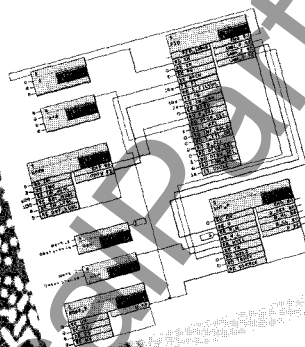


SIEMENS

SIMATIC Software

CFC for S7
Continuous Function Chart

Manual



CFC

SIMATIC

CFC for S7 Continuous Function Chart

Manual

This manual is part of the
documentation package with
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Preface, Contents

Essentials of CFC

Getting Started

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C79000-G7076-C750

Preface

Purpose of the Manual

This manual "CFC for S7" provides you with the information you require to use the CFC configuration tool in conjunction with CPUs in SIMATIC S7 programmable controllers (PLCs).

For a complete description of CFC for other systems, you also require the supplementary CFC descriptions for the particular system (for example, "CFC for M7", "CFC for SIMADYN D")

How Sections for Specific Systems are Indicated

If sections, paragraphs or even individual sentences in this S7 manual relate solely to S7 users, this is indicated by [S7]. This means that the information is relevant only to S7 or is different in other systems. In this case, if you use a different PLC, you will find the information you require in the manual for your specific system. If the [S7] label is in a title, the entire section applies only to S7; if the label is at the start of a paragraph, the paragraph is solely relevant to S7. In lists, the [S7] label applies only to the particular list.

Audience

This manual is intended for personnel involved in configuring, commissioning and service.

Validity of the Manual

This manual is valid for CFC software version 5.0 and higher.

Standard

The CFC software is based on the international standard DIN EN 61131-3 (IEC 1131-3) for programming languages for programmable logic controllers.

Conventions

References to other documentation are indicated by numbers in slashes /.../. Based on the number, you can check the full title of the documentation in the References at the end of the manual.

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To help you to become familiar with working with PLCs, we offer a range of courses. Please contact your regional training center or the central training center for more information.

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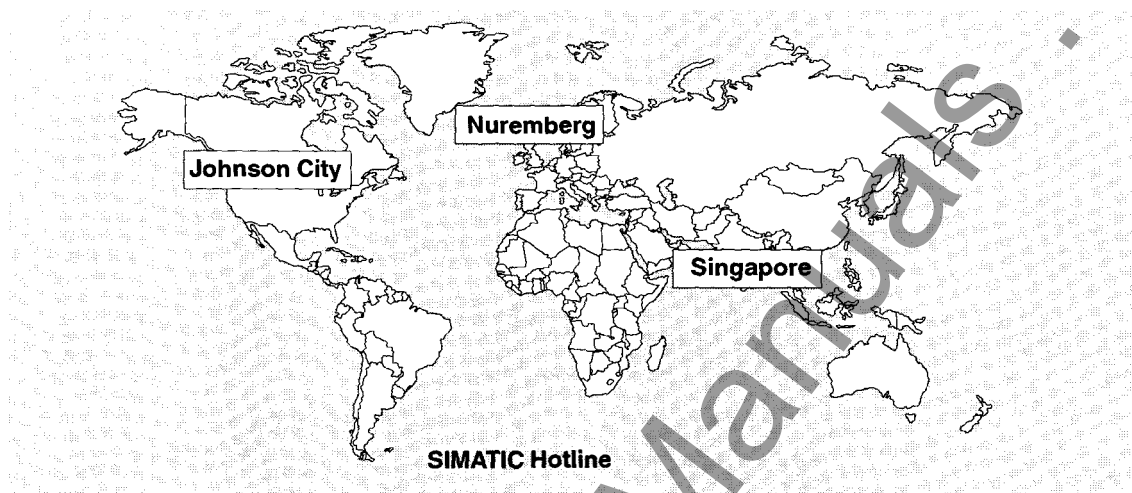
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Essentials of CFC

Introduction

This chapter provides you with basic information about CFC, shows how it fits into the STEP 7 software package, describes the block concept, and explains the steps required from creating the project structure to testing the program.

For a description of installation, authorization, and starting up the CFC software, refer to the readme file shipped with the CFC package.

1.1 General

What is CFC?

CFC (Continuous Function Chart) is a graphic editor that can be used in conjunction with the STEP 7 software package. It is used to create the entire software structure of the CPU from ready-made blocks. When working with the editor, you place blocks on function charts, assign parameters to them, and interconnect them.

Interconnecting means, for example, that values are transferred from one output to one or more inputs during communication between the blocks.

How the Package Works

In the CFC editor, you work with graphic tools: You select ready-made blocks from the pool of blocks, drag the blocks to your chart (a form of "drawing page") and then interconnect them using the mouse. You do not need to be aware of details such as algorithms or the assignment of machine resources but can concentrate solely on the technological aspects of your configuration.

The run-time properties of the blocks have default settings but these can be adapted individually for each block. Since individual blocks or whole groups of blocks can be copied or moved from chart to chart, you can save a considerable amount of time. Interconnections between the blocks are retained.

Once you have created all the functions you require, you can create executable machine code with a simple mouse click, download the code to the PLC, and test it with the CFC test functions.

Blocks

You can take the blocks you require in CFC from block libraries or other projects or you can create the blocks yourself.

1.2 [S7] CFC in the STEP 7 Environment

SIMATIC Manager

The SIMATIC Manager is used for all PLCs as the graphic interface to coordinate the tools and objects. The SIMATIC Manager manages tools and data and is used, for example, for creating and modifying a project structure (CPU, CFC charts) and to start the CFC Editor.

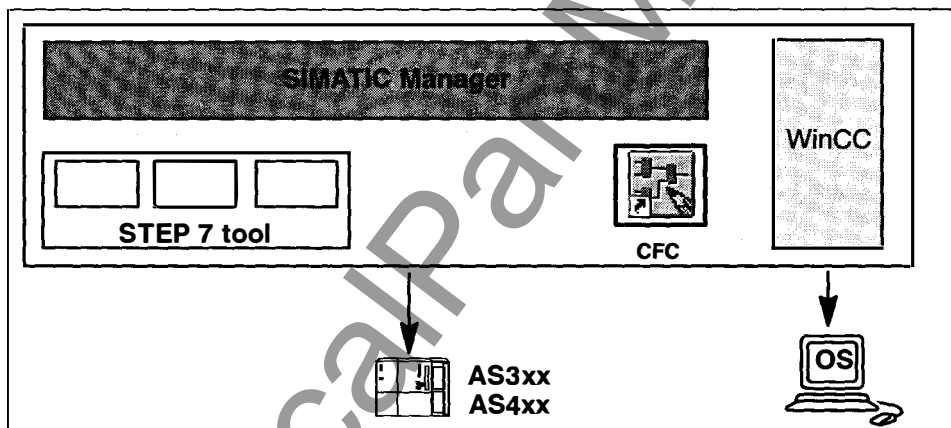


Figure 1-1 CFC in the STEP 7 Environment

Further Components

Depending on your programmable controller, you can use further components, for example different language packages for creating block types and tools for creating input data for the CFC charts such as I/O data that you can reference from within CFC.

1.3 The CFC Chart

To establish the terminology we will be using, the section below describes the CFC chart and its elements.

Charts and Chart Partitions

The basic working unit of the CFC editor is the chart. Each chart has a name that is unique in the CPU. You can create charts either in the SIMATIC Manager or directly in the CFC editor.

Each chart consists of up to 26 chart partitions. A newly created chart consists of a single chart partition, further chart partitions can be added.

Sheets and Sheet Bars

Each chart consists of six sheets arranged in two columns of three in the CFC editor (see Figure 1-2). A sheet consists of a central working area and sheet bars containing the sheet and chart references. On the working surface, you can position and interconnect blocks or further charts.

Overflow Page

If there are so many entries that there is no more space in the sheet bars, an overflow page is automatically created. The overflow page is an extension of the sheet bars and contains no further objects.

Nested Charts

A CFC chart can be nested in another CFC chart (chart-in-chart technique). This allows hierarchical structures to be created. Each nested chart can be opened just like any other chart, edited, and individually modified.

A chart can be “encapsulated” for further use; in other words it is given chart I/Os. For each chart, you can decide which block I/Os are available at the chart I/Os.

For further information about creating nested charts, refer to this manual, Chapter 3 or look in the online help.

Chart Overview and Sheet View

You can change between the chart overview and the sheet view at any time.

The overview is useful for copying and moving blocks/charts and for inserting larger blocks. Since, however, certain details cannot be displayed in this view, for example the names of inputs and outputs, certain functions are only possible in the sheet view.

With the zoom functions, you can change the size of the view in regular steps between the smallest and largest display.

Display of a Chart

You can customize the display of the various chart elements. You can, for example, decide whether the type name or the FB/FC assignment is displayed in the block headers and whether the data type and I/O name or the comment is displayed for I/Os. You can also select how parameters, addresses, and connections are displayed.

For more detailed information, refer to the online help.

Example of a Chart Overview

Figure 1-2 shows an empty CFC chart (6 sheets) in the chart or overview display.

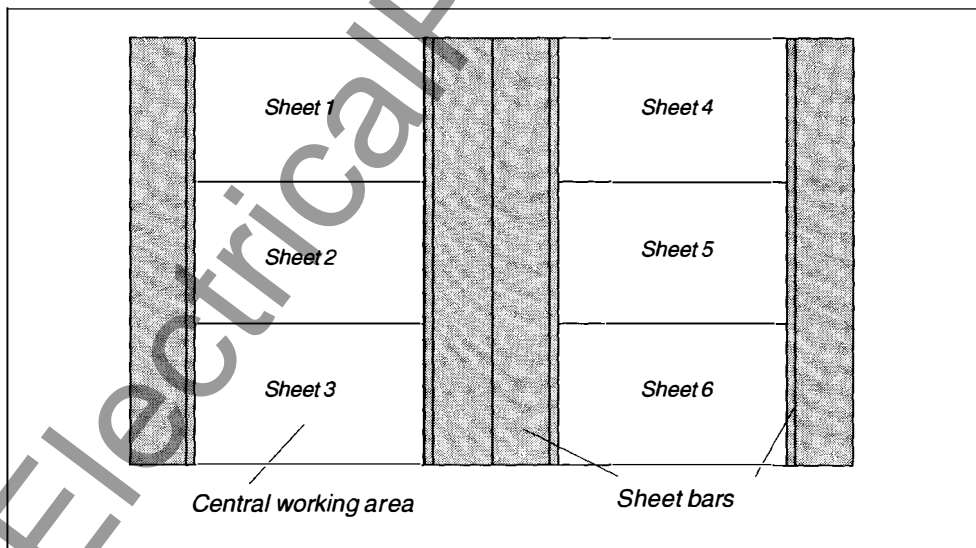


Figure 1-2 CFC Chart as an Overview

Example of the Sheet View

Figure 1-3 shows the sheet view of a CFC chart with 4 interconnected blocks:

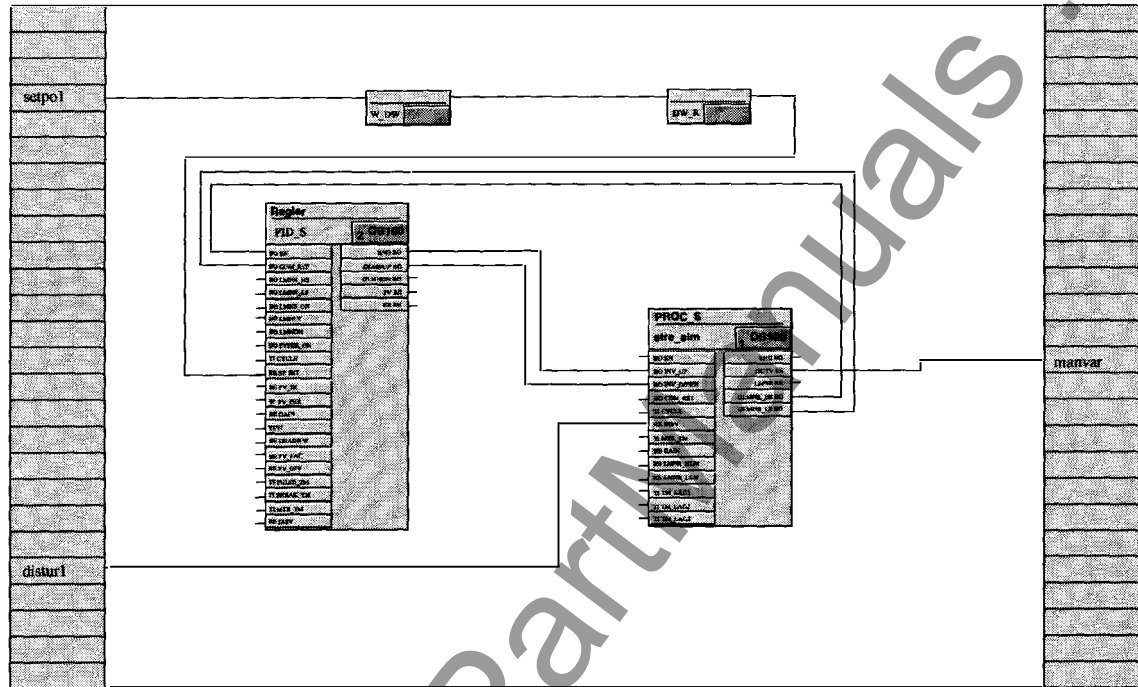


Figure 1-3 CFC Chart in the Sheet View

1.4 Blocks in the CFC Chart

Functions in the Form of Blocks

In CFC, you work with ready-made blocks that have a specific function. You place these function blocks in the chart, interconnect them, and assign parameters to them.

The Block Type

A type definition that specifies the algorithm, the type name, and the data interface (the input and output parameters) exists for each function block.

The **type name** is an abbreviation or acronym of the function, for example:

- **CTUD** (**C**OUNT **U**P and **D**OWN) for the function of an edge-controlled count up/count down counter.
- **COUNT_P**, a counter that counts up or down (depending on the setting) at the positive edge of a binary signal.
- **ADD_R**, a simple function that adds input values and applies the sum to the output.

The type definition also specifies the **data types** of the input and output parameters. These input and output parameters are known as block inputs and block outputs since this is how they appear in the graphic display of the block. The data type of an input or output specifies the values it can adopt, for example:

BOOL Boolean type, can only adopt the values 0 or 1.

STRING Character string type, can contain a string of characters as its value. There are also other data types, refer to the Appendix, Table A-2.

The Block Instance

When you place a block in your CFC chart, you create a block instance by inserting this block type in the chart. Instance in this sense means that it is an instance or usage of the selected block type.

You can create any number of block instances from a particular block type. You can assign names to these block instances, interconnect them, and assign parameters to them without changing the functionality specific to the type.

One advantage of this type instance concept is, for example, that following later central changes to the block type, these changes can be automatically made in all the corresponding block instances.

[S7] Multi-Instance Blocks

Functions can also be put together using different subfunctions. These subfunctions themselves are blocks and are put together to create a complex block (for example a closed-loop control block that itself contains blocks including a message block and a control block).

Multi-instance blocks can be created in CFC by interconnecting different blocks (functions) and assigning suitable parameters in a chart. You then compile the chart as a block type (see section 3.9.2).

Blocks with a Variable Number of Block Inputs

In CFC, there are blocks whose number of inputs are variable and can be changed with the CFC editor. A block with a variable number of inputs is, for example, the **AND** block.

Block Families

Blocks are grouped together according to their functional properties to form block families. When it is created, each block receives a family identifier. One such family, for example, is made up of

- the conversion blocks for adapting various data types
CONVERT (BO_BY, BY_DW, W_DW, ... etc.)
- the multiplexer blocks =
MULTIPLX (MUX8_R, MUXn_DI, ... etc.)
- the blocks with math (floating point) functions
MATH_FP (SQRT, ADD_R, ... etc.)

The names of the block families are used, among other things as a criterion for sorting blocks in the CFC catalog.

[S7] Organization Blocks

The interface between the operating system of the CPU and the user program are the tasks known in S7 as organization blocks (OBs). Using these OBs, specific program sections can be executed at certain times and in certain situations. There are OBs for CPU startup (cold restart, hot restart), for process interrupts, for cyclic interrupts (with different time bases) etc.

Organization blocks or tasks are not blocks in the sense understood in CFC; they can neither be inserted nor edited in CFC. In CFC, the OBs are displayed when you edit the run sequence (see Section 3.8.1).

Further Distinctions

Blocks also differ in their type. When a block is created, it must be “declared” as a function block (FB), a function (FC) or a basic operation (BOP).

- An **FB** is a block with memory; in other words the data exist during processing from cycle to cycle and can be accessed. To make this data accessible, a data block (DB) is created for each block instance. In a complex block, the FB has further subsidiary FBs for which only one common DB is created.
- An **FC** is a block without memory; in other words the values generated by the block are processed immediately. No data block is required here. An FC does not have default values at the outputs.
- A **BOP** (like the FC) is also a block without memory. Basic operations are program components in CFC and are entered as SCL statements during compilation and are used for simple functions such as AND, OR etc.

Special Situation: Unplaced Blocks

Unplaced blocks are blocks that can no longer be displayed in the chart but remain functional in the program and are also executed on the CPU. Unplaced blocks can arise for example:

- When changes are made via the CFC programming interface.
- Due to migration of projects from V4 to V5 where space has become short due to the introduction of value identifiers.

The unplaced blocks are kept in a separate catalog from where you can place them in the chart again. Previous interconnections are then automatically regenerated.

1.5 The Catalog

Catalog of Blocks, Charts and Libraries

Blocks and charts that you want to insert in the CFC chart (using drag-and-drop) can be taken from a catalog.

The catalog consists of a window in which the existing block families, libraries etc. are listed (tree structure). The range displayed depends on the PLC and the installed libraries.

You can switch from window to window using the buttons visible at the lower edge of the window:



Blocks: Here you will find the existing (imported) blocks and BOPs sorted according to families and the blocks of the current program that you can insert in the chart.



Libraries: Here you will find the block libraries from which you can insert new blocks into the chart. The libraries known to the SIMATIC Manager are displayed.



Charts: Here you will find the CFC charts of the current program that you can insert (copy) or open.



Unplaced Blocks: This contains the blocks of the current program that can no longer be displayed in the CFC chart. The CFC chart to which the blocks are assigned is displayed here.

In the catalog Windows, Blocks, Libraries and Charts, there is a text field that you can insert in the chart just like a block.

In the lower part of the catalog, you will find the following buttons:



Find block or chart: You can specify a block or chart name in the box and search for it with the "Find" button. The folder (for example of the block family) in which the object is located is opened. You only need to type the first few letters. The search stops when an object with these letters is found. During the search, a dialog box with a progress bar is displayed. Here, you can also stop the search if it takes too long.



Close folders: Below the "Find" button, there is a "Close" button. With this button, you can close all the open folders in the catalog.

1.6 [S7] Operator Control and Monitoring

During operation of the process, messages are generated on the PLC that need to be passed on to the operator control and monitoring system (PCS 7).

With the message configuration in CFC, you can configure event-dependent messages, their texts, and attributes directly in the block.

While configuring the PLC, you create data that are required on the OS for communication between the PLC and OS; in other words for operator control and monitoring. You can transfer the data to the OS in the SIMATIC Manager.

Message Blocks

When you insert a block with message capability into the CFC chart, a message is created automatically. This block has a message structure with default attributes and message texts; in other words the PLC sends the message when an event occurs without any extra configuration on the part of the user. The signals that form messages can also have associated values that allow dynamic values to be entered in the message texts.

You can edit the attributes (such as message class, message type) and the message texts for the individual block instances with the message configuration functions (Special Object Properties "Messages"). If the "Messages" button is not activated, the block is not capable of sending messages.

For further information about configuring messages, refer to the manual */256/* and the online help.

Operator Control Blocks

All the message blocks for PCS 7 have an attribute for operator control and monitoring (S7_m_c). Texts can be selected and edited for blocks with inputs that allow operator input. You can call up the appropriate dialog box by selecting the "Operator control and monitoring" checkbox in the object properties of the block. The "operator control and monitoring" attribute of CFC blocks (instances) can also be modified. To modify this attribute, select the "Operator control and monitoring" check box in the object properties of the block.

PLC-OS Communication

When you have completed configuring the messages, the data required on the OS for communication between the PLC and OS is transferred to the OS. This data is transferred to one or more destination operator stations and is used on these stations by graphic objects or picture blocks. To make this transfer, the "PLC-OS Engineering" software package must be installed.

For further information about transferring data, refer to the manual */256/* and the online help.

1.7 Steps in Configuration

Order of the Steps

1. Creating the Project Structure
2. Create blocks and import them to CFC (optional)
3. Inserting Blocks in the Chart
4. Set parameters for the blocks and interconnect them
5. Adapting Run-Time Properties
6. Compile the CFC charts
7. Downloading the CFC Program
8. Testing the CFC Program

Creating the Project Structure

To work with CFC, you must create a chart folder below the program (folder for the system-specific program) using the SIMATIC Manager.

You create the individual CFC charts in the chart folder either using the SIMATIC Manager or directly in the CFC editor.

[S7] When you create the project structure, you are supported by the “New Project” wizard (depending on the setting either the STEP 7 or the PCS 7 wizard). The PCS 7 wizard creates the project in the component view and in the plant view. The default setting of the PCS 7 wizard is also to create a CFC chart.

Creating Blocks (optional)

CFC works with ready-made blocks. These can be blocks from libraries, other programs, or types you created yourself. For more information about creating blocks, refer to the manual on creating block types.

Importing Blocks

The way in which block types are included and, in some cases, imported depends on the PLC.

For more detailed information, refer to Section 3.3.1.

Inserting Blocks in the Chart

Blocks are inserted in the chart by dragging them from the catalog. This creates a block instance with a name that is unique throughout the chart. You can create any number of block instances from each block type.

For more detailed information, refer to Section 3.3.5.

Setting Parameters and Interconnecting Blocks

You can assign parameters to the inputs and outputs of the blocks or you can interconnect them either with other blocks or with shared addresses. (Shared addresses are connection endpoints located outside the CFC charts, for example in S7: I/O signals, memory bits, timers, counters, and shared data blocks.)

Interconnecting means that values are transferred from one output to one or more inputs during communication between the blocks or other objects.

For more detailed information, refer to Section 3.5.

Adapting Run-Time Properties

The run-time properties of a block decide how the block is included in the run sequence within the entire structure of the PLC. These properties are decisive for the response of the PLC in terms of reaction times, dead times, or the stability of time-dependent structures, for example closed loops.

When it is inserted, each block is assigned default run-time properties. The block is installed in a task at a position that you yourself can select. You can change the position at which the block is installed and other attributes later if necessary.

For more detailed information, refer to Section 3.7.

Compiling the CFC Chart

During compilation as a program, all the charts of the active CPU are converted to machine code. Different compilers are used depending on the destination PLC; the call is, however, identical. If you compile as a block type, only the individual chart is compiled.

For more detailed information, refer to Section 3.9.

Downloading the CFC Program

After compilation, you can download the CFC program to the CPU.

For more detailed information, refer to Section 3.10.

Testing the CFC Program

After compiling and downloading the program you can test it. The range and type of test functions available differs from PLC to PLC. In the test mode, you are connected online to the programmable controller.

For more detailed information, refer to Section 4.3.

Getting Started

2

Introduction

This chapter “Getting Started” is intended as a primer for newcomers to CFC who want to get to know the package quickly. The example is divided into various tasks and guides you step-by-step from the simplest configuration jobs to the creation of a chart with chart I/Os and blocks in CFC.

You will find a completely configured example in “CFC_SAMP”.


In this example, it is assumed that CFC will be used in the STEP 7 environment. This means that the STEP 7 standard package, SCL, and CFC are installed. The PLC used is either S7-300 or S7-400.

You create the sample project “CFCBSP_2” with the SIMATIC Manager.

2.1 Creating a Closed-Loop Control with a Simulated Process

2.1.1 Creating the Project

This section describes the steps involved in creating a project with the menu commands of the SIMATIC Manager. The hardware can be configured later; in the example we have restricted ourselves to the S7 program.

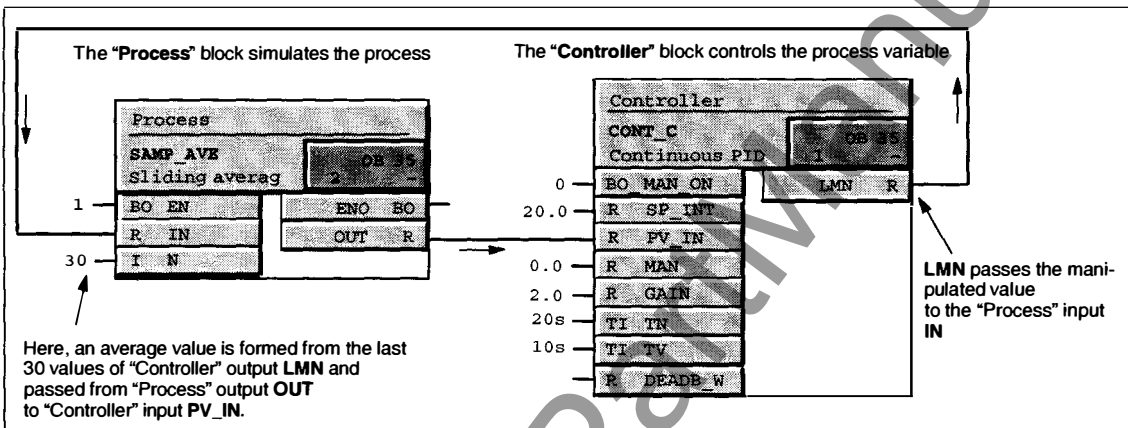
- In the toolbar, select  or **File > New**.
In the “New Project” dialog box, enter the project name “CFCBSP_2” and enter it with “OK”.
- With the project folder selected, click the menu command **Insert > Program > S7 Program**. The S7 program is created with the source folder, block folder and symbol table. The project must be in the “Component View”.
- With the S7 Program folder selected, click the menu command **Insert > S7 Software > Chart Folder**. The chart folder is created.
- With the chart folder selected, click the menu command **Insert > S7 Software > CFC**. A chart “CFC1” is created; Give this the name “Control”.
- Double-click the CFC chart to open it.

All the requirements for working with the CFC editor have now been satisfied.




2.1.2 Creating a Chart

Aim

You will now create a control with process simulation in which the process is simulated by a sliding average value. You will use two blocks for this, SAMP_AVE and CONT_C. The SAMP_AVE block forms the average value from a number of input values and the CONT_C is a PID controller that controls this variable average value.



Inserting the Blocks

- Open the catalog  if it is not already open (default).
- In the catalog, click the button  of the libraries; Here you can open the **CFC Library**. This is a collection of block libraries.
- Now open the folder **ELEM_300**. This is a library with blocks suitable for the AS 3xx CPU. If you are using the AS 4xx CPU, open the folder **ELEM_400**. You can drag blocks from the list that appears to the chart.
- Click **CONT_C**, hold down the mouse button and drag the block to the chart. Position it to the top right on sheet 1.
- Then take the block **SAMP_AVE** and position it on the left beside the CONT_C block.
- Double-click a free position close to the two blocks to change to the sheet view (or, in the toolbar click ).

In the sheet view, you can see the blocks as graphic objects with a header and several I/Os on the body. The I/Os (inputs left, outputs right) are displayed as fields with the I/O name and data type.

Interconnecting the Blocks

Now interconnect the blocks as follows:

- On the SAMP_AVE block, click the output **OUT** and then click the input **PV_IN** on the CONT_C block.
On the CONT_C block, click the output **LMN** and then click the input **IN** on the SAMP_AVE block.
As an alternative, you can also drag a block output to the input with which you want to connect it using the mouse.

The two blocks are now interconnected.

Changing the Appearance of the Blocks.

The blocks are displayed in the chart with all their I/Os (inputs and outputs) as dictated by the block type. In our example, however, we do not require all the I/Os and to make the display simpler and clearer we want to make the unnecessary I/Os invisible in the chart. In the same dialog, we will also change the block names.

- Double-click the block body of the CONT_C block: The “Properties” dialog box is opened for this block. The name (“1”) is already selected and you can type in the new name “Controller” immediately.
- Now select the “Inputs/Outputs” tab. Using the horizontal scroll bar, go right until the “Not displayed” column appears.
- Click the column header: The entire column is selected. With the mouse pointer in the selected area, click the right mouse button and select the “Set” command in the menu.

All unconnected I/Os are set to “Not displayed”. Some I/Os will, however, be needed later in the test mode to input values. We will make these visible again.

- In the “Not displayed” column, click the check boxes of the following:

MAN_ON
SP_INT
MAN
GAIN
TN
TV
DEADB_W.

Setting Parameters for the I/Os and Selecting Them for Testing

- In the “Inputs/Outputs” tab, go to the column “Watched” and set all the visible I/Os including the interconnected output **LMN**.
- In the “Value” column, enter “20” for **SP_INT** (this is the default setpoint for the controller).
Close the Object Properties by clicking “OK”.


You can also set parameters directly for an individual I/O:

- Double-click the block input **MAN_ON** of the controller.
- In the “Value” box, change the “1” to “0”.
This disables the “Manual Mode” that would interrupt the control loop.
- Close the dialog box by clicking “OK”.

Follow the same procedure with the **SAMP_AVE** block (using the Properties dialog of the individual I/Os or in the Properties dialog of the block as described below).


- Double-click the **SAMP_AVE** block body. Name this block “Process”.
- In the “Inputs/Outputs” tab, set the input **N** in the column “Watched”.
- In the “Value” column, enter the value “30” for **N**.
(This is the number of input values to be used for the average value.)
- Close the dialog box by clicking “OK”.

The blocks are now interconnected and have the parameters required for our process simulation.

Note: If you only want to include the I/Os of a block in the watch list (in other words to register them for monitoring), you do not need to open the Properties dialog but can simply select the block (by clicking the block header) and then clicking the  button in the toolbar.


2.1.3 Compiling and Downloading the Chart

The next step is to compile the chart as a program.

- Select the following symbol in the CFC toolbar  or **Chart > Compile > Charts as Program**.
In the dialog box that appears, set "Compile: Entire program". Complete the dialog with "OK". Compilation is now started and the progress is displayed in a dialog box. Confirm the final message with the S7 protocols with "Close" (you can ignore the displayed warning).

Note:

The next step is only possible if you have connected a CPU of the type S7-3xx or S7-4xx to your PC. The setting of the key switch on the CPU must be: RUN-P.

- To download the program to the CPU, select the button  or **PLC > Download**.
In the dialog box, select the type of download (this is already set: "Entire program").

Before you download the program, the CPU is set to STOP (after a prompt that you answer with "Yes") and any blocks already on the CPU are deleted. The download is displayed in a further dialog box. After downloading the programs successfully (with no errors), a message is displayed to show that downloading is complete and asking you whether you want to restart the CPU. If you answer "Yes", you can return the CPU to the "RUN" mode.


The CPU changes to the **RUN** mode. The program is loaded and can now be tested.

2.2 Testing the Program

In the test mode, you can monitor the values of the block I/Os and change the values of the block inputs. The values registered for testing are shown on a yellow background.

If you now change some of the parameters, you can monitor the controller response, for example how the manipulated value approaches the setpoint and settles.

Activating the Test Mode

- Click the button in the toolbar  or select **Debug > Test Mode**.

Changing Values Online

You can set a different setpoint for the example, as follows:

- On the controller, double-click the **SP_INT** input and set a different value (<100) as the internal setpoint in the dialog box that follows. Click "Apply" so that the value is adopted and the dialog box remains open for further changes. After you have made a few changes and observed the control response, close the dialog box with "OK".

You can, for example, influence the speed of the settling at the block inputs:

GAIN (Proportional gain, determines the control gain)

TN (Reset time, determines the I-action)

TV (Derivative time, determines the D-action)

If you change "GAIN" to a lower value and "TN" to a longer time, the dynamic response of the controller is changed and the control response of the example is more "sluggish".

With the **MAN_ON** block input, you can interrupt the control loop and switch over to "Manual Mode" (=1). The manipulated value (in other words the value at the output **LMN**) is then set by the value of the **MAN** input.

The Result

In this part of the example, you have got to know the elementary aspects of configuring in CFC. You have created a project with the SIMATIC Manager, created a CFC chart, and inserted blocks from a library. You have interconnected the blocks and set parameters. You have created an executable program and downloaded it to the CPU. In the test mode, you were able to monitor and modify the dynamic response of the control loop.

2.3 Making Changes to the Chart

We will now leave the test mode.

- You change to the edit mode by clicking the  button in the toolbar.

2.3.1 Changing the Run-Time Properties

Introduction

The blocks of a chart have certain run-time properties. These run-time properties determine when and in which order the blocks are executed on the CPU. To structure their execution, the blocks are installed in OBs.


In this example, the default installation of the blocks is in OB35 (cyclic interrupt 100 ms) and because they also involve a restart, they are installed in OB100 (cold restart).

So that you do not need to worry about the run sequence for every block, CFC installs the blocks one after the other after a particular block. This block is also the "Predecessor for Installation" for blocks installed later. In the CFC status bar (to the bottom right in the window), you can see which block is currently the "Predecessor for Installation".

You can change the run sequence of the blocks (by installing them in another OB) or structure them differently by putting the blocks together to form a run-time group. You can assign attributes to the run-time group that decide the scan rate of the OB cycle and the phase offset with which the blocks are executed.

Changing the Run-Time Properties

You want the blocks to be executed in a different sequence. The test mode is off, you can now open the run sequence.

- Click the button in the toolbar  or select **Options > Run Sequence**.

A new window is opened displaying all the OBs. Objects have already been installed in OB100 and OB35 as can be seen by the + in a box in front of the OB icon.

- Select OB35. The blocks are displayed in the right detailed window.
- Keep the mouse pointer on the OB and now select the **Insert Run-Time Group** menu command with the right mouse button. A dialog box is displayed.

- Make the following entries in this dialog box:

NAME:	Group1
Comment:	U8_PV0
Scan rate:	8
Phase offset:	0 (default retained)

- Accept your entries with "OK".
- Click OB35 and select the two blocks in the detailed window. Drag these to the new "Group1" folder in the left window.

When you drag the blocks, they can be installed either in or after the folder. You will then be asked whether or not you want to install the blocks within the group.




- Answer the question with "Yes".

With the setting you have made for the scan rate, the blocks are now executed every eighth run; In other words with the basic cycle for OB35 of 100 ms they will be executed every 800 ms.


The phase offset can be used to achieve a better distribution of load on the CPU when you have blocks in several run-time groups. Since this is irrelevant in our example, the phase offset remains inactive.

Copying Blocks within the Chart

As a practical exercise, you will now copy the content of sheet 1 to sheet 2 and continue editing there. When you copy interconnected blocks, the interconnections between the blocks are retained, external interconnections are however lost.

- Change from the run sequence back to chart editing (CFCEXA_2\S7Program(1)\...\Control).
In the title bar of the run sequence, click  and change to the overview by clicking .
- In sheet 1, hold down the left mouse button and draw a lasso around the interconnected blocks. The blocks are now selected (blue).
- Remain on the selection with the mouse pointer, hold down the Ctrl key and drag the blocks to sheet 2 (below sheet 1).
- Change back to the run sequence window by clicking .

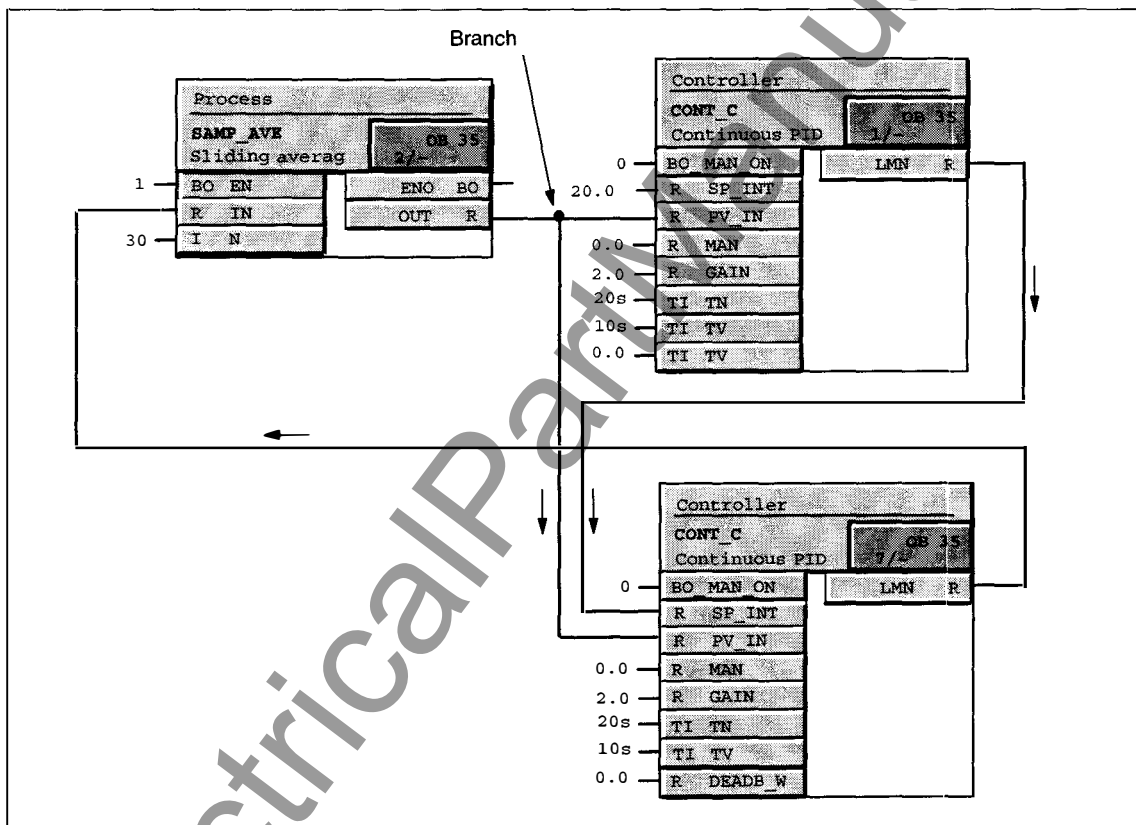
You will see that when you copied the blocks, the run-time group was also copied and was installed in OB35 with the new name "Group2".

- Now change back to chart editing by closing the run sequence window with  in the title bar of the window. Now go to the sheet view of sheet 2.
- Select the "Controller1" block, copy it and insert it in the same sheet again. The block is called "Controller2".

Changing the Interconnection


- Click the connecting line or the output **LMN** of "Controller1" and press the "Del" key. The connection to input **IN** of "Process1" is deleted.
- Click **LMN** of "Controller1" and then **SP_INT** of "Controller2".
- Click **LMN** of "Controller2" and then **IN** of "Process1".
- Click **OUT** of "Process1" and then **PV_IN** of "Controller2".


With the blocks positioned as shown, the interconnection appears as follows:



Compiling, Downloading and Testing Changes

The chart must be compiled again and then downloaded to the CPU.

- Select the button  in the toolbar.
In the dialog box, set the option "Compile: Changes only" and acknowledge with "OK". Compilation is started, confirm the completed message with "Close".

- To download the program, select the button  .
In the dialog box, set "Download: Changes only" and confirm with "OK".

When you download changes (as opposed to the entire program) the CPU does not need to be set to STOP.

Caution! If you are working with a real project, make sure that you are familiar with the information in "Reasons for STOP when Downloading Changes Online" in the online help.

(Help > Contents, "Index" Tab: Type in "Reasons for" and click the "Display" button.)

After downloading, you can return to the test mode and test your modified program.

The Result

In this part, you have learnt that the blocks of the CFC chart have certain run-time properties on the CPU and that you can modify them. You have also seen that substructures known as run-time groups can be used in the run sequence and which attributes you can assign to them.

You have copied blocks within a chart and seen that the interconnections between the blocks are retained. You have modified interconnections and once again created an executable program. You have seen the difference between downloading the entire program and downloading changes only.




2.4 Creating Chart I/Os and a Chart-in-Chart


In the following section you will create chart I/Os for a CFC chart and insert this chart in a different CFC chart.

2.4.1 Creating a Chart with Chart I/Os

The chart I/Os of a chart can be used to “encapsulate” CFC charts for further use. When you create the chart I/Os, you can specify which block I/Os are relevant for interconnection with other charts or blocks and must be applied to chart I/Os.

Preparations

- Create a new chart by clicking  in the toolbar. In the dialog box, enter the object name : “Sim_reg” and confirm with “OK”. The new chart is displayed.
- By clicking  in the toolbar, the chart “Sim_reg” and the chart “Control” are displayed one beside the other.
- Set the overview display for both charts by clicking ).
- Copy the blocks of sheet 1 of the “Control” chart to sheet 1 of the “Sim_reg” chart in the same way as you did when copying blocks within a chart.
- Close the “Control” chart and change to the sheet view (sheet 1) of the “Sim_reg” chart.
- Open the run sequence. By copying the blocks to the “Sim_reg” chart, “Group4” has been created. To be able to compile the chart as a block later, it must not be installed in a run-time group and we therefore want to install the blocks directly in OB35.
- Select “Group4” and then select the blocks “Sim_reg\Controller” and “Sim_reg\Process” in the detailed window.
- Drag these blocks to OB35.
- Now select the empty “Group4” and press the Del key. Confirm the prompt with “Yes”.
- Now close the run sequence again.
- Select the “Process” block in the “Sim_reg” chart. Using the right mouse button, select “Predecessor for Installation”. In the list that then appears, select OB35 and confirm with “OK”.
All further blocks installed in OB35 will be installed after “Sim_reg\Process” you can see this in the CFC window to the bottom right in the status bar.

- Open the block catalog in the catalog by clicking the  button and open the block family **MULTIPLX**.
- Drag the block **SEL_R** to sheet 1 and give it the name "Switch" (in the Properties dialog).

To include the "Switch" block in our example, you must now "rewire" an existing interconnection; In other words you modify an interconnection without deleting the existing one.

- On the "Controller" block, select the **PV_IN** input, hold down the mouse button and drag the I/O to "Switch" **IN1**. The output **OUT** of "Process" is now connected to **IN1** of "Switch".

As an alternative, you could also delete the existing connection and create new interconnections.

The output of "Switch" must now be connected to the input for the process variable of "Controller".


- Connect "Switch" **OUT** with "Controller" **PV_IN**.

The "Switch" now switches depending on the value of the input **K**, the value of the input **IN0** (K=1) or **IN1** (K=0) to output **OUT**.

In a real project, this would allow you to switch over between a process simulation (**IN1**) and a real process (process value from the process connected to **IN0**).

Creating Chart I/Os for the Chart

You now create the chart I/Os for the chart. These are then connected to the selected block I/Os.

- Click the button in the toolbar  or select **View > Chart Inputs Outputs**.
The dialog for editing chart I/Os is opened and "docked" to the upper part of the chart window.
- In the left-hand window, click the folder of the inputs (**IN**). The block inputs are displayed in the right-hand window (currently empty).
- In the working field of the chart, select the **MAN_ON** block I/O on "Controller", hold down the Ctrl key and drag the I/O to the right window of the chart I/Os to the "Name" box. The I/O is then adopted with all its properties.
- Follow the same procedure with all further inputs (see table).
- Change the name of I/O **K** of the "Switch" block in the chart I/Os by double-clicking in the "Name" box. Enter **SIM** here. Instead of **IN0**, enter **PV** (Process value).

- In the left-hand window with the chart I/Os, click the outputs folder (**OUT**). Select the **LMN** output on the “Controller”, hold down the Ctrl key and drag the I/O to the right window of the chart I/Os to the “Name” field.

The chart I/Os then appear as follows:

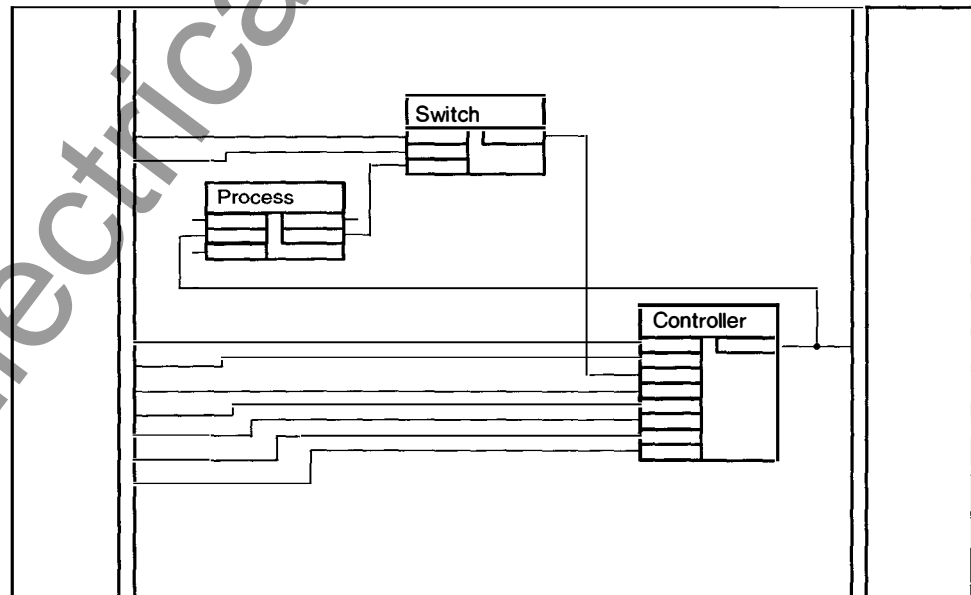
Block:	Block input	Data type	Block output	Data type
Controller	MAN_ON	BOOL	LMN	REAL
	SP_INT	REAL		
	MAN	REAL		
	GAIN	REAL		
	TN	TIME		
	TV	TIME		
	DEADB_W	REAL		
Switch	SIM (previously: K)	BOOL		
	PV (previously: IN0)	REAL		

The sheet bar displays the I/O names and comments, I/O type, and data type applied to the chart I/Os.

All the chart I/Os are now prepared for the chart; You can close the chart I/Os



window by clicking  and can “tidy up” the chart to make it clearer to read.

- Move the blocks in the chart so that as few connection lines as possible cross over other lines. One possible arrangement is shown below.



2.4.2 Inserting a Chart in Another Chart

The chart “Sim_reg” created in the previous configuration step with chart I/Os will be inserted in another chart. Create the new chart as follows:

- Click  in the toolbar. In the dialog box, enter “Top Chart” in **Object name:** and confirm with “OK”. The new chart is displayed.
- Open the “Charts” catalog by clicking the button  .

In a tree hierarchy (apart from the text element) you will see the charts “Top Chart”, “Controller” and “Sim_reg”.

Note: If a catalog only contains the text element and the message “! (no hierarchy folder exists)” then you have set the option “Display catalog with plant hierarchy” in the **Options > Customize > Display..** dialog box. Since the project was created without the plant hierarchy, this option must be disabled (click the check box: The check mark is removed).

- Select the “Sim_reg” chart and drag it to the working area of “Top Chart”. The original chart is copied.
- Change to the sheet view.

The chart with its chart I/Os appears like a block and can be recognized as a chart by its icon.



So that you can see that this is a copy of the previously created chart, open it by selecting it and then selecting the **Open Chart** command using the right mouse button. In the title bar, you will recognize that this is a “nested chart” by the path: ...\\Topchart\\Sim_reg.

In the catalog of the charts, a + box is displayed in front of “Top Chart”. By clicking the box (or double-clicking the chart icon), you can open up the tree and the hierarchy of the chart becomes visible: The “Sim_reg” chart is displayed in this branch.

To return to the top chart, you can select “Open Parent Chart” with the right mouse key or select the path for the “Top Chart” in the “Window” menu.

The Result

In this part, you have learnt how to edit a chart so that it has chart I/Os that allow it to be interconnected to other block I/Os and to be used as often as required. You have seen how a chart can be inserted like a block with the chart-in-chart technique. You have seen that, in contrast to the block, the inserted chart can be opened and modified.

With the chart-in-chart technique, you can create nested charts and therefore create a structure according to technological aspects with greater clarity.

2.5 Creating a Block Type

Normally, the entire chart folder containing the open chart is compiled. This produces a program that can be downloaded to a CPU. You can, however, also compile a single chart and create a block type from it. This is then placed in the block library or in the S7 program so that it can be used again.

Compiling a Chart as a Block Type

You will now compile the original chart "Sim_reg" as a block type.

- Close all the charts (**Window > Close All**).

Make sure that you open the **Original chart** "Sim_reg" that is located at the same hierarchical level as the charts "Top Chart" and "Controller".

- Select the "Sim_reg" chart in the "Charts" catalog and open it with "Open Chart" using the right mouse button.
- Select **Chart > Compile > Chart as Block**.

A dialog appears in which you can enter further information.

- In the "Properties Block Type" box, enter the following:

FB number:	110	
Name (header):	REG_1	
Family:	CONTROL	
Author:	TEST	
Version (header):	0.1	

and confirm with "OK".

The compilation is started and progress is indicated in a dialog. When compilation is complete, the block "FB110" is located in the block folder.

Entering the Block in the Symbol Table

The block is listed as "FB110". To assign a symbolic name to the block, you must enter it in the symbol table.

- Select **Options > Symbol Table**. The symbol table is opened.
- In the first free line, enter the symbol name **REG_1** and as the address **FB110**. As comment, enter **example1**.
- Save the changes (**Table > Save**) and close the symbol table.

FB110 now has the symbolic name **REG_1**.

2.5.1 Testing the Block

The next step is to create a new chart and to insert the block REG_1 in it.

- Create a new “Test” chart as described in Section 2.4.2.
- Press the “F5” key (or **View > Update**) so that CFC reads the changes in the symbol table and the block folder.
- Open the S7 program in the catalog of the blocks. Here, you will see the new block type REG_1.
- Insert REG_1 into the “Example” chart by dragging it with the mouse and change to the sheet view. You will see the block I/Os as you created them as chart I/Os. The “EN” and “ENO” I/Os are added by the system (so that the block can be activated and deactivated).

- Now compile the charts as a program



- Download the program to the CPU



- Then change to the test mode



to monitor and modify the I/Os of the block.

With the **SIM** input, you can switch over between internal simulation and an external process value (input **PV**).

Final Comments

In this brief example, you have got to know a few of the possibilities available with CFC. The exercises have illustrated how simply and conveniently you can create a program for an automation task that can then be run on the CPU.

Once you have worked through this example, you will know CFC well enough to start tackling more complex tasks.

The following chapters and the comprehensive online help of CFC will provide you with more information.

Working with the CFC Editor

3

Overview

This chapter describes how to configure an entire software structure for a CPU using the CFC editor.

Requirements:

Using the SIMATIC Manager, you have created a project with a program folder for a specific PLC (for example an S7 program for SIMATIC S7) including a chart folder.

Note

CFC is “upwards compatible”, this means that programs modified with other tools and not with the CFC editor lead to inconsistencies.

Restrictions for multi-users in network operation:

Several users can work on one project. This allows configuration, testing and startup of PLCs to be performed at different locations or in a PC network (multi-user mode).

If several people want to work on a project at different locations, the project can be divided up, edited, and put back together again (branch-and-merge). If the PCs are connected in a network, remember that one PLC must only be edited by one user at any one time.

For more detailed information, refer to the online help.

3.1 Handling Charts

Creating a Chart

You normally create a chart with the **SIMATIC Manager**; this is, however, also possible directly in the CFC editor ("Chart > New" menu command). The name must be unique on the CPU (this is checked by the system) and can be a maximum of 22 characters long.

Opening a Chart

You can open a chart with the **SIMATIC Manager**. Select a project and the project folder, open the charts folder and double-click the required chart to open it and start the CFC editor at the same time.

In the **CFC Editor**, the "Chart" menu always displays the last four charts that you edited (and closed) as a menu item. If you select one of these names, the corresponding chart is opened or if it is already open it is displayed.

You can open a chart that is not displayed in the "Chart" menu by selecting the "Chart > Open" menu command, selecting the project in the dialog box, selecting the program folder and the chart folder and opening the selected chart by double-clicking it.

Copying/Moving a Chart

Copying entire charts allows you to duplicate or move structures or substructures you have tested, even to other CPUs.

You can copy or move not only individual charts but also an entire chart folder with all the charts it contains.

Remember that the Copy/Move function has effects on existing interconnections and blocks etc. For more detailed information, refer to the online help.

CFC charts can be copied and moved from one PLC to another. This assumes that identical block types to those used exist.

Closing/Deleting Charts

Since all the changes in the chart are saved immediately, you can close the chart or exit the editor at any time.

You can delete a CFC chart in the **SIMATIC Manager**.

3.2 Creating a Chart

In its original form, in other words after it has been inserted in the chart folder, a CFC chart consists of a chart partition with 6 sheets without further chart partitions. You can rename such a chart and extend it.

You can add chart I/Os to a chart (see Section 3.2.3) so that, for example, it can be interconnected with other charts or inserted inside another chart where it can be interconnected with blocks. If you use the chart-in-chart technique, in other words inserting charts with chart I/Os in another chart, you can create nested charts (see Section 3.2.4).

A chart can also be inserted into another chart without chart I/Os (for example when you want to create the chart I/Os later).

3.2.1 Adapting Chart Properties

In the “Properties CFC” dialog box, you can set properties such as the chart name, author, and comment for the active chart.

In CFC, you can display this dialog box with the “Chart > Properties...” menu command.

For further information and information about assigning names in PCS 7, refer to the CFC online help.

3.2.2 Inserting and Deleting Chart Partitions

You can add further chart partitions to the CFC chart at any time if it is not large enough for your needs.

When you **insert** a chart partition, you can decide whether the new chart partition is inserted before the current chart partition or whether it should be appended as the last chart partition. A chart can consist of up to 26 chart partitions; they are identified in alphabetical order (A – Z). The alphabetical identifier of the individual chart partitions can change if you insert further chart partitions.

If, for example, the “CFC1” chart consists of a single chart partition, this is given the letter “A”. If you insert a further chart partition before this chart partition, the new “first” chart partition becomes “A” and the previous one now becomes “B”.

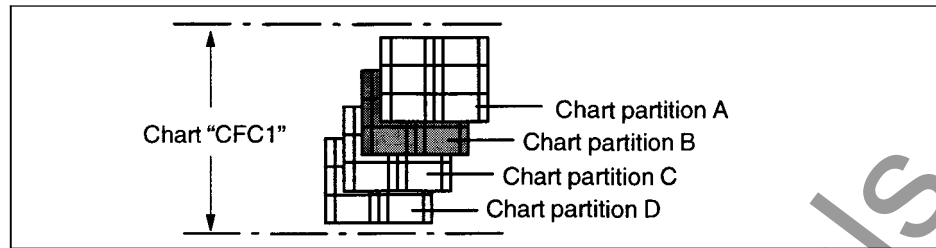
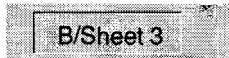


Figure 3-1 Chart with Chart Partitions

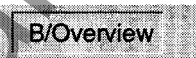
Depending on the view (sheet or overview), the ID of the current chart partition is displayed along with the sheet number or with “Overview” in the status bar.

Example:

Sheet view:



Overview:



You can only **delete** the active chart partition. If the active chart partition is empty, it is deleted after you select the “Edit > Delete Chart Partition” menu command. If the chart partition contains blocks, the menu command is deactivated.

3.2.3 Creating a Chart with Chart I/Os


You can provide a chart with I/Os to extend your options such as

- Inserting the chart in a different chart (nested charts, see Section 3.2.4) and interconnecting it with other charts or blocks.
- Compiling it as a block type.

You assign the selected I/Os of the internal blocks contained in the chart or the nested charts to the chart I/Os.

The “Chart Inputs/Outputs” Window

You create the chart I/Os in a separate CFC window.

With the “View > Chart Inputs/Outputs” menu command or the  button in the toolbar, you can open (and close) the “Chart Inputs/Outputs” window.

The procedure for creating chart I/Os is described in detail in the example in Section 2.4.1.

System Attributes

Just as in blocks, you can also assign system attributes to the individual chart I/Os of a chart.

A chart with chart I/Os does not have system attributes itself (apart from those of the I/Os). You can assign these attributes when the chart is compiled as a block type (see Section 3.9.2).

Notes

- The inputs of blocks that are connected to a chart I/O cannot be negated.
- Chart outputs cannot be assigned parameters if they are interconnected.
Remedy: You assign parameters to the output of the block; this value is then entered for the corresponding chart output.

3.2.4 Creating Nested Charts

You can insert a CFC chart in another CFC chart. This allows you to create a program structured according to your technological requirements using standardized sections that can be used again and again.

The charts nested in the parent chart can be opened and modified in the Edit mode and can be run and monitored in the Test mode.

The chart containing further charts is the parent chart. In the SIMATIC Manager, you can only see the parent chart in the chart folder. The maximum nesting depth for nested charts is 8 (parent chart + 7 levels of nested charts).

Inserting a Chart in a Chart

To allow charts to be used like blocks in CFC, they are displayed in the chart catalog in a tree structure. From here, you can drag-and-drop a chart to the currently open chart. When you insert the chart, it is copied to the chart folder along with its own nested charts (if it contains nested charts).

Navigating in a Chart

To open a nested chart, select the chart within its parent chart and select the "Open Chart" menu command with the right mouse button or in the "Edit" menu. By repeating this, you can work down to the lowest chart nested in the hierarchy. To move up through the hierarchy (as far as the parent chart), select the nested chart and then select the "Open Parent Chart" menu command with the right mouse button or in the "Chart" menu.

You can also open a chart in the chart catalog. Select a chart and then select the "Open Chart" menu command with the right mouse button.

Copying and Deleting

If you want to delete a nested chart from its parent chart but not from the chart folder (you may have modified it and want to use it later at a different point), you can first copy it into the chart folder. Select the chart and then select the “Chart > Copy to Chart Folder” menu command. The chart is copied and inserted in the chart folder with a new name. You can now delete the chart within a chart as usual.

Interconnecting

If the nested chart has I/Os, you can interconnect it in the chart with other nested charts, with blocks, or with shared addresses.

How to assign block I/Os to the chart I/Os is described in Section 2.4.1. You can use the same procedure when you want to connect the chart I/Os of nested charts to chart I/Os of charts higher up in the hierarchy.

You can also make this assignment if you select a block/chart I/O and then select “Connection to Chart I/O...” with the right mouse button or in the “Insert” menu. The “Chart Inputs/Outputs” window does not need to be open. A dialog box is displayed with the list of all available I/Os; in other words if you have selected an input, a list of chart I/Os of the type “IN”, and if you have selected an output, a list of the type “OUT”.

3.3 Handling Blocks

Blocks for CFC

A basic pool of blocks is shipped with CFC. You can add further blocks from libraries or other projects.

Help

The online help provides you with a description of the blocks shipped with CFC that you can display by clicking the block with the "Help arrow" (in the CFC chart or in the catalog of blocks or libraries) or by pressing F1 for the selected block.

Note

[S7] The library "CFCLIBS (V4)" or "CFC Library" contains the blocks for the CPU 3xxx in the "ELEM_300" folder. These blocks cannot be run on a CPU 4xxx.

3.3.1 [S7] Importing Blocks

Importing into CFC

By importing, existing blocks are made known to CFC. You can only use such blocks in CFC.

You can import blocks by inserting them from the catalog (disguised import) or explicitly with the "Options > Block Types..." menu command.

Explicit importing is always useful when you require a lot of different blocks. Afterwards, inserting from the catalog is much faster since disguised importation is no longer necessary.

You would use this dialog, for example when you want to import a number of blocks from the user program (block folder) into the chart folder. The same situation occurs if modified blocks (after a type change) exist in the block folder, and exist with the same name in the chart folder and you want to update them there (see also Section 3.3.2, Central Block Type Change).

You can select the blocks you require in the "Block Folder Offline" box and then import the blocks to the chart folder by dragging them with the mouse or using the "—>" button. If a block already exists in the chart folder, a warning is displayed.

3.3.2 Central Block Type Change

What You Should Know about Central Block Type Changes

If the interface description and/or system attributes of a block type are changed and this is imported into the CFC data, an existing block type of the same name can be replaced (updated) by this new version. All the block instances of this type are then also changed to conform to the new block type.

The idea of central block type changes relates to FBs and FCs. The types of BOPs cannot be changed since they are an integral part of CFC.

Sequence

Before the central changes are made, a warning is displayed pointing out the effects and displaying information about the old block type such as the name, date of the last interface modification etc. At this point, you can still stop the update.

A warning appears in the following situations:

- During disguised type import (inserting a block from the catalog into the chart), when a new version of a block type that has already been imported is involved.
- When you open the same dialog box with the “Options > Block Types” menu command, import a block with the same name, and click the “New Version” button.

The central block change is not made if the category of the block type has been changed (for example FB \longleftrightarrow FC).

Log of the Block Types

The modifications resulting from a central type change are logged and automatically displayed following the update. You can also display the log again and, if required, print it out with the “Options > Logs...: Block Types” menu command. If modifications to block instances are necessary, you can use the log to help you saving both time and reducing the risk of errors.

3.3.3 Effects of Type Changes on Block Instances

Note the Effects!

The automatic modification of block instances of the updated block type can have effects that you should always take into account. It is possible that parameter assignments and SFC accesses are lost if a block I/O is deleted or modified (for example a different data type or different name).

Effects of Changes on Block I/Os

- **An I/O is added**
The change is also made in the block instances and the default is set for the system attributes. Block I/Os that are added and have the “visible” attribute (S7_visible:=true), are set to “invisible” (S7_visible:=false). This guarantees that the modified (larger) block continues to have enough space in the chart.
- **An I/O is deleted**
The I/O is removed from the block instances. If the I/O is interconnected, the interconnection (or an SFC access) is also deleted. The deleted interconnection (or deleted SFC access) is entered in the log of the changes.
- **Order of the I/Os is modified**
The order of the I/Os is taken into account and the interconnection, parameter assignment, and attributes are retained.
- **Data type of an I/O is modified**
All the assigned parameters and interconnections of this I/O are lost. This situation occurs when you delete and then recreate an I/O.
- **Name of the I/O is modified**
All the assigned parameters and interconnections of the I/O are lost. The reference to the old name cannot be established automatically by the system. This situation can occur when you delete and recreate an I/O.

Effects of Changing System Attributes

If you modify attributes, the affects can be summed up in the general rule:
What cannot be modified for a specific instance is automatically modified in the instances as a result of a type change.

Effects on Other Functions

- It is no longer possible to download changes only (only the entire program).
- The “Read Back Chart” function is no longer possible, since the blocks on the PLC no longer match the configuration in CFC.

[S7] Effects on WinCC

- If a block type is changed, DBs with new DB numbers can be created by compressing and compiling. To ensure online access is retained, the data must be transferred to WinCC again.
- If block I/Os intended for operator control and monitoring are affected (attribute S7_m_c=true), the following rules apply:
 - If an I/O is added, this is known in WinCC following the PLC-OS transfer and can be used in WinCC.
 - If an I/O is deleted, the WinCC tag no longer exists. The existing interconnection(s) must also be deleted in WinCC.
 - If the name of an I/O is changed, the name of the WinCC tag also changes. The interconnections of the picture elements and faceplates must be adapted.
- Whenever a change is made that affects WinCC, a new PLC-OS transfer is necessary.

3.3.4 [S7] Importing a New Version

If, following a block type change, you want to use the modified blocks for the previously used old block types, the new block types must be imported into the chart folder. The block instances used in CFC can then be adapted to the modified block types. Blocks are imported as follows:

- When you insert a modified block type from the S7 program or the block library into the chart.
- Using the “Options > Block Types...” menu command in the “Block Types” dialog. Here, you select the block to be imported from the list of source files (“Block Folder Offline”) and then drag the block to the “Chart Folder” list (or click the “—>” button).

Using a New Version

If a block type with this name exists in the chart folder, the “New Version” dialog box appears with a message outlining the consequences and the version information. If you answer the question “Do you really want to use the new version of the block?” with “Yes” all the corresponding block instances will be adapted. If you answer with “No”, no adaptation takes place.

Same Version

If you import a block type and the same version already exists in the chart folder, you receive the message “You do not need to use the new version” and the version information.

Adapting Block Instances

You can adapt the block instances later by selecting an existing new version of a block type in the chart folder and then clicking the “New Version” button.

Blocks in Libraries

If you have made a type change to blocks that were previously only in the library, please remember to include the blocks in the S7 program (block folder) first before you update the blocks in the chart folder with “New Version”.

If you have made a type change to blocks within the S7 program (in the block folder), please remember that the library is also updated.

3.3.5 Inserting Blocks

Inserting a Chart in a Chart

You can insert blocks both in the sheet view and in the overview.

You can select a block type in the Libraries catalog or the Blocks catalog and drag it to your chart.

Inserting from the Libraries Catalog

In S7, when you insert the block types from the libraries catalog they are implicitly imported into CFC.

Inserting from the Blocks Catalog

Blocks from the S7 program are automatically imported into CFC when you insert them in the chart. They then also appear in a family of CFC blocks. The icon for the blocks appears differently depending on whether the block is already known to CFC; in other words whether it was imported or not.

These blocks in the S7 program are not yet known to CFC (even if a block of this type has already been imported). This means that when you want to insert a block from the S7 program into the chart, a check is always made to determine whether the block has already been imported.

Blocks that have already been imported are in one of the block families or, if the block is not assigned to a family (specified in the header), it will be in the “Other Blocks” folder.

Note

Inserting blocks from the block families is the fastest way of placing blocks in your chart since no check is required.

Specifying Run-Time Properties

When you insert a block, its run-time properties must also be specified, for example the point at which the block is inserted in the run sequence.

Default rule: The block is always inserted after the block displayed in the status bar.

You can change the installation position by selecting the block that will count as the “predecessor” for the next block to be installed and then selecting the menu command “Edit > Default Insert Position”.

The current installation position is displayed to the right in the status bar. It displays the task name as well as the chart and block name after which the next block will be installed in the run sequence when a block is inserted in the CFC chart.

For more detailed information about run-time properties, refer to Section 3.7.

Aligning Blocks in the Chart

You can automatically align blocks inserted in the chart, including those that are already interconnected (menu command: “Edit > Align > Left / Right / Top / Bottom”).

The blocks are aligned at the visible edge of the block graphic (not the frame of the selected blocks). The block furthest to the left or right or nearest the top or bottom decides where the blocks are aligned.

If the alignment leads to a conflict, for example blocks overlapping, a message is displayed and the old situation restored. In this case, no blocks are aligned, not even those that normally could have been.

Inserting and Editing a Text Box

You can insert a text field at any point in the chart by dragging it from the block catalog. You can enter text after you have opened the text box by double-clicking it. You can adapt the size of the box to the text you have entered.

For more detailed information about editing the text field, refer to the online help.

3.3.6 Copying and Moving Blocks

You can copy or move blocks within a chart or to other charts. It is also possible to copy or move several or all the blocks of a chart together. This allows you to duplicate tested substructures quickly and without errors.

It is possible to copy blocks to a different CPU. The effects on the functionality are the same as those when copying charts to a different CPU.

Note

If you want to duplicate several blocks that exist in more than one chart, it is more efficient to copy charts or chart folders using the SIMATIC Manager. Multiple selection is possible.

Effects of Copying/Moving

Functionality: Moving blocks has no effects whatsoever on the functionality; in other words the interconnections and run-time properties are retained. As far as possible, block names are retained. If there is a conflict, numbers are appended to the names.

Refer to the information in the online help.

3.3.7 Deleting Blocks

If you delete blocks, all interconnections between the deleted blocks and to objects that you have not deleted are lost.

If an output is connected to a block that you are not deleting, a warning is displayed. If you decide to delete, instead of the capped interconnections, the inputs of the block that is not deleted are assigned the standard parameter values.

3.4 Editing Blocks

Editing blocks in the chart means modifying their properties. Properties can relate both to an entire block or to individual inputs and outputs. The setting of properties of inputs and outputs is described in Section 3.5.

3.4.1 Setting Object Properties

The “Properties-Block” dialog box contains various tabs with which you can set properties:

“General” Tab

All the properties that you assigned when you inserted the block (and the system-specific options in the “Special Object Properties” and “Import/Export Assistant” boxes).

The **Name** of the block is unique throughout the entire chart and is displayed in the block header (maximum 16 characters).

The **comment** is a freely selectable text that appears in the block header. A maximum of 14 characters of this comment are displayed in the block header. In small blocks, the comment is not displayed.

I/Os

You can assign parameters to block I/Os, add comments to them, include them in the watch list etc. see also Section 3.5.

3.4.2 Changing the Number of I/Os.

If the block has a variable number of inputs and the same data type, for example NAND, OR etc., you can change the number of block inputs using the “Edit > Number of I/Os...” menu command.

The number of inputs is adapted according to what you select in the dialog box. If inputs are added, there may no longer be enough space for the block, in this case it is displayed in a frame with a broken line so that you can move it (within the chart).

3.5 Modifying the Properties of Inputs and Outputs


You can modify the properties of the block I/Os. Two different dialogs are available for this purpose:

- The dialog to edit **all I/Os** of a block is in the “Inputs/Outputs” tab of the “Properties-Block” dialog box that you can display by double-clicking the block. In the “Inputs/Outputs” tab, you will see all the properties of the I/Os in table form.
- For a **single I/O**, open the “Properties – Input/Output” dialog box by clicking the required block I/O.
Depending on the properties and data type of the I/O, the dialog box will contain different information some of which can be edited and some of which is read only.

3.5.1 Inverting a Block Input

Binary inputs can be inverted. After inversion, “0” becomes “1” and “1” becomes “0”. This is only possible with interconnected inputs.

Setting the Inversion

You invert an interconnected binary input by selecting the input and clicking the icon  in the toolbar.

As an alternative, you can also double-click the block input to open the Properties dialog box and then select the “Inverted” option.

Clearing an Inversion

To cancel the inversion, repeat the functions described above.

You can also cancel the inversion by deleting the interconnection at the input or moving it to another input or making a new connection to the input.

Points to Note:

- If you copy a signal from an inverted input to another input, the new input is not automatically inverted. You must invert an input explicitly.
- If you move an interconnection from an inverted input to a non-inverted input, the new input is not automatically inverted and the inversion is canceled at the input that is no longer interconnected.
- Inputs assigned to a chart I/O cannot be inverted.
Remedy: Insert a NOT block into the connection.

3.5.2 Value Identifiers

In addition to the identifiers “Text for 0” and “Text for 1” for the Boolean values 0 and 1, value identifiers are also possible for some numeric data types (BYTE; INT, DINT, WORD, DWORD).

Creating Value Identifiers

Using the value identifiers for the parameter values of the block or chart I/Os, you can define symbolic names. You make this definition with the system attributes (“S7_string_0” to “S7_string_25”) when you create the block type or when you create the chart I/Os.

The text for “S7_string_0/1” can have a maximum of 16 characters and for “S7_string_2 to 25” it can have 8 characters. Only 8 characters are displayed. If you use more than 8 characters, you can decide which characters are displayed. You do this by including the “=” character in the text.

- If the equality sign (=) is included in the text, the first 8 characters to the right of the equality sign are displayed.
Example: Motor=ON; Motor=OFF4567890; ON or OFF45678 is displayed.
- If the text does not include the equality sign, the first (left) 8 characters are output.

Displaying and Modifying in the Chart

With the data type BOOL, the value identifiers for “Text for 0” and “Text for 1” can be changed in each instance if the system attribute is defined at the I/O of the block type. With all other data types, no individual modification in an instance is possible.

In the chart, you can decide whether the symbolic value identifier or the absolute value is displayed. In the “Customize Display” dialog box, you can activate or deactivate the “Parameter: Value identifier” (**Options > Customize > Display...**).

If value identifiers are defined for an I/O, you can select them in the properties dialog. The “Value” box then contains an additional button to open the drop-down list box. The selected value identifier is then displayed at the I/O.

Converting from Older Projects

If you convert from older projects to CFC Version V5, read the following topics in the online help: “Migration of Text Attributes at Block I/Os” and “Converting to

- ◆ Value Identifiers”.

3.6 Interconnections

In CFC, you can make interconnections between the blocks, between blocks and shared addresses, and between blocks and run-time groups.

You can also modify (rewire), copy, and delete these interconnections. By tracking signals (see 3.6.5) and using the sheet bar jumps, you can navigate through the chart.

Interconnections from one sheet to another or from one chart to another can be created easily by opening several windows at the same time and using the sheet view.

3.6.1 Block Interconnections

A block interconnection is the connection from the output of a block to one or more inputs of another or the same block. In general, the connection is displayed as a line, in exceptional cases as a connector. The data types of the input and output must be compatible.

The interconnected blocks can be in the same sheet, in different sheets of the same chart, or in different charts belonging to the same CPU.

The following interconnection rules apply to block I/Os of the following data types: ANY, STRING and DATE_AND_TIME: For more information, read the interconnection rules in the online help.

3.6.2 Interconnections to Shared Addresses

Shared addresses are connection endpoints located outside the CFC charts. The different PLCs recognize different shared addresses (for example in [S7] shared data blocks, I/O signals, memory bits, timers, counters).

You can specify the addresses in symbolic or absolute form. You must, however, keep to certain conventions. A sheet bar entry with a connection to the destination block is then created.

If you use symbolic addressing, the symbols of the addresses must exist in the symbol table. For more detailed information about possible interconnections and examples of symbolic and absolute addresses, refer to the online help.

3.6.3 Interconnections with Run-Time Groups

You can disable and enable run-time groups dynamically. This means that an output value of a block decides whether a particular run-time group is executed or not. To achieve this, you connect the binary output of a block with the enable attribute of the run-time group.

Inserting Interconnections

With the "Insert > Connection to Group" menu command, you display a dialog box with a list of all the tasks on the CPU and a list with the corresponding run-time groups. After selecting the required run-time group (double-click), the interconnection is entered in the sheet bar.

Deleting Interconnections

If you delete the run-time group, the interconnection is automatically deleted. The Enable attribute of the run-time group is set to "1" again.

To delete the run-time group select the small field in the sheet bar and press "Del".

3.6.4 [S7] Interconnecting with SFC Charts

SFC Access (CFC in PCS 7)

A special form of an interconnection is direct SFC access from within actions or transitions to block inputs or outputs in the CFC chart. You cannot edit these interconnections in CFC.

In the CFC chart, a marker on the block I/O indicates these SFC accesses. Write and read access are indicated differently.

A marker above the I/O means "read access" and below the I/O means "write access". The color of the marker is the same as used to indicate the data type of the connection.

SFC References

You can display the SFC references in the "Properties – Inputs/Outputs" dialog. If the I/Os involve SFC access, this dialog box contains the "SFC Access..." button with which you can display a dialog box with the list of SFC references.

Double-click the name of a listed SFC chart to open the relevant SFC chart where the referenced object is displayed as selected.

3.6.5 Handling Interconnections

Tracking Signals

Even when there are a lot of interconnections displayed in a sheet, you can nevertheless track the path of an individual connection.

Click the line or the large field in the sheet bar, all the lines and sheet bar entries, including those in overflow pages, that are connected to the selected line start to flash. You can track signals along branched lines and beyond connectors.

To stop the flashing, simply click a free position in the chart.

Jump from a Sheet Bar

If you double-click the large field in the sheet bar, you can move quickly to the interconnected block on the other sheet or in the other chart.

The sheet or chart in which the connected block is located appears. The signal tracking is also activated (the line flashes).

With the "Edit > Go To > Jump Back" menu command, you return to the point at which you started the jump even if you have closed the selected chart or have deleted the block.

Copying Interconnections

To copy an interconnection, select the connected input, press and hold down the Ctrl key and the left mouse button and then drag the mouse pointer to the required input (of the same type). When you have reached the required input, release the mouse button first and then the Ctrl key. A further connection is created.

Copying is extremely convenient particularly when the interconnection originates in a block from a different chart, since you do not need to find the source.

Modifying an Interconnection (Rewiring)

You can move existing interconnections from one input to another input or from one output to another output.

This procedure is described in the online help.

The rules for an output are as follows:

- If you have multiple interconnections, they will all be moved to this output.
- If you drag the interconnection with an address to an output that is already connected to the same address, a warning is displayed. You can decide whether to retain the interconnection with the original block or delete it.

Deleting Interconnections

To delete an interconnection:

- Multiple interconnections:
 - If you want to delete all the interconnections of an output, select the output or the connection line(s) and select the “Edit > Delete” menu command or press the Del key.
 - If you want to delete one or more specific interconnections of an output, select the relevant input and press the Del key.

- Single interconnection:

You can select the output, the input or the connecting line and delete the interconnection with the “Edit > Delete” menu command or with the DEL key.

3.6.6 Structures

Using a structure, any data can be put together in a tree structure and then applied to a block I/O. In the block display, a structure has an I/O name and a type; the type is "ST".

A structure is made up of several elements (with a nesting depth of up to 8 levels):

- Elementary data type (BO, WO, ..)
- Structure

A structure element contains the following information:

- Type (of the elementary data type, otherwise "ST")
- The name
- The value (only with the elementary data type)

Interconnecting

A block I/O with a structure can only be interconnected with another structure and not with an elementary data type. The structures to be interconnected must be compatible; in other words, the order, the data type, and the element name of the elementary data types contained must be identical. The names of the structures can be different.

The elements within a structure cannot be interconnected separately, only the block I/O can be interconnected as an entire structure.

For more detailed information, refer to the online help.

Editing the Elements of the Structure

You can display the object properties of the structure or of an elementary data type in the structure and edit it (assign parameters).

Double-click the block I/O to display the "Select Structure Element" dialog. In the structure that appears, open the Properties dialog for the element you want to edit (double-click the element or using the "Open" button). You can display the dialog box both in the Edit and in the Test mode.

Note

- In structures, the system attributes for "operator control and monitoring" or "message" must not be used at any point.
- Structures cannot be edited in SFC.
- A block I/O with a structure cannot be interconnected with a shared address that refers to an entire data block (DBx); interconnections to structures within the DB are possible (DBx.name_st).

3.7 Run-Time Properties of the Blocks

There are several ways in which you can display the run-time properties; either for an individual block or for the entire CPU.

Single Block

The run-time properties of each block are displayed in the part of the block header on a colored background.

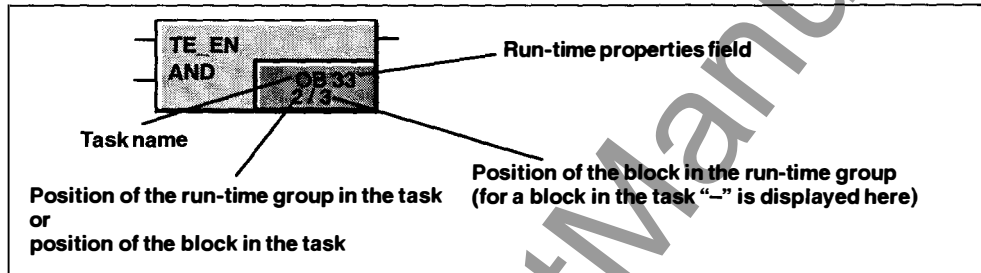


Figure 3-2 Block with Run-Time Properties Field

If the block is installed more than once, the last position at which the block was installed manually is displayed.

Entire CPU

You can obtain a view of the entire run sequence in the chart reference data or using the "Edit > Run Sequence" menu command. You can adapt the entire run sequence. For information on editing the run sequence, see Section 3.8.1.

3.7.1 Modifying Run-Time Properties

You can modify the run-time properties of a block by removing it from its old position in the run sequence and installing it at a new position (moving). Each block must be installed at least once. A block can be installed in several tasks, however only once per task.

3.8 Run Sequence on the CPU

You can modify the run sequence of all the objects installed (blocks, SFC charts, run-time groups) for the entire CPU.

Installing in a Task

When you insert blocks in a chart, each block is assigned run-time properties. It is therefore installed in a task. Where it is installed is determined by the "Default Insert Position". The default insert position can be following a block or a run-time group in the task. If this is following a run-time group, the default insert position can be after or in the run-time group.


Run-Time Groups

Run-time groups are optional. They are used to structure tasks. The blocks are installed sequentially in the run-time groups.

Run-time groups can be activated and deactivated separately. If a run-time group is deactivated, the blocks it contains are no longer executed.

The activation and deactivation of a run-time group is controlled by the run-time attribute. For more detailed information about run-time attributes, refer to the online help.

3.8.1 Editing the Run Sequence

With the "Edit > Run Sequence" menu command or by clicking the  button in the toolbar, you can open the window for the run sequence.

The chart window is not closed. Using the "Window > Arrange" function, you can display both windows or switch over between them.

The left-hand part of the window contains the complete structure (tasks, run-time groups, and blocks); the right-hand side contains details. The installed objects are displayed in four columns (name, type) along with the installation positions and comments.

You can drag an installed object to a different position in the run sequence with the mouse or copy it by dragging and holding down the CTRL key.

In the window of the run sequence, you can search for the insert point of an object. Select the "Edit > Find" menu command. In the dialog box, you can select the object you want to find using the Option buttons (task, group, SFC or block).

3.8.2 Creating and Editing Run-Time Groups

Creating a Run-Time Group

You create a run-time group by selecting the task in the left-hand window in which the run-time group will be installed or the object following which the run-time group will be installed. With the “Insert > Run-Time Group” menu command, you start the “Create New Run-Time Group” dialog. For further information, refer to the online help.

Editing and Deleting Run-Time Groups

You can also edit run-time group properties later.

To **edit**, select the run-time group (in the left or right window) and select the Edit > Object Properties.... menu command.

In the “Object Properties” dialog box, you can modify the name/comment and the values entered for the phase offset and scan rate.

You can **delete** run-time groups only when they contain no objects. To delete a group, select the run-time group and then select the “Edit > Delete” menu command.


If the deleted run-time group was selected as the “Predecessor for Installation”, the default insert position becomes the next element of the task before the deleted group, or if no further element exists, the start of the task.

3.9 [S7] Compiling

When the CFC chart is complete, the SCL code is generated and converted to machine code. You can compile the chart (in other words all the charts of the chart folder) as a program or an individual chart as a block type.

3.9.1 [S7] Compiling as Program

During compilation, the charts of the active CPU are converted to machine code. In S7, the SCL Compiler is used.

You start the compiler with the “Chart > Compile > Charts as Program...” menu command or by clicking the button  in the toolbar.

Relationships

If you want to control the assignment of resources on the PLC resources using the “Customize Compilation” function, it is important understand the relationships explained below.

The structure you configure in CFC is mapped to the S7 machine objects FC and DB.

FCs are required to call the blocks processed in the CFC chart according to the configured run sequence, as follows:

- One FC for each OB used
- One FC for each run-time group

DBs are used as follows:

- An instance DB is created for each block instance of an FB.
- To store interim results, for example from FCs, pool DBs are created. One pool DB is required per data type. When the maximum length (4 Kbytes) is reached, a further DB is created.

Notes on the SCL Compiler

Note the following points about compiling charts in conjunction with the SCL compiler:

- With CFC, you can create SCL source files that are too large for the SCL compiler. This can occur when there are too many blocks installed in a task or run-time group. The FC containing the block calls becomes too large and the SCL Compiler signals:
"Internal symbol list full".

Remedy: Distribute the blocks in more run-time groups. During compilation, more smaller FCs are created since the blocks of one group are called in their own FC.

- Compiling extremely large CFC structures can take an extremely long time in the SCL compiler; in some cases there may be no progress visible for several minutes.

What is Compiled?

When you compile, you can choose between two options:

- **Compile: Entire program**
If you compile the entire program, all the PLC resources; in other words the content of the entire chart folder is compiled regardless of whether changes have been made or not.
- **Compile: Changes only**
If you select changes only, you only compile the PLC resources that have been modified since the last compilation. Changes are solely changes in content (interconnections, block attributes, number of inputs etc.), but not the movement of objects within the chart. By selecting changes only the time required for compilation is significantly shorter and this should be the setting you normally choose.

Note: When you compile the changes, only the changes are checked. If you want to check the entire program, start the consistency check.

Settings for the SCL Compiler

In the “Compile” dialog, you can display a dialog box using the “Settings” button and adapt the compilation to your requirements. The options you can set for the SCL Compiler are as follows:

- Create reference data
Reference data are created automatically during compilation. This does, however, increase the time required for compilation. You require the reference data, for example, to calculate the local data requirements.
- Optimization
Optimization produces shorter code.
- Range Check
The Range Check checks whether array indices are in the range permitted for the array. This increases reliability, however extends the run time.
- Debug info
Information is generated that is required for testing the higher-level language debugger.

Consistency Check

During compilation, a consistency check is made automatically. You can also start this check manually, for example before you overwrite an old executable CFC program by compiling.

During the consistency check and compilation, logs are created that you can display in CFC (see Section 5).

Preparing for Compilation

With the “Options > Customize > Compile...” menu command, you can call a dialog box in which you can reserve FC and DB numbers for your own use. This prevents CFC from using these areas.

For explanations of the dialog and further information about the settings, refer to the online help.

After Compiling

When the compilation is completed (or aborted), the S7 Logs dialog box is displayed. The entire compilation is logged here including warnings and errors. Based on the log, you can check whether compilation was correct and can print out the log with the “Print” button.

You can also display the log again and, if required, print it out with the “Options > Logs...” menu command.

3.9.2 [S7] Compiling as a Block Type

You can create block types from existing CFC charts that you want to use more than once. You can assign system attributes to these block types.

In this case, you start the compiler with the “Chart > Compile > Chart as Block...” menu command; a dialog box with two tabs is then displayed.

In the “General” tab, you can specify the properties of the block type before you compile (FB number, name, family, author, and version) and specify the PLC on which the block will be used (S7-300 or S7-400).

As an option, you can also activate the know-how protection. As a result of this, the algorithm of the block can only be seen and, if required, modified when the suitable SCL source files exist.

Using the “Customize Compiler (SCL)” button, you can adapt the compilation to your own requirements (see above).

In the “Attributes” tab, you can enter the system attributes for the block type (for example the system attribute “S7_blockview” value “big”).


For further information, refer to the online help.

3.10 Downloading the User Program to the PLC

To test a user program for a CPU and to start it up, it must be downloaded to the PLC>

The program is downloaded to the CPU assigned to the active chart.

Downloading

To download the user program, select the "PLC > Download" menu command (or click the button in the toolbar ).

A dialog box is then displayed in which you can select the type of download and start a further dialog for options. If the user program is modified before the download, a message is displayed.

[S7] Downloading

You can download user programs in one of two ways: "Entire program" or "Changes only". If you select "Entire Program", all loadable objects of the program are downloaded; if you select "Changes Only", you download only the changes since the last download.

You can download changes in the "RUN-P" CPU mode. The loader maintains the correct download order with the granularity required for the data to be downloaded. Please remember that there is no absolute guarantee that the CPU will not change to STOP due to temporary inconsistencies since the loader is not capable of checking all the conditions (for example local data requirements).



Caution

Further causes of a stop are listed in the online help topic "Reasons for STOP when Downloading Changes Online". Please read this topic before you download changes online to the CPU in the "RUN-P" mode.

3.11 [S7] Reading Back Charts

Modified Data

You can save (read back) the parameters of all CFC charts contained in the chart folder of the active chart and whose PLC data were changed (for example limit values or rule parameters changed by operator input from an OS with WinCC).

Reading Back

You start the read back function with the “Chart > Read Back....” menu command. If you select “Program of the CPU” as the source in the “Read back” dialog box, the program on the CPU (online block folder) is read back to the chart folder with the current parameters.

Another method of reading back when you previously read out the data from the CPU using the SIMATIC Manager (with the “PLC > Upload Station” menu command) is to specify “Program Offline” as the source in the “Read Back” dialog box. The data are then read from the offline block folder and written to the chart folder.

In either case, in the dialog you can select whether you want to read back all parameters of the block inputs or only the parameters assigned the system attribute for “operator control and monitoring” (S7_m_c:=‘true’).

Note

If the block types used in CFC were modified later, the blocks on the CPU no longer match the (modified) configuration in CFC. When you read back the chart, a message is displayed with the list of blocks that have a different time stamp. You can then decide whether to continue reading back or not.

If charts contain nested charts, the nested inputs (assignment to the chart I/Os) of the nested charts cannot be read back.

If values are modified on the PLC and the chart is then read back, these modified values are marked as downloaded, in other words if you then download changes to the CPU, these values are not included.

4

Test and Startup

Overview

To support you when installing and starting up a new project, the CFC editor includes test functions allowing you to monitor and, if necessary, modify the block I/Os on the PLC.

4.1 General

The CFC editor has two operating modes: The Edit mode and the Test mode.

- In the Edit mode, you configure the entire software structure for a CPU offline (see also Section 3 "Working with the CFC Editor").
- When you change to the Test mode, you can monitor and assign parameters to the block I/Os; In other words monitor and modify values online.

During a test, there must be a unique assignment between objects in the graphic program representation and the physical addresses on the CPU. For this reason, in the Test mode, in contrast to the Edit mode, you cannot make changes that affect the structure of the user program (for example inserting or deleting blocks, changing interconnections from inputs and outputs etc.).

Further Test Functions

- To allow you to monitor specific block I/Os in different blocks and charts (and even on different CPUs) at once, you can collect these I/Os in a dynamic display window and display the constantly updated values.
- In addition to the direct test functions, there is also a group of functions that help you to prepare for test and startup, for example displaying module information, setting the time of day etc.

Requirements:

To use the test and start-up functions, the user program created in the CFC editor must first be compiled free of errors and downloaded to the CPU.

4.2 Functions Before and During the Test

In addition to the direct functions, there are also other functions that you require for testing and starting up. These include the following:

- General functions such as “Set Time and Date”
- Functions that support you during system diagnostics and troubleshooting, such as displaying the mode or module information.

These functions are described below.

4.2.1 Comparing the Time Stamp of the CPU Program

You can display the time stamp of the loaded user program with the “PLC > Compare...” menu command.

Three time stamps are displayed in the dialog:

- The last download-relevant change
- Last offline program change
- Last online program change

Note

The “Last download-relevant change” time stamp is also changed by assigning parameters to block I/Os in the Test mode.

The user program that you downloaded to the CPU is only identical with the user program in CFC and the machine code when all the time stamps are identical.

From the time stamps that match or do not match, you can see where changes have been made in the user program and can decide whether you need to recompile or download again.

4.2.2 Starting and Stopping the CPU Program

You can start or stop the CPU program by selecting the “PLC > Operating Mode...” menu command and then clicking the appropriate button “Cold Restart”/“Hot Restart” or “Stop” in the dialog box.

This function is identical to the corresponding function of the SIMATIC Manager. The procedure is described in detail in the manual /231/ or in the online help of the SIMATIC Manager.

4.2.3 Clearing/Resetting a CPU

Clearing or resetting means that the entire user program on the CPU and all the existing connections are deleted. The CPU must be in the STOP mode.

This function is identical to the corresponding function in the SIMATIC Manager described in the manual /231/ or in the online help of the SIMATIC Manager.

Note

If you download the **entire** user program, all the blocks on the CPU are deleted after you confirm a prompt. In this case, you do not need to clear the CPU memory first. When you clear the CPU memory, not only the user data of the CPU but also the connections to the module are deleted.

4.2.4 Set Time and Date

You can set the "Date and Time" on a particular CPU by selecting the "PLC > Set Time and Date..." menu command.

This function is identical to the corresponding function in the SIMATIC Manager described in the manual /231/ or in the online help of the SIMATIC Manager.

4.2.5 Displaying Module Information


You can display the current status of the CPU module with the "PLC > Module Information..." menu command.

This function is identical to the corresponding function in the SIMATIC Manager described in the manual /231/ or in the online help of the SIMATIC Manager.

4.3 Activating or Deactivating the Test Mode

The Test mode relates to the CPU belonging to the currently active chart.

Activating the Test Mode:

Select the “Debug > Test Mode” menu command or click the button  in the toolbar. The Test mode is activated. You can now activate the test functions; Most of the functions of the Edit mode become inactive.

If the user program has been modified in the meantime, a message will be displayed when you change to the Test mode.

Deactivating the Test Mode

When you deactivate the Test mode, the debug functions become inactive and the functions of the Edit mode are activated again.

You deactivate the Test mode by clicking the button  again in the toolbar or by selecting the “Debug > Test Mode” menu command.

Changing Mode

When you change the editor mode, the relevant CPU is accessed in the background.


The following processes are started when you change to the Test mode:

- Each time you change to the Test mode, the dynamic display attributes stored in the data management are available again. You can activate these by selecting the relevant menu commands.
- Following this, the connection to the PLC is opened. If a user program already exists on the PLC, the CFC editor compares its characteristic data (name, version, compilation date/time) with the data of the current user program of the CPU to which the currently active chart belongs. If the programs have the same version, the Test mode is activated.

The status bar indicates whether the program is in the Edit or Test mode.

The new operating mode can only be adopted after the background operations have been completed successfully.

4.4 Monitoring and Assigning Parameters to Block I/Os

When you activate the Test mode, the “Watch” function  is automatically activated.


This means that in the Test mode, you can display the development of the values of block I/Os logged on for the watch function, in other words the values are read out cyclically from the CPU and displayed.

Note

You cannot watch block I/Os that are not stored in DBs. This also applies, for example, to unconnected inputs of FCs or BOPs and for output variables of the type STRING, DATE_AND_TIME, ANY.


4.4.1 Block I/Os in the Chart Window

Adding/Removing I/Os in the Watch List

You can include the **block I/Os of a selected block** (or of several selected blocks) in the watch list by selecting the “Debug > Add to Watch List” menu command or by clicking the button  in the toolbar. All the input and output values of all the

selected blocks are then included for monitoring.

You can add or remove **individual I/Os** from the watch list by selecting the I/O and clicking the “Add to Watch List” button. As an alternative, you can add an remove block I/Os from the watch list with Ctrl and a mouse click.

You remove blocks from the watch list by selecting the “Debug > Inputs/Outputs > Remove from Watch List” menu command or by clicking the button  in the toolbar.


Alternative: You can also include and remove individual I/Os and the I/Os of an entire block in the Edit mode by displaying the “Object Properties” for a selected block and selecting or deselecting the I/Os in the “For Test” column in the “Inputs/Outputs” tab.

Note

You should avoid watching too many I/Os at one time, otherwise there is a large communication load on the bus and on the CPU. If the load is too great (for example >500 in the 1s monitoring cycle), the watchdog may respond; The I/O values are then marked as temporarily “disturbed”.

Activating and Deactivating I/O Watching

You activate watching (display of the current values of a block I/O) of the block I/Os in the watch list as follows:

- Automatically by activating the Test mode
- With the “Debug > Watch” menu command or with the button  in the toolbar.
- By selecting this function again, you deactivate the watch function.

All the input and output values in the watch list are updated within the monitoring cycle.

Test Settings

With the “Debug > Test Settings” menu command, you can modify the cycle time for updating in the dialog box. Default: 1 s.

Representation of the Values

The values are displayed beside the I/Os according to their data type. They are shown on the screen on a colored background.

- **Asterisks black on yellow** = values when changing to dynamic display
- **Value black on yellow** = values read from the CPU
- **#### on a red background** = while the dynamic values from the CPU cannot be supplied (problem)

Setting Parameters for I/Os

When the Test mode is active, you can modify the parameters of all unconnected inputs that are included in the watch list

Before the modified value is adopted on the PLC, its validity is checked.

Please note that parameters modified in the Test mode are always included in the CFC data management.

4.5 The Dynamic Display

In the Test mode, the values of block I/Os can be displayed dynamically in a separate window. This is possible for the elementary data types (BO, W, R, ...) and for structures (see Section 3.6.6, Structures).

The Dynamic Display Window

The dynamic display window can be opened and arranged in the window of the CFC editor along with any chart windows. You can adjust the size of the window. There is only one dynamic display window without a separate menu for all the charts.

Within the window, you can display and monitor the values of block I/Os from different charts and different CPUs. The relevant chart does not need to be open.

The dynamic display window is activated and deactivated with "View > Dynamic Display".

The dynamic display window is divided into columns (you can vary the width) and includes the following titles and information:

- **Status** displays a check box, in which you can decide whether or not the block I/O is watched; in other words whether the value will be displayed dynamically. If required, a status message is displayed (for example CPU fault, value error, ...).
- **Path** in the project (for example project\S7 program(1)\..)
If a plant hierarchy exists, the hierarchy path is displayed (for example project\plant\unit\function).
- **Chart** displays the name of the chart. If the chart is a nested chart, the name of the parent chart (for example parent chart\Sim_reg) is displayed.
- **Block and I/O** show the name of the CFC block (for example switch, controller, ...) and the name of the I/O (for example LMN, IN1, ...).
- **Value** shows the actual value of the block I/O read from the CPU (if the check box for "Watching" is set for status). If there are problems with a value ##### is displayed.
- **Unit** shows the text for the corresponding unit (if it exists)
- **Comment** shows the comment for the block I/O (if it exists).

The value selected in the dynamic display window are retained after it is closed, even if the chart is closed or you quit the CFC editor.

4.5.1 Block I/Os in the Dynamic Display Window

Inserting and Deleting Block I/Os

You can insert block I/Os into the dynamic display in the Edit or in the Test mode. The way in which the function works is analogous to the adding and removing block I/Os in the watch list.

You can include block I/Os from an open chart in the dynamic display window as follows:

- Select the required block I/O and then select “Debug > Inputs/Outputs > Include in Dynamic Display”.
- Drag the required chart I/O to the dynamic display window with the mouse.

If the block I/Os have a **structure**, before the I/O is included in the dynamic display, a dialog box appears in which you can select the value you want to be displayed.

To delete block I/Os, select the corresponding line (or several lines) in the dynamic display and remove them as usual.

Watching Values

You can watch or monitor the values of block I/Os of charts without opening the relevant chart.

The value is displayed dynamically updated at the selected monitoring cycle rate in the following situations:

- The Test mode is activated for the active dynamic display window
- The block I/O (or element of a structure) has been enabled for watching (selection in “Status”).
- and the connection to the CPU could be established.

If there is a problem displaying a value, #### is displayed.

Documentation

5

Overview

This chapter provides you with an overview of how to create comprehensive documentation for your CFC configuration structure. This includes the following:

- The chart
- The chart reference data
- The logs

5.1 Printing a Chart

With the print function, you can print the current chart in CFC. You can set the layout you require ("Chart > Page Setup...") and display a preview ("Chart > Print Preview") of the chart as it will be printed on the printer.

Printing the Active Chart

With the "Chart > Print" menu command, you print the active chart on the default printer.

The chart is printed in the overview or in the sheet view depending on the current screen view.

If the chart is empty, only the overview will be printed or in the sheet view the first empty sheet.

If the chart has chart I/Os, the chart I/Os will be printed on a separate page in a table (containing all the relevant information such as data type, invisible, ...). If there are too many I/Os to fit on one page, further pages are printed.

5.1.1 Headers and Footers

Overview

With the DOCPRO optional package, you can print the CFC chart (or the CFC charts) along with header and footer data. In the header and footer data, a distinction is made between global data and local data specific to a chart.

You can enter the global data for the project using DOCPRO or the SIMATIC Manager; the local chart-specific data must be entered with the CFC editor. Remember that the data specific to a chart overwrite the entries of the global data for the particular chart.

You can also enter data specific to a chart even when you have not installed the DOCPRO optional package. This data is saved and can be printed later when DOCPRO is available for print jobs.

Header and Footer Data for a Specific Chart

With the "Chart > Headers and Footers" menu command, you display a dialog box with several tabs: "Part 1" to "Part 4" and "Free Fields".

Here, you can make entries in the active boxes such as:

Type of document, date created, document number, date modified, free text etc.

5.2 Chart Reference Data

Overview

In addition to the graphic representation of the chart in the CFC editor, you can also display and print the following information in the form of a list using the “Options > Reference Data...” menu command.

- Cross-References
Lists of accesses to various objects.
- Run Sequence
Graphic display of the entire run sequence of a CPU.

These lists help you to check your configuration structure.

Handling

With the “Edit > Find...” menu command, you can search for terms (text strings) in the active window. If a term is found, the location is displayed.

If you double-click the name in the first column, you can open the chart in which the point of use is located. The relevant object is then selected.

Various Versions

A list created once by the system is not updated automatically. Each list provides information about the status of the project at the time the list was created. Several versions of these lists can be opened at the same time.

If required, you can update the list using the “View > Update” menu command or with the “F5” key.

Various Projects

You can generate lists not only of the project currently being edited in CFC, but also access all other CFC projects. This allows you to compare several projects. Lists of several projects can be opened at the same time.

Documentation

Along with the printed charts, the reference data provide you with complete documentation of your configuration structure.

Export

You can save the generated list as a file in the CSV format (for example for use in EXCEL) with the “Reference Data > Export...” menu command.

5.2.1 Lists of Reference Data

You can display and print the following reference data:

- **Cross-References of Addresses**
The list includes all the global addresses used in the project with the elements that access them.
- **Cross-References of CFC I/Os (SFC only)**
The list includes the accesses by all SFC charts to the CFC block I/Os.
- **Cross-References of Run-Time Groups**
The list includes the accesses to all run-time groups by all CFC and SFC charts.
- **Cross-References of SFC (SFC only)**
The list includes the accesses to all SFC charts by all SFC charts.
- **Cross-References of Block Types**
The list includes block types used and their locations (CFC chart).
- **S7 Resource Allocation**
The list includes the assignment between CFC configuration objects and S7 resources.

For a detailed description of the lists and the meanings of the columns, refer to the online help of CFC.

Note:

In the "Cross-References for CFC" list, no cross-references from CFC to CFC are listed, since these correspond to the connections between CFC charts and can be seen clearly in the CFC documentation.

5.2.2 Run Sequence

Figure 5-1 shows the graphic representation of the run sequence of a CPU (tasks, run-time groups, and blocks). The actual display in this window differs from PLC to PLC and may also differ from the example shown in Figure 5-1.

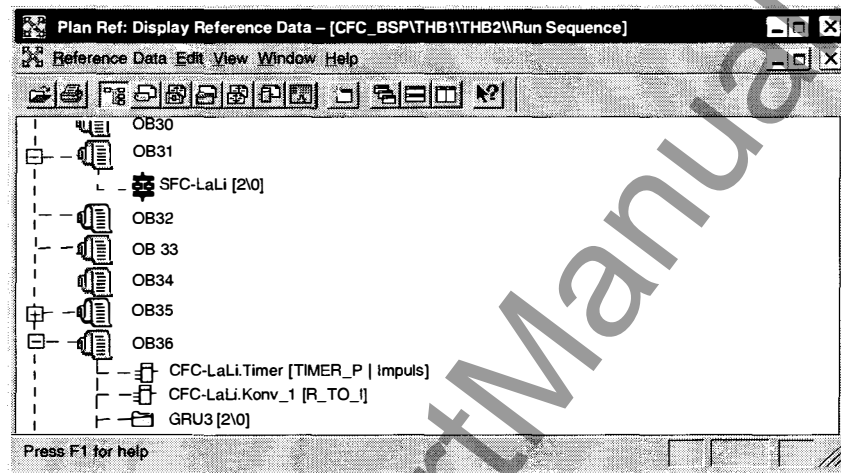






Figure 5-1 Reference Data: Run Sequence

The object labels have the following meaning:

-  OB 33
Task name
-  SFC-LaLi [2\0]
SFC chart name [scan rate \ phase offset]
-  CFC-LaLi.Timer [TIMER_P | Impuls]
Chart name.Block name [Block type name | Comment]
-  GRU3 [2\0]
Group name [scan rate \ phase offset]

5.3 Logs

The logs do not belong to the documentation of the configuration structure but can provide important information during configuration and trial startups if errors occur.

For further information on the logs, refer to the online help of the dialog box.

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Technical Specifications

A.1 [S7] Technical Specifications

Hardware Requirements

- SIMATIC PG or PC
- Pentium
- RAM at least 32 Mbytes
(recommended 64 Mbytes or more)
- Hard disk (free space) approx. 200 Mbytes (less RAM memory)
- Graphics card VGA 640 x 480
(recommended: SVGA 1024 x 768 or higher)
- SIMATIC S7-300, S7-400

Software Requirements

- Microsoft Windows 95 / 98 / NT
(Windows NT incl. Service Pack 3)
- STEP 7
- SCL Compiler

A.2 Field/Name Lengths and Conventions

Table A-1 Name Lengths

Object	Length	Remarks
Chart	22	Must not include the following characters: \\ . " %
Chart comment	255	All ANSI characters are permitted.
Run-time group	22	Character set as for "chart"
Task	22	Character set as for "chart"
Block type	8	Determined by STEP 7.
Comment for block instance	80	All ANSI characters are permitted.
Parameter name	24	Determined by STEP 7. The 1st character must not be a number (0 - 9).
Parameter comment	80	All ANSI characters are permitted.
Name of the block instance	16	Must not include the following characters: \\ . " %
Global variables	24	Characters determined by the symbol editor; all permitted even blanks and special characters except "

A.3 [S7] Data types

Table A-2 Data Type in SIMATIC S7

Abb.	Keyword	Meaning	Bits
A	ANY	Pointer to data element	80
BO	BOOL	Logical number	1
BY	BYTE	Sequence of 8 bits	8
C	CHAR	Single character	8
CR	COUNTER	Number of an S7 counter	16
D	DATE	Date	16
DB	BLOCK_DB	Number of a DB	16
DI	DINT	Double integer	32
DT	DATE_AND_TIME or DT	Date and time	64
DW	DWORD	Sequence of 32 bits	32
FB	BLOCK_FB	Number of an FB	16
FC	BLOCK_FC	Number of an FC	16
I	INT	Integer	16
P	POINTER	Pointer to memory area	48
R	REAL	Floating-point number	32
S	STRING	Text string of any length	256 bytes
SD	BLOCK_SDB	Number of an SDB	16
SN	STRING[n]	Text string with maximum n characters, $1 \leq n \leq 253$	
ST	STRUCT	Parenthesis for elementary data types and other structures (nesting depth: 8)	
T	TIME_OF_DAY or TOD	Timer	32
TI	TIME	Duration	32
TR	TIMER	Number of an S7 timer	16
T5	S5TIME	Duration in S5 format	16
W	WORD	Sequence of 16 bits	16

For a detailed description of the data types, refer to the online help.

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Abbreviations

C / C++	High-level language for programming computers
CFC	Continuous Function Chart
CPU	Central Processing Unit
HID	Higher level designation
DB	Data Block
ES	Engineering System
FB	Function Block
FC	Function Code (function block without memory)
IEA	Import/Export Assistant
LAD	Ladder Diagram
OB	Organization Block
OS	Operator Station
OCM	Operator Control and Monitoring (WinCC)
PC	Personal Computer

PCS 7	Process Control System (SIMATIC)
PG	Programming Device
PH	Plant Hierarchy
PLC	Programmable (Logic) Controller
SFB	System Function Block
SFC	Sequential Function Chart
SINEC	Siemens Network Architecture
STEP 7	Software development environment for SIMATIC S7 / M7
STL	Statement List

References

- /100/** Manual: *S7-400, M7-400 Programmable Controllers Hardware and Installation*
- /101/** Reference Manual: *S7-400, M7-400 Programmable Controllers Module Specifications*
- /102/** Instruction List: *S7-400 Programmable Controller*

- /231/** User Manual: *Standard Software for S7 and M7, STEP 7*
- /232/** Manual: *Statement List (STL) for S7-300 and S7-400, Programming*
- /233/** Manual: *Ladder Logic (LAD) for S7-300 and S7-400, Programming*
- /236/** Manual: *Function Block Diagram (FBD) for S7-300 and S7-400, Programming*

- /250/** Manual: *Structured Control Language (SCL) for S7-300 and S7-400, Programming*
- /253/** Manual: *Continuous Function Chart, CFC for S7*
- /254/** Manual: *Continuous Function Chart, CFC for M7*
- /255/** Manual: *Sequential Function Chart, SFC for S7-400*

- /257/** Manual: *BATCH flexible Automating Batch Processes*

- /258/** Reference Manual: *Library of Standard Blocks*
- /259/** Reference Manual: *Library of Technological Blocks*
- /260/** Reference Manual: *Library of Field Device Blocks*

- /261/ System Description: *Process Control System 7*
- /262/ Getting Started: *PCS 7 Process Control System*

- /300/ Brochure: *SIMATIC WinCC, Windows Control Center*
- /301/ Manual: *SIMATIC WinCC, Control Center + Global Script + User Administration*
- /302/ Manual: *SIMATIC WinCC, Graphics Designer*
- /303/ Manual: *SIMATIC WinCC, Tag Logging+Alarm Logging+Report Designer*
- /304/ Manual: *SIMATIC WinCC Options, Basic Process Control+ Advanced Process Control +ChipCard+Video*

Glossary

A

Absolute addressing

If data is addressed in absolute form, the absolute address is used to access the value with which the operation will be performed. Example: The address Q4.0 identifies bit 0 in byte 4 of the process output image (PIQ).

Access

Chart elements or block I/Os can access addresses, charts, block I/Os, or run-time groups. A distinction is made between read and write access.

Address

An address is part of a STEP 7 instruction and tells the processor what it should perform an operation on. It is the identifier of the location of data or an area containing data, examples: input I12.1; memory word MW25; data block DB3. It can be addressed in symbolic or absolute form.

In SFC, the address is part of an assignment (step) or condition (transition).

B

Basic operation

Basic operations (BOPs) are objects resident in the system that perform simple functions such as AND, OR etc. They are represented in CFC as blocks.

Block

Blocks are separate parts of a user program that are distinguished by their function, their structure or purpose.

CFC works with ready-made block types that are placed (inserted) in a CFC chart. When a block type is inserted in the chart, a block instance is created. These block instances and their graphic representation are blocks in the sense of CFC.

Block category

The block category identifies different forms of blocks. Block categories include, for example, data blocks (DBs), function blocks (FBs), and functions (FCs).

Block header

The top part of a block when displayed in CFC. It contains the name and the task assignment (run-time property).

Block input

Block I/O that can be interconnected with block outputs and ↑ addresses of the same data type or can have parameters assigned to it.

Block instance

A block instance is the implementation of a block type. A block type inserted in a CFC chart becomes a block instance. When it is inserted, the block instance is assigned run-time properties and is given a name that is unique within the chart.

Block interface

This consists of the I/Os of a block.

Block I/O

Block input or block output

Block library

↑ Library

Block output

Block I/O that can be interconnected with block inputs and ↑ addresses of the same data type.

Block type

Block types are ready-made program sections that can be used in a CFC chart (for example, controllers, multiplexers etc.). When they are inserted, block instances are created. You can create any number of block instances from a block type.

The block type determines the characteristics (algorithm) for all implementations of this type. The name of the block is entered in the symbol table.

C**CFC**

Continuous Function Chart.

1. Function chart (CFC chart) with the graphic interconnection of technological functions (blocks).
2. An editor for plant/oriented, graphic configuration of automation tasks. Using CFC, entire software structures are created (CFC charts) from ready-made blocks.

Chart

Document in which continuous automation functions are created with the CFC configuration tool or in which sequential control systems are created with SFC.

Chart folder

Folder in the project structure containing charts of a user program.

Chart overview

The overview of a CFC chart or chart partition with its six sheets.

Chart partition

Part of a CFC chart. A CFC chart is subdivided into a maximum of 26 chart partitions (named A to Z) each with 6 sheets.

Clear/reset

This function clears the following memory areas on the CPU:

- RAM
- Write/read area of the load memory
- System memory except for the MPI parameters and the diagnostic buffer

Code compilation

Conversion of the graphic CFC into a user program (SCL for S7 or C for M7).

Component view

Device-oriented view in the SIMATIC Manager. The project is displayed with its components (station, module, program ...); alternative to the ↑ Plant View.

Connector

The connection point on the block with a reference to the I/O to which it is connected. Connectors are used when no more connecting lines can be drawn on a sheet because it is already full. The connectors allow complex CFC structures, including those extending to other sheets, to be displayed completely.

Consistency Check

Checks the consistency of block types, shared addresses etc. of the chart folder.

Control block for SFC

With the SFC control block (SFC_CTRL), you can query the status of an SFC chart and influence its execution in CFC. The control block is inserted in the CFC chart, interconnected, and assigned parameters. It has its own run-time properties and can be modified (along with the SFC chart) in the run sequence. The control block must always be installed immediately before an SFC chart in the run sequence.

CPU

The CPU (central processing unit) is a module in the programmable controller on which the user program is stored and run. It contains the operating system and the communications interfaces.

Cycle time

The cycle time is the time required by the CPU to execute the user program once.

D

Data block (DB)

Data blocks are data areas in the user program containing user data. There are shared data blocks that can be accessed by all logic blocks and instance data blocks that are assigned to a particular FB call. In contrast to all other blocks, they contain no instructions.

Data type

A data type specifies how the value of a variable or constant is used at a block I/O. "BOOL", for example, defines a binary variable; "INT" defines a 16-bit fixed-point variable.

Diagnostic buffer

A buffer on the CPU in which all the diagnostic events are entered in the order in which they occur.

Download-relevant change

A modification in the CFC/SFC chart is download-relevant when it causes a change in the user program of the CPU (for example a change to an interconnection). Changes that are not download-relevant change involve, for example block positions and comments.

Dynamic display

In the dynamic display, input and output values of a block in a CFC chart or address values in an SFC chart are updated from the CPU in the Test mode.

Dynamic display window

Window in CFC for monitoring selected block I/Os on CPUs.

E**Edit mode:**

(Alternative to the ↑ Test mode) In **CFC**, blocks can be inserted, copied, moved, deleted, assigned parameters, or interconnected.

Enable attribute

The enable attribute is a run-time attribute. It activates or deactivates a run-time group or an SFC chart. As long as it is deactivated (FALSE), the run-time group / the SFC chart is not executed regardless of any other conditions.

The enable attribute can be set dynamically. In this case, the output value of a CFC block or the assignment in an SFC action decides whether the run-time group or SFC chart is activated or deactivated.

F

Function (FC)

(FUNCTION) According to IEC 1131-3, functions are logic blocks without memory. A function allows parameters to be transferred in the user program. Functions are suitable for programming frequently recurring complex functions, for example calculations.

See also ↑ Block category.

Function block (FB)

(FUNCTION BLOCK) According to IEC 1131-3, a function block is a logic block with static data. An FB allows the transfer of parameters in the user program. Function blocks are suitable for programming frequently recurring complex functions, for example closed-loop controls. Since an FB has a memory (instance data block), its parameters (for example outputs) can be accessed at any time and any point in the user program.

See also ↑ Block category.

H

Higher level designation (HID)

This is made up of the hierarchical path of the plant hierarchy.

I

Import/Export Assistant (IEA)

Software component in PCS 7 for handling ↑ prototypes and ↑ replicas of the prototypes).

Installation and startup

The CFC/SFC editors provide test functions to allow you to monitor, modify, and change parameter settings on the PLC during installation and startup.

Interconnection

Connection of an interface I/O to another element. The value of the interconnected input is fetched from the other end of the interconnection during run time.

Interface

The interface consists of the inputs and outputs of a block (block interface) or a chart (chart interface) that can be interconnected and assigned parameters.

Internal block

A block within a ↑ multi-instance block.

L**Ladder Logic (LAD)**

Graphic representation of the automation task with symbols of circuit diagrams complying with DIN 19239.

Library

A folder for objects that can be used again and again. A library is not project-related. Blocks are made available in block libraries sorted according to certain criteria (block families, alphabetical order etc.). Different block libraries are used depending on the PLC or situation.

Local data

Local data are data assigned to a ↑ logic block that are listed in its declaration section or its variable declaration.

Logic block

In SIMATIC S7, a logic block is a block that contains part of the STEP 7 user program. In contrast, a data block contains only data. The following logic blocks exist:

- ↑ Organization blocks (OB)
- ↑ Function blocks (FB)
- ↑ Functions (FC)
- System function blocks (SFB)
- System functions (SFC)

M**Message class**

The message class determines the properties of a message. In SIMATIC PCS 7, there are the message classes alarm, warning, tolerance, PLC and OS process control message, process message, operator request and operator message.

Message configuration

Creating messages with their attributes and texts. Messages can be configured in CFC/SFC.

MPI address

In an MPI network, every programmable module is assigned its own MPI address.

Multi-instance block

A block consisting of several internal blocks with a common ↑ interface and a common instance DB.

N

Nested chart

A CFC chart that is inserted in another CFC chart (nested or top chart). Nested charts are not displayed in the SIMATIC Manager.

O

Online/offline

In the SIMATIC Manager, objects of the programmable controller are displayed in the online view and the objects of the ES in the offline view. Online, there is a data connection between the PLC and the programming device/PG, offline there is no connection.

Operating system

General term for all the functions that control and monitor the execution of the user programs, the distribution of resources to the individual user programs, and the maintenance of the operating mode in conjunction with the hardware (for example standard operating system MS-WINDOWS, real-time operating system M7 RMOS32).

Operating mode

1. The programmable controllers of SIMATIC S7 can adopt the following modes: STOP, STARTUP, RUN and HOLD.
2. (SFC) The sequential control system can operate in the following modes OFF, ACTIVE and HOLD.

Organization block (OB)

Organization blocks form the interface between the operating system of the CPU and the user program. The order of execution of the user program is specified in organization blocks.

An organization block corresponds to a ↑ task.

OS

Operator Station. A station for controlling and monitoring the process. In PCS 7, the WinCC software system is used for the OS with which all the process monitoring and control functions can be implemented.

Overflow page

(CFC) If there are so many entries in the ↑ sheet that there is no more space in the sheet bars, an overflow page is automatically created. An overflow page consists only of the ↑ sheet bars with entries and contains no other objects.

P**Parameter**

A parameter is

1. the value of a CFC block/chart I/O.
2. a variable of an S7 logic block (actual parameter, formal parameter)

Phase offset

The phase offset shifts the point of activation of the run-time group or the SFC chart within a task by a defined time compared with the basic cycle. Phase offset allows a uniform distribution of load within the CPU. See also ↑ scan rate.

Plant hierarchy (PH)

A hierarchy structured according to technological aspects.

Plant view

View in the SIMATIC Manager based on technological aspects (plant, unit, function ...); alternative to ↑ component view.

Process control point

The smallest unit in process control. This handles processing functions of a process variable such as closed-loop control, display, alarm generation etc.

Process image

Reserved areas in the RAM of the CPU. Signal states of the input and output modules are entered here.

Process variable

The process variable is a neutral object in terms of resources. It is used to connect the PLC configuration world (STEP 7, CFC ...) with the OS configuration world (WinCC). It contains information about its location during run time (for example the network address and the memory area on the PLC) as well as information on specific OS-relevant properties.

Program

General term for S7 and M7 programs.

Programmable controller (PLC)

Programmable controllers are electronic controllers whose function is stored as a program on the controller.

The programmable controller has the structure of a computer; it consists of a CPU with memory, input/output modules and an internal bus system. The I/Os and the programming language are designed for the requirements of process control.

A programmable controller is a controller in SIMATIC S7, a compact device (PLC with integrated operator controls) SIMATIC C7, or a SIMATIC M7 automation computer.

Programming device (PG)

Portable and compact personal computer specially designed for use in an industrial environment. A programming device is completely equipped for programming SIMATIC programmable controllers.

Project

A folder for all the automation solutions regardless of the number of stations or modules and how they are networked.

R

Reference data

Reference data are data available to the user in addition to the graphic chart display in the form of lists, for example the list of accesses to shared addresses.

Resources

Resources are pools of objects (FBs, FCs, DBs, OBs, bit memory, counters, timers etc.) that can be accessed when configuring and setting parameters for a CFC/SFC chart.

Restart

(S7) When a CPU starts up (for example after changing the mode selector from STOP to RUN or after power on), before the cyclic program is run (OB1), either organization block OB100 (cold restart) or organization block OB101 (hot restart, S7-400 only) is executed. During a hot restart, the process input image is read in and the STEP 7 user program is resumed at the point at which it was stopped (STOP, power off).

Run-time attribute

Each run-time group has run-time attributes that control its activation. The group passes on these attributes to all the blocks it contains.

Run-time group

Run-time groups are used to structure tasks. The blocks are installed sequentially in the run-time groups. Run-time groups can be activated and deactivated separately. If a run-time group is deactivated, none of the blocks it contains will be activated any longer.

Run-time properties

The run-time properties of a block decide how the block is included in the run sequence within the entire structure of the PLC. These properties are vital to the performance of the PLC in terms of reaction times, dead times, or the stability of time-dependent structures, for example control loops.

In S7, a user program on the ES consists of the symbol table, the source files, the blocks, and the charts.

S**S7 program**

A folder for the ↑ symbol table, the blocks, the source files, and the charts for the programmable S7 modules.

Scan rate

The scan rate is a ↑ run-time attribute. It specifies whether a chart or a ↑ run-time group is executed every time a task is executed or only every nth time. See also ↑ phase offset.

SCL

A high-level language similar to Pascal complying with IEC 1131-3 for programming complex solutions on a PLC, for example algorithms and data processing jobs.

Sequential control system

A sequential control system switches from one to the next step dependent on conditions. In PCS 7, sequential control systems are implemented with SFC charts.

SFC

An SFC chart is a sequential control system that runs as a separate control system within the programmable controller.

Shared address

Shared addresses are objects that can be accessed by every logic block (FC, FB, OB). They include bit memory (M), inputs (I), outputs (Q), timers (T), counters (C) and elements of data blocks (DB). To access shared addresses, you can use absolute addresses or symbols.

Shared data block

This is a data block that can be accessed by all blocks in the program. Each CFC block instance can therefore read the shared data from the block or write data to the block.

Shared data blocks are created with the LAD or STL editor.

Sheet

Subdivision of a chart partition. A chart partition consists of 6 sheets. The sheet represents a working area (with sheet bars), on which blocks can be placed, assigned parameters, and interconnected.

Sheet bar

Margin at the right and left edges of a CFC chart. The sheet bars contain:

- references to connected objects (block/chart interface, address, and run-time group) that are not located on the active sheet
- the number of the connector reference when the connecting line cannot be drawn to the sheet bar because the chart is full.

SIMATIC Manager

Graphic user interface for SIMATIC users under Windows NT. The SIMATIC Manager is used, for example, to create projects and access libraries.

Source file

Part of a program that is created with a graphic or textual editor that is compiled to create the executable user program.

Statement List (STL)

Statement List is a textual programming language similar to machine code (complying with IEC 1131-3).

Structure

A structure is a structured ↑ data type made up of various elements. An element can be an elementary or a structured data type.

Symbol

A symbol is a name defined by the user according to certain syntactical rules. After its purpose has been defined (for example to represent a variable, data type, jump label, block), it can be used in programming and in operator monitoring and control.

Example: address : I5.0, data type: BOOL, symbol: Emer stop.

Symbol table

Table for assigning symbols (= name) to addresses for shared data and blocks.

Examples:

Symbol	Address
Emer stop	I1.7,
Control	FB24

Symbolic addressing

If data is addressed using symbols, the address to be processed is specified as a symbol (not as an absolute address). Symbols are assigned to addresses in the symbol table.

T**Task**

Tasks form the interface between the operating system of the CPU and the user program. The order of execution of the user program is specified in tasks. In S7 the tasks are implemented as ↑ organization blocks (OBs). In M7, a task is the interface between the operating system of the M7-CPU and the user program. The tasks are mapped on RMOS tasks.

Test mode

(Alternative to the ↑ Edit mode) Mode of CFC/SFC for testing and optimizing user program running online on the CPU.

Top chart

A CFC chart that is not nested in another chart and can be displayed in the SIMATIC Manager (↑ nested charts).

U

Update cycle

In the Test mode, this specifies the intervals at which the watched block I/Os are updated.

User program

The user program contains all the instructions and declarations and the data for processing the signals allowing a plant or process to be controlled. It is assigned to a programmable module (for example CPU, FM) and can be structured in smaller units.

V

Value identifier

Symbolic substitute (text) for defined values of block I/Os of the data types BOOL, BYTE, INT, DINT, WORD and DWORD.

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