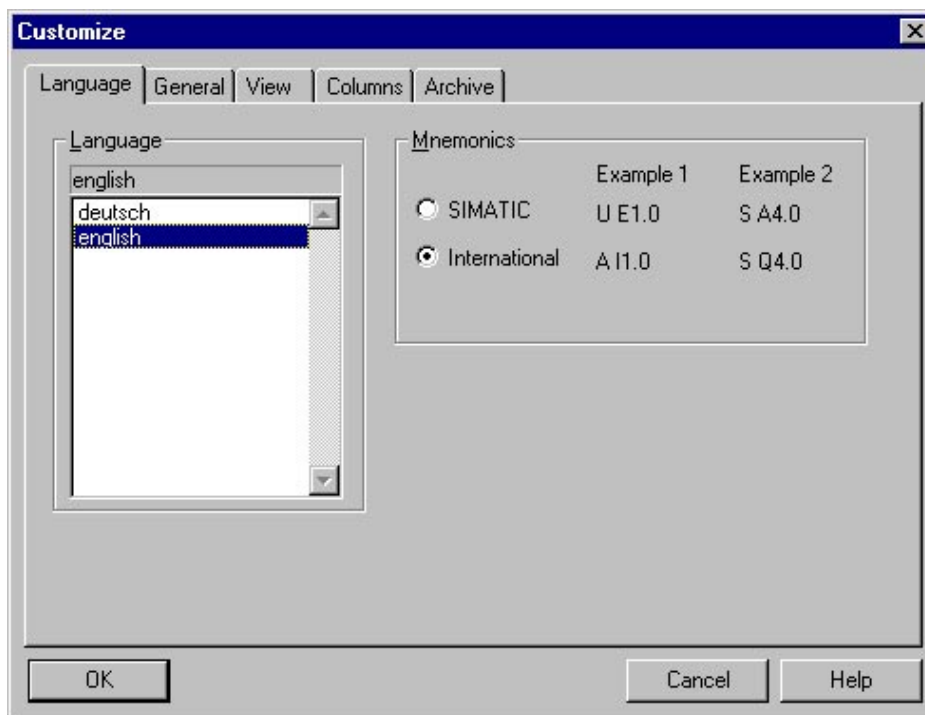
Online help

If you encounter a problem during programming, or if you want further information on a topic, press the *F1* key. This action starts the on-line help, where you can find explanations of various STEP 7 topics.

General settings

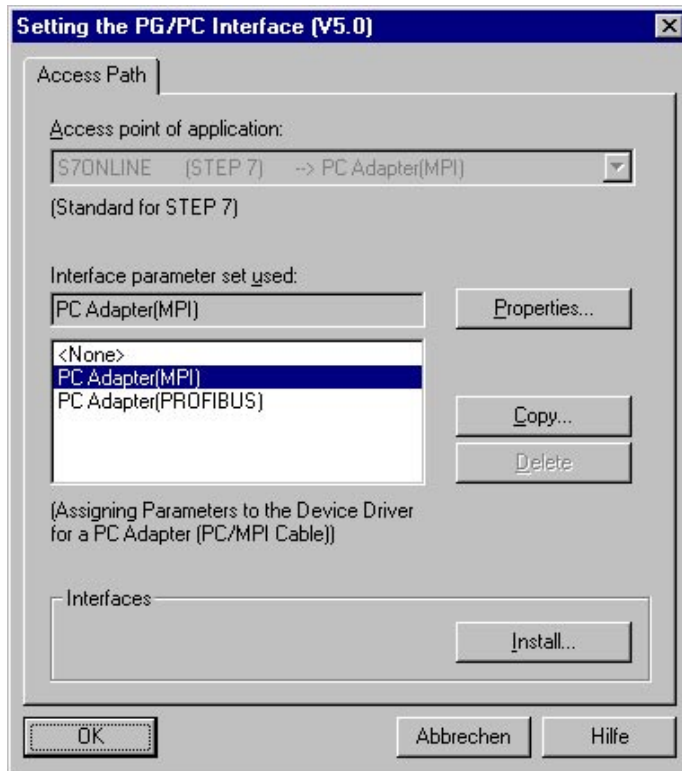
Before you start programming, you need to select one of two mnemonic options in the SIMATIC Manager for displaying program statements.

- You will find the *Language* catalog under *Options* → *Customize*. Select *English* as the language and *International* mnemonics.



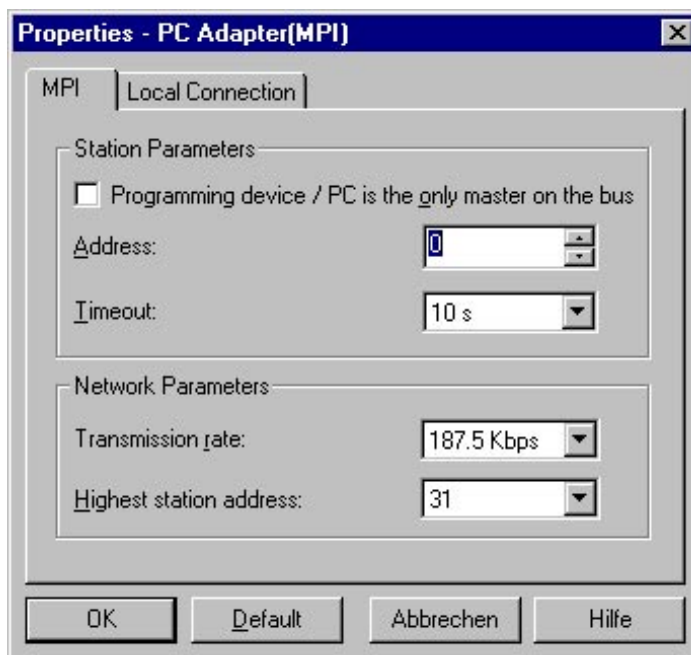
Select *OK* to close the dialog box and save the settings.

- You also have to set the PC/programming device interface. To do this, select the menu item *Options* → *Set PG/PC-Interface...* Set the *PC Adapter(MPI)* in the dialog box that appears.

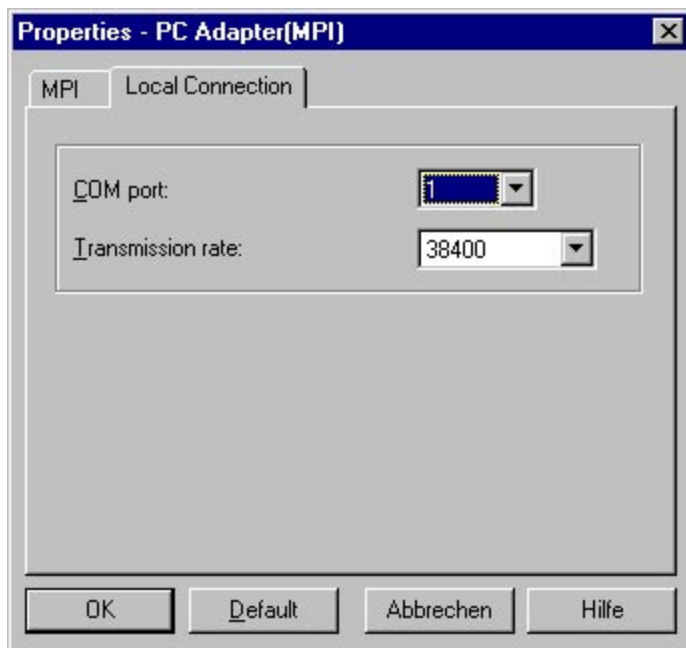


If the PC Adapter is not displayed in the window, you can install it now. Activate the *Install* button and follow the instructions.

- Enter the following settings as the PC/programming device interface *Properties*:



- For the local connection, select the COM port to which you connected the PC/MPI cable.



Save the settings with *OK*.

You can now start to create your project.

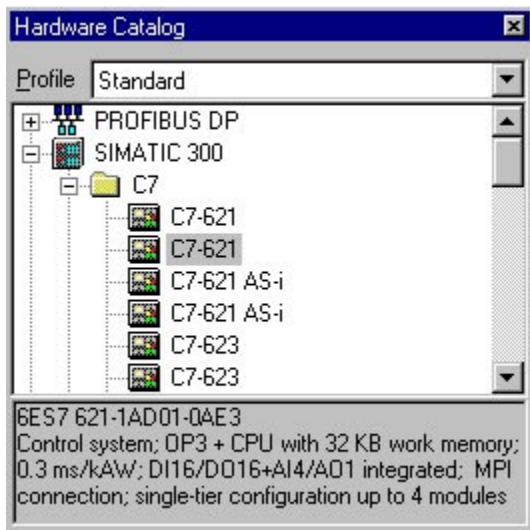
Create a project

- Select the menu item *File* → *New*. In the dialog box that appears, create a new project with the name *Getstart*.
- Assign a hardware item to your project with the menu item *Insert* → *Station* → *2 SIMATIC 300 Station*. The *SIMATIC 300 Station(1)* folder appears. Overwrite the name of this station with the new name *Quickmix*.

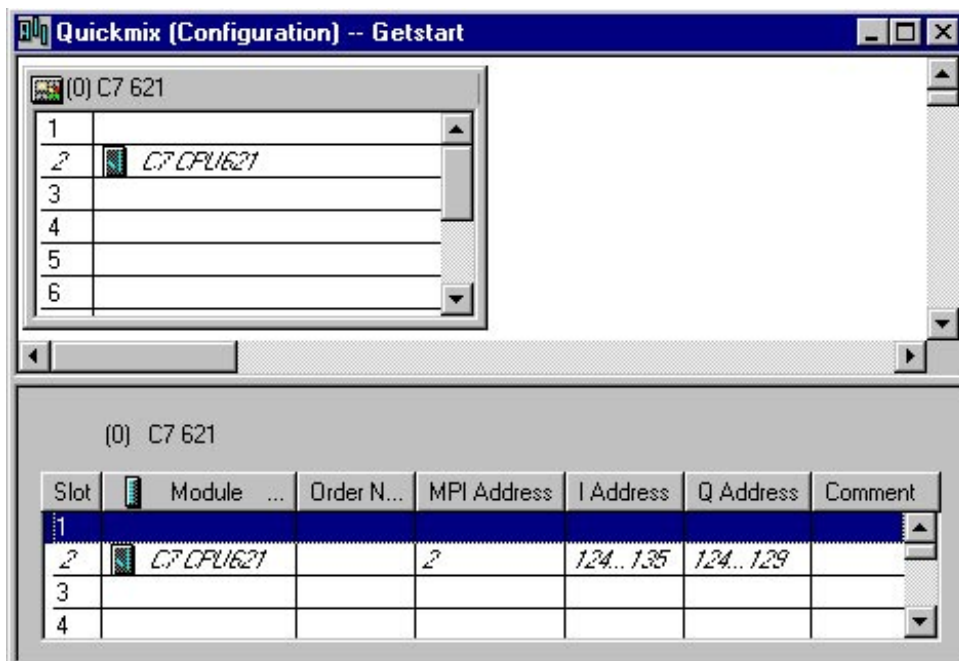


Define the hardware

- ☞ Open the Quickmix station by double-clicking. Select the Hardware folder and open it by double-clicking again.
- ☞ In the Hardware Configurator call up the hardware catalog with *Insert* → *Hardware Components*. In this box, select the *C7-621* from *SIMATIC 300* → *C7*. A short description of the control system is displayed.



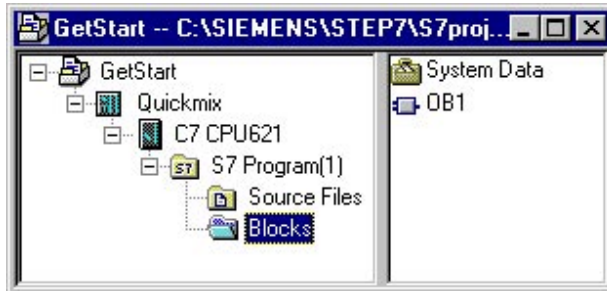
- ☞ Double-click *C7-621* to insert the device in slot 2 of the Hardware Configurator. You have now defined your hardware. The window displays the MPI address of the C7 CPU (default MPI address 2) and the address allocation of the integrated digital I/O.



- ☞ To save the configuration, select *Station* → *Save and Compile*.
- ☞ To quit the Hardware Configurator, select *Station* → *Exit*.

The folder C7 CPU621, which contains the S7 program, is created automatically by the SIMATIC Manager. This S7 program file contains the Blocks folder with an empty OB1 organization block.

- ☞ Open the folders by double-clicking.



Program development

Start by programming the operating modes for the filling plant.

Conveyor control

I 124.0  Start

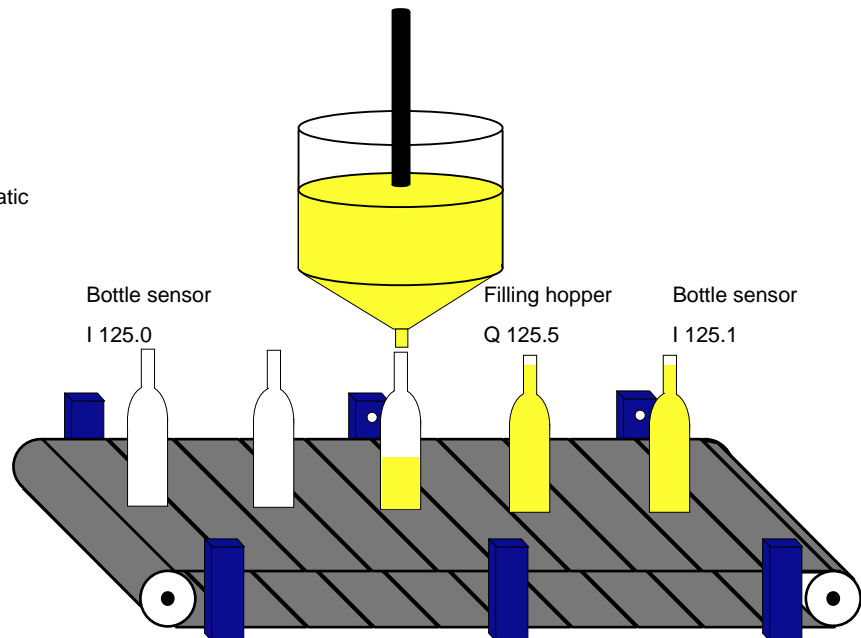
Manual/automatic mode

I 124.3  Manual/automatic

I 124.4  Accept mode

I 124.5  Jog forward

I 124.6  Jog back



Q 125.3 Conveyor forward

Q 125.4 Conveyor back

Program the mode section as follows:

- The start switch switches on the plant.
- When the plant is switched on, the indicator lamp at output Q 125.0 is lit.
- When the plant is switched on, the Manual and Automatic modes can be selected.
- The mode setting is accepted via a pulse.
- The mode setting should be displayed (Manual=Q 125.1, Automatic=Q 125.2)
- To prevent malfunction, the previously selected mode should be deselected when the mode is changed or the plant is switched off.
- The conveyor can be moved forward and back in jog mode when Manual mode is active.

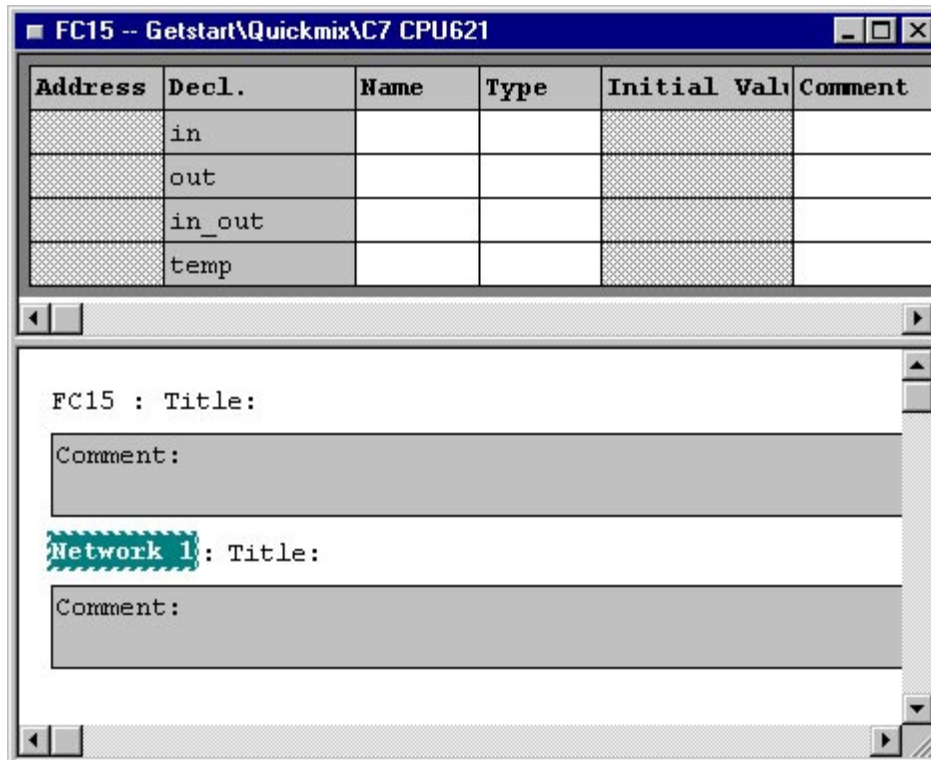
In your program, use the I/O addresses shown in the figure above.

Insert a block

- Select the *Blocks* folder in the SIMATIC Manager and select *Insert* → *S7 Block* → *3 Function Block* to insert a new function. In the dialog box that appears, allocate the internal identifier FC15. Select *STL* as the programming language and close the dialog box with *OK*.

Edit the block

- Now open the LAD/STL/FBD Editor from the SIMATIC Manager by double-clicking the *Function FC15* you have just created.





- Click *Title* beside block number FC15 and enter the block name *Mode*. You can enter a block comment in the gray field directly below the block name.
- Now assign the name *Plant ON/OFF* to Network 1. Do this by clicking *Title* beside the network number. Once again, you can enter a network comment in the gray field directly below the network name.
- You can now insert the first program lines below the network comment. Use the mouse to click the white area below the gray comment field. A box appears with the current cursor position. Please remember to enter spaces between inputs (at least one space separating each of the command code, operand and comment) in every program line, otherwise STEP 7 will not recognize the statement and will highlight the line in red italics. Enter the following code in the first network:

FC15: Mode

Network 1 : Plant ON/OFF


```
A  I  124.0  // Start      (if input 124.0  on /off)
=  Q  125.0  // Plant ON  (plant is then  switched on/off)
```

Insert a network

 To insert a new network, click  on the tool bar. You will program the MANUAL mode in this network.

Network 2 : MANUAL mode

```
A  Q  125.0  // Plant ON
AN I  124.3  // and MANUAL mode selected (switch=0)
A  I  124.4  // Confirm acceptance of selected mode
S  Q  125.1  // Manual mode activated
A(
ON  Q  125.0  // plant OFF (LED of DO not lit)
O  I  124.3  // OR AUTOMATIC mode selected (switch=1)
)
R  Q  125.1  // Then select Manual mode
```

 Insert three further networks for the plant functions Automatic mode, conveyor forward and conveyor back.

Network 3 : AUTO mode

```
A  Q  125.0  // If plant ON
A  I  124.3  // and AUTOMATIC mode selected (switch=1)
A  I  124.4  // and acceptance of selected mode confirmed
S  Q  125.2  // Then set automatic mode
A(
ON  Q  125.0  // Plant OFF (LED of DO not lit)
ON  I  124.3  // or Manual mode set
)
R  Q  125.2  // Then select AUTOMATIC mode
```


Network 4 : Conveyor forward

```
A  Q  125.1  // If MANUAL mode set
A  I  124.5  // and Jog Forward is pressed (enabled)
AN I  124.6  // and Jog Back is not pressed (enabled)
=  Q  125.3  // Then move conveyor forward
```

Network 5 : Conveyor back

```
A  Q  125.1  // If MANUAL mode set
A  I  124.6  // and Jog Back is pressed (enabled)
AN I  124.5  // and Jog Forward is not pressed (enabled)
=  Q  125.4  // Then move conveyor back
```





Save the block

- ☞ The mode section of the filling plant is now fully programmed. Now save function FC15 by activating the symbol .
- ☞ For an executable program you still need to call FC15 in organization block OB1. Open *OB1* in the SIMATIC Manager and insert the following program line in the first network:

```
OB1 : Filling plant
Network 1 : Mode section
CALL FC 15
```

- ☞ Now save organization block OB1 and close the LAD/STL/FBD Editor.


Set the operating mode

- ☞ Now press the   keys on the C7-621 to select the system function menu.
- ☞ Select the C7 CPU mode menu "KEY" by pressing .
- ☞ Select the STOP mode by pressing . The STOP LED lights up.
- ☞ If you have not yet entered a password, you are now prompted to do so. Password 100 is the default setting when the C7 is delivered. Enter the digits 100 on the numeric keypad and press ENTER. Now, select STOP mode again.

Clear the C7 CPU memory / reset the C7 OP

Before you load a project into the CPU for the first time, you need to establish a neutral state on the C7-621. This is achieved by deleting both of the integrated C7 flash memories and then restarting the C7-621. Proceed as follows to delete the C7 flash memory:

Delete C7 CPU memory:




In the SIMATIC Manager select the *Accessible Nodes*  symbol. In the dialog window that appears, double-click the folders *MPI=2* and *Blocks* to open them.

Select all OBs, FBs, FCs and DBs. Delete the selected objects from the C7 CPU. The load memory of the C7 CPU is then cleared.

Select the folder *MPI=2* and copy the contents of the load memory into the C7 CPU flash memory by activating *PLC → Copy RAM to ROM*. This action clears the integrated CPU flash memory.

Close the *Accessible Nodes* window.


Reset the C7 OP:

- ☞ Activate transfer mode on the C7-621 by performing a reset:
 - Switch off the power supply to the C7-621.
 - Then press the keys  and  and 
 - Hold down the above keys
 - and switch the power supply on.
- Do not release the keys until the message "Flash Test" appears on the display. A message is displayed after the start-up tests are complete and the C7 OP has been reset.


Load blocks



There are two ways of loading blocks into the CPU. It is best to load blocks individually in large projects when changes are made only to a small number of specific blocks. It is more practical to load all blocks in smaller projects, or when changes have been made to a large number of different blocks.


Load all blocks:

- ☞ Select the Blocks folder in the SIMATIC Manager and click the  symbol on the tool bar once.

Load individual blocks:

- ☞ Select function *FC15* in the SIMATIC Manager and load this block into the CPU of the SIMATIC C7-621. You only need to click the  symbol on the tool bar once. Then load organization block OB1 into the CPU following the same procedure.

- ☞ Now select the system function menu on the C7-621 by pressing  .

- ☞ Select the C7 CPU mode menu "KEY" by pressing .

- ☞ Select **RUNP** mode by pressing . The **RUN** LED lights up.

- ☞ If you have not yet entered a password, you are now prompted to do so. Password 100 is the default setting when the C7 is delivered. Enter the digits 100 on the numeric keypad and press ENTER. Now, select RUNP mode again.


Test your program on the C7-621 using the simulator. The functions of the plant described on Page 15 must be fulfilled.

- ☞ You can simulate the pulse for accepting the selected mode by simulating a short on/off switch.

Extend the program

Now extend the program with the filling process. The plant should operate as follows:

- The conveyor drive motor is switched on (Q 125.3) in Automatic mode and remains switched on until the stop switch opens or the sensor (I 125.0) detects a bottle.
- The filling process starts when a bottle is positioned underneath the filling hopper. Filling is simulated for a period of 3 seconds and is displayed via output Q 125.5.
- When the bottle has been filled, the conveyor must start up again automatically and remain switched on until the next bottle is detected or the stop switch is pressed.
- After the plant is switched on, the full bottles should be counted via a further sensor (I 125.1).

☞ To implement the process, call up your project offline in the SIMATIC Manager  and insert another *Function* in the *Blocks* folder. Assign the internal identifier FC16, select *STL* as the programming language and open the block.

☞ Insert the following program lines in the individual networks:

```
FC16 : Filling cycle
```

```
Network 1 : Fill bottles
```

```
A  I  125.0  // Bottle sensor 1 has detected a bottle
L  S5T#3s   // Load filling time (3s)
SE  T  1     // Set extended pulse (3s)
A  T  1     // When timer 1 reaches level 1
=  Q  125.5  // Open inlet valve
```

```
Network 2 : Scratchpad memory for conveyor, AUTO
```

```
A  Q  125.2  // If AUTOMATIC mode set
A(                                     // and
ON  I  125.0  // no bottles have been detected by bottle sensor 1
O                                     // or
A  I  125.0  // bottle sensor 1 has detected a bottle
AN  T  1     // and filling process not running (valve closed)
)
=  M  5.0    // Then the conveyor is moving
```

```
Network 3 : Count full bottles
```

```
A  I  125.1  // Bottle sensor 2
CU  C  1     // Increase counter by 1
A  Q  125.0  // When plant is switched on
L  C#0
S  C  1     // Reset counter to 0
```

☞ Programming of block FC16 is now complete. The block can be saved and loaded into the CPU.

- ☞ You now need to allow for the filling cycle in the mode section. Insert the program line `O M 5.0` in Network 4 of Function FC15. The complete network then appears as follows:

```
Network 4 : Conveyor forward
A   Q   125.1   // If MANUAL mode is set
A   I   124.5   // and Jog Forward is pressed (enabled)
AN  I   124.6   // and Jog Back is not pressed (enabled)
O   M   5.0     // or filling process running in AUTOMATIC mode
=   Q   125.3   // Then move conveyor forward
```

- ☞ Save function FC15 and overwrite the block on the CPU by loading the new block.
- ☞ Finally, you need to modify OB1. Open OB1 in the SIMATIC Manager, insert a second network, and call FC16.

```
OB1 : Filling plant
Network 1 : Mode section
CALL FC 15







Network 2 : Filling cycle
CALL FC 16
```

- ☞ Save OB1 and load it into the CPU to overwrite the old organization block.


To protect the PLC program in the C7 CPU against a power failure, you still need to transfer the program to the C7 CPU flash memory. This is described in the following section.

Copy RAM to ROM

Since the PLC program is only saved in volatile load memory and not automatically in the C7 CPU flash memory when it is loaded into the C7-CPU, the program would be lost if you restarted the C7-621. To prevent this from happening, you must copy the PLC program explicitly into the flash memory. The procedure is as follows:

- ☞ Select the system function menu on the C7-621 by pressing the keys  .
- ☞ Select the C7 CPU mode menu "KEY" by pressing .
- ☞ Select the STOP mode by pressing . The STOP LED lights up.
- ☞ If you have not yet entered a password, you are now prompted to do so. Password 100 is the default setting when the C7 is delivered. Enter the digits 100 on the numeric keypad and press ENTER. Now, select STOP mode again.
- ☞ Select the *Accessible Nodes*  symbol again in the SIMATIC Manager. In the dialog window that appears, select the folder *MPI=2*. Copy the contents of the load memory into the C7 CPU flash memory by activating the menu item *PLC → Copy RAM to ROM*. The PLC program is now secure. Close the *Accessible Nodes* window.
- ☞ Change back to RUNP mode on the C7-621 by pressing . The RUN LED lights up.

You can now test the program for your filling plant on the practice PLC.

To check the function of the counter, call up the online database by selecting  from the tool bar in the SIMATIC Manager. Open *Function FC16* and select the third network. Activate Test mode with *Debug → Monitor*.

The status bit, the result of logic operation and the standard status are displayed for each program line. In the last program line you will see the current counter state in hexadecimal notation.

Network 3 : count failed bottles

	VKE	STA	STANDARD
A I 125.1	1	1	2003
CU C 1	1	1	7
A Q 125.0	1	1	2003
L C#0	1	1	0
S C 1	1	1	7

Then close the LAD/STL/FBD Editor and your *Getstart* online project in the SIMATIC Manager.

Now open the *Getstart* folder.

Preparations for OP configuration

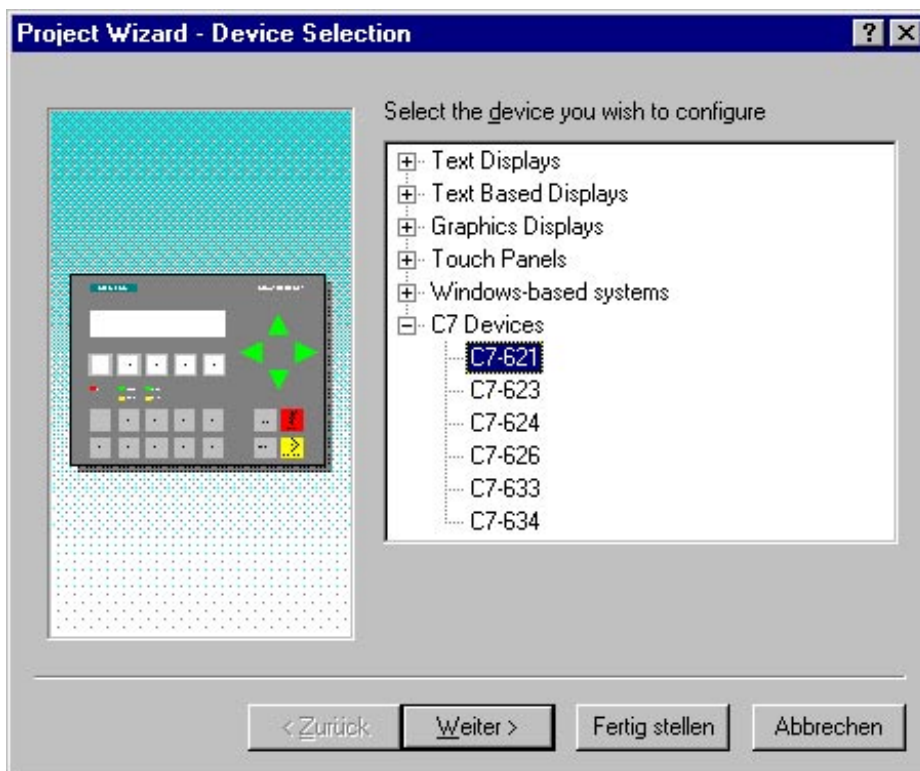
Start ProTool, create a configuration

There are two ways to create an OP configuration. You can create a new (empty) configuration and add all the necessary system functions manually (e.g. change mode, allocate passwords, etc.), or you can base your project on a standard configuration supplied with ProTool.

We recommend you use the standard configuration the first time you use ProTool. The standard configuration contains basic settings, e.g. Device: C7-621, *Language*: German, and standard screens for access to frequently used functions, e.g. change mode, allocate passwords, etc.

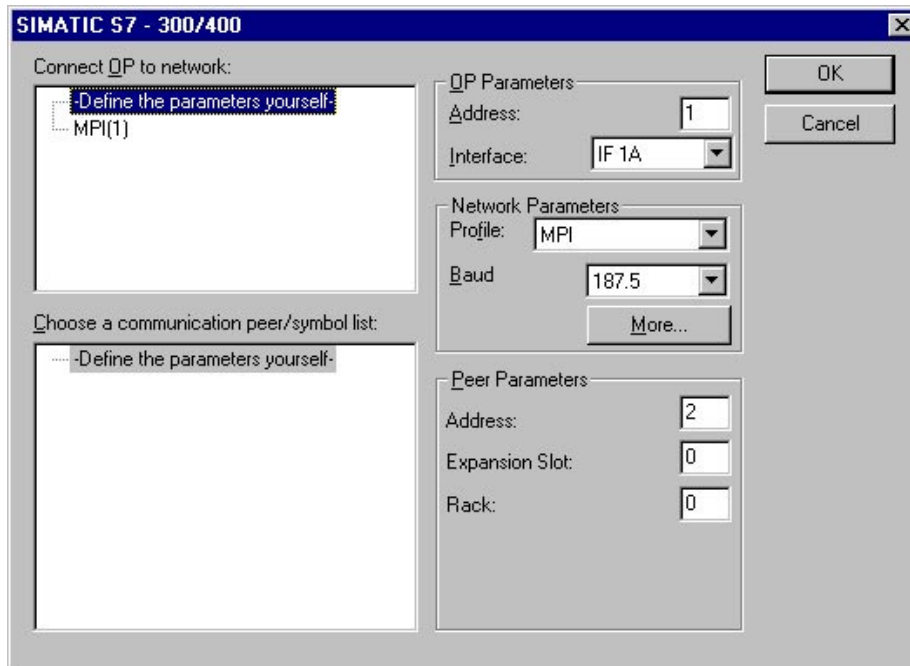
Create a new configuration:

- ☞ In the SIMATIC Manager select *Insert* → *Station* → *g SIMATIC OP* and name the new OP station Quickmix OP.
- ☞ Open the station (e.g. by double-clicking). ProTool/Lite and the Projekt Wizard are started automatically.

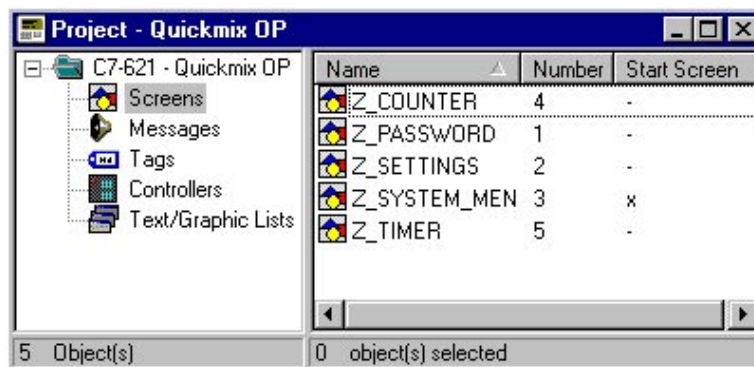


- ☞ Select the C7-621 from the C7 Devices and confirm with *Continue* >.
- ☞ Define a name for the PLC which you use to reference it in the configuration: Quickmix.

- To check and, if necessary, correct the PLC parameters, display the dialog box with the PLC parameters from the Driver window by activating the *Parameters* button (see dialog box directly below).



- When you have entered all the settings, close the dialog box by activating the button *OK*. In the Project Wizard confirm this step with *Continue*.
- Select *Use Standard Projects* and close the Project Wizard with *Fertig stellen* to create the Project *Quickmix OP* in ProTool.



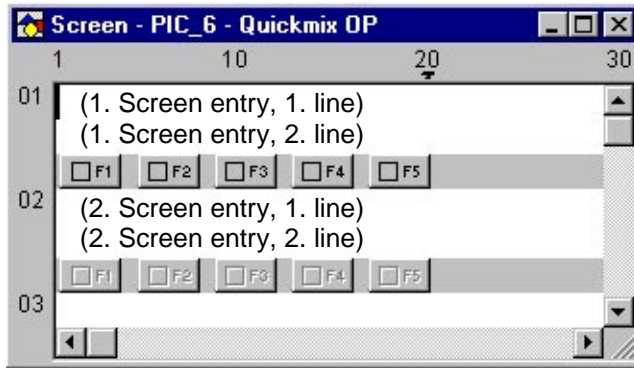
Online help

If you encounter a problem during programming, or if you want further information on a topic, press the *F1* key. This action starts the on-line help, where you can find explanations of various ProTool topics.

Display and enter values in screens

You can start by configuring your first screen.

- Open the Screen Editor with the menu item *Insert* → *Screen*. This action calls up the Screen-PIC_6.



Configure texts

The first screen is to be the start screen on the C7. Only the plant name is to appear on this screen.

The plant name is configured as a text.

- The cursor is displayed in the first line of the first screen entry (see above). Enter the plant name there: `Plant Quickmix`.

The C7 always displays the configured start screen when it has finished the start-up routine. The screen configured above (text display: `Plant Quickmix`.) is to be displayed the next time the configuration is loaded. You must therefore define the screen configured above as the start screen.

- Select the menu item *Edit* → *Properties*. In the *Attributes* dialog box, select *Start Screen*. Do not change the other settings.
- You can also define a new name for the screen: `Start_QM`.
- Close the dialog box with *OK*.

You have now created the first screen. Now, transfer the configuration to the OP to see what the screen looks like.

Transfer the configured data

Before the actual transfer, you need to perform three steps:

- Save
- Generate the project
- Define the transfer parameters (once).

☞ To save the project, select the menu item *File* → *Save*.

☞ Then activate the menu item *File* → *Compile* to generate an executable file, which will run on the OP, from the configuration file. During the generation process, a status window displays any messages, warnings and errors relating to the configuration.

☞ Finally, set the parameters for the transfer:

Select the menu item *File* → *Settings* → *Transfer*. The following dialog box appears:






Define the OP address in the dialog box (default is 1).

Note

The transfer parameters are stored; you do not have to set them again before each new transfer.

☞ Then activate the transfer mode by resetting the C7-621:

- Switch off the power supply to the C7-621.

- Simultaneously press the keys  and  and 
- Hold down the above keys
- and switch the power supply on.

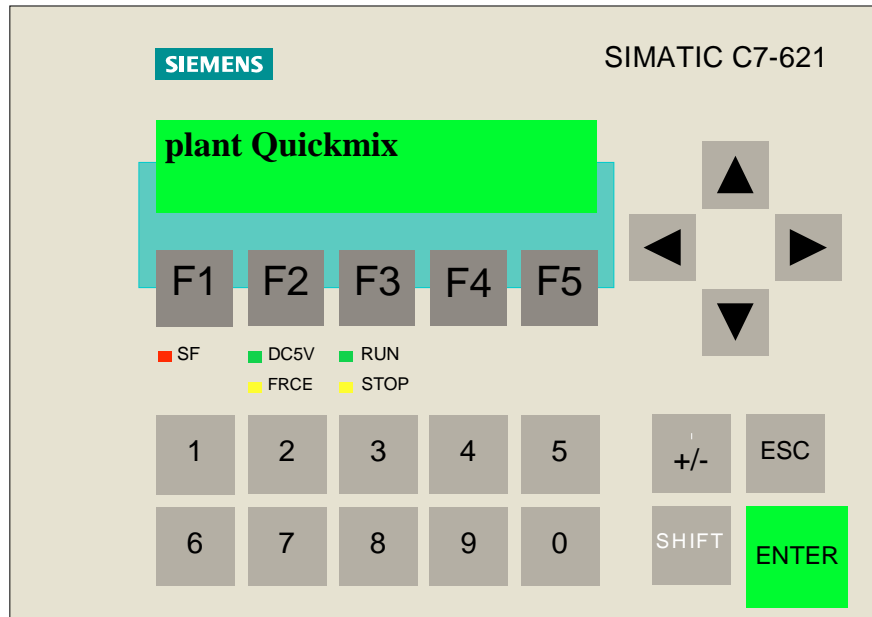
Do not release the keys until the message "Flash Test" appears on the display. A message is displayed after the start-up tests are complete and the SIMATIC C7 OP has been reset.

☞ When the SIMATIC C7 has started up, press the ENTER key to select the system screens stored in the firmware in English. Select *System* with the F4 key and *OpMode* with the F2 key. Simultaneously press the keys SHIFT and Arrow Down to switch to *MPI down* and confirm the input with ENTER. The message *Ready for transfer* appears on the C7-OP.

☞ If you have not yet entered a password, you are now prompted to do so. Enter the digits 100 again on the numeric keypad and press *ENTER*. Select *MPI down* again and confirm with ENTER.

☞ Now activate the menu item *File* → *Transfer* to initiate the data transfer from PC/programming device to the C7.

The C7 starts up when the transfer is complete. Press the ENTER key. If the start screen is displayed on the C7, the transfer was successful.



If the transfer was unsuccessful, repeat the steps beginning on Page 23.

Extend the configuration

Now add another screen to your configuration.

- ☞ Open another Screen with the menu item *Insert* → *Screen*.
- ☞ Now select *Edit* → *Properties ...* and change the screen name: `Plant_QM`.

In this screen, you want to enter the filling time and display the number of full bottles.

You can do this as follows:

- Define an **input field** for the filling time.
- Display the number of full bottles in an **output field**.

Configure texts

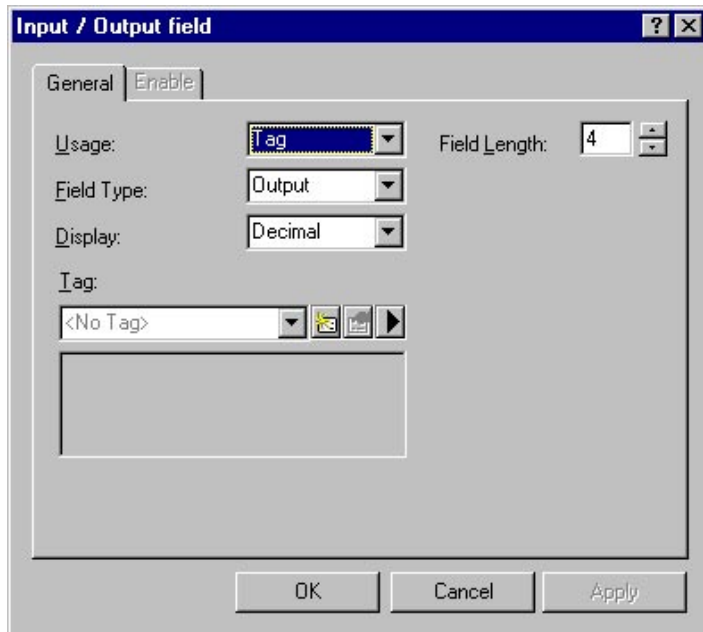
To distinguish the input field from the output field, configure a text before each field.


- ☞ Using the cursor, select the first line of the first screen entry, and enter the text: `Filling time`. Then position the cursor in the first line of the second screen entry and configure the text: `Full bottles`.

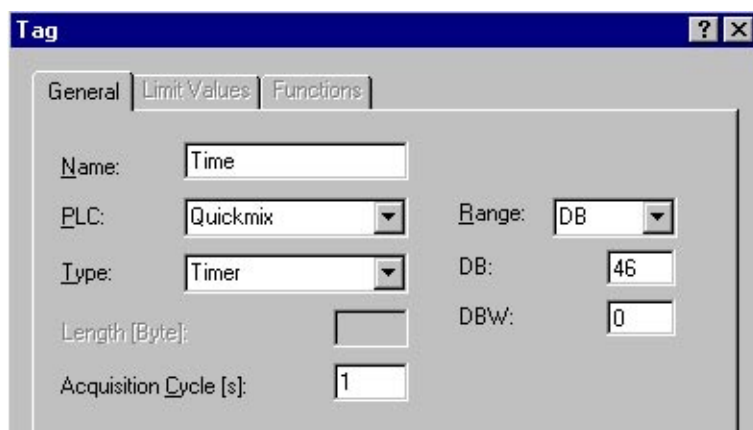
Then define the fields for input and output.

Configure an input field

- Use the cursor to select the first line of the first screen entry. Using the cursor control keys, position the cursor behind the text `Filling time`. Activate the menu item *Insert* → *Input/Output Field* or press the button **(F)** in the function bar. The *Input/Output field* dialog box appears.




- Set the *Field Type*: `Input` and specify a *Field Length* of 4. Do not change the settings *Usage*: `Tag` or *Display*: `Decimal`.
- To establish the link between the field and the PLC, create a new variable with the button .
- In this box, enter `Name`: `Time`, `Type`: `Timer`, `DB`: 46 and `DBW`: 0.



- Click the *OK* button to close the *Tag* and *Input/Output field* dialog boxes. You have now defined the input field. The variable is identified by `{Time}` in the Screen Editor.
- Position the cursor between the text `Filling time` and the input field `{Time}`. Now enter some spaces to pad out the line, taking care not to exceed the maximum of 20 characters per line. Ten characters of text plus 4 characters field length allow a maximum of 6 spaces.

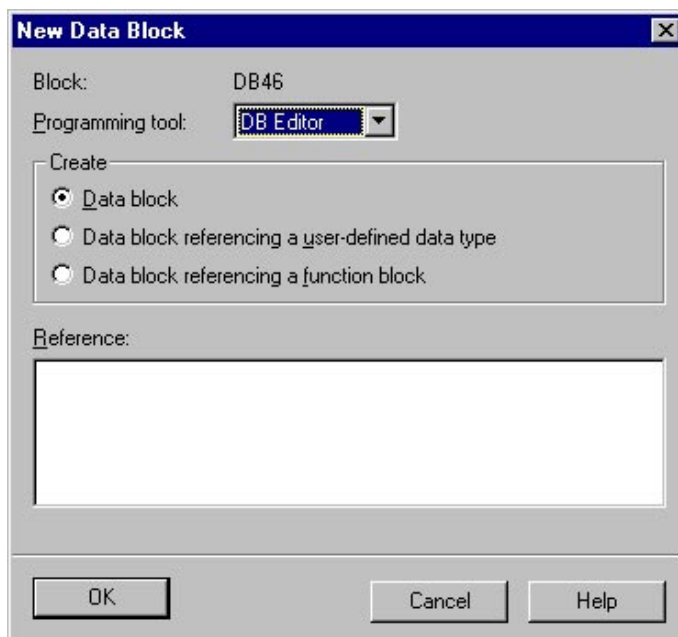
Configure an output field

- ☞ Position the cursor in the first line of the second screen entry behind the configured text `Full bottles`. Activate the menu item *Insert* → *Input/Output Field*.
- ☞ In the *Input/Output field* dialog box, set the *Field Type*: `Output` and *Field Length*: `4`.
- ☞ Then click the button . The Tag dialog box appears. Assign the variable name `Count`, type `Word` and `DB46` and `DBW 2` as the interface area and save the entries with *OK*.
- ☞ Position the cursor between the text `Full bottles` and the output field `{Count}`. Now enter some spaces to pad out the line, taking care not to exceed the maximum of 20 characters per line. 14 characters of text plus 4 characters field length allow a maximum of 2 spaces.

Modify the PLC program

To allow data exchange between the C7 PLC and C7-OP, you will need to modify and reload the PLC program.

- ☞ Set up data block DB46 on the PLC. DB 46 must be at least three data words in length. Select the *Blocks* folder in the SIMATIC Manager and insert a data block with *Insert* → *S7 Block* → *4 Data Block*. In the dialog box that appears, assign the internal identifier DB46.
- ☞ Open data block DB46 and select *Data Block* as the desired type. Accept the settings with *OK*.



- ☞ In the DB Editor, use the mouse to activate the second item in the *Name* column. Assign the name `Fill_Time` here for `DW0` and press Return.
- ☞ This automatically activates the *Type* entry. Click the entry with the right mouse button, insert the type `Word` via *Elementary Types* and press Return again.
- ☞ Assign `3sec.` in BCD format `w#16#2003` as the initial value for the filling time. The first digit defines the time reference (2 = seconds). The three following digits contain the time value. Press Return to complete the input.
- ☞ You can enter a comment in the *Comment* column. Accept your entry with Return. The editor automatically inserts a new line in which you can enter the next data block word. Data word 2 is to be named `Full_Bottles`, with type `Word` and an initial value of `w#16#0`.

- ☞ Create data word 4 with the name *Messages*, type *Word* initial value *w#16#0*. You will need this data word later in order to configure the event messages.

Address	Name	Type	Initial Value	Comment
0.0		STRUCT		
+0.0	Fill_Time	WORD	W#16#2003	
+2.0	Full_Bottles	WORD	W#16#0	
+4.0	Messages	WORD	W#16#0	
=6.0		END_STRUCT		

- ☞ You have now created DB46. Save the block and load it into the C7-621.
- ☞ You now need to change Function FC16. Open FC16 in the SIMATIC Manager and overwrite the S5 timer with `L DB46.DBW0` in the first network. In the third network, transfer the counter state to the second data word of data block DB46 instead of to memory word MW 10.

```

FC16 : Filling cycle
Network 1 : Fill bottles
A   I   125.0   // Bottle sensor 1 has detected a bottle
L   DB46.DBW0 // Load filling time (3s)
SE  T   1      // Set extended pulse (3s)
A   T   1      // When timer 1 reaches level 1
=   Q   125.5  // Open inlet valve
:
:

```

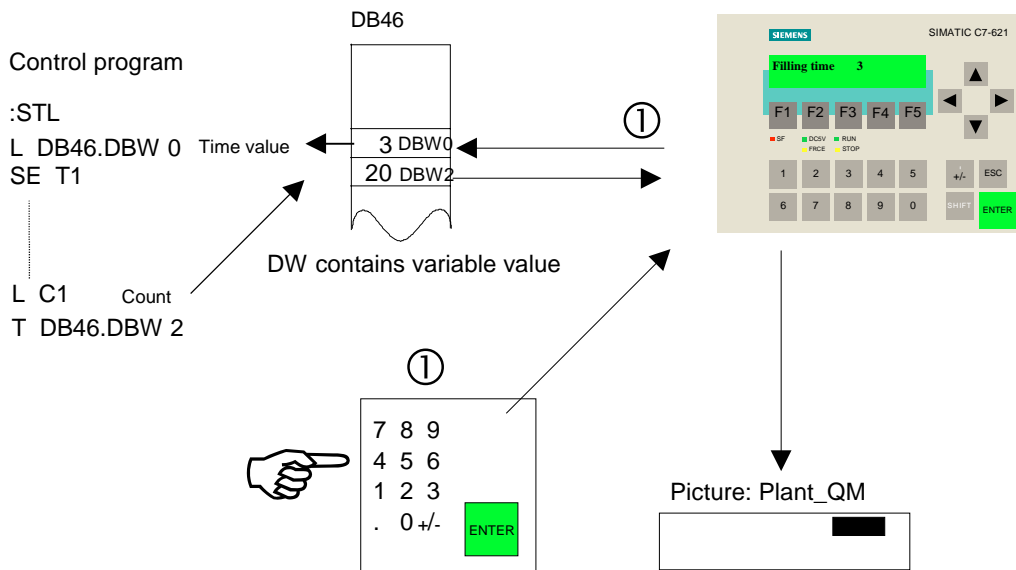
```

Network 3 : Count full bottles
A   I   125.1   // Bottle sensor 2
CU  C   1      // Increase counter by 1
A   Q   125.0  // When plant is switched on
L   C#0
S   C   1      // Reset counter to 0
L   C   1      // Write current counter state to
T   DB46.DBW2 // data block word

```

- ☞ Save the block and load it into the CPU again. Activate the function *Copy RAM to ROM via Accessible Nodes* so that the current program is also stored in the flash memory. Please make sure that the C7 CPU is in STOP mode during the copy process. Then select the CPU mode RUNP again. (see Page 22)

The following figure shows the relationship between the value entered, the PLC program and the current number of full bottles.



The values of the inputs are stored in the data interface (DB46).

The PLC program evaluates the current inputs and updates the data in the interface for output.

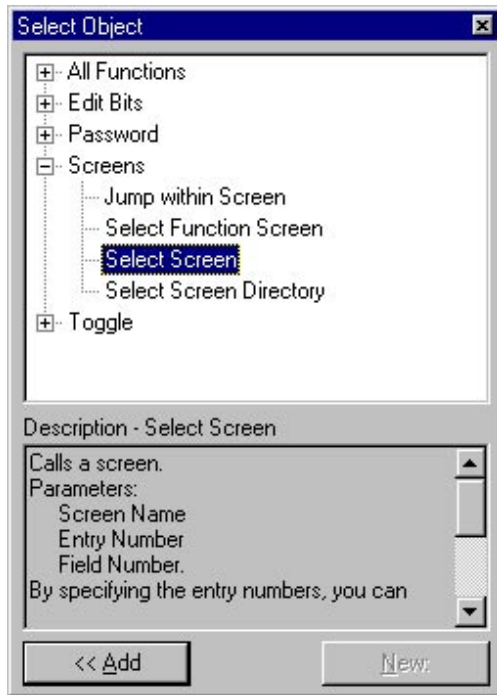
The C7 OP reads all the values independently from the interface and updates its display.

Link the screens and enable navigation via softkeys

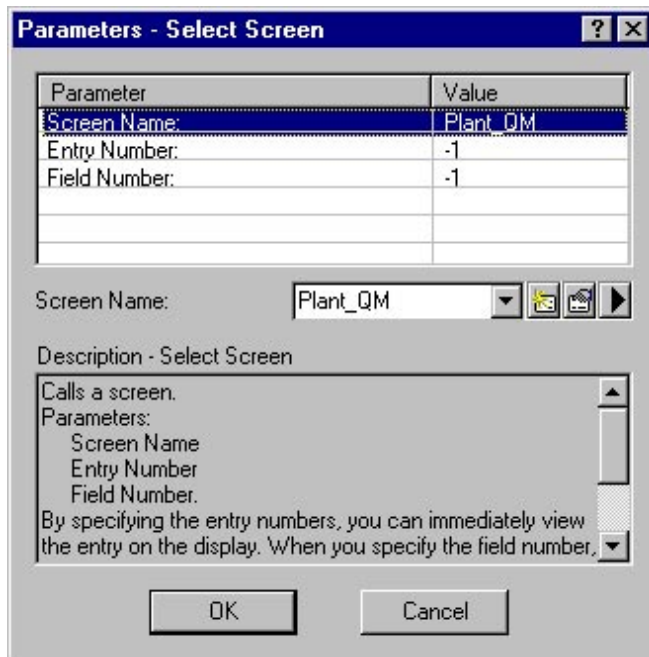
To enable the second screen to be called up on the C7, you must use ProTool/Lite to configure the screen change from start screen `Start_QM` to plant screen `Plant_QM` and back. Navigation from the first screen entry to the second and back must also be configured for the plant screen.

To do this, assign a softkey to the *Select Screen* function in both of the screens. You will use these softkeys to activate the screen change. In the plant screen, assign the *Jump within Screen* function in both screen entries.

- ☞ Open the screen `Start_QM` and select the Softkey `F5`. The dialog boxes *Softkey-F5* and *Select Object* appear.
- ☞ In the dialog box *Select Objekt* choose the function *Select Screen* from the *Screens*. A short description of the function is displayed.



- Click the button <<Add. The dialog box *Parameters - Select Screen* appears. In this dialog box, select the name of the screen you want to call up: `Plant_QM`. Do not change the parameters *Entry Number* or *Field Number*.



- Close the dialog boxes *Parameters - Select Screen* and *Softkey F5* by clicking the *OK* button. A function is now assigned to the softkey.

The box F5 in the function key is now checked. You can therefore see immediately which function keys have been configured in the screen.

Label the softkey

To inform the operator of the C7 which softkey is assigned, create a text for this softkey. The text will be displayed in the appropriate screen. The procedure is as follows:

- ☞ Position the text cursor in the second line of the screen above the softkey you have assigned. by entering a space. Enter the text `Pla` to label the softkey.

So that you can navigate from the `Plant_QM` screen back to `Start_QM`, repeat the procedure for Softkey `F1` in the `Plant_QM` screen. Enter `Start_QM` as the screen name and `back` as the text for the softkey description.

- ☞ To enable navigation within the screen, select Softkey `F5` in the first screen entry of the plant screen and assign the function *Jump within Screen*. Assign *Entry Number 2* and *Field Number 0* as the parameters.

- ☞ Label the softkey with the `>>` symbol in the plant screen.




To enable navigation from the second screen entry back to the first, repeat the procedure to configure Softkey `F1` in the second screen entry. Use `1` as the entry number and `<<` as the symbol for the softkey description.

All extensions to the project are now complete. You have:

- configured a second screen with an input and output field,
- configured a softkey in each screen in order to switch back and forth between the screens,
- configured a softkey in each screen entry in order to switch back and forth between the entries,
- labeled each softkey with text/symbol.

You can now display the configuration on the OP, change between the screens and perform inputs/outputs.

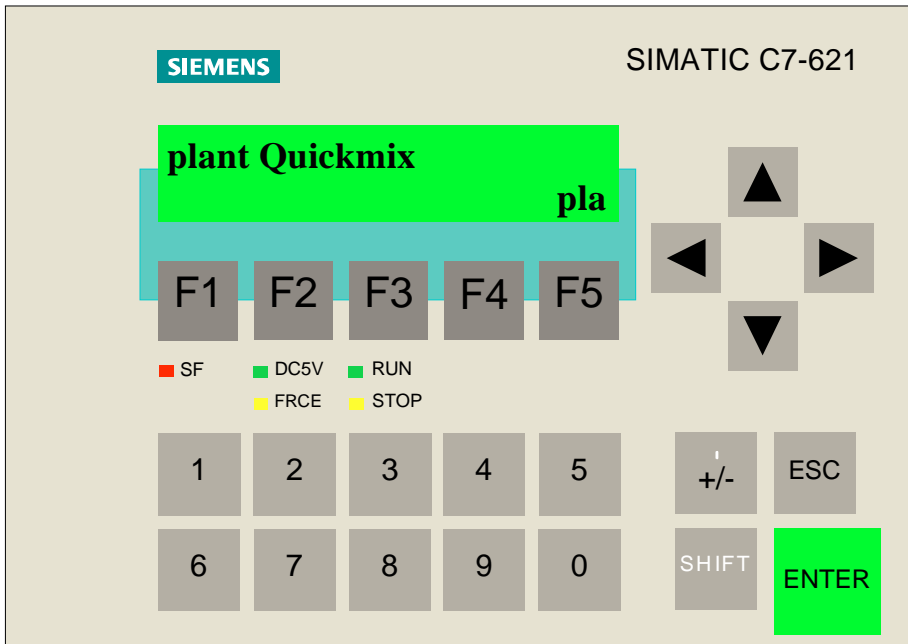
- ☞ Now, activate transfer mode on the C7-621 by performing a reset:
 - Switch off the power supply to the C7-621.

- Simultaneously press the keys  and  and 
- Hold down the above keys
- and switch the power supply on.

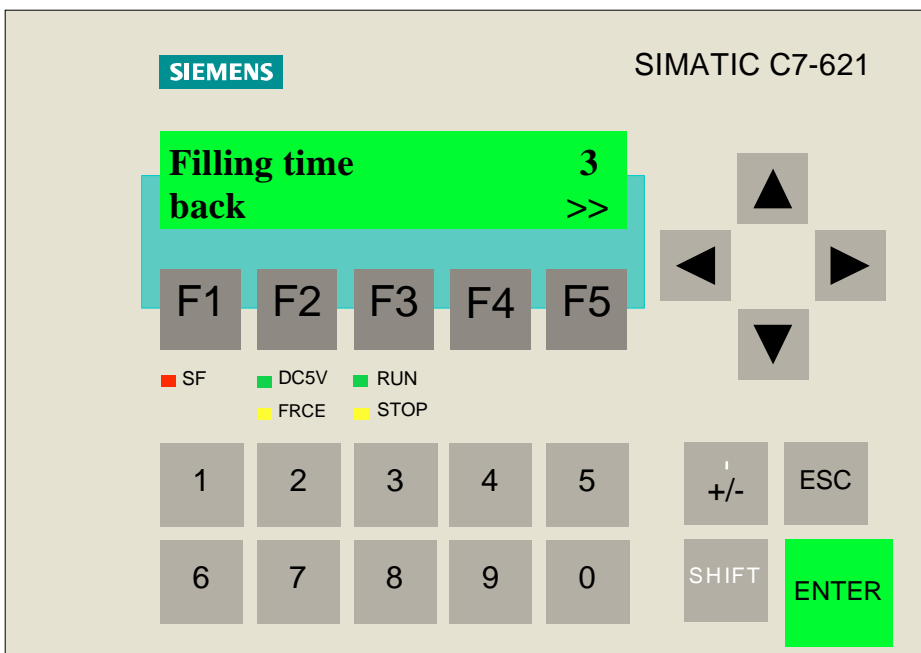
Do not release the keys until the message "Flash Test" appears on the display. A message is displayed after the start-up tests are complete and the C7 OP has been reset.

- ☞ When the C7 has started up, press the ENTER key to select the system screens stored in the firmware in English. Select *System* with the F4 key and *OpMode* with the F2 key. Simultaneously press the keys SHIFT and Arrow Down to switch to *MPI down* and confirm the input with ENTER. The message *Ready for transfer* appears on the C7-OP.
- ☞ If you have not yet entered a password, you are now prompted to do so. Enter the digits `100` again on the numeric keypad and press *ENTER*. Select *MPI down* again and confirm with ENTER.
- ☞ Now activate the menu item *File* → *Transfer* to initiate data transfer from the PC/programming device to the SIMATIC C7. The steps for saving and generation are performed automatically by the system after a user prompt if you have made changes to the configuration. Confirm the prompt to save the data with *Yes*.

The C7 starts up when the transfer is complete. The start screen will appear when you press the ENTER key.



- ☞ Then press Softkey *F5* to call up the plant screen.
- ☞ Enter a value in the input field and, using the simulator, check the value change.



- ☞ Press Softkey *F5* to navigate to the second screen entry. Now check the functionality of the counter.

Include standard screens in the configuration

When you started configuring, you selected standard screens as the basis for your configuration and saved the file under the name `Quickmix`.




You need the standard screens if you want to use the standard functions of the C7-621. These functions are, for example, Change mode, Edit password, Log on and off with password, etc.

Once you have identified your configured screen (`Start_QM`) as the start screen, the integrated standard screens can no longer be selected on the OP. In order to use the standard screens, you can define a softkey which you will use to select the standard screens.

- ☞ To do this, select Softkey *F1* in the start screen and follow the instructions in "Link the screens and enable navigation via softkeys" on Page 31. Use the name of the standard main screen `Z_SYSTEM_MEN` as the screen name. Configure the abbreviation `Sys` at the beginning of the 2nd line of the start screen to label the softkey.

You can now transfer the extended configuration to the OP and test it out.

- ☞ Activate transfer mode on the C7-621 by performing a reset:

Switch off the power supply to the C7-621, then simultaneously press the  and  and , hold down these keys and switch the power supply on.

Do not release the keys until the message "Flash Test" appears on the display. A message is displayed after the start-up tests are complete and the C7 OP has been reset.

- ☞ When the C7 has started up, press the ENTER key to select the system screens stored in the firmware in English. Select *System* with the F4 key and *OpMode* with the F2 key. Simultaneously press the keys SHIFT and Arrow Down to switch to *MPI down* and confirm the input with ENTER. The message *Ready for transfer* appears on the C7-OP.
- ☞ If you have not yet entered a password, you are now prompted to do so. Enter the digits 100 again on the numeric keypad and press ENTER. Select *MPI down* again and confirm with ENTER.
- ☞ Now activate the menu item *File* → *Transfer* to initiate data transfer from the PC/programming device to the C7. The steps for saving and generation are performed automatically by the system after a user prompt if you have made changes to the configuration. Confirm the prompt to save the data with *Yes*.

The C7 starts up when the transfer is complete. The start screen will appear when you press the ENTER key. The cursor is positioned in the first screen entry.

- ☞ Now, press Softkey *F1* to call up the standard screens. Select the various screens to activate the functions already implemented.
- ☞ Press the ESC key to quit the standard screens. You are returned to your own configuration.

Configure event messages

Your plant is now virtually complete. The only missing element is event messages. These provide information during operation of the plant.

Enter communication areas

To enable the PLC to communicate with the OP, you must define data areas which can be accessed on both sides. The *Area Pointers* dialog box is used for this purpose.

☞ Select this dialog box via *System* → *Area Pointers*.

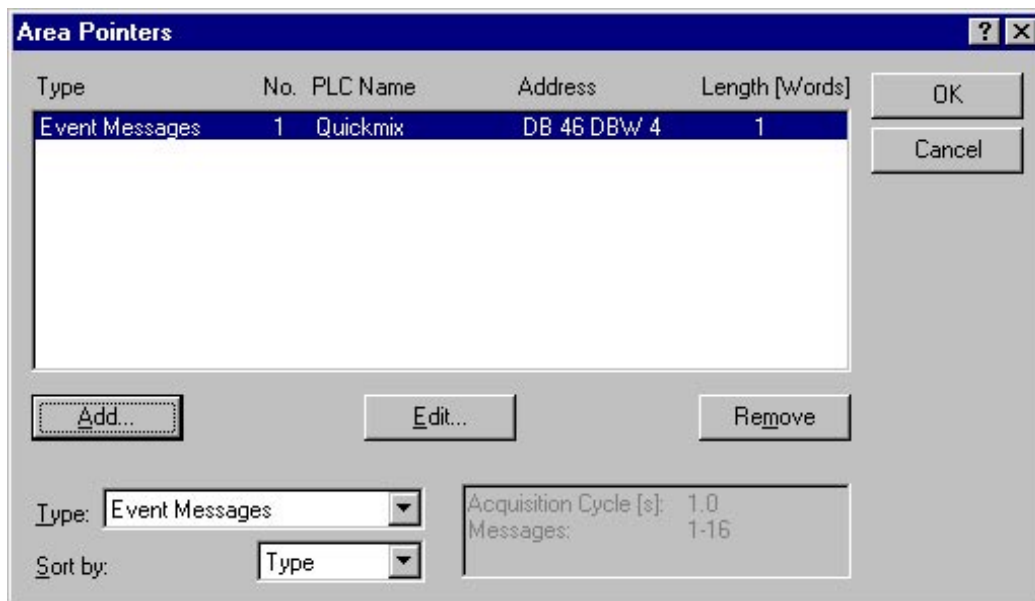
You already know that you want to configure screens with variable values (input, output) and messages. You do not need a special data area for the variables, but you do need separate data areas for event messages and fault messages.

☞ Since you only want to configure event messages, select *Type: Event Messages* in the *Area Pointers* dialog box. Then click the *Add* button.

The *Event Messages* dialog box appears. Configure the event messages area as follows:

☞ Enter *DB: 46* as the *Address*; enter *DBW: 4* and *Length: 1*. For *PLC Name* select *Quickmix*.

☞ Click *OK* to close the *Event Messages* dialog box and return to the *Area Pointers* dialog box

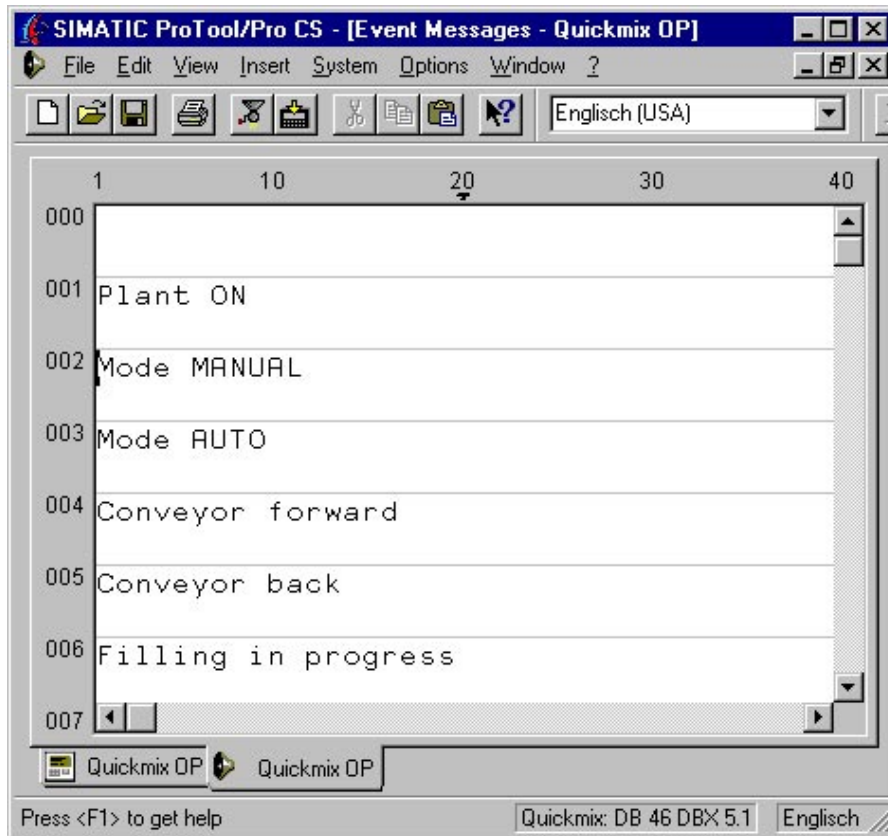


☞ When you have completed the entries, close the dialog box by clicking *OK*. The entries are saved.

You can now start configuring the screens and messages.

Configure event message texts

- ☞ Open the Message Editor with the menu item *Insert* → *Message* → *Event Message*.
- ☞ Configure six messages numbered from 001 to 006, e.g. Plant ON, Mode MANUAL, Mode AUTO, Conveyor forward, Conveyor back and Filling in progress.



In the status line you will see the address which links the message to the PLC. In your example, the address for message no. 002 is `Quickmix: DB 46 DBX 5.1`.

Modify the PLC program

To enable data exchange between the C7 CPU and the C7 OP, you must change the PLC program and load it onto the C7 again.

- ☞ Open organization block OB1 in the SIMATIC Manager and create a new network with the following program lines.

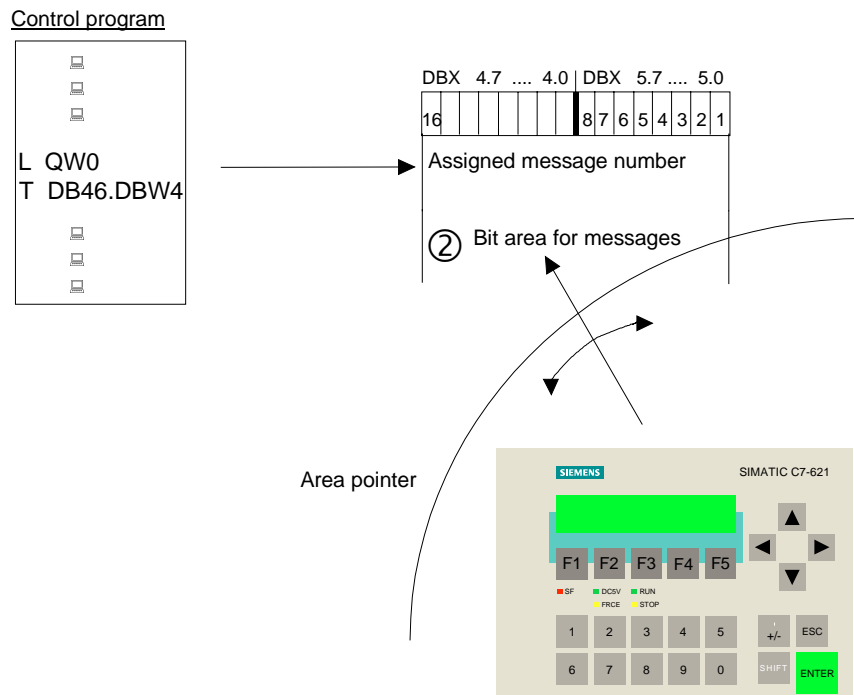
```
OB1 : Filling plant
Network 3 : Data interface
L   QW   124
T   DB46.DBW4
```

- ☞ Save the block and load it into the CPU again. Update the flash memory using the function *Copy RAM to ROM*. Please make sure that the C7 CPU is in STOP mode during the copy process. Then select the CPU mode RUNP again. (see Page 22)

☞ Activate Softkey *F1* on the C7-621 to select the standard screens, and switch the device to Transfer mode with *System* → *Mode*.

☞ Transfer the ProTool configuration to the C7-621 again.

You can trigger the messages on the SIMATIC C7 using the PLC program and the configuration you loaded.



The relationship between the PLC and the OP on the occurrence of a message is shown in the figure above. The procedure is described in detail below.

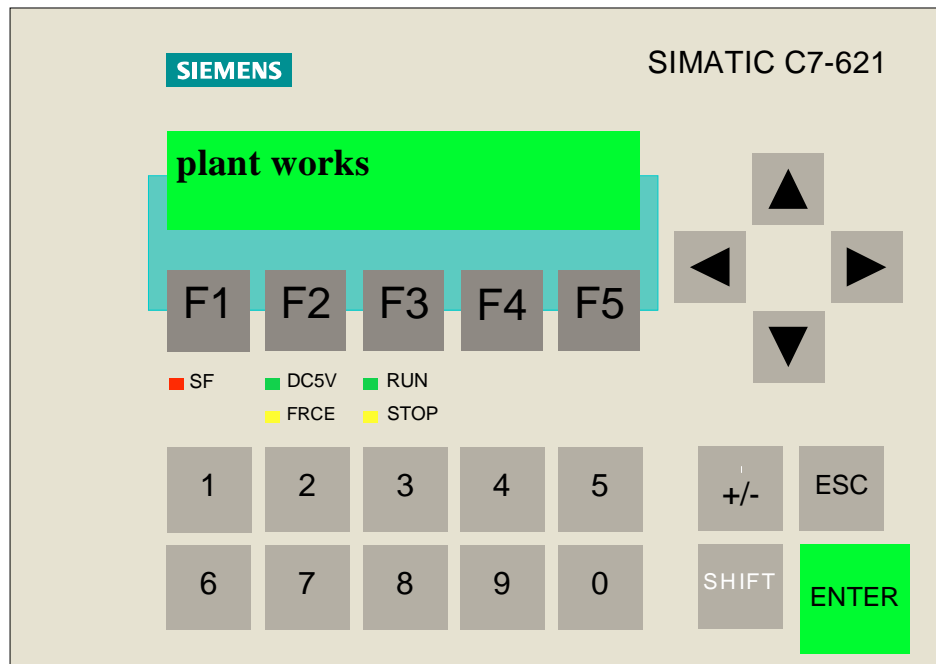
The information, e.g. indicating that the plant has been switched on, must be evaluated in the user program. This can be achieved by transferring output word 0 to data block 46.

A bit area indicates the current status of the messages. Each enabled bit indicates that a message is waiting.

The area pointer you defined at the start of configuration scans the bit area cyclically, detects whether a bit is enabled, and outputs the associated message on the C7 display.

☞ When you have transferred the configuration to the C7-OP (as described above), press the ENTER key. The start screen appears.

☞ Switch the plant on using the start switch on the simulator. This action triggers an individual message. The message interface is displayed with the message.



You have now completed the configuration.

The Quickmix plant has introduced you to some of the functions of the C7-621, programming with STEP 7-Mini and configuration with ProTool/Lite. The full functionality of the C7-621, STEP 7-Mini and ProTool/Lite is described in the C7-621, STEP 7-Mini and ProTool/Lite manuals.

Symbolic addressing

When you program a PLC with STEP 7, you use operands such as I/O signals, bit memories, counters, timers, data blocks and function blocks. Up to now, you have used absolute addresses to reference these operands in your program (e.g. I 124.0, M 5.0, FC15). It is more practical to assign symbolic names, however (e.g. Plant_Start, M_Conv, FC_Mode). To define these symbolic names, proceed as follows:

- ☞ Select the *Symbols* folder in the *S7-Program(1)* folder in the SIMATIC Manager and open it by double-clicking. The Symbol Editor displays the symbol table.
- ☞ In the *Symbol* column of the symbol table, activate the first field by clicking it with the mouse. Then enter a symbol name (e.g. Plant_ON).
- ☞ Use the TAB key to jump to the *Address* column and assign an address to the symbol name (e.g. Q125.0).
- ☞ Skip the *Data Type* column by pressing the TAB key twice. A default value (e.g. Bool) is entered automatically for the data type and the *Comment* field is active.
- ☞ Enter a comment in the comment field, and press the TAB key again. The second field in the Symbol column is activated again. Repeat the steps to input further symbol names. After the input, save the symbol table and close the Symbol Editor.

	Symbol	Address	Data Type	Comment
1	Bottle_Cntr	C 1	COUNTER	Bottle counter
2	DB_OP	DB 46	DB 46	Interface datd block to C7-OP
3	FC_Mode	FC 15	FC 15	Program section for mode
4	FC_Fill	FC 16	FC 16	Program section for filling cycle
5	Plant_Start	I 124.0	BOOL	Plant start switch
6	Mode_M_A	I 124.3	BOOL	Select manual or automatic mode
7	Mode_Accept	I 124.4	BOOL	Accept selected mode
8	Jog_F	I 124.5	BOOL	Jog forward
9	Jog_B	I 124.6	BOOL	Jog back
10	Sen_Hop	I 125.0	BOOL	Bottle sensor on filling hopper
11	Sen_Full	I 125.1	BOOL	Bottle sensor for full bottles
12	M_Conv	M 5.0	BOOL	Scratchpad memory bit for conveyor
13	Plant_ON	Q 125.0	BOOL	Plant Quickmix switched on
14	Mode_M	Q 125.1	BOOL	Manual mode
15	Mode_A	Q 125.2	BOOL	Automatic mode
16	Conv_F	Q 125.3	BOOL	Conveyor forward
17	Conv_B	Q 125.4	BOOL	Conveyor back
18	Filling	Q 125.5	BOOL	Filling in progress
19	E_Msg	QW 124	WORD	Output word for event messages
20	T_Fill	T 1	TIMER	Timer for filling
21				

Note

Long symbolic names are intuitive but take time to enter. With a combination of short symbolic names and detailed comments you can create good program documentation and an effective program.

Set symbolic representation

To enable the symbolic names to be displayed in your program, you must set the appropriate type of representation.

- ☞ Open Function FC15 in the offline database. In the LAD/STL/FBD Editor that appears, select the menu item *View* → *Display* → *Symbolic Representation*. The absolute addresses are replaced by the symbolic names.
- ☞ You can display the absolute addresses and the comments from the symbol table by activating *View* → *Display* → *Symbol Information*. The network comments are then no longer visible.

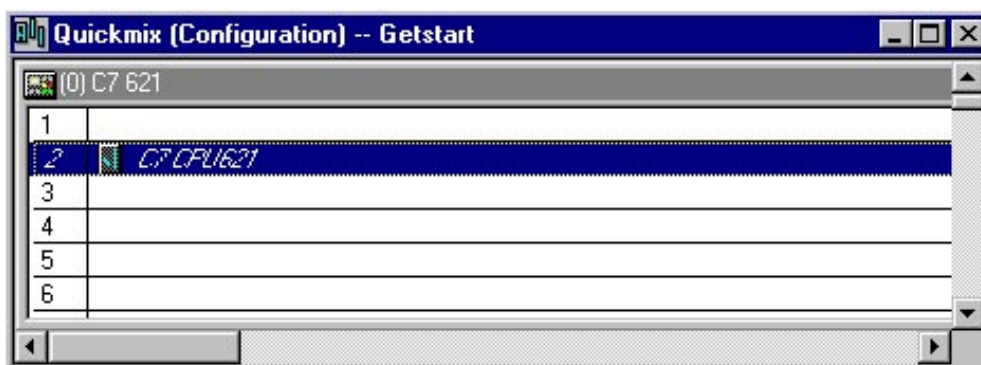
Note

If you want to include new operands during programming, you can assign symbolic names to individual absolute addresses by activating the menu item *Options* → *Symbol Table* from the LAD/STL/FBD Editor. The entries are automatically inserted in the symbol table.

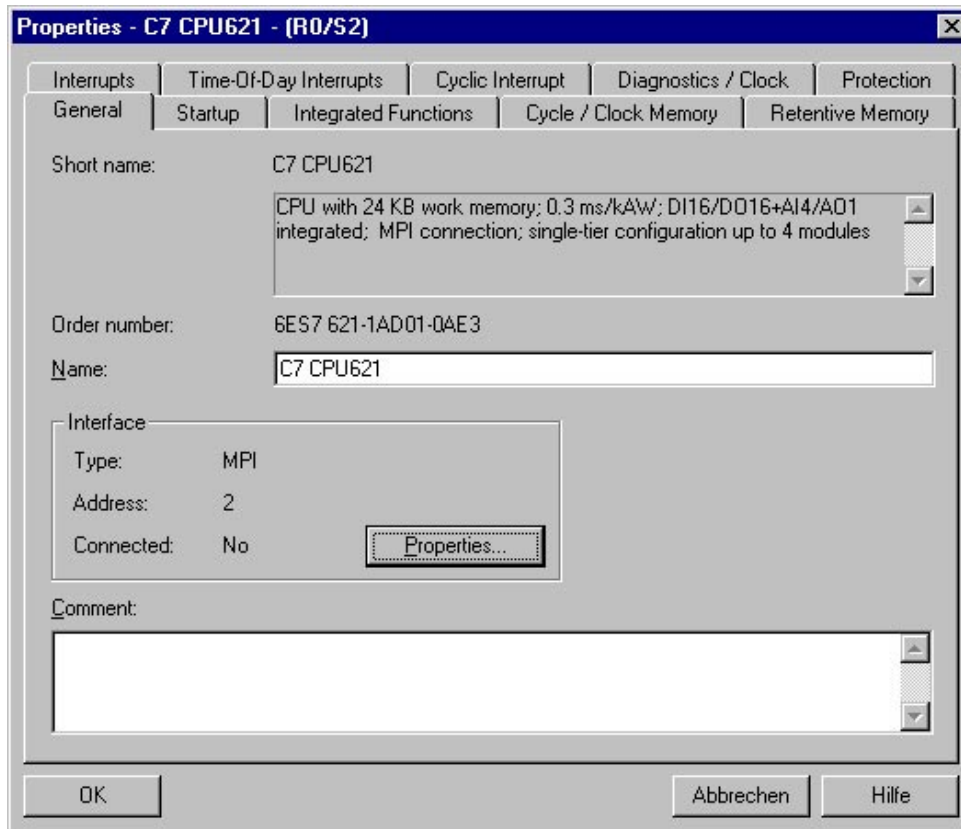
Use symbolic names in ProTool

Before you can use symbolic names in ProTool you must define certain settings.

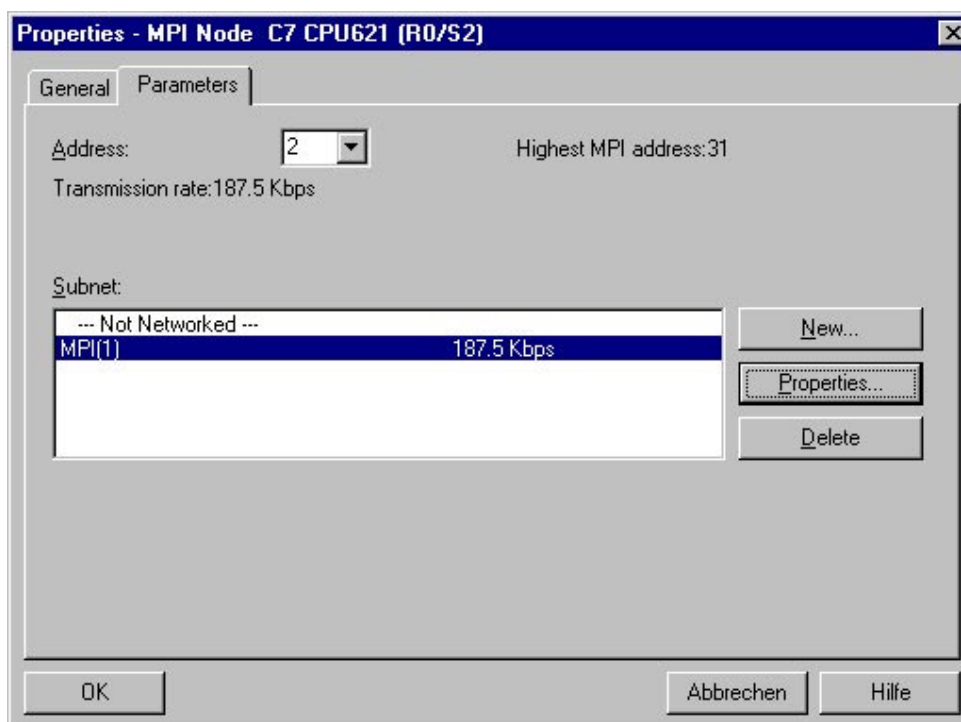
- ☞ To do this, open the *Hardware* folder in the SIMATIC Manager by double-clicking. The Hardware Configurator appears.



- Open the *Properties - C7 CPU621* window in the Hardware Configurator by double-clicking the *C7 CPU621* symbol.



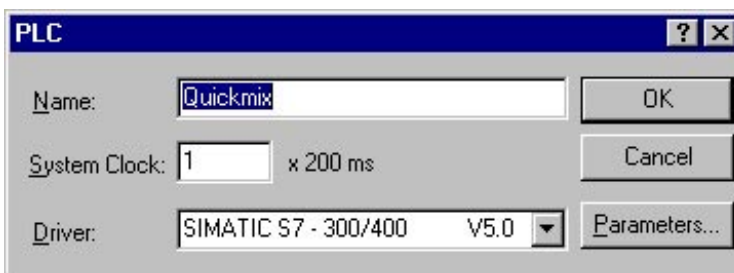
- Open the *Properties - MPI Nodes* window by clicking the button *Properties ...*, and select the *Subnet: MPI(1)*. Accept the settings with *OK*, save and compile the hardware configuration, and load it into the *C7 CPU* again.



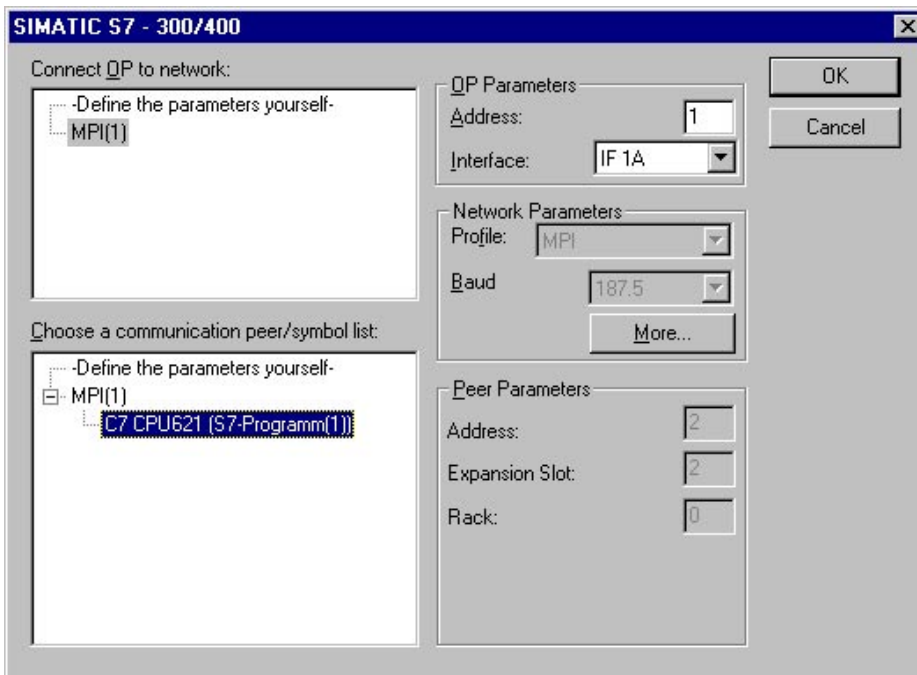
- Now open your C7-621 ProTool configuration and select the folder *Controllers*.




- Open the PLC Quickmix by double-clicking.

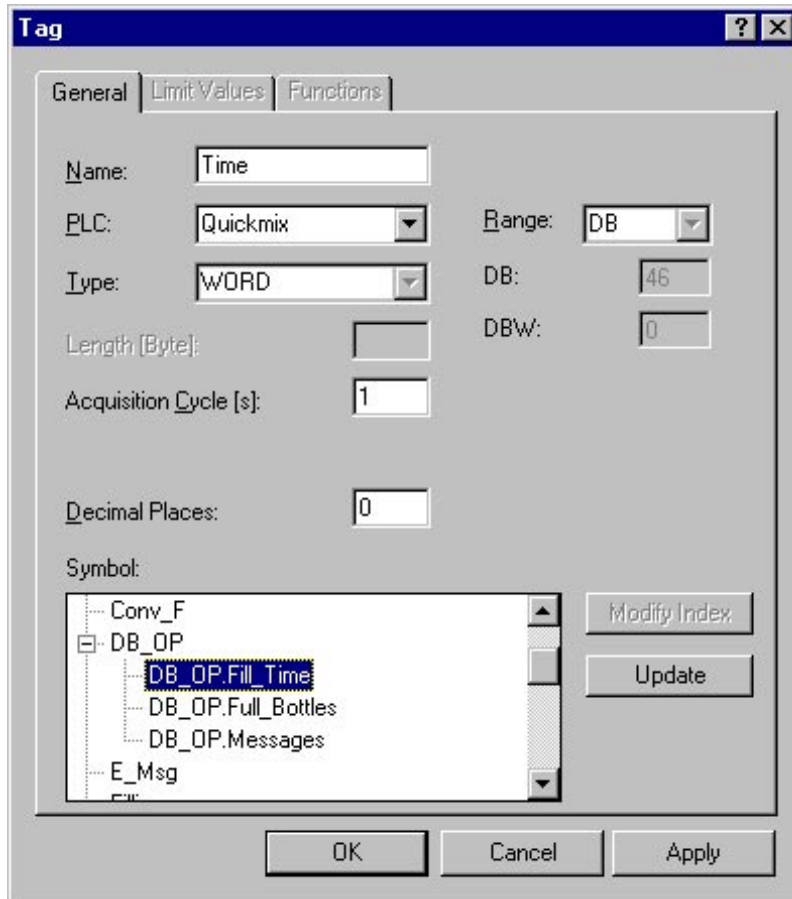


- Click the *Parameters...* button. Select *MPI(1)* under *Connect OP to network*. *MPI(1)* appears under *Choose a communication peer/symbol list*, and the network parameters are displayed on a gray background.
- Double-click *MPI(1)* under *Choose a communication peer/symbol list*. The PLC: *C7 CPU621(1)(S7-Programm(1))* appears. Select the PLC by double-clicking. Then accept the entries with *OK*.



The initial settings are now complete and you can include the symbolic names in your configuration.

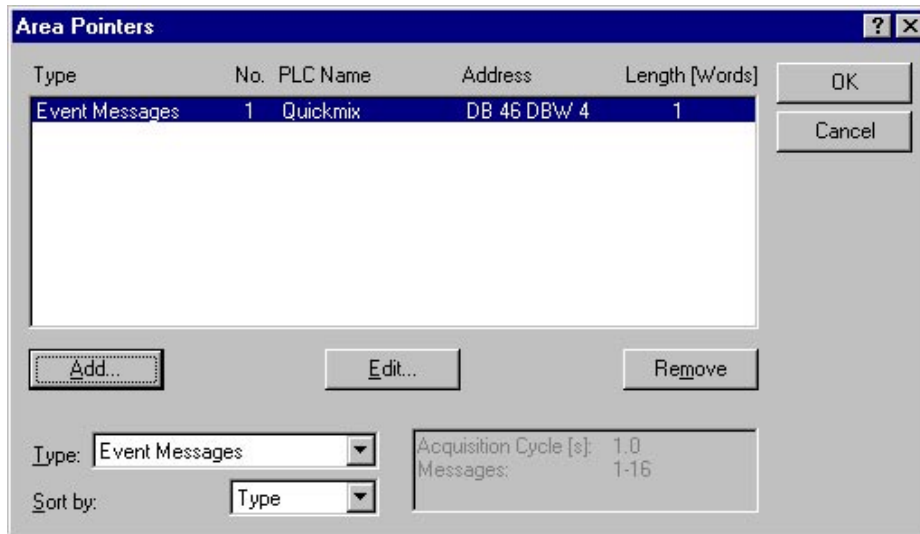
- Open the *Plant* screen, double-click the variable *Time* and click the *Edit* button  in the *Input/Output field* dialog window. In the dialog window that now appears, the symbolic names are displayed under *Symbol*.
- Select the name `DB_OP.fill_time` under `DB_OP` in the variable list. The absolute addresses are displayed on a gray background. Confirm the entry with *OK*.



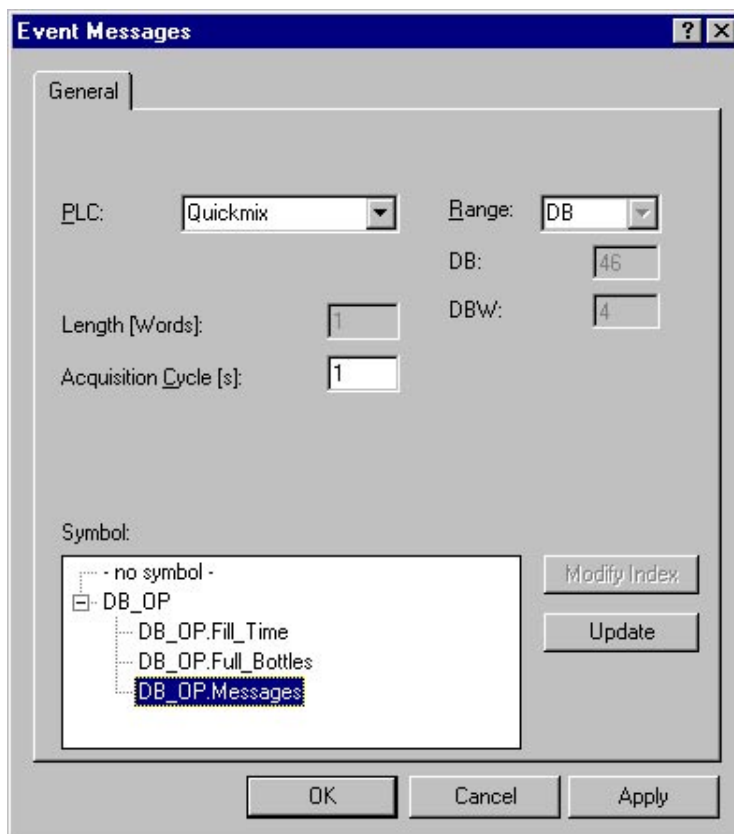
- Repeat the steps for the variable *Count* with the symbolic name `DB_OP.full_bottles`. Close the window again with *OK*.

You must now assign the symbolic names to the event messages.

- To do this, open the *Area Pointers* window in ProTool from the *Target System* menu. Click the *Edit...* button in the *Area Pointers* window.



- In the *Event Messages* window, select the symbolic name `DB_OP.messages` and confirm the entries with *OK*.

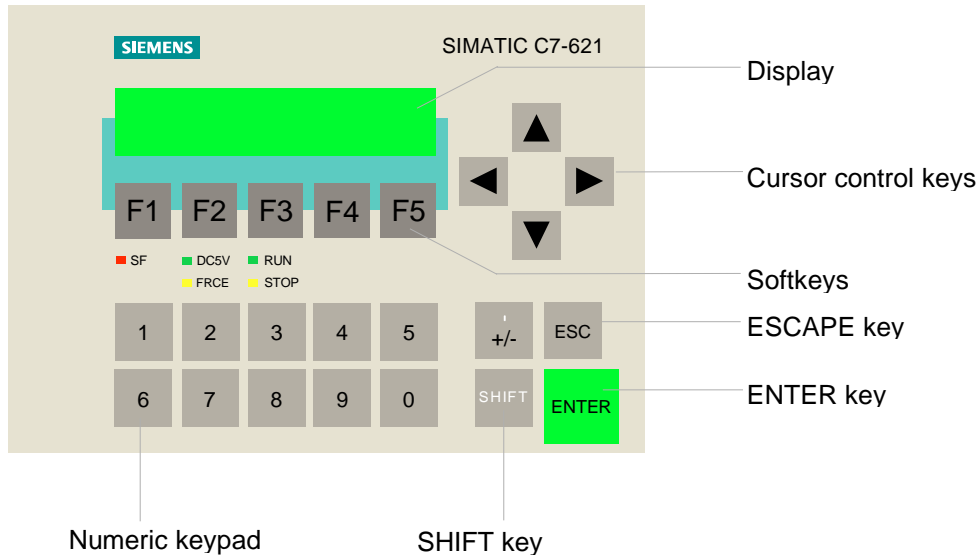


- Save the revised configuration and transfer it to the C7 OP again.

This completes the conversion to symbolic addressing.

How to operate the C7-621

To facilitate operation of the C7-621, here is a brief description of the main keys on the C7-621 and their meaning.



ESCAPE key

- Pressing ESCAPE quits the current operating level and moves back one level.
Example: Press ESCAPE to close the plant screen `Plant_QM` and return to the start screen `Start_QM`. Press ESCAPE again to reach the message level.
- You can use ESCAPE to cancel entries, i.e. a value which you have already entered in an input field is discarded.

ENTER key

- ENTER is used to accept entries, i.e. the value you entered in the input field is transmitted to the PLC.

Cursor control keys

- The Up and Down cursor control keys are used to scroll between different entries within a screen.
Example: You can use the Down key in the `Plant_QM` screen to move the cursor down to the second screen entry.

Example program

You will have created and started up the following STEP 7 program by following the instructions.

DB46:

Address	Declaration	Name	Type	Initial Value	Comment
0.0	stat	Fill_Time	Word	W#16#2003	
+2.0	stat	Full_Bottles	Word	W#16#0	
+4.0	stat	Messages	Word	W#16#0	

FC15: Mode

Network 1 : Plant ON/OFF

```
A I 124.0 // Start (if input 124.0 on /off)
= Q 125.0 // Plant ON (plant is then switched on/off)
```

Network 2 : MANUAL mode

```
A Q 125.0 // Plant ON
AN I 124.3 // and MANUAL mode selected (switch=0)
A I 124.4 // Confirm acceptance of selected mode
S Q 125.1 // Manual mode activated
A( // If
ON Q 125.0 // plant OFF (LED of DO not lit)
O I 124.3 // OR AUTOMATIC mode selected (switch=1)
)
R Q 125.1 // Then select Manual mode
```

Network 3 : AUTO mode

```
A Q 125.0 // If plant ON
A I 124.3 // and AUTOMATIC mode selected (switch=1)
A I 124.4 // and acceptance of selected mode confirmed
S Q 125.2 // Then set automatic mode
A(
ON Q 125.0 // Plant OFF (LED of DO not lit)
ON I 124.3 // or Manual mode set
)
R Q 125.2 // Then select AUTOMATIC mode
```

Network 4 : Conveyor forward

```
A Q 125.1 // If MANUAL mode set
A I 124.5 // and Jog Forward is pressed (enabled)
AN I 124.6 // and Jog Back is not pressed (enabled)
O M 5.0 // or filling process running in AUTOMATIC mode
= Q 125.3 // Then move conveyor forward
```

Network 5 : Conveyor back

```
A Q 125.1 // If MANUAL mode set
A I 124.6 // and Jog Back is pressed (enabled)
AN I 124.5 // and Jog Forward is not pressed (enabled)
= Q 125.4 // Then move conveyor back
```

FC16 : Filling cycle

Network 1 : Fill bottles

```
A  I  125.0  // Bottle sensor 1 has detected a bottle
L  DB46.DBW0 // Load filling time (3s)
SE T  1      // Set extended pulse (3s)
A  T  1      // When timer 1 reaches level 1
=  Q  125.5  // Open inlet valve
```

Network 2 : Scratchpad memory for conveyor, AUTO

```
A  Q  125.2  // If AUTOMATIC mode set
A(                                     // and
ON I  125.0  // no bottles have been detected by bottle sensor 1
O                                     // or
A  I  125.0  // bottle sensor 1 has detected a bottle
AN T  1      // and filling process not running (valve closed)
)
=  M  5.0    // Then the conveyor is moving
```

Network 3 : Count full bottles

```
A  I  125.1  // Bottle sensor 2
CU  C  1     // Increase counter by 1
A  Q  125.0  // When plant is switched on
L  C#0
S  C  1     // Reset counter to 0
L  C  1     // Write current counter state to
T  DB46.DBW2 // data block word
```

OB1 : Filling plant

Network 1 : Mode section

```
CALL FC  15
```

Network 2 : Filling cycle

```
CALL FC  16
```

Network 3 : Data interface

```
L  QW  124
T  DB46.DBW4
```