

# **SIEMENS**

## **SIMATIC**

### **Windows Automation Center RTX**

### **WinAC RTX V4.0 incl. SP1**

#### **User Manual**

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# Preface

The Windows Logic Controller with Real-Time Extensions (WinLC RTX) provides the functionality of a programmable logic controller (PLC) in a real-time, PC-based environment. WinLC RTX uses the Venturcom Real-Time Extensions (RTX) to Windows and is fully code-compatible with the SIMATIC product family. You can use many of the SIMATIC products, such as WinCC, with WinLC RTX.

WinLC RTX uses a PROFIBUS-DP network to control the distributed I/O, such as an ET 200M device. WinLC RTX uses S7 communications (such as PROFIBUS, Industrial Ethernet, or MPI) for connecting to STEP 7 or other programming software on another computer.

## Audience

This manual is intended for engineers, programmers, and maintenance personnel who have a general knowledge of programmable logic controllers.

## Scope

This document describes the features and the operation of WinAC RTX version 4.0.

## Other Manuals

You can find additional information in the online help for STEP 7, and in the following manuals:

- *Programming with STEP 7 Manual.* This manual provides basic information on designing and programming a WinLC RTX control program. Use this manual when creating a user program with the STEP 7 automation software.
- *System Software for S7-300/400 System and Standard Functions Reference Manual.* WinLC RTX includes integrated system functions and organization blocks, which you can use when programming. This manual provides you with descriptions of the system functions, organization blocks, and loadable standard functions.
- *Working with STEP 7 Getting Started Manual.* This manual explains the usage and the functions of the STEP 7 automation software. This manual provides you with an overview of the procedures used to configure WinLC RTX and to develop control programs.

To find these and other manuals, select the **Start > Simatic > Documentation** menu command from the Start menu of the computer where STEP 7 and SIMATIC NET are installed.

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For information about Venturcom Real-Time Extensions (RTX):

- Internet: <http://www.vci.com>

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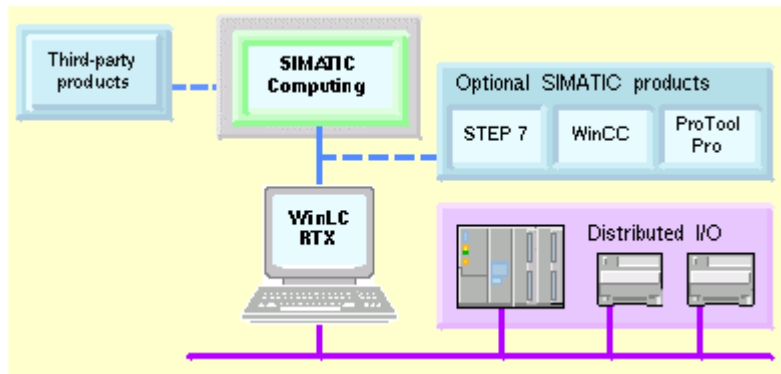
# Product Overview

## Introduction to PC-Based Control

WinAC RTX includes WinLC RTX and SIMATIC Computing for process control and operator access.

- WinLC RTX provides the PC-based solution for your process automation needs: a PC-based controller that uses a PROFIBUS-DP network to connect to distributed (remote) I/O.
- SIMATIC Computing provides an OPC server and other controls that allow you to link other Windows applications to your process data. Refer to the *SIMATIC Computing User Manual* for more information.

As shown in the following figure, you can use other SIMATIC products, such as STEP 7, ProTool Pro or WinCC, with WinAC RTX.

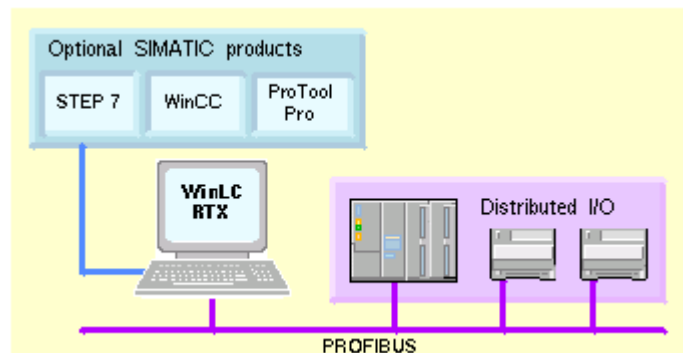


## Introducing the "Soft PLC": WinLC RTX

WinLC RTX is a programmable "soft logic" controller – a software version of an S7 controller – that runs on a standard computer (PC), using the Windows 2000 Professional or Windows XP Professional operating system.

WinLC RTX supports multiple networks and connects to the distributed I/O, such as ET 200M, by means of CP cards (CP 5613 V3 or CP 5613 V6 or later) that you install in your computer.

As part of the SIMATIC family of automation products, WinLC RTX can also communicate with STEP 7 or other SIMATIC products, such as WinCC, ProTool Pro, or other SIMATIC S7 controllers, including WinLC RTX V4.0 or later, over PROFIBUS, Ethernet, or MPI networks. This allows you to use WinLC RTX in a typical factory automation configuration:




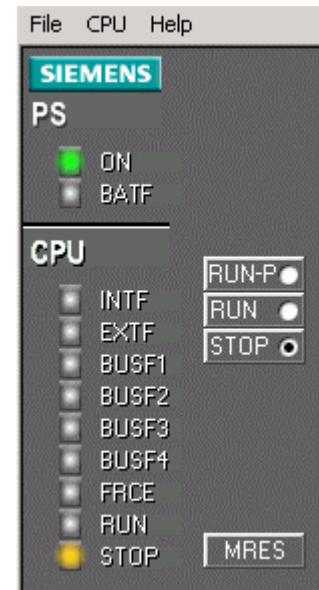
## Introduction to the Control Panel

The control panel corresponds to the faceplate of the S7 controllers. It enables you to start or shut down the controller and to perform other controller operations.

The control panel contains the following elements for working with the controller:

- Three mode buttons for changing the operating mode of the controller  
(The mode buttons are similar to the keyswitch on a hardware S7 controller)
- Status indicators for the controller
- An MRES button for resetting the memory areas
- Menus for controller operations

An icon  is displayed in the Windows taskbar whenever the controller is operating. When the controller is operating and the control panel is closed, you can double-click this icon to open the control panel. Opening or closing the control panel does not influence the state of the controller. The status of the operator switches and the LEDs are stored in the controller.



## WinLC RTX Features

WinLC RTX is a software version of an S7 controller that adds real-time control provided by a real-time subsystem (RTSS) for the Windows operating system. It executes S7 user programs like other S7 controllers and allows for easy integration with STEP 7 and standard Windows applications. WinLC RTX is divided into two separate processes: one process runs in the real-time subsystem and one runs in the Windows environment.

- One process runs in the real-time subsystem and executes the WinLC RTX control program, giving process control the highest priority.
- The other process runs in the Windows environment and handles other operations, such as communication and interfaces to Windows systems and applications.

WinLC RTX uses real-time extensions (RTX) to provide the following features:

- Deterministic operation ensures that response is predictable and reduces "jitter" because program execution occurs entirely in the real-time subsystem.
- The control process is protected from hard disk crash and Windows system failure. WinLC RTX is notified of all Windows shutdowns (including the "blue screen") in order to programmatically shut down in an orderly fashion.

You can configure Windows to reboot automatically after a system failure. This option is accessed by the Startup and Recovery button under the Advanced tab of System Properties in the Control Panel.

WinLC RTX provides the following features:

- Implements a comprehensive subset of the S7 logic blocks of SIMATIC controllers: Organization Block (OB), System Function Block (SFB), and System Function (SFC)
- Uses PROFIBUS-DP as its I/O subsystem, supporting DPV0 and DPV1 slaves (PROFIBUS DPV1 provides enhanced alarm and status reporting, in order to communicate with intelligent slave devices)
- Uses S7 communication services, offering compatibility with SIMATIC applications such as STEP 7 and WinCC (for tasks such as programming, debugging, or monitoring)
- Supports up to 4 separate PROFIBUS-DP subnets for controlling distributed I/O
- Supports the routing of S7 communications through the submodule CP cards of WinLC RTX, allowing STEP 7 on one subnet to connect to an S7 station (such as an S7-400 controller) on a different subnet
- Provides ability to archive and restore control programs
- Allows you to control the operational mode of WinLC RTX and to view status information from the control panel
- Provides a tuning panel for optimizing system performance
- Allows peer-to-peer communications between controllers (hardware or software) on the network
- Supports an isochronous mode, which allows WinLC RTX to operate in constant bus cycle mode to help eliminate jitter

**Note:** WinLC RTX allows you to use isochronous mode on more than one PROFIBUS-DP subnet; however, your computer must not share the interrupt (IRQ) of the PCI slots used by the CP cards with the Windows operating system. For example, the SINUMERIK PCU 50 provides two PCI slots that can be used for isochronous mode on two different PROFIBUS-DP subnets.

## System Requirements

To use WinAC RTX, your personal computer (PC) must meet the following criteria:

<p>Operating System</p>	<p>Microsoft Windows 2000 Professional Service Pack 3 or Microsoft Windows XP Professional Service Pack 1</p> <p><b>Note:</b> You must have administrative (ADMIN) privileges to start WinLC RTX.</p> <p>Venturcom RTX version 5.1.2 or greater (included with WinAC RTX)</p> <p><b>Note:</b> Some hardware configurations do not support installation or operation of Venturcom RTX. Computers known to not support Venturcom RTX include Compaq AP400, Dell 7000 portables, HP Kayak, and Alpha systems.</p>
<p>Processor and memory</p>	<p>Pentium uniprocessor or multiprocessor system:</p> <ul style="list-style-type: none"> <li>• 800 MHz or faster, single or dual processor</li> <li>• 128 Mbytes or more of RAM</li> <li>• BIOS must support plug-and-play (ACPI, Advanced Configuration and Power Interface)</li> </ul>
<p>Hard drive</p>	<p>A hard drive with 125 Mbytes of free space</p> <p>The setup program uses additional free space on drive C:</p> <ul style="list-style-type: none"> <li>• At least 1 Mbyte for the WinLC Setup program</li> <li>• At least 1 Mbyte for the SIMATIC Computing Setup program</li> </ul> <p>(Setup files are deleted when the installation is complete)</p>
<p>Operator interface</p>	<p>A color monitor, keyboard, and mouse or other pointing device (optional) that are supported by Windows</p>
<p>Network interface</p>	<p>At least one PCI slot with an installed Siemens CP card (CP 5613 V3 or CP 5613 V6 or later) connected to a PROFIBUS-DP network for distributed I/O communication</p>
<p>Siemens software</p>	<p>Communications software</p> <ul style="list-style-type: none"> <li>• For Windows 2000: SIMATIC NET CD 7/2001 (SP5 or later)</li> <li>• For Windows XP: SIMATIC NET CD 11/2002</li> </ul> <p><b>Note:</b> The SIMATIC NET software must be installed before you install WinAC RTX.</p> <p>Programming and configuration software</p> <ul style="list-style-type: none"> <li>• STEP 7 V5.2 or later</li> </ul>

## Using Help

The online help system provides information about the control panel and the controller. This topic provides information about using online help:

- Accessing Help from the Control Panel
- Using the Table of Contents
- Using the Index
- Using Full-Text Search
- Printing Help Topics
- Changing the Language of a Help Topic

### Accessing Help from the Control Panel

To access online help from the control panel, use one of the following methods:

- Click one of the following entries on the Help menu:
  - **Help on Panel:**

The **Help > Help on Panel** command opens the initial page of the online help for the control panel when it is not connected to a controller. The table of contents is in the left navigation pane.
  - **Help on Controller** (available when panel is connected to a controller):

The **Help > Help on Controller** command displays the initial page of the online help for the controller that is connected to the control panel. It describes controller and control panel operations. The table of contents is in the left navigation pane.
  - **Introduction** (available when panel is connected to a controller):

The **Help > Introduction** command displays a topic that provides an introduction to the controller and the tasks you can perform with it.
  - **Getting Started** (available when panel is connected to a controller):

The **Help > Getting Started** command displays a topic that helps you get started when you begin using the control panel to work with the controller for the first time.
- Click the Help button in a dialog or message box.
- Press the F1 key to view context-sensitive help on the currently selected item (for example, a window, dialog, or menu).

## Using the Table of Contents

The table of contents is in the left navigation pane of the browser; you can navigate to any topic by clicking the mouse:

- Click a book to open it and display the books and topics that it contains.
- Click the book again to close it.
- Click any topic within the table of contents to display that topic.

The topic you are currently viewing is highlighted in the table of contents.

The table of contents can be either hidden or displayed:

- Click the "x" in the left navigation pane to close the table of contents.
- Select the Contents tab or the "Show" link in a topic to display it. (The "Show" link appears only when you have displayed a context-sensitive topic from the application.)

## Using the Index

You can use the index to find information about a specific subject. Use one of the following methods to access the index:

- Select the Index tab in the navigation pane. (If the Index tab is not visible, click the "Show" link at the top of the topic. The "Show" link appears only when you have displayed a context-sensitive topic from the application.)
- Click the Index button in any help topic.


## Using Full-Text Search

The help system also provides full-text search capabilities. You can use the search field that is displayed above the topic, or select the Search tab from the navigation pane. (If the Search field and Search tab are not visible, click the "Show" link at the top of the topic. The "Show" link appears only when you have displayed a context-sensitive topic from the application.)

You can use the Boolean operators AND, OR, and NOT and parentheses in your search expression. Wildcards ("\*") are not supported.

## Printing Help Topics

To print a single topic that is displayed in your browser, right-click in the topic pane and select Print from the context menu. Select the print options of your choice.

To print the all or part of the online manual that corresponds to the help system, click the PDF icon on the help system navigation bar: . The help system opens the PDF file in a separate window. Use the **File > Print** menu command from Adobe Acrobat Reader to print all of the online manual or selected pages.

## Changing the Language of a Help Topic

The browser contains language buttons for each of the supported languages. To see the current help topic in another language, click the language button of your choice. The current topic is displayed in the language you selected, but the contents, index, and search features of the online help system remain in the original language. This may be helpful if a topic is unclear and you want to read it in another language.

If you select a language that you did not install, the online help system cannot display the topic in that language and displays a "Page not found" error. Changing the language of an online help topic does not change the language of the control panel.

## Differences between WinLC RTX and WinLC Basis

Some of the operations of WinLC RTX differ from WinLC Basis:

- WinLC RTX provides a way to shut your process down in an orderly manner in the case of a Windows system failure.
- WinLC RTX provides deterministic operation, ensuring predictable response time and reduced "jitter".
- WinLC RTX provides superior timing resolution in microseconds; WinLC Basis provides timing resolution in milliseconds. For example, the lapse time in SFC78 and the sleep time in SFC47 have a higher resolution in WinLC RTX.
- WinLC RTX supports an isochronous mode (constant bus cycle time).

WinLC RTX and WinLC Basis differ in how the blocks of the control program are stored in the memory of your computer:

- WinLC RTX uses only the non-paged RAM memory. All blocks of the control program and all of the process data must fit in the available non-paged memory that is also shared with other applications (such as device drivers) that are running on the computer.
- WinLC Basis runs in virtual memory that may be swapped to disk by the Windows operating system.



### Caution

Downloading a control program that is too large for the memory of the computer can lock up the computer or cause the operation of WinLC RTX to become unstable. Non-responsive or non-deterministic operations can cause damage to equipment and/or injury to personnel.

Although STEP 7 and WinLC RTX do not limit the number of blocks or the size of the control program, your computer does have a limit, based on the available disk space and RAM memory. The limit for the size of the control program and number of blocks for your computer can only be determined by testing a configured system against the requirements of your control application.





# Installation

## Overview of the Installation Tasks

You must install the following products in order to complete the installation of WinAC RTX:

- Communications processor (CP) card and SIMATIC NET software
- Venturcom RTX extensions
- WinAC RTX software
- WinAC RTX Authorization

You must install the SIMATIC NET software before installing the Venturcom RTX and WinAC RTX components.

**Note:** WinLC RTX allows you to use isochronous mode on more than one PROFIBUS-DP subnet; however, your computer must not share the interrupt (IRQ) of the PCI slots used by the CP cards with the Windows operating system. For example, the SINUMERIK PCU 50 provides two PCI slots that can be used for isochronous mode on two different PROFIBUS-DP subnets.

## Installing SIMATIC NET and the CP Card

WinAC RTX V4 supports the following Siemens CP cards for communicating with the distributed I/O over a PROFIBUS-DP subnet: CP 5613 V3 or CP 5613 V6 or later

You can install up to 4 CP cards in your computer. For specific installation instructions, refer to the documentation for your CP card.

WinAC RTX V4 requires the following SIMATIC NET software:

- For Windows 2000: SIMATIC NET CD 7/2001 (SP5 or later)
- For Windows XP: SIMATIC NET CD 11/2002

The SIMATIC NET software installs components that are used by WinAC RTX.

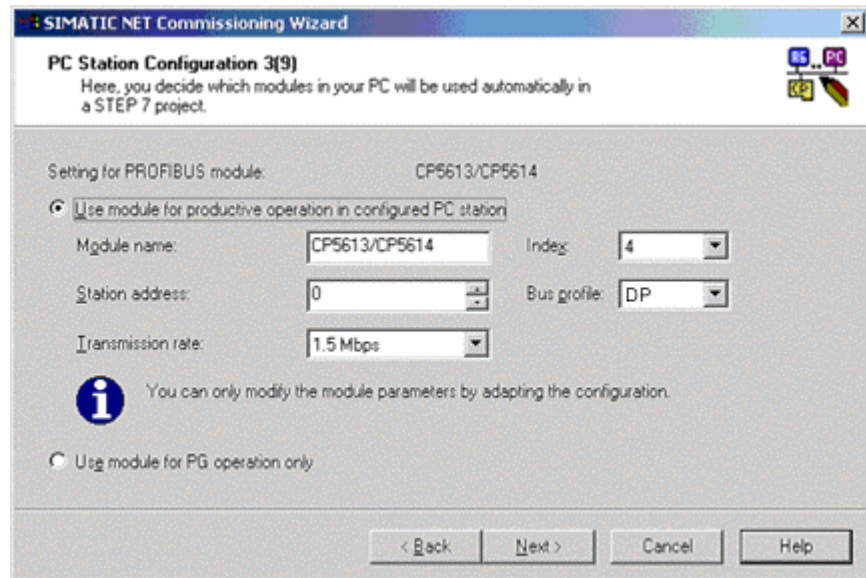
## Commissioning the CP Card

When the SIMATIC NET software detects a new CP card in your computer, the Commissioning Wizard automatically appears. With this wizard, you can configure device drivers for the CP card and specify how the card is going to be used (in Configured mode or PG/PC Interface mode).




**Note:** If the CP card is to be used as a submodule of WinLC RTX, you must select Configured mode. Selecting Configured mode enters the CP card in a slot (index) in the PC Station.

In the Commissioning Wizard, you assign a name and an index to each CP card. You can also specify important parameters such as baud rate and network protocol (bus).

In the Commissioning Wizard, make sure the field "Use module for productive operation in configured PC station" is selected. This sets the mode of the CP card so that it can be used for controller communications.



As you go through the Commissioning Wizard, use the following checklist to ensure that your CP card is configured correctly for use with WinLC RTX.

	Select the "Use module for productive operation in configured PC station" option.
	Set the Bus profile to DP.
	If you are not using OPC, clear the "SIMATIC NET OPC Server in configured PC station" field and select the "Do not use a symbol file" field.


The Configuration Console appears automatically when you finish commissioning the CP card. You can use this console to check the configuration of the CP card. WinLC RTX supports CP 5613 V3 or CP 5613 V6 or later.

**Note:** For some operations, such as isochronous mode, you must set the CP card to Interrupt mode. See the following topic: Improving the Performance of the CP 5613 Card.

## Testing the CP Card

You can verify that the CP card is installed correctly or to determine which CP card in which PCI slot is associated with a given index. This test is especially important if you have installed more than one CP card in your computer.

You use the Station Configuration Editor to check the configuration of the CP card:

1. Double-click the  icon in the Windows taskbar to open the Station Configuration Editor.
2. Select the CP card in the Station Configuration Editor.
3. Click the Ring ON button.

The LEDs on the CP card at the back of your computer flash in an alternating pattern so you can verify that you have configured the correct CP card. The computer also emits an audible beep if the CP card is functioning.

4. Click the Ring OFF button to end the test of the CP card.

This test is especially useful if you have installed more than one CP card in the PC station and need to verify the index location for a specific card.

## Troubleshooting the CP Card

After testing the CP card, you can make changes if necessary.

You can use the Configuration Console to review or to modify the configuration settings for the CP card.

You can also improve the performance of the CP 5613 card by changing the IRQ settings.

These tasks are described in detail in the Troubleshooting section of the Reference Information.

## Installing the Venturcom RTX Extensions

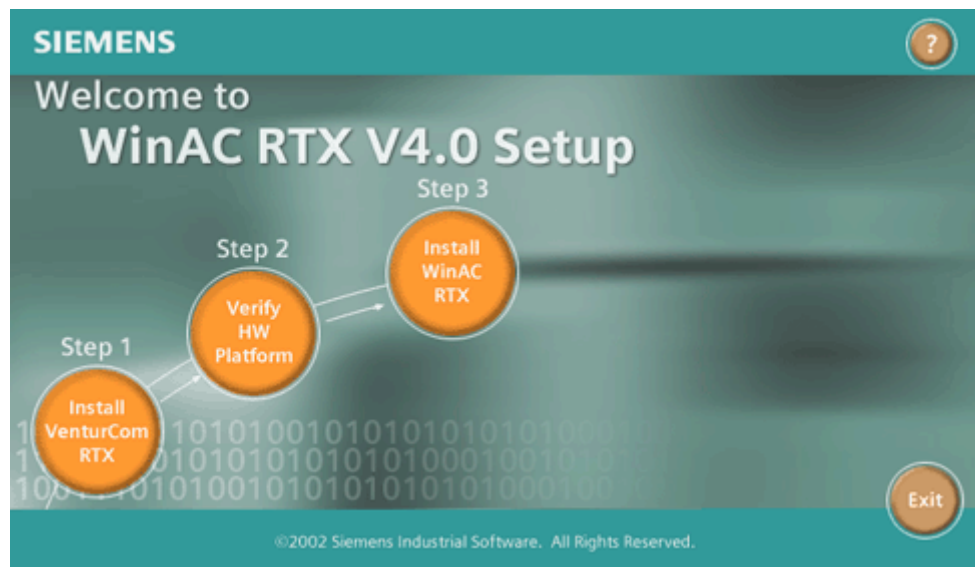
To install WinAC RTX, you must complete the following tasks:

- Install the appropriate SIMATIC NET software for your operating system.
- License the Venturcom RTX extensions.
- Verify that the Venturcom RTX extensions are working.
- Install the WinAC RTX software.

**Note:** You must have Windows administrator (ADMIN) privileges to install the Venturcom RTX extensions and the WinAC RTX software.

The Setup program starts automatically. If the Setup program does not automatically start, browse the CD and double-click on the Setup.exe program.

After you select the language for the Setup program, the Setup program displays a dialog that guides you through the installation tasks.



### Step 1: Install the Venturcom RTX Extensions

Clicking the circle under Step 1 starts the Install Wizard for installing the Venturcom RTX extensions. The Install Wizard prompts you to license the Venturcom RTX extensions. Enter the Venturcom PAC number (part of the WinAC RTX package).

**Note:** If you have previously installed Venturcom RTX Version 5.1.2 or later, the installation software detects its presence and the first circle is inactive.

## Step 2: Verify that the Venturcom RTX Extensions Are Operational

The Install Wizard restarts your computer after installing the RTX extensions. Click the circle under Step 2 to verify that the RTX extensions are working. The Install Wizard displays the following instructions:

1. Select the Windows **Start > Settings > Control Panel** menu command to display the Windows Control Panel.
2. Double-click the RTX Properties icon to display the RTX Properties dialog.
3. Click the Control tab to view the status of the RTX extensions. The Status field lists the state of the RTX extensions (either running or stopped).
4. Click the Start RTX button to start the RTX extensions. Wait a few seconds to see that the status of the RTX extensions changes from Stopped to Running.

### Caution

Clicking the Stop RTX button before the RTX extensions have completely switched to Running can cause the computer to become unresponsive. If this happens, you must restart your computer to recover.

Always wait a few seconds until the requested action is complete and the display shows current status before clicking the Start RTX or Stop RTX buttons.

5. Wait a few seconds and then click the Stop RTX button. Verify that the RTX extensions in the Status field change to Stopped. If the Start and Stop buttons work correctly, your RTX extensions are installed and functioning. However, this procedure verifies only a minimum level of platform suitability for RTX.
6. If the RTX extensions are working correctly, close the RTX Properties dialog.

For uniprocessor (single processor) computers, Venturcom provides a Platform Evaluator tool that measures the suitability of the platform for real-time control with the Venturcom RTX extension. Some hardware, such as video cards and network cards, can add considerable jitter or interrupt latency (time-lag between an interrupt and the handling of the interrupt) to an RTX application. The Platform Evaluator measures timer response latencies, thread switch times, and other aspects that can affect performance and allows various loads to be placed on the hardware while gathering these statistics. If your control application is highly time-critical, run the Venturcom Platform Evaluator in addition to performing the basic verification tasks of the Installation Wizard.

**Note:** The Platform Evaluator works **only** for uniprocessor systems.

Another consideration is whether your computer can be configured to provide a non-shared interrupt (IRQ) for the CP card. Running the CP card with a shared IRQ configures the CP card to operate in Polled mode. In order to run the CP card in Interrupt mode, you must configure your computer to provide a non-shared IRQ. In order to use an isochronous DP cycle for communicating with the distributed I/O requires, the CP card must run in Interrupt mode.

Running the CP card in Interrupt mode is also more efficient than running in Polled mode. If your application is highly time-critical, refer to the section on improving the performance of the CP card.

## Step 3: Install the WinAC RTX Software

When you have completed the verification of the RTX extensions on your platform, you are ready to install the components of WinAC RTX.

## Installing the WinAC RTX Software

The WinAC RTX software includes a Setup program that guides you step by step through the installation procedure. The Setup program begins when you click the circle under Step 3 of the setup screen. If the Setup program does not start automatically, double-click the Setup.exe file on the CD.

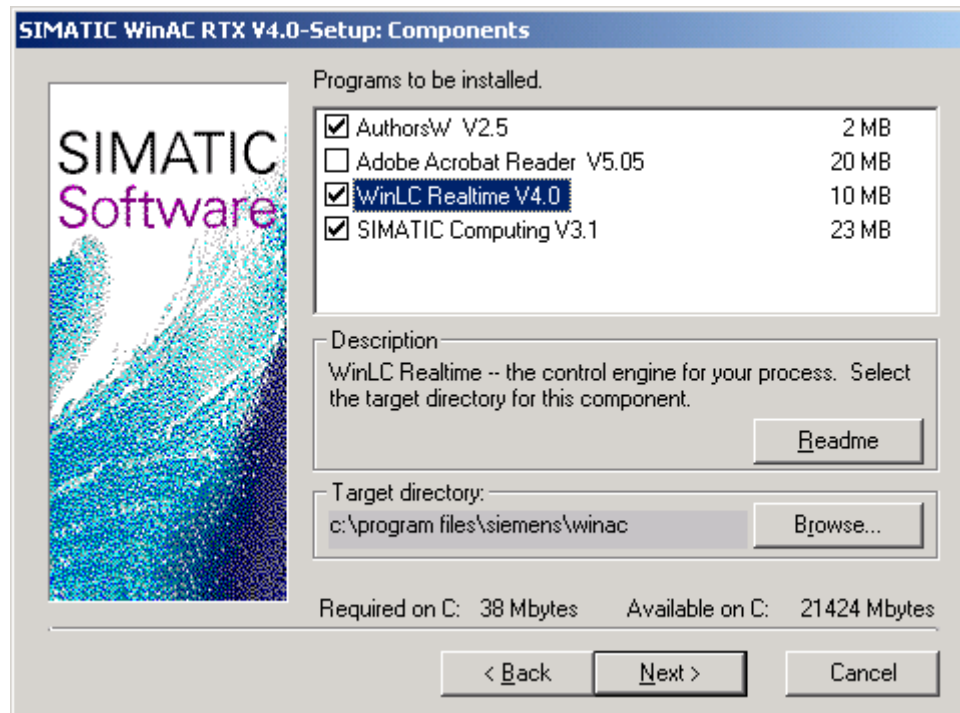
**Note:** You must have Windows administrator (ADMIN) privileges to install the WinAC RTX software.

If you select the "Run automatic authorization" checkbox in the Target Drive dialog, the Setup program checks to see whether an authorization is installed on the hard disk.

If no authorization is found, a message notifies you that the software can be used only with an authorization. You can run the authorization program immediately or you can continue the installation and execute the authorization later.

Follow the instructions of the Setup wizard. From the list of WinAC RTX components, select the components to be installed.

If you get messages from SIMATIC NET that say the CP card is configured for use with SIMATIC NET and STEP 7, click OK. This is a normal part of the installation process.



After installing the components WinAC RTX, the Setup wizard prompts you to insert the WinAC RTX authorization diskette in drive A.

The Setup program notifies you that the installation is complete.

## Authorizing the WinAC RTX Software

The WinAC RTX software requires a product-specific authorization (or license for use). There are separate authorization diskettes for each of the SIMATIC automation software products. You must install the authorization for each product.

### Caution

If improperly transferred or removed, the authorization for the WinAC RTX software may be irretrievably lost.

The Readme file on the authorization diskette contains guidelines for installing, transferring, and removing the authorization for the WinAC RTX software. If you do not follow these guidelines, the authorization for the WinAC RTX software may be irretrievably lost.

Read the information in the Readme file on the authorization diskette, and follow the guidelines in regard to transferring and removing the authorization.

## Installing the Authorization for the First Time

When you install the software for the first time, a message prompts you to install the authorization. Use the following steps to install the authorization for the WinAC RTX software:

1. When prompted, insert the authorization diskette in a drive.
2. Acknowledge the prompt.

The authorization is transferred to a physical drive, and your computer registers the fact that the authorization has been installed.

**Note:** Always enter drive C as the destination drive for the authorization for WinAC RTX.

## Adding an Authorization at a Later Date

If you attempt to start the WinAC RTX software and no authorization is found, a prompt appears on the screen. If you want to install the authorization, you can do so using the AuthorsW program. The AuthorsW program allows you to display, install, and remove authorizations. To authorize the WinAC RTX software, follow these steps:

1. Select the **Start > Simatic > AuthorsW > AuthorsW** menu command.
2. Select the Move Authorization tab from the AuthorsW dialog to display the authorizations available.
3. Select the authorization for WinAC RTX 4.0 from the list of available products on the authorization diskette.
4. Click the right arrow to transfer the authorization from the diskette to your hard drive.

If AuthorsW is not installed on your computer, insert the WinAC RTX installation CD. When the Welcome screen appears, click the circle for Step 3. When the Setup Components dialog appears, select the AuthorsW checkbox. After the installation is complete, select the AuthorsW program from the Start menu as described above.

## Removing an Authorization

If you need to repeat the authorization (for example, if you want to reformat the drive on which the authorization is located), you must first remove the authorization. You need the original authorization diskette to do this.

Use the following steps to transfer the authorization back to the authorization diskette:

1. Insert the original authorization diskette in your floppy disk drive.
2. Select the **Start > Simatic > AuthorsW > AuthorsW** menu command.
3. From the list of all authorizations on drive C, select the authorization to be removed.
4. Select the **Authorization > Transfer** menu command.
5. In the dialog box, enter the target floppy drive to which the authorization will be transferred and confirm the dialog box.
6. The window with the list of authorizations remaining on the drive is then displayed. Close the AuthorsW program if you do not want to remove any more authorizations.

You can then use the diskette again to install an authorization.

## Running the WinLC Controller without the Authorization

If you remove (or accidentally delete) the authorization for the software, the WinLC RTX controller continues to operate; however, a notification message appears every six minutes to alert you that the authorization is missing.

If you install an authorization while the WinLC RTX controller is running, you must also change the operating mode of the controller before the authorization takes effect.

## Recovering the Authorization in Case of a Defective Hard Drive

If a fault occurs with the authorization file on your hard disk or on the authorization diskette, contact your local Siemens representative.

## Uninstalling the WinAC RTX Software

Use the following procedure to remove the WinAC RTX software from your computer:

1. Double-click the Add/Remove Programs icon in the Windows Control Panel.
2. Select the WinAC RTX component entry in the displayed list of installed software. Click Add/Remove to uninstall the software. Each component of WinAC RTX is listed separately.

If the Remove Shared File dialog boxes appear, click No if you are unsure how to respond.



# Getting Started

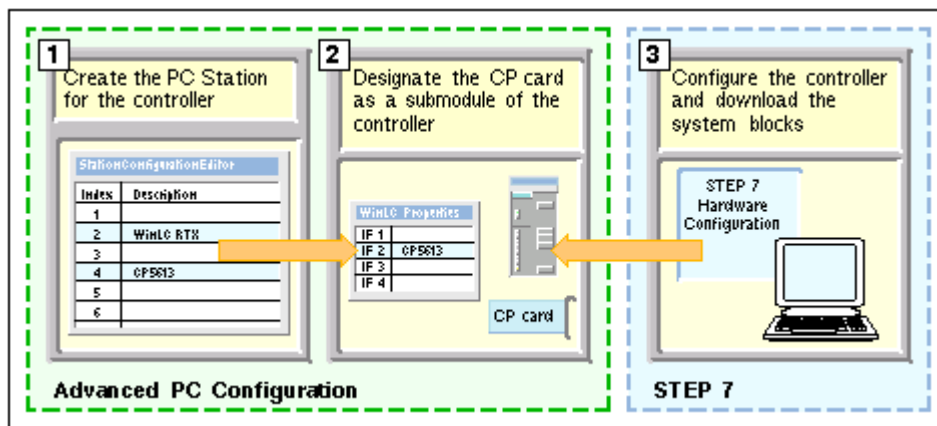
## Getting Started Overview

The Getting Started section helps you to establish communications between the WinLC RTX controller, STEP 7, and the distributed (DP) I/O by performing the following tasks:

- Use the Station Configuration Editor to designate the CP card as a submodule of WinLC RTX
- Use STEP 7 to configure the controller and CP cards and to download the system blocks

The Getting Started section also helps you understand the basic concepts for setting up WinLC RTX: PC station, Index, Submodule, and Interface (IF) Slot.

To establish communications for the WinLC RTX controller, you must perform the tasks shown in the following figure. (Click on one of the numbered sections to see a use case describing that task.)



## Prerequisites

Before you can get started, you must install the following components:

- SIMATIC Communications Processor (CP) card, such as a CP 5613
- SIMATIC NET communications software
- WinLC RTX software
- STEP 7 programming software

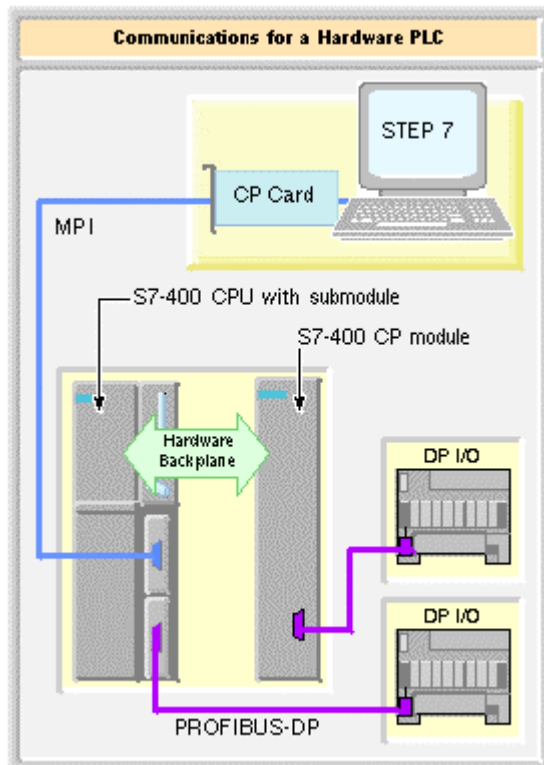
**Note:** STEP 7 can be installed either on the same computer as WinLC RTX or on a remote computer.

## Understanding the Concepts

### What Is a PC Station?

The PC station functions as a software-based virtual rack for creating a PC-based automation system. You create the PC station in the Station Configuration Editor when you install the SIMATIC NET software. When you install WinLC RTX, it automatically appears in a slot (index) of this virtual rack in the Station Configuration Editor. When you install and commission a CP card (set for Configured mode), it also appears in a slot (index), but is not yet configured as a submodule of WinLC RTX.

The PC-based controller (WinLC RTX) is similar to an S7-400 hardware controller. The following figure shows a communication model for a hardware controller.

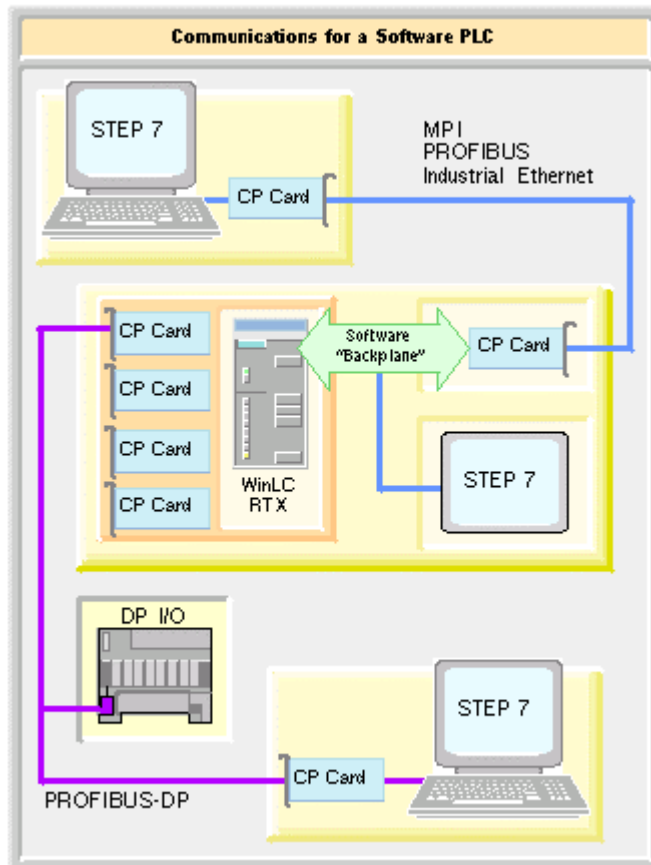


The hardware controller consists of modules that are inserted into a rack. These modules communicate over the backplane of the rack.

- STEP 7 communicates with the controller (in this example, an S7-400 CPU module) over an MPI subnet, using a CP card that is installed in the computer.
- The controller communicates with other modules, such as a CP module) over the backplane of the rack.
- The CP module communicates with the distributed I/O over a PROFIBUS-DP subnet.

For this example, the S7-400 controller has a communications submodule that allows the controller to communicate with distributed I/O over a PROFIBUS-DP subnet.

WinLC RTX communicates very much like the hardware controller.



Because WinLC RTX is located on your computer, WinLC RTX uses one or more CP cards (CP 5613 V3 or CP 5613 V6 or later) for communicating to the distributed (DP) I/O remotely through the PROFIBUS-DP network. You use the Station Configuration Editor to configure the CP cards as submodules.

- WinLC RTX and any CP card that is not configured as a submodule communicate over a software "backplane."
- If STEP 7 is installed on the same computer as WinLC RTX, STEP 7 communicates over the software "backplane."
- WinLC RTX uses a submodule CP card to communicate with the DP I/O.
- STEP 7 on a remote computer uses a CP card to communicate with WinLC RTX. In this example, the local CP card uses the software "backplane" to communicate with WinLC RTX.
- STEP 7 on a PROFIBUS-DP subnet can communicate with WinLC RTX through the submodule CP card.

### Configuring the "Hardware" of the PC-Based Controller

In the same way that you use STEP 7 to create the control program and system blocks for a hardware controller, you must use the Hardware Configuration tool of STEP 7 to configure the components that you installed in the PC station. When you download the system blocks to WinLC RTX, the name of the PC station is renamed to the name as configured by STEP 7.

After you configure your PC station both in the Station Configuration Editor and in STEP 7, you can download your control program to the PC station.

**Note:** To use the CP card for communicating both with STEP 7 and with the distributed I/O may require an additional software license. See your Siemens sales representative or distributor for more information.

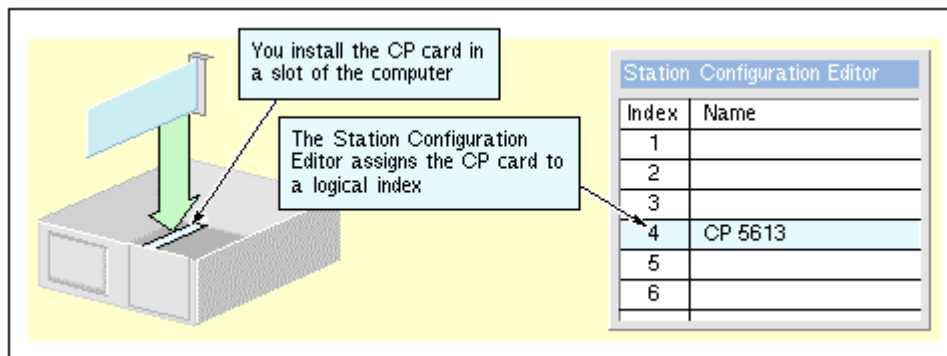
## What Is an Index?

An index is a numbered slot in the virtual rack of the PC station. The PC Station provides slots for the SIMATIC components of a PC-based automation solution, including not only WinLC RTX and CP cards, but also SIMATIC HMI and SIMATIC NET OPC.

Each slot in the PC station is assigned a number or index. When you install a SIMATIC component, such as WinLC RTX or the CP card, the component is inserted in an index line in the Station Configuration Editor. The Station Configuration Editor shows the configuration of your PC station.

**Note:** You install a CP card in a physical location (one of the PCI slots) in your computer. There is no implied or required correspondence between this physical location and the index of the CP card in the Station Configuration Editor.

The index number for a CP card in a PC station is its virtual slot on the virtual rack. This can be any index number you choose. It does not have to be the same as the hardware slot number for the CP card. The index number in the Station Configuration Editor, however, must be the same as the slot number in the STEP 7 Hardware Configuration tool for the same component.



## What Is a Submodule?

In order for WinLC RTX to communicate with the DP I/O devices on the PROFIBUS-DP network, you must designate a PROFIBUS CP card to be a submodule for the controller. With this submodule approach, WinLC RTX has full control over the CP card, providing optimum performance and determinism for operating the I/O. WinLC RTX supports up to four submodules.

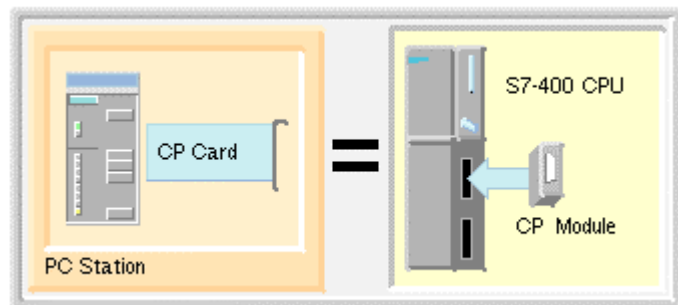
You can configure up to four CP 5613 cards as submodules for WinLC RTX. CP 5613 cards can be inserted in any of the four IF slots.

To configure the CP card as a submodule, you move the CP card from an index in the PC station to an IF slot in the controller.

After you have configured the CP card as a component of the PC station, you can use it only for SIMATIC communications (such as MPI, TCP/IP, Industrial Ethernet, or PROFIBUS) with STEP 7, SIMATIC HMI, or other SIMATIC controllers. For example, you can download a program from STEP 7 to WinLC RTX. However, the CP card cannot communicate with the distributed (DP) I/O on the PROFIBUS-DP network until you designate it as a submodule of the controller.

Configuring a CP card as a submodule of WinLC RTX is like installing a CP submodule into a slot of an S7-400 CPU.

Designating the CP card as a submodule of WinLC RTX not only allows WinLC RTX to use that CP card for SIMATIC communications when WinLC RTX is active, but also allows WinLC RTX to use that CP card for communicating with the DP I/O.



In order for a submodule CP card to be used for SIMATIC communications with an application other than WinLC RTX (on the PC Station), the second application must be a configured part of the PC Station.

### Notice

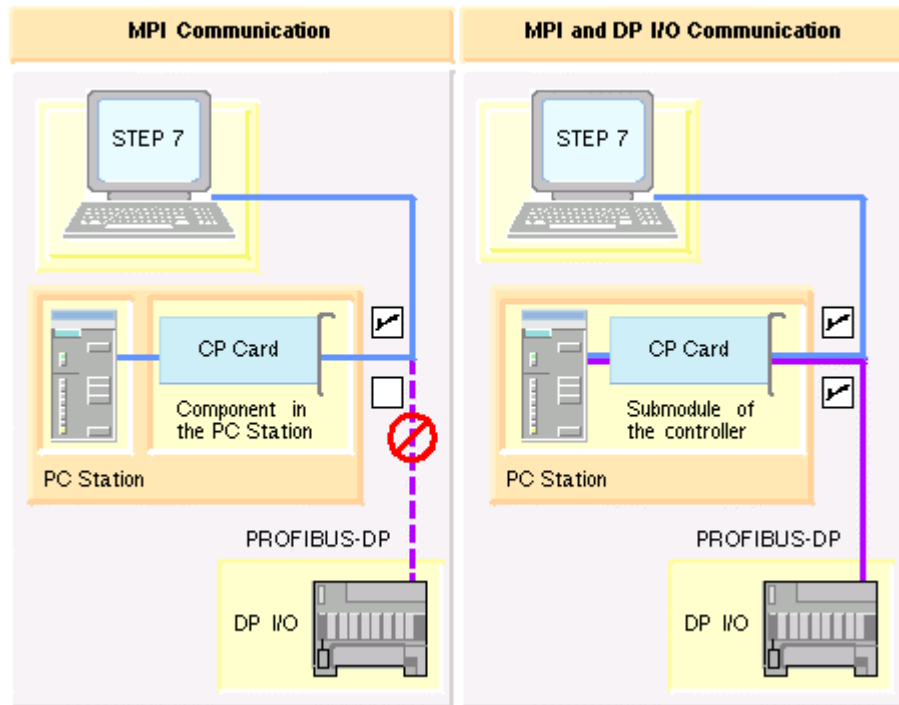
Any change to the configuration of a submodule causes WinLC RTX to delete the control program. You must then download a new control program and configuration.

For example: Moving the submodule CP card to a different slot, WinLC RTX recognizes that the hardware configuration has changed and deletes the control program, even if you had reconfigured the CP card for the same IF slot in the configuration of the PC station. You must still reload the control program from STEP 7.

The figure shows the difference between the CP card as a component of the PC station and the CP card as a submodule of WinLC RTX.

With the CP card configured as a component of the PC station, WinLC RTX can communicate with STEP 7 on a remote computer, but cannot communicate with the DP I/O.

With the CP card configured as a submodule, WinLC RTX can communicate with both STEP 7 on a remote computer (using SIMATIC communications) and with the DP I/O on the PROFIBUS-DP subnet.



## What Is an IF Slot?

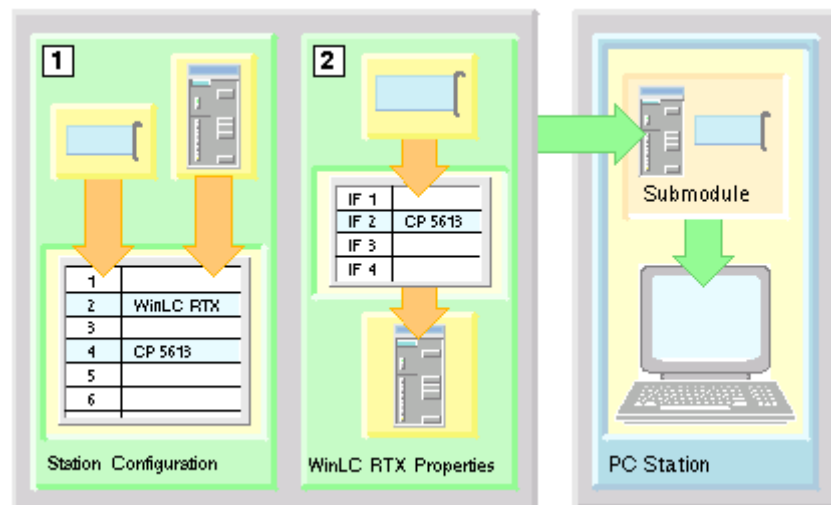
WinLC RTX provides four interface (IF) slots for designating CP cards as submodules. WinLC RTX must have exclusive control of any CP card that you move to an IF slot. This allows the controller to communicate with the distributed (DP) I/O.

To use the DP network to communicate with I/O, you must configure the CP card to be a submodule of WinLC RTX. You use the WinLC RTX Properties dialog to move the CP card to one of four interface slots, IF1 through IF4.

The IF slot number of the submodule is independent of the PCI hardware slot for the CP card. However, the IF slot number for the CP card submodule in the Station Configuration Editor must match the IF slot number in the STEP 7 Hardware Configuration tool.

You first install both the CP card and WinLC RTX in the PC station. You then move the CP card into one of the IF slots for WinLC RTX.

For more information, refer to the following topic: Use Case: Designating a CP Card as a Submodule



## Configuring the CP Card as a Submodule

### Use Case: Designating a CP Card as a Submodule

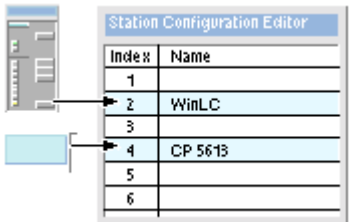

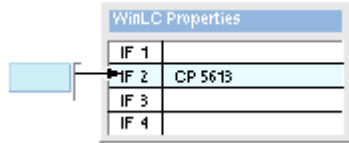
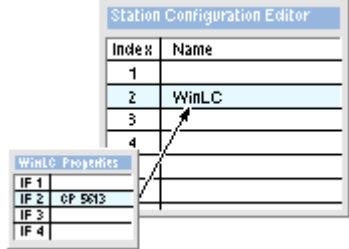
**Goal:** To move the CP card from the index in the PC station into an IF slot of the controller so that WinLC RTX can communicate with DP I/O over the PROFIBUS network and to verify that configuration.

**Prerequisite:** Both WinLC RTX and the CP card be assigned indices in the virtual rack of the PC station.

**Software Tool:** You use the Station Configuration Editor of SIMATIC NET to move the CP card from the virtual rack to the submodule slot of WinLC RTX.

**Next Step:** You configure WinLC RTX and all other components of the PC station in STEP 7.

To configure your CP card as a submodule, follow these steps:

 <p>The screenshot shows the 'Station Configuration Editor' window. It contains a table with the following data:</p> <table border="1"> <thead> <tr> <th>Index</th> <th>Name</th> </tr> </thead> <tbody> <tr> <td>1</td> <td></td> </tr> <tr> <td>2</td> <td>WinLC</td> </tr> <tr> <td>3</td> <td></td> </tr> <tr> <td>4</td> <td>CP 5613</td> </tr> <tr> <td>5</td> <td></td> </tr> <tr> <td>6</td> <td></td> </tr> </tbody> </table>	Index	Name	1		2	WinLC	3		4	CP 5613	5		6		<ol style="list-style-type: none"> <li>1. Double-click the computer icon  on the Windows taskbar. The Station Configuration Editor appears. The components screen should show the WinLC RTX station and the CP card.</li> <li>2. Select WinLC RTX and click the Edit button to display the Edit Component dialog. You use this dialog to change the module name and index number for the WinLC RTX controller.</li> <li>3. Click the Properties button to display the WinLC RTX Properties dialog.</li> </ol>
Index	Name														
1															
2	WinLC														
3															
4	CP 5613														
5															
6															
 <p>The screenshot shows the 'WinLC Properties' dialog box. It has a 'SubModule' tab. The table below shows the configuration for the submodules:</p> <table border="1"> <thead> <tr> <th>IF</th> <th>Name</th> </tr> </thead> <tbody> <tr> <td>IF 1</td> <td></td> </tr> <tr> <td>IF 2</td> <td>CP 5613</td> </tr> <tr> <td>IF 3</td> <td></td> </tr> <tr> <td>IF 4</td> <td></td> </tr> </tbody> </table>	IF	Name	IF 1		IF 2	CP 5613	IF 3		IF 4		<p>In the SubModule tab, the four submodule interfaces are listed (IF1 to IF4).</p> <ol style="list-style-type: none"> <li>1. Click an empty slot to highlight the IF slot.</li> <li>2. Click the Add button to display the list of configured modules in the PC station.</li> <li>3. Select the CP card that you want to configure as a submodule, and click OK.</li> </ol>				
IF	Name														
IF 1															
IF 2	CP 5613														
IF 3															
IF 4															
 <p>The screenshot shows the 'Station Configuration Editor' and the 'WinLC Properties' dialog box. An arrow points from the 'CP 5613' entry in the Station Configuration Editor to the 'IF 2' slot in the WinLC Properties dialog, indicating the transfer of the CP card to the submodule slot.</p>	<p>The CP card moves from the virtual rack of the PC station to the submodule slot of the WinLC RTX controller. (This configuration may take several seconds.)</p>														



**Note:** If you need to move the CP card back to the Station Configuration Editor, select the IF slot in the WinLC Properties dialog and click the Delete button. Removing the CP card from the IF slot starts The SIMATIC NET commissioning wizard.

You can select an occupied interface slot (IF slot) and click the Edit button to change the interface slot assignment for a configured CP card, or to change its name.

**Notice**

Any change to the configuration of a submodule causes WinLC RTX to delete the control program. You must then download a new control program and configuration.

For example: Moving the submodule CP card to a different slot, WinLC RTX recognizes that the hardware configuration has changed and deletes the control program, even if you had reconfigured the CP card for the same IF slot in the configuration of the PC station. You must still reload the control program from STEP 7.

## Testing the Submodule CP Card


**Goal:** To verify that the submodule CP card is configured correctly.

This test is especially important if you have installed more than one CP card in your computer.

**Prerequisite:** You must start the WinLC RTX controller.

**Software Tool:** You use the Station Configuration Editor of SIMATIC NET.

After you start WinLC RTX, you can check the operation of the submodule CP card:

1. Double-click the computer icon  on the Windows taskbar. The Station Configuration Editor appears.
2. Select the WinLC RTX station and click the Edit button to display the Edit Component dialog.
3. Click the Properties button to display the WinLC Properties dialog.
4. Select the interface slot (IF slot) containing the CP card to be tested.
5. Click the Ring ON button.

The LEDs on the CP card at the back of your computer flash in an alternating pattern so you can verify that you have configured the correct CP card. The computer also emits an audible beep if the CP card is functioning.

6. Click the Ring OFF button to end the test of the CP card.

## Viewing the Diagnostics for the CP Card

You can select an occupied interface slot (IF slot) and click the Diagnostics button to display to view communication information for a CP card. The Submodule Network Diagnostics dialog displays the current version of the selected CP card and the bus parameters.

You can also see a display of all of the nodes on the communication network, and the status of each one. You must click the Update button to build this display, because querying each node puts an additional load on the communication network.

For some operations, such as isochronous mode, you must set the CP card to Interrupt mode. See the following topic: [Improving the Performance of the CP 5613 Card](#).

**Sub-Module Network Diagnostics - CP 5613**

Status/Network Diagnostics

Interface: IF1  
 CP5613\_5614(PROFIBUS)<3>  
 The device is operating in interrupt mode.

Bus Parameters	Value
Highest Station Address	126
Station address of this station	2
Baud rate in bits per second	12.0 Mbps
Target token rotation time	66035
Minimum Tsd	11
Maximum Tsd	800

Version:  
 Siemens AG; CP 5613 EL (E2); FW: V 6.0.; HW: 5.0+

Bus Nodes

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
0	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
40	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
60	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
80	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
120	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Update

Key  
 passive  
 active  
 active ready

OK

## Configuring the Controller in STEP 7

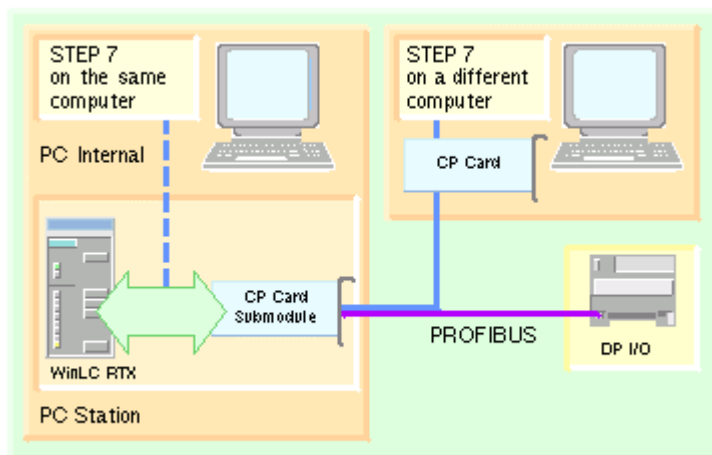
### Use Case: Connecting STEP 7 to WinLC RTX

WinLC RTX uses two different network protocols:

- Communications with STEP 7, SIMATIC HMI products, and peer-to-peer communications with other controllers
- PROFIBUS-DP for communicating with the I/O devices on the DP subnet

In order for WinLC RTX to function as an S7 controller, it must be able to communicate both with STEP 7 and with the distributed (DP) I/O.

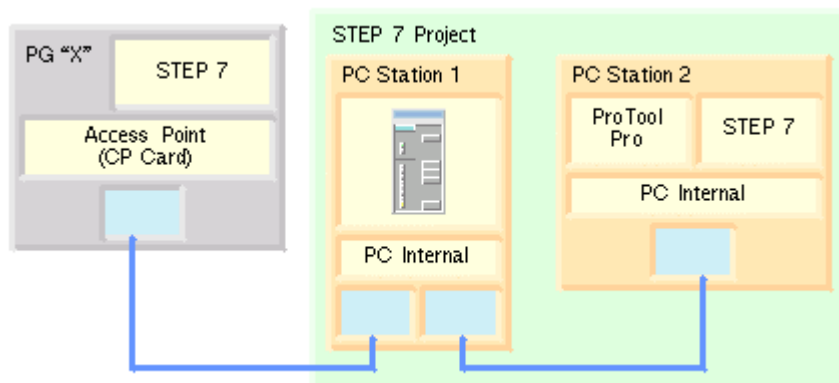
The following figure shows how WinLC RTX communicates with distributed I/O over PROFIBUS-DP and with STEP 7 over MPI.

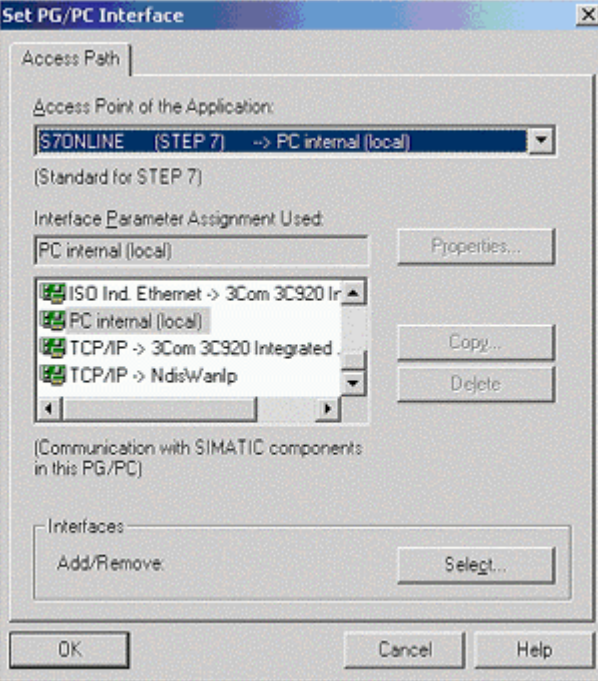
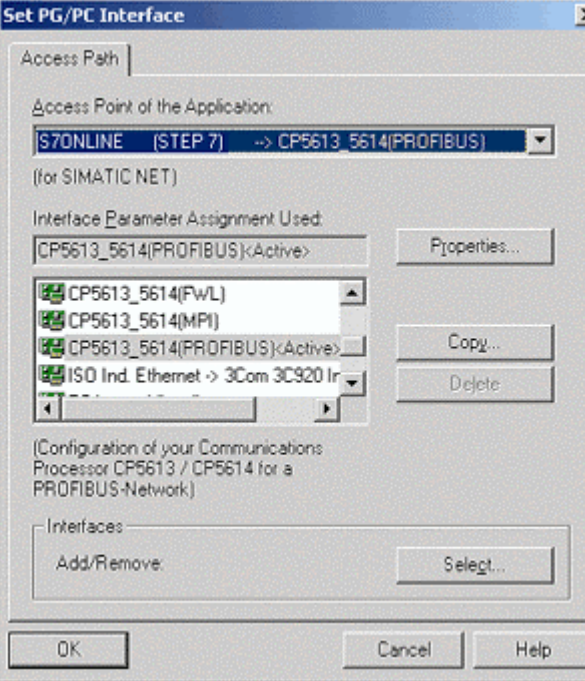


### Configuring Communications between STEP 7 and WinLC RTX

As shown in the following figure, you set the PG/PC interface to the appropriate access point to configure STEP 7 for communicating with WinLC RTX:

- For a SIMATIC PC Station within the STEP 7 project, select the PC Internal access point.
- For a programming device (PG or PC) somewhere on the network (with no Station Manager), select the access point for the CP card in the programming device.



STEP 7 on the same computer or on a PC Station within the same STEP 7 project	STEP 7 on a different computer and not part of the STEP 7 project
Set the PG/PC Interface in STEP 7 to PC Internal.	Set the S7ONLINE access point to the CP card that is used for S7 communications. The figure below shows an access point for a PROFIBUS network.
	

WinLC RTX can also use the S7 communication protocols (MPI, TCP/IP, Industrial Ethernet, or PROFIBUS) for peer-to-peer communication with other controllers.

### Configuring Communications between WinLC RTX and the DP I/O

To configure WinLC RTX for communicating with the DP I/O, you must designate one or more of the CP cards as submodules of WinLC RTX. Configuring a CP card as a submodule of WinLC RTX allows WinLC RTX to use the CP card for communicating over both MPI and PROFIBUS-DP subnets.

#### Notice

Do not assign a submodule CP card for direct use by applications other than WinLC RTX. For example: if you designated a CP card as a WinLC RTX submodule, do not assign S7ONLINE to any parameter setting for that CP card.

Failure to observe this restriction may result in an inability to configure the CP card when WinLC RTX is downloaded.

## Use Case: Hardware Configuration in STEP 7

**Goal:** To configure the PC station in STEP 7 and to create the system blocks for WinLC RTX.

**Prerequisite:** You must have installed both WinLC RTX and STEP 7.

**Software Tool:** You use STEP 7 to create and download the configuration and the system blocks.

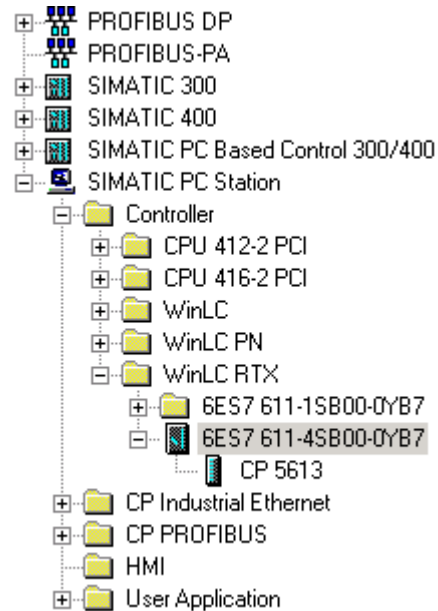
**Next Step:** You have finished with the configuration tasks and are ready to design and test your control program.

You configure the WinLC RTX project in STEP 7 as you would for any S7 hardware controller. Refer to the STEP 7 help system and documentation for detailed information.

### 1 Using SIMATIC Manager

Create the project and PC station:

1. Select the **File > New** menu command to create a new project.
2. Select the **Insert > Station > SIMATIC PC Station** to insert a PC station into the project.
3. Change the name of the PC station to match the name of the target PC station defined in the Station Configuration Editor on the target computer. To find the station name, open the Station Configuration Editor and click the Station Name button.
4. Open the PC Station folder and double-click the Configuration icon to invoke the Hardware Configuration application.



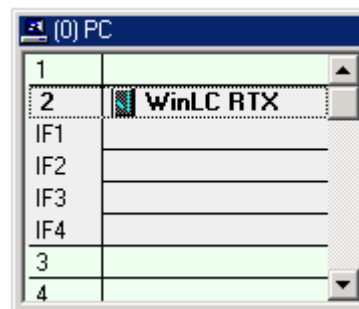
### 2 Using the Hardware Configuration application

Drag components from the Hardware Catalog to specify the hardware and software configuration for the PC station.

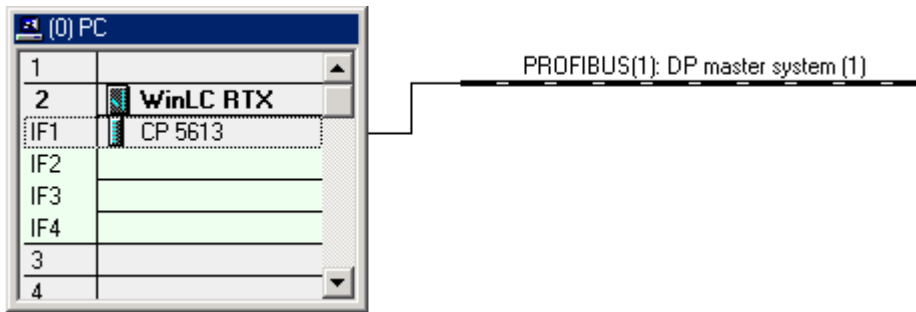
- Insert the WinLC RTX controller (part number 6ES7 611-4SB00-0YB7) in the same index as for the target PC station that you configured with the Station Configuration Editor on the target computer.





Verify that the name of the WinLC RTX controller matches the name of the WinLC RTX controller that you configured in the target PC station.

- Insert the submodule CP cards for the WinLC RTX controller. The WinLC RTX folder in the Hardware Catalog lists the CP card types that are available.



The submodule CP cards do not have to have the same name as in the PC Station configuration. However, this is recommended. They must have the same type and interface (IF) number as specified in the PC Station.



-  Configure the distributed (DP) I/O for each of the submodule DP networks.
-  **Optional:** Insert any CP cards that are not used as submodules for the WinLC RTX controller. These are the CP cards installed in the virtual rack of the PC station.
-  **Optional:** Insert any HMI devices.
-  **Optional:** Configure WinLC RTX for peer-to-peer communications:
  1. Select the controller name in the SIMATIC Manager.
  2. Double-click the Connections icon in the right-hand pane.
  3. Use NET-PRO to describe the network.

After you have configured WinLC RTX, you can use SIMATIC Manager to develop and to download your control program.



#### Caution

Downloading a control program that is too large for the memory of the computer can lock up the computer or cause the operation of WinLC RTX to become unstable. Non-responsive or non-deterministic operations can cause damage to equipment and/or injury to personnel.

Although STEP 7 and WinLC RTX do not limit the number of blocks or the size of the control program, your computer does have a limit, based on the available disk space and RAM memory. The limit for the size of the control program and number of blocks for your computer can only be determined by testing a configured system against the requirements of your control application.

After you have downloaded your program to WinLC RTX, you can start the controller and use STEP 7 to monitor and modify the process variables.

#### Notice

Any change to the configuration of a submodule causes WinLC RTX to delete the control program. You must then download a new control program and configuration.

For example: Moving the submodule CP card to a different slot, WinLC RTX recognizes that the hardware configuration has changed and deletes the control program, even if you had reconfigured the CP card for the same IF slot in the configuration of the PC station. You must still reload the control program from STEP 7.





# Controller Operations

## Starting and Shutting Down the Controller

The controller operates independently from the control panel:

- Closing the panel does **not** shut down WinLC RTX.
- Shutting down WinLC RTX does **not** close the panel.


The following settings affect the starting or shutting down of the controller:

- Selecting the Autostart option
- Configuring the controller for start at PC boot

### Starting WinLC RTX

You must have administrative (ADMIN) privileges to start WinLC RTX.


If the control panel is not open, use one of the following methods to start the control panel and WinLC RTX:

- Select the **Start > Simatic > PC Based Control** menu command. Then select the name of your WinLC RTX controller. (After you have downloaded the control program to your WinLC RTX, the name in the menu matches the name in STEP 7.)
- Double-click the desktop icon for WinLC RTX: 

If the control panel is open, but WinLC RTX is shut down, select the **CPU > Start Controller** menu command.

### Shutting Down WinLC RTX

Select the **CPU > Shut Down Controller** menu command to shut down the WinLC RTX controller. This action does not close the control panel. This command is only available from the control panel when the controller is operating. After you shut down the controller, you can still change customization options.

An icon  is displayed in the Windows taskbar whenever the controller is operating. When the controller is operating and the control panel is closed, you can double-click this icon to open the control panel.

**Note:** To shut down the Venturcom RTX extensions after you shut down WinLC RTX, you must either reboot your computer or else manually stop a WinAC service that is still running. Use the **Start > Control Panel > Services** menu command to display the Windows Services dialog, and then stop the SIMATIC WinAC FeatureServer service. You can then use the RTX Properties dialog to stop the RTX extensions.

### Closing the Control Panel

Select the **File > Exit** menu command to close the control panel.

**Note:** Closing the control panel does not shut down the controller.

## Changing the Operating Mode of the Controller

The control panel provides mode buttons that allow you to change the operating mode of WinLC RTX between RUN mode and STOP mode. Like the other S7 controllers, WinLC RTX also provides a RUN-P option that allows STEP 7 to interact with the controller in RUN mode. By clicking the appropriate mode button (or selecting the appropriate command from the **CPU** menu), you change the operating mode of the controller either to RUN mode (choosing either the RUN or RUN-P options) or to STOP mode.

The mode buttons correspond to the keyswitch positions of an S7 hardware controller:

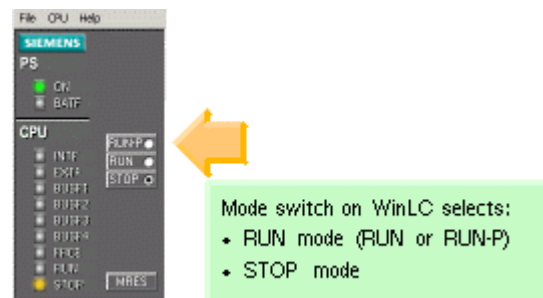
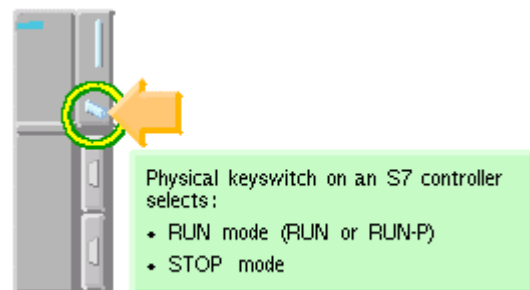
- **RUN-P:** The controller executes the control program. You can use STEP 7 to interact with the control program and to change the operating mode of the controller.
- **RUN:** The controller executes the control program. You can use STEP 7 to monitor the control program, but you cannot use STEP 7 to change the variables, reset the memory (MRES), or change the operating mode of the controller.
- **STOP:** The controller does not execute the control program. Outputs are set to their safe states. You can use STEP 7 to modify the control program and to reset the memory (MRES), but you cannot use STEP 7 to change the operating mode of the controller.

## Relating the Mode Buttons and Status Indicators to the Operating Mode of the Controller

The mode buttons on the control panel function like the manual keyswitch on a hardware S7 controller.

- **For a hardware controller:** The keyswitch does not change position if you use STEP 7 to change the operating mode, or if the controller automatically changes mode (for example, encounters an error condition that causes the controller to change from RUN mode to STOP mode).
- **For WinLC RTX:** The mode buttons (RUN-P, RUN, STOP) do not change if you use STEP 7 to change the operating mode, or if the controller automatically changes mode.

For both a hardware controller and WinLC RTX, the RUN and STOP status indicators show the current operating mode of the controller. If the status indicator shows a different operating mode than the selected mode button, the controller has changed operating mode, possibly due to some error in the program or because you used STEP 7 to change the operating mode.



## Using the Mode Buttons to Control Access to the Controller

You can use the mode button to allow or to prohibit access to the controller. As shown in the following table, the setting of the mode button limits the type of actions that can be performed.

Mode Button	Description
RUN-P	<p>Allowed:</p> <ul style="list-style-type: none"> <li>• Uploading a program from the controller to your computer</li> <li>• Downloading a program to the controller</li> <li>• Downloading individual blocks to the controller</li> <li>• Using STEP 7 to modify program variables and to change the operating mode of the controller</li> <li>• Performing a memory reset from either WinLC RTX or STEP 7</li> </ul> <p>The controller automatically goes to STOP mode when you reset the memory from WinLC RTX. To perform a memory reset from STEP 7, you must first change the controller to STOP mode.</p> <p>Not Allowed:</p> <ul style="list-style-type: none"> <li>• Archiving and restoring a control program</li> </ul>
RUN	<p>Allowed:</p> <ul style="list-style-type: none"> <li>• Uploading a program from the controller to your computer</li> <li>• Using STEP 7 programming software to monitor but not to modify variables</li> <li>• Using STEP 7 to change the operating mode</li> <li>• Performing a memory reset from WinLC RTX</li> </ul> <p>The controller automatically goes to STOP mode when you reset the memory from WinLC RTX.</p> <p>Not Allowed:</p> <ul style="list-style-type: none"> <li>• Downloading a control program or individual blocks to the controller</li> <li>• Using STEP 7 to modify variables in the program</li> <li>• Archiving and restoring a control program</li> <li>• Performing a memory reset from STEP 7</li> </ul>
STOP	<p>Allowed:</p> <ul style="list-style-type: none"> <li>• Uploading a program from the controller to your computer or programming device</li> <li>• Downloading a program or individual blocks to the controller</li> <li>• Performing a memory reset from either WinLC RTX or STEP 7</li> <li>• Archiving and restoring a control program</li> </ul> <p>Not Allowed:</p> <ul style="list-style-type: none"> <li>• Using STEP 7 to change the operating mode</li> </ul>

## Resetting the Memory Areas: MRES Command (CPU Menu)

The MRES (memory reset) command functions like a master reset of the controller by resetting the controller to its initial (default) state. The MRES command deletes the control program and the system data (configuration), and also disconnects any online communications (such as STEP 7, WinCC, PROFIBUS, or peer-to-peer).

Use one of the following methods to reset the memory:

- Click the MRES button on the control panel
- Select the **CPU > MRES** menu command
- Press the ALT+C+M keys

You can also use STEP 7 to perform a memory reset. However, you must use the mode buttons to change the controller to STOP or RUN-P mode before you can reset the memory from STEP 7.

The MRES command changes the controller to STOP mode, if necessary, and then performs the following tasks:

- Deletes the entire control program from both the work memory area and the load memory area. This includes OBs, DBs, FCs, FBs, and the system data.
- Resets the memory areas (I, Q, M, T, and C) to 0.
- Restores the default system configuration (for example, the size of the process-image areas, and the size of the diagnostic buffer).
- Deletes all active communications jobs (such as TIS) and all open communications.

The MRES command does not affect the submodule network addresses and does not affect the contents of the diagnostic buffer.

The STOP indicator flashes while the memory reset is in progress. After the memory has been reset, the diagnostics buffer is resized to its default size. Input (I) and output (Q) memory areas are also resized to their default sizes. After a memory reset, you may need to reconfigure these values to your own specifications.

You typically perform an MRES before downloading a new program to the controller. You **must** perform an MRES if the STOP indicator on the control panel is flashing slowly to alert you to one of the following conditions:

- Errors were detected in the work memory area, such as the size of the user program exceeds the work memory area
- A power cycle followed a defective state of the controller

## Using the Status Indicators

You can use status indicators on the control panel to determine the current operating mode or to troubleshoot an error condition. These indicators correspond to the LED indicators on a hardware S7 PLC.

You cannot change the status of the controller by clicking the status indicators.

If the control program reaches a break point set by the STEP 7 Program Editor, both the RUN and STOP indicators turn on while the breakpoint is active: the RUN indicator flashes, and the STOP indicator is on.

During a change from STOP mode to RUN mode, the RUN indicator flashes, and the STOP indicator is on. When the STOP indicator turns off, the outputs are enabled.

The table below describes the different status indicators for the control panel:

Indicator	Description
ON	Power supply. Always on for the controller.
BATF	Battery fault. Always off for the controller.
INTF	This indicator lights up (solid) to show error conditions within the controller, such as programming errors, arithmetic errors, timer errors, and counter errors.  If the control program handles the error by executing OB80, OB121, or OB122, the INTF indicator goes off after 3 seconds if there is no subsequent error condition.
EXTF	This indicator lights up (solid) to show error conditions that exist outside of the controller, such as hardware faults, parameter assignment errors, communication errors, and I/O fault errors.
BUSF1 BUSF2 BUSF3 BUSF4	These indicators light up (flashing) to identify fault conditions in the communication with the distributed I/O.  The number of the BUSF indicator corresponds to the IF number of the submodule that has a fault condition.
RUN STOP	Lights up (solid) to show the operating mode (RUN or STOP). When RUN is flashing and STOP is lighted (solid): <ul style="list-style-type: none"> <li>The controller is executing a mode change from STOP to RUN/RUN-P. (Run light blinks with 2 Hz.)</li> <li>The control program has reached a breakpoint. (Run light blinks with 0.5 Hz.)</li> </ul> <p><b>Note:</b> The RUN and STOP indicators show the actual operating mode of the controller. The RUN, RUN-P, and STOP mode buttons show the selected mode (similar to the keyswitch position on a hardware PLC), which can differ from the operating mode. For example: Changing the operating mode with STEP 7 causes the status indicators to change, but the mode buttons do not change.</p>

### **Corrective Action If the STOP Indicator is Flashing Slowly**

If the STOP indicator flashes slowly, the controller is requesting that you perform a memory reset (MRES). To recover from this condition, you must use the MRES command to reset the controller.

### **Corrective Action If All Status Indicators Are Flashing**

If all of the status indicators are flashing at the same time, the controller is in a defective state and has encountered an error condition that cannot be fixed by resetting the memory with the MRES command. To recover from this condition, you must perform the following tasks:

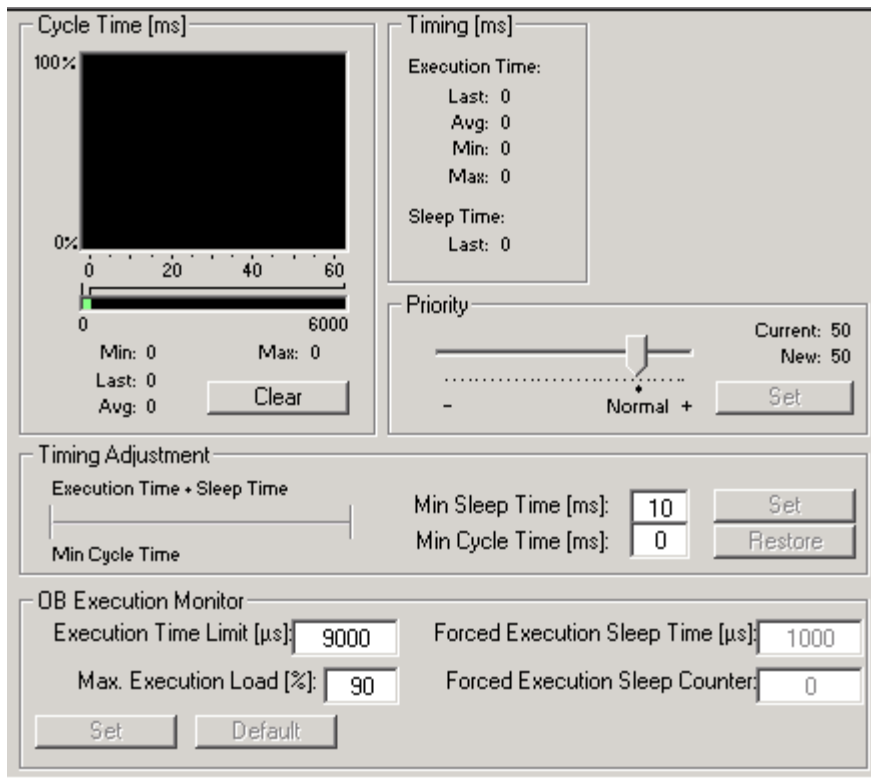
1. Shut down the controller.
2. Restart the controller. The STOP indicator flashes with the RUN indicator off.
3. Use the MRES command to reset the memory.
4. Use STEP 7 to download the control program and system configuration, or to restore an archived control program.

## Using the Tuning Panel

You can use the tuning panel to view and adjust the current performance of the controller. The tuning panel displays information about the scan cycle, such as the execution time and the sleep time. By adjusting these values, you can tune the performance of the controller.

**Note:** The tuning panel is designed for adjusting the parameters and verifying the performance for WinLC RTX. Because the tuning panel causes an additional load on the computer resources, do not leave the tuning panel open during normal operation of WinLC RTX.

To open or close the tuning panel, select the **CPU > Tuning Panel** menu command. WinLC RTX opens the tuning panel, as shown below.



Values other than the minimum cycle time are unique to WinLC RTX and are not stored in the system configuration. Using the tuning panel to enter a value for minimum cycle time does not change the configuration of the controller.

Changing the controller from STOP mode to RUN mode resets the minimum scan cycle time parameter to the value that you configured in STEP 7.

To make any changes made with the tuning panel permanent, you must use the STEP 7 Hardware Configuration tool.



**Warning**

Variation in the execution time or response time of the control program could potentially create a situation where the equipment or application being controlled can operate erratically and possibly cause damage to equipment or injury to personnel.

If the controller does not provide sufficient sleep time for the other applications to run, the computer can become unresponsive to operator input, or the controller and other applications can operate erratically. In addition, the execution of the control program can experience non-deterministic behavior (jitter) such that execution times can vary and start events can be delayed.

Always provide an external emergency stop circuit. In addition, always tune the sleep time and manage the performance of the controller so that your control program executes consistently.



The tuning panel contains the following functional areas:

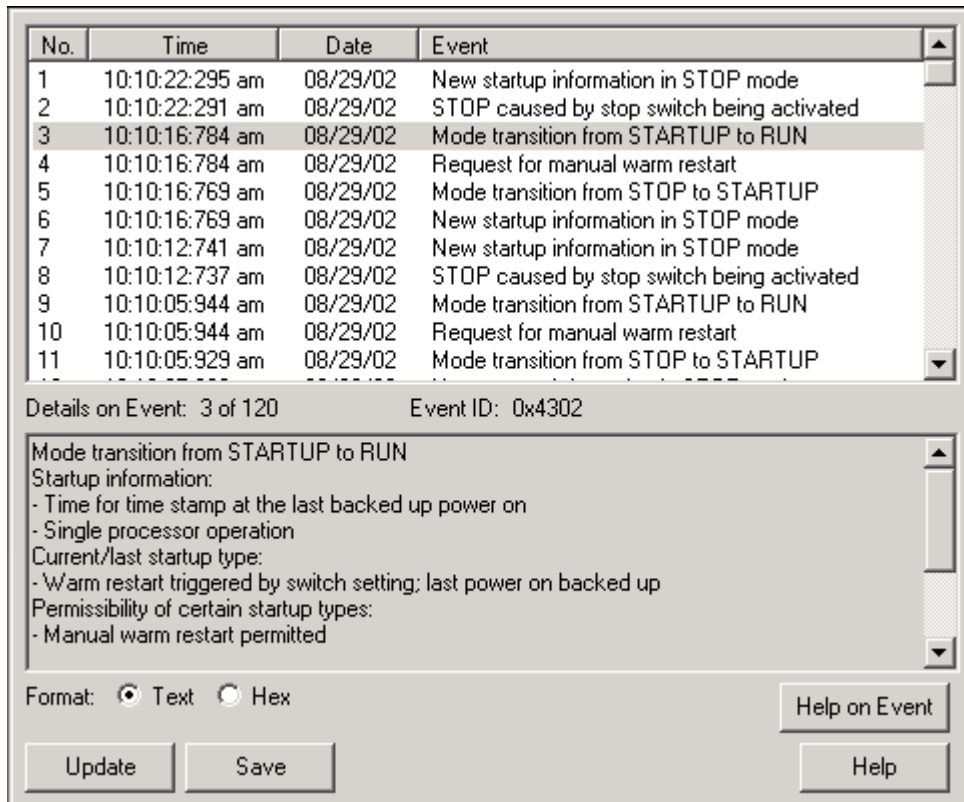
Area	Description
Cycle Time	<p>This area provides a histogram of execution times of the scan cycle over a 60-ms range. This histogram tracks minimum (shortest) and maximum (longest) scan times, as well as the percentage of scans that fall in various ranges of scan times. To delete the historical data and start a new histogram, click Clear. A STOP-to-RUN transition also resets the Cycle Time display, as does closing and reopening the tuning panel.</p>
Timing	<p>This read-only field displays the following information about the scan cycle:</p> <p><b>Execution Time</b> displays the execution time for the last (most current) scan, the average scan cycle time, the shortest (minimum) scan cycle time, and the longest (maximum) scan cycle time.</p> <p><b>Sleep Time</b> displays the amount of sleep time for the last (most current) scan.</p>
Priority	<p>Use this slider to set the priority level for the execution of WinLC RTX relative to other applications running on your computer.</p> <p>Because WinLC RTX runs at a higher priority than any Windows application, you change the priority for WinLC RTX only if you are running other RTX applications.</p> <p>Setting the priority higher means that the operating system responds to WinLC RTX before executing lower-priority tasks. This results in less jitter in the start times and execution time of the OBs in your program.</p>
Timing Adjustment	<p>Use these fields to tune the scan cycle by entering values for the minimum sleep time and the minimum cycle time. These parameters determine the amount of sleep time that is added at the end of the free cycle.</p> <p>Click the Set button to apply these values. Click the Restore button to reset the values to those currently being used by the controller. After you apply new values, the panel stores these values for the controller and you can monitor the effect on the execution of your control program.</p> <p>To ensure that the minimum cycle time controls the sleep time for the controller, you must configure the scan cycle monitoring time and minimum scan cycle time parameters on the Cycle/Clock Memory tab of the Properties dialog box in STEP 7. Set the minimum scan cycle time to a value less than the value for scan cycle monitoring time. (The default scan cycle time is 6 seconds.)</p>
OB Execution	<p>Use these fields to adjust the execution monitor that enforces a maximum execution load for the controller. These parameters determine the forced sleep intervals within the execution of the control program.</p> <p>In order for the execution time limit parameter on the tuning panel to control the sleep time, set the execution time limit to a value that is less than the minimum scan cycle time that you configured in STEP 7.</p>

## Using the Diagnostic Buffer

Select the **CPU > Diagnostic Buffer** menu command to display the SIMATIC Diagnostic Buffer.

The Diagnostic Buffer allows you to view system diagnostic information without using the SIMATIC STEP 7 programming software and consists of an upper panel that displays an event list, a lower panel that displays specific event details, and controls for using the Diagnostic Buffer.

The diagnostic buffer is implemented as a ring buffer that contains single event entries. The events are displayed in descending order by time, with the most recent event at the top. If the ring buffer is full, a new event overwrites the oldest entry in the buffer.



The Diagnostic Buffer displays the following information:

**Event List** (upper panel): A list of all the events in the diagnostic buffer. The following information is shown for each diagnostic event:

- The number of the entry
- The date and time of the diagnostic event
- A brief description of the event

**Event ID** (between the upper and the lower panels): Displays the ID number of a selected event.

**Event Details** (lower panel): Displays the event details in either text or hexadecimal format.

If you have chosen Text format, the following details about a selected event appear in the lower panel:

- A brief description.
- Additional information, depending on the event, such as the address of the instruction that caused the diagnostic event and the mode transition that was caused by the event.
- The event state (incoming or outgoing).

If a single parameter of text cannot be identified, the diagnostic buffer displays the string "###". If no text exists for new modules or new events, the event numbers and the single parameters are displayed as hexadecimal values.

If you have chosen Hexadecimal format, the hexadecimal values of the selected event appear in the lower panel.

### **Sorting Events (upper panel)**

You can sort the events listed in the upper panel by clicking the specific column:

- Number (determined by time and date)
- Event description

### **Choosing Format (lower panel)**

You can display the diagnostic information in the lower panel in text or hexadecimal (Hex) format. In Hex format, the hexadecimal values of the 20 bytes of the selected event are displayed. To select the format:

- Click Text to display the event details in text format.
- Click Hex to display the hexadecimal values of the event.

### **Saving the Diagnostic Buffer**

To save a text file containing the event list and the detailed information for every event, click the Save button. The text file contains the information either in text or in hexadecimal format.

### **Displaying Help**

To display help on the diagnostic buffer, click the Help button. To display help on a specific event:

- Select the event in the upper panel.
- Click the Help on Event button.

## Archiving and Restoring Control Programs

You can save the configuration and control program to an archive file (\*.wld). You can use this archive file like the removable memory cartridge of a hardware PLC. The archive file allows you to easily restore the configuration and control program for the controller.

**Note:** A project or program from a previous release of WinLC RTX must be updated to a WinLC RTX V4 project. Use STEP 7 to create a new project and to create a new configuration for the WinLC RTX V4 controller and any submodules.

You cannot archive or restore a file when the controller is in RUN or RUN-P mode or shut down.

Saving the configuration of the controller and the control program to an archive file makes it easy to restore the controller after a memory reset. However, the archive file does not function like the EEPROM cartridge of the hardware PLC in that the controller does not automatically restore the archive file after a memory reset (MRES). You must manually restore the archive file.

### Creating an Archive File

An Archive file stores the current control program, the current system configuration, and the initial values of the DBs. The Archive file does **not** store the configuration of the PC station.

To create an Archive file, select the **File > Archive** menu command. This command displays the Archive Active File dialog box, which allows you to give a name to the file. The controller then creates the archive file with the extension .wld.

You can also use the SIMATIC Manager of STEP 7 to create an Archive file. Select the **File > Memory Card File > New** menu command.

### Restoring an Archive File

When you restore an archive file, you reload the configuration and the control program for the controller. You can only restore archive files of extension .wld.

Before you can restore an archive file, you must set the controller to STOP mode. Use the following procedure to load an archived configuration and control program:

1. Click the STOP button to place the controller in STOP mode.
2. Select the **File > Restore** menu command.
3. Select the specific archive file to restore and click OK.

## WinLC RTX Operation When Windows Crashes

WinLC RTX supports OB84 (CPU Hardware Fault), which allows you to initiate orderly shutdown of your process in case Windows detects an unrecoverable fault ("blue screen") or STOP error while WinLC RTX is operating. If WinLC RTX can still operate after Windows has initiated the system shutdown procedure, and the memory used by the real-time subsystem is not corrupted, one of the following occurs:

- If WinLC RTX is in RUN mode and the user program includes OB84, WinLC RTX starts OB84 and continues in RUN mode until the user program calls SFC46 (STP) to place the controller in STOP mode. Windows does not complete its system shutdown until after WinLC RTX transitions to STOP mode.
- If WinLC RTX is in RUN mode and the user program does not include OB84, WinLC RTX transitions to STOP mode and then Windows completes its system shutdown.
- If WinLC RTX is in STOP mode, Windows completes its system shutdown.

If Windows is configured to reboot automatically after a STOP error occurs, WinLC RTX automatically restarts if it is configured to start after a reboot. (To configure automatic reboot for Windows, select the menu command **Start > Settings > Control Panel** and double-click System. In the System Properties dialog box, select the Advanced tab, click Startup and Recovery, then select the "automatically reboot" checkbox.)

When WinLC RTX is restarted, it uses the program as it was last downloaded and executes OB100 (not OB102) if it is present. OB100 is always executed after a Windows failure, even if OB102 "Cold start" is configured in the STEP 7 Hardware Configuration. Event 1382 (hex) is used to start OB100. The current/last startup type is shown in the diagnostic buffer as "automatic warm reboot after non-backup power on with system memory reset".

You can program OB100 to respond to event 1382. For more information, refer to the *System Software for S7-300/400 System and Standard Functions Reference Manual*. To view this manual from a computer where STEP 7 is installed, select the **Start > Simatic > Documentation > English** menu command, and double-click "STEP 7 - System and Standard Functions for S7-300 and S7-400."

The following restrictions apply when Windows is shutting down:

- The WinLC RTX control panel is unavailable.
- Some system functions are disabled, including SFC22, SFC23, SFC82, SFC83, and SFC84.
- Block operations fail, returning an error code.
- Communication with external CP cards is unavailable.
- Communication with Windows applications is unavailable.
- Events in the diagnostic buffer that occurred after the last disk update are lost.
- Alarm messages may not be sent.
- Communication with external systems (such as HMI devices or programming devices) is only available if the network is connected to a configured submodule of WinLC RTX.
- Cycling the power to the computer initializes all of the program variables to their default values and empties the diagnostic buffer.

## Storing Retentive Data

### Storing Information About the Controller

WinLC RTX stores the following operational information in the active file on your hard disk:

- Load memory stores the system data (configuration of the controller) and the initial values of the blocks of the control program.
- WinLC RTX stores the state of the controller, which includes the last transition of the operating mode (STOP, RUN, or STARTUP) for the controller and the setting for the mode button (STOP, RUN, or RUN-P).
- As part of the shutdown process, WinLC RTX creates the power-down state of the controller. The power-down state includes the contents of the diagnostic buffer, the current values for the retentive memory areas of the controller (such as timers, counters and M memory), and the current values for the data blocks (Work memory).

WinLC RTX updates these areas during operation and uses this information when starting up the controller.

### Load Memory

When you download the control program from STEP 7, WinLC RTX saves the blocks of the control program (program blocks and system data) in the Load memory area. These blocks include the initial values for the process variables used by the control program.

SFC82 (CREA\_DBL) allows you to create new blocks in Load memory during the execution of the control program. You can use SFC84 (WRIT\_DBL) to modify these blocks. The blocks created by these SFC82 are stored in the Load memory at the time that SFC82 runs.

**Note:** Data blocks (DBs) created by SFC22 (CREAT\_DB) are not saved in the Load memory. These DBs are stored only in the Work memory.

### Retentive Data

When you configure WinLC RTX in STEP 7, you can determine the ranges of retentive data for the timers (T memory), counters (C memory), and M memory. All data blocks (DBs) in Work memory are retentive.

WinLC RTX saves the retentive memory areas as part of the power-down state. If the power-down state was saved and the controller performs a warm restart (OB100), WinLC RTX restores the retentive memory areas, including the values of the DBs stored in Work memory.

### State of the Controller

WinLC RTX stores the current operational status of the controller and updates the status on the following events:

- Whenever the controller changes operating mode (RUN to STOP, STOP to STARTUP, or STARTUP to RUN), WinLC RTX updates the state of the controller to show the latest transition.
- Whenever the mode button on the control panel changes (STOP, RUN or RUN-P), WinLC RTX updates the state of the mode button to show the latest action.

## Power-Down State

Under normal circumstances, WinLC RTX saves the current state of the controller and the retentive data, including the DBs from Work memory, when you shut down the controller. (The shutdown process can be initiated by the **CPU > Shut Down Controller** menu command or by shutting down Windows 2000 or Windows XP, either by user action or by UPS signal.) WinLC RTX stores the following information from the Work memory:

- Values for the retentive data in the S7 memory areas (such as T, C, M, and DB)
- Diagnostic buffer

**Note:** The power-down state (which includes the diagnostic buffer) is **not** saved in cases when WinLC RTX terminates abnormally, such as when the computer loses power (either by turning off the power or by power failure), or when WinLC RTX is not able to write to the hard disk, such as following a Windows crash ("Blue Screen").

The power-down state is saved at the time WinLC RTX shuts down. After WinLC RTX starts up, the power-down state is loaded into WinLC RTX and then is deleted (to avoid problems in case of an abnormal termination of the controller).

## Shutting Down the Controller Saves the Retentive Data

The following table shows the actions that cause WinLC RTX to save the retentive data.

Retentive Data	Action That Causes WinLC RTX to Save This Data
Load memory (blocks and initial values of the control program, DBs, and system data)	Downloading the control program from STEP 7
State of the controller	Changing the operating mode (RUN to STOP, or STOP to RUN), either from STEP 7 or from the control panel Successfully shutting down WinLC RTX
Power-down state	Successfully shutting down WinLC RTX
Work memory	Successfully shutting down WinLC RTX
Retentive memory areas (T, C, M, and DBs)	Successfully shutting down WinLC RTX
Diagnostics buffer	Successfully shutting down WinLC RTX

## Restoring Memory Areas on Start Up

When starting the controller, WinLC RTX searches the active file for the power-down state to determine whether the controller had been shut down correctly and performs the following tasks:

- WinLC RTX restores the downloaded blocks of the control program from the Load memory.
- If WinLC RTX finds the power-down state (showing that the controller had been shut down properly and successfully), WinLC RTX updates the Work memory from the power-down state and loads the current values (at the time that the controller was shut down) for the retentive data.
- If WinLC RTX does **not** find the power-down state (showing that the controller had **not** been shut down correctly), WinLC RTX restores the Work memory to its initial state from Load memory (as downloaded from STEP 7).
- WinLC RTX restores state of the controller, based on the saved operating mode and the Autostart configuration, and resets the mode button setting on the control panel.

If WinLC RTX cannot read some element of the Load memory, state of the controller, or the power-down state), WinLC RTX starts an unconfigured (empty) controller.

## Restoring Memory Following a Successful Shutdown of the Controller

If the power-down status was successfully saved when shutting down the controller, WinLC RTX restores the operational data for the controller:

- WinLC RTX uses the data stored in the power-down state to restore the controller. This includes the retentive S7 memory areas, the current values of the process blocks (Work memory), and the contents of the diagnostic buffer.  
**Note:** If you configured the controller for a cold restart (OB102), WinLC RTX resets the process variables and S7 memory areas to the initial values from the Load memory.
- Based on the Autostart settings, WinLC RTX restores the state of the controller to either STOP mode or RUN mode. In case of a Windows crash or "Blue Screen," WinLC RTX will restore the state of the controller before the Windows crash occurred. Although the controller performed a "normal" RUN-to-STOP transition, WinLC RTX is unable to save the state of the controller during a Windows crash.  
**Note:** If the controller was configured for Autostart, WinLC RTX generates a startup event that identifies the type of startup: buffered or unbuffered. (An unbuffered startup is like reloading the control program from an EPROM file.) You can program OB100 to read this start event. For an unbuffered startup, the variable OB100\_STOP at address LW6 is set to W#16#4309.
- WinLC RTX restores the mode button to the setting when the state of the controller was last saved.

After restoring and starting the controller, WinLC RTX deletes the Power-Down Status from the retentive memory area.



## Restoring Memory if the Controller Was Not Shut Down Properly

If the controller was not shut down properly, WinLC RTX does not create the power-down state.

**Note:** If the power-down state was not created, the diagnostic buffer is not saved. When you restart the controller, the diagnostic buffer will be empty.

If the power-down state was **not** saved when shutting down the controller, WinLC RTX performs the following tasks when restarting the controller:

- WinLC RTX reads the Load memory and restores the system configuration, the process variables and S7 memory areas to the initial values configured in STEP 7.
- WinLC RTX reads the state of the controller and performs an unbuffered startup. (An unbuffered startup is like reloading the control program from an EPROM file. WinLC RTX generates a startup event that you can program the OB100 to read.) Based on the Autostart settings, WinLC RTX sets the controller to either STOP mode or RUN mode.
- WinLC RTX restores the mode button to the setting when the controller was shut down.

## Encountering Problems When Starting the Controller

If WinLC RTX cannot read (or encounters an error) some element of the retentive memory area (Load memory, state of the controller, or power-down state), WinLC RTX starts with an unconfigured (empty) controller. In this case, the controller is set to STOP mode with the mode button set to STOP, and the system data and control program are deleted.

Possible causes for this problem include a hardware error in your computer, or a partial block in the Load memory area caused by an error that occurred when WinLC RTX was writing a block to the Load memory.

To recover from this condition, you must reload your control program and system data from STEP 7.

**Note:** The mode button of the controller is set to STOP mode. You can download the control program and system data from a remote computer, but you cannot use the remote computer to set the controller to RUN mode. You must go to the local computer for WinLC RTX and set the mode button to RUN or RUN-P in order to place the controller in RUN mode.

## Starting the Controller After a Windows Crash

When restarting a controller that was in RUN mode and was configured for Autostart, WinLC RTX starts the controller in RUN mode. If OB84 (CPU Hardware Fault) had responded to a Windows crash and had placed the controller in STOP mode before shutting down, WinLC RTX still starts the controller in RUN mode because WinLC RTX **cannot** update the state setting for the controller during the shut-down process.

If you do not want the controller to restart in RUN mode after a Windows crash, you must include code in the startup OB (OB100 or OB102) to place the controller in STOP mode when restarted.

## Using SFCs to Retain Data

You can use SFC82 (CREA\_DBL), SFC83 (READ\_DBL), and SFC84 (WRIT\_DBL) to save data at significant events in your process. For example, you may want to store the recipe values into Load memory when changing a recipe without downloading new blocks for the control program.

SFC82 and SFC84 modify the data for the control program that is stored in the Load memory. Saving the blocks to Load memory (instead of keeping the values in Work memory) ensures that these blocks are available even if WinLC RTX cannot save the power-down state when shutting down the controller.

SFC82 (CREA\_DBL), SFC83 (READ\_DBL), and SFC84 (WRIT\_DBL) create and update blocks that are stored as part of your control program in Load memory. The blocks are created or modified in Load memory when your control program executes these SFCs.

SFC82, SFC83, and SFC84 are asynchronous SFCs that run in the background.

**Note:** If you call SFC82, SFC83, or SFC84 from the startup OB (OB100 or OB102), WinLC RTX executes these SFCs synchronously. This differs from the operation of a hardware PLC.

Like the other asynchronous SFCs, SFC82, SFC83, and SFC84 are typically long-running SFCs that can require a relatively long time to complete. (The time for the SFC call itself will be short, but the actual operation for the SFC will be executing in the background.) In order to use asynchronous SFCs, you must allow sufficient sleep time to allow WinLC RTX to process the SFCs without encountering jitter.

**Note:** Do not use a polling loop that looks for the completion of an asynchronous SFC, especially for SFC82, SFC83, or SFC84. Because the asynchronous SFC is being executed in the background, having your control program loop until the SFC finishes will extend the execution of the OB that is performing the polling loop and can cause jitter.

### Caution

Whenever your control program calls SFC82, SFC83, or SFC84, the SFC reads or writes data to the disk. If you call these SFCs every scan (such as from OB1) or from a cyclical OB that is executing rapidly, the constant reading or writing to the disk can cause the disk to fail or can add jitter.

You should only call SFC82, SFC83, or SFC84 to record a significant process event, such as a change of recipe.

## Uninterruptible Power Supply (UPS)

You can use a UPS system to provide emergency power for your computer. The UPS system can help ensure that WinLC RTX shuts down correctly and saves the power-down state in case of a power failure.

Refer to the manufacturer's documentation for your computer and your UPS system.

Microsoft Windows 2000 and Windows XP provides a dialog for configuring the UPS for your computer:

1. Select the **Start > Settings > Control Panel** to display the control panel.
2. Double-click the Power Options icon to display the Power Options Properties dialog.
3. Click the UPS tab and configure the parameters for your UPS system.
4. Click Apply or OK to set the UPS properties.

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## Customizing and Security Options

### Customizing Options

To open the Customize dialog box, select the **CPU > Options > Customize** menu command. The tabs of the dialog box allow you to customize the control panel as follows:

#### General

Select **Always On Top** to display the control panel on top of all other open windows.

#### Language

The language field displays the current display language for the control panel.

The language select list displays the installed languages for the control panel. Click a language selection to change the control panel display language.

**Note:** To install the languages that are available for the control panel, run the setup program and select the languages from the dialog.

#### AutoStart

Select **Autostart CPU** to set the autostart feature. The autostart feature allows the controller to start automatically in RUN mode under the conditions described in *Selecting the Autostart Feature*.

### Selecting the Language

You can change the display language for the control panel menus and online help.

To change the display language, follow these steps:

1. Select the **CPU > Options > Customize** menu command to display the Customize dialog.
2. In the Customize dialog, select the Language tab.
3. Select the language for the control panel.
4. Click Apply to change the language.
5. Click OK to close the Customize dialog.

The control panel automatically changes to the selected language.

## Selecting the Autostart Feature

The control panel includes an Autostart feature that defines whether the controller starts up in STOP or RUN mode if WinLC RTX is configured to start at PC boot. (If WinLC RTX is configured for a manual start, then the controller always starts in STOP mode.) The following table lists the parameters that the Autostart feature uses to determine the operating mode of the controller.

Mode at Shutdown	Autostart	Mode on Restart
STOP	No	STOP mode
	Yes	STOP mode
RUN	No	STOP mode
	Yes	RUN mode

**Note:** If WinLC RTX was in RUN mode but was terminated abnormally because of a situation such as power loss or Windows failure, then WinLC RTX always starts in STOP mode even if the Autostart feature was selected.

Use the following procedure to enable the Autostart feature:

1. Select the **CPU > Options > Customize** menu command to display the Customize dialog.
2. In the Customize dialog, select the Autostart tab and select the Autostart CPU option for the Startup Mode.
3. Click Apply to enable the Autostart feature.
4. Click OK to close the Customize dialog.

## Setting the Security Options

Select the **CPU > Options > Security** menu command to change security options. The control panel displays the Access Verification dialog. You must enter your password in this dialog in order to make any changes to the security settings for the controller.

**Note:** The default password is an empty field containing no characters. To enter the default password, press the Enter key.

### Security Level

The Security dialog allows you to set levels of password security that limit access to the controller. The following security access options are provided:

- **Password:** When you select Password, certain control panel operations, such as changing the operating mode, archiving and restoring a control program, and opening the tuning panel, require that the user enter a password.
- **Confirmation:** When you select Confirmation, operating mode changes require that the user acknowledge a confirmation dialog box.
- **None:** When you select None, no confirmation or password is required.

## Password Prompt Interval

You can set the Password Prompt Interval to a time interval of your choice, from 0 to a maximum of 23 hours, 59 minutes. After you have entered your password, you are not prompted for it again until this time interval has expired. The default setting of 0 means that you must enter a password for each protected operation.

Shutting down and starting the controller does not affect the expiration of the Password Prompt Interval; however, it is reset whenever you shut down the control panel. The next time you start the control panel and access a password-protected function, you will be prompted for password entry.

## Change Password

Click the Change Password button to display the Change Password dialog.

**Note:** If you create a password, but set the security level to None (disabling the password), you still need to enter the configured password in the Access Verification dialog before you can access the Security dialog box again.



### Warning

Running the controller without confirmation or password protection increases the risk that an operator may change the controller mode inadvertently, which could cause the process or equipment to operate unpredictably, resulting in potential damage to equipment and/or death or serious injury to personnel.

Exercise caution to ensure that you do not inadvertently change the operating mode, or permit unauthorized persons to access the machine or process. Always install a physical emergency stop circuit for your machine or process.

## Changing the Password

The Change Password dialog allows you to change the current password.

**Note:** The default password is an empty field containing no characters. To enter the default password, press the Enter key.

Use the following procedure to change the password:

1. In the Old Password field, enter the old password.
2. In the New Password field, enter the new password (maximum length 12 characters).
3. In the Confirm New Password field, enter the new password again.
4. Click OK to apply all the changes made in this dialog, or click Cancel to reject all changes.

To subsequently access the security options, you must enter the password at the Access Verification dialog.

## Startup Options for the Controller

### Starting the Controller at PC Boot

By default, you must start the controller manually after the computer reboots. You can, however, register the controller to start automatically after a reboot.

If you register the controller to start at PC reboot, you can also use the Autostart feature to configure the controller to start in RUN mode. Otherwise, the controller always starts in STOP mode..

### Registering the Controller for Start at PC Boot

To register the controller to start automatically, follow these steps:

1. Shut down the controller.
2. Select the **CPU > Register Controller for Start at PC Boot** menu command.

WinLC RTX will now start automatically whenever you start your computer.

### Unregistering the Controller for Start at PC Boot

To unregister the controller for starting automatically, follow these steps:

1. Shut down the controller.
2. Select the **CPU > Unregister Controller for Start at PC Boot** menu command.

WinLC RTX will now **not** start automatically whenever you start your computer. To start WinLC RTX, you must manually start the controller.

## Setting the Restart Method

The restart method determines which startup OB is executed whenever the controller changes from STOP mode to RUN mode. The startup OB allows you to initialize your control program and variables. WinLC RTX supports two restart methods:

- **Warm restart:** The controller executes OB100 before starting the free cycle (OB1).

A warm restart deletes the peripheral I/O (PII and PIQ), deletes the non-retentive memory bits (M), timers (T) and counters (C), and changes the peripheral outputs to a pre-defined safe state (default is 0). A warm restart saves the retentive memory bits, timers, counters and data blocks (DBs).

- **Cold restart:** The controller executes OB102 before starting the free cycle (OB1).

Like a warm restart, a cold restart deletes the peripheral I/O (PII and PIQ), deletes the non-retentive memory bits (M), timers (T) and counters (C), and changes the peripheral outputs to a pre-defined safe state (default is 0). A cold restart does **not** save the retentive memory bits, timers, counters and data blocks (DBs), but sets these areas to their default (initial) values.

You use STEP 7 to configure the default restart method for the controller. The default restart method is stored in the configuration (system data) for the controller that you download with your control program.

Whenever you click (using the left mouse button) the RUN or RUN-P mode button on the panel to change from STOP mode to RUN mode, WinLC RTX uses the default restart method and executes the startup OB that you configured.

To override the default restart method and select a different restart method, use one of the following options for changing WinLC RTX from STOP mode to RUN mode:

- Using the **CPU** menu (selecting either the **CPU > RUN** or **CPU > RUN-P** menu command) to change the controller from STOP to RUN mode
- Right-clicking (using the right mouse button) to select the RUN or RUN-P mode button

Both of these actions display the Restart Method dialog that allows you to select either a warm or cold restart.

**Note:** If you have configured the confirmation security option, you must acknowledge a confirmation dialog before the control panel displays the Restart Method dialog.

If you have configured the password security option and the password prompt interval is either 0 or has expired, the control panel displays the Access Verification dialog for you to enter the password. After verifying successful password entry, the control panel displays the Restart Method dialog.

After executing OB100 or OB102, WinLC RTX executes the free cycle (OB1).





# STEP 7 Operations

## Using STEP 7 with the Controller

STEP 7 provides programming and configuration tools for working with WinLC RTX. You define the WinLC RTX configuration through the Hardware Configuration tool of STEP 7, as well as in the Station Configuration Editor. You can develop a control program using any of the STEP 7 control programming languages, and download it to WinLC RTX once you have established a connection. You also use STEP 7 to configure operational parameters and I/O addresses for the controller.

## Accessing WinLC RTX from STEP 7

To access WinLC RTX from the STEP 7 programming software, follow these steps:

1. Using the SIMATIC Manager, open the project for WinLC RTX.
2. Select the **View > Online** menu command to change to the "Standard Hierarchy, Online" view.

STEP 7 establishes an online connection to WinLC RTX.

## Configuring the Operational Parameters

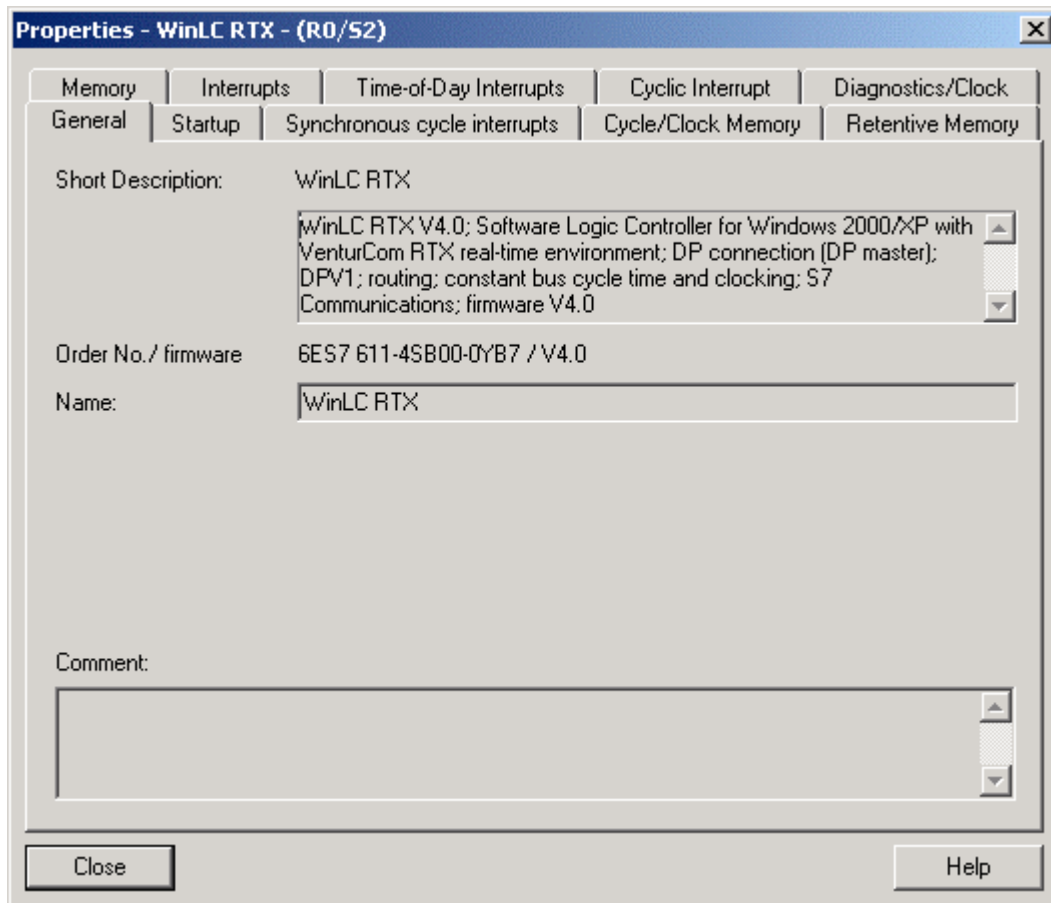
### Configuring the Operational Parameters for WinLC RTX

STEP 7 provides a Hardware Configuration tool for configuring the operational characteristics for WinLC RTX. This configuration is then stored in various SDBs in the System Data container.

After you download the System Data, WinLC RTX uses the configured parameters for the following events:

- Whenever you start up the controller
- On the transition to RUN mode (if you modified the hardware configuration online while WinLC RTX was in STOP mode)

You use the Properties dialog to configure the operational parameters.



The parameters that you can access from the Properties dialog are described below:

Parameter	Description
General	Provides information about WinLC RTX
Startup	Defines the operational characteristics of WinLC RTX for powering on or going to RUN mode
Cycle/Clock Memory	Cycle: defines any constraints on the scan cycle (such as the minimum and maximum scan cycle time, the size of the process image, and program requirements relating to I/O access error reporting.) Clock Memory: defines a memory byte to function as a "clock memory"- each bit of this byte toggles on and off at a different frequency
Clocked Interrupts	Configures the clocked interrupts (OB61 and OB62)
Time-of-Day Interrupt	Configures the operation of the time-of-day interrupts (OB10)
Interrupts	Defines the priority class for the hardware interrupts (OB40), the time-delay interrupts (OB20), the DPV1 interrupts (OB55 to OB57), and the asynchronous error interrupts (OB82, OB83, OB85, and OB86)
Retentive Memory	Defines the memory areas (M, T, and C) to be retained following a power failure or a transition from STOP mode to RUN mode
Cyclic Interrupt	Defines the operation of the cyclic interrupts (OB32 to OB36)
Diagnostics/Clock	Defines the reporting of diagnostic errors and the synchronization and the correction factor for the WinLC RTX clock
Memory	Defines the amount of local data (L memory) for each priority class and the maximum number of communication jobs that can be outstanding at one time.

### Accessing Operational Parameters

To configure any of these operational parameters in STEP 7, open the SIMATIC Manager and follow these steps:

1. In the SIMATIC Manager, select the PC station.
2. Click the Configuration icon.
3. Right-click the WinLC icon in the Hardware Configuration rack and select Object Properties.
4. Click the tab with the name of the parameter that you want to configure (such as Cyclic Interrupt) and enter the appropriate values in the dialog.
5. Click OK to confirm your configuration.

## Configuring the Startup Characteristics

You can use the Startup tab of the STEP 7 Hardware Configuration tool to configure WinLC RTX to perform certain tasks before going to RUN mode. The table below lists the parameters for configuring the startup characteristics.

Parameter	Description	Range	Default
Startup when expected / actual configuration differ	Startup is allowed even if I/O is not configured properly	Yes/No	Yes
Startup after Power On	Specifies what type of restart to perform if you have selected the autostart feature	Warm restart Cold restart	Warm restart
Finished message by modules	Specifies how long WinLC RTX waits for configured S7 I/O modules to respond with a ready message	1 to 650 (100 ms intervals)	650 (65 s)
Transfer of parameters to modules	Specifies how long WinLC RTX waits for transfer of parameters to S7 I/O modules following a ready message	1 to 650 (100 ms intervals)	100 (10 s)

You can also change the restart method from the WinLC RTX control panel for a particular change to RUN or RUN-P mode.

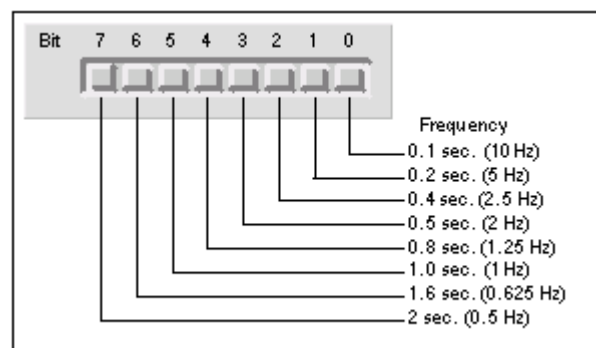
## Configuring the Clock Memory

You can use the Cycle/Clock Memory tab of the STEP 7 Hardware Configuration to configure a byte of the bit memory (M) area to function as a "clock memory." The following table lists the parameters and ranges for configuring a clock memory.

Parameter	Description	Range	Default
Clock Memory	Enables the clock memory (if enabled, you must enter a memory byte address)	Yes or No	No
Memory Byte	Defines a memory byte (MB) to function as a clock memory	0 to MB2047	Disabled

When this byte has been configured as clock memory, the bits turn on and off (with a duty cycle of 1:1) at fixed frequencies. (The eight bits in the byte yield eight different, fixed frequencies.)

The figure shows the frequencies of the different bits for the byte used as clock memory.



## Configuring the Scan Cycle

You can use the Cycle/Clock Memory tab in the Hardware Configuration tool of STEP 7 to configure certain aspects of the scan cycle. The table below lists the parameters for configuring the scan cycle.

**Note:** The minimum cycle time of WinLC RTX includes both the time required for executing the control program and the sleep time (which allows your computer to perform other tasks).

WinLC RTX monitors the execution time of the scan cycle. If the scan cycle (execution time of the control program plus the sleep time) exceeds the scan cycle monitoring time (watchdog), WinLC RTX starts an error OB. The scan cycle monitoring time must be greater than the maximum execution time for the scan cycle plus the configured sleep time.

Parameter	Description
Update OB1 process image cyclically	Indicates whether to update the process images as part of execution of OB1. Range: Selected / Unselected Default: Selected
Scan cycle monitoring time	Defines the maximum time for the scan cycle. (The value for the scan cycle includes both the execution time of the control program and the sleep time of the controller.)  This value must be larger than the value for the minimum scan cycle time.  The following list gives a few examples of events that could cause the controller to exceed the limit on maximum cycle time: <ul style="list-style-type: none"> <li>• Starting other PC applications</li> <li>• Processing an increasing number of interrupts in the program</li> <li>• PC blocked by high-priority drivers or by continuous hardware activities</li> <li>• Processing an error in the control program</li> </ul> Range: 1 to 6000 ms Default: 6000 ms
Minimum scan cycle time	Defines the minimum time for the scan cycle. (This value includes both the execution time of the control program and the sleep time of the controller.)  The minimum scan time allows you to determine the percentage of processing time of your computer to dedicate to the controller. For example: if you entered a minimum scan time that is twice as long as the actual execution time of the user program, 50% of the processing time would be dedicated to WinLC RTX and 50% could be used by another application (based on process priority).  Range: 0 to 5999 ms Default: 0 ms

Parameter	Description
Size of process image input area	Defines the overall size of the process image input area Range: 0 to 8192 bytes Default: 512 bytes
Size of process image output area	Defines the overall size of the process image output area Range: 0 to 8192 bytes Default: 512 bytes
OB85 Call Up	Specifies handling of I/O access errors during process image reading or writing. The choices are: <ul style="list-style-type: none"> <li>Do not call OB85 (Never)</li> <li>Call OB85 when module first fails and again when module returns to normal operation (Coming/Going)</li> <li>Call OB85 on every access while the module is failed (Always)</li> </ul> Range: Never, Coming/Going, Always Default: Always

### Configuring Retentive Memory Areas

You can use the Retentive Memory tab of the STEP 7 Hardware Configuration tool to configure the following areas of memory to be retained in the event of loss of power or on a transition from STOP mode to RUN mode:

- Number of Memory bytes: up to 2048 bytes (from MB0 to MB2047)
- Number of S7 timers: up to 512 timers (from T 0 to T 511)
- Number of S7 counters: up to 512 counters (from C 0 to C 511)

In the event of an abnormal shutdown while the controller is running, the current values for these areas, as well as the DBs, are lost. Otherwise, the values are retained according to the configured parameters shown in the table below.

**Note:** DBs that were created by SFC22 (CREATE\_DB) are not retained following a cold restart. All other DBs are retentive following a normal shutdown.

The table below lists the parameters for configuring the retentive memory areas:

Parameter	Description	Range	Default
Memory Bytes	Enters the number of memory bytes to be retained (starting from MB0)	0 to 2048	16
S7 Timers	Enters the number of S7 timers to be retained (starting from T 0)	0 to 512	0
S7 Counters	Enters the number of S7 counters to be retained (starting from C 0)	0 to 512	8

## Configuring the Time-of-Day Interrupt

WinLC RTX supports one time-of-day interrupt (OB10). To configure OB10, use the Time-of-Day tab in the Hardware Configuration tool of STEP 7. The table below lists the parameters for the time-of-day interrupt.

Parameter	Description	Range	Default
Active	Determines whether OB10 is automatically activated following a warm restart	Yes/No	No
Execution	Selects the frequency for executing OB10	None Once Once per minute Hourly Daily Weekly Monthly End of the month Yearly	None
Start Date/Time	Determines the starting date and time for executing OB10  Date: day.month.year  Time: hours:minutes:seconds (24-hour format)	Any valid time and date	01.01.94 00:00:00

## Configuring the Interrupts

Use the Interrupts tab in the Hardware Configuration tool of STEP 7 to configure the priority class for the interrupt OBs supported by WinLC RTX. You deselect an OB by configuring it with a priority class of 0.

The table below lists the parameters for the different interrupts:

Parameter	Description	Range	Default
Hardware Interrupts: OB40	Defines the priority class and process image segment for the hardware interrupt OB	Priority class: 2 to 24 PI partition: None, 1 to 15	Priority Class: 16 PI partition: None
Time-Delay Interrupt: OB20	Defines the priority class and process image segment for the time-delay interrupt OB	Priority class: 2 to 24 PI partition: None, 1 to 15	Priority Class: 3 PI partition: None
DPV1 Interrupts: OB55, OB56, OB57	Defines the priority class for the DPV1 interrupt OBs	Priority class: 2 to 24	Priority Class: 2
Asynchronous Error Interrupts: OB82, OB83, OB85, and OB86	Defines the priority class for the asynchronous error interrupts	Priority class: 24 to 26	Priority Class: 25



## Configuring a Cyclic Interrupt

WinLC RTX supports cyclic interrupts OB32 to OB36. You can use the Cyclic Interrupts tab in the Hardware Configuration tool of STEP 7 to configure a time interval for executing a cyclic interrupt OB. The table below lists the parameters for the cyclic interrupt. To deselect a cyclic OB, configure the priority class to 0.

Parameter	Description	Range	Default
Priority	Determines the priority class of the cyclic interrupt	Priority class: 2 to 24	OB32: 9 OB33: 10 OB34: 11 OB35: 12 OB36: 13
Execution	Determines the time interval (in milliseconds) for executing the cyclic interrupt	0 to 60000	OB32: 1000 OB33: 500 OB34: 200 OB35: 100 OB36: 50
Phase Offset	Defines an amount of time (in milliseconds) that the start of a cyclic interrupt can be delayed in order to allow another cyclic interrupt to finish	0 to 59999	0
Process Image	Defines the process image segment to be updated automatically when the OB runs.	None, or 1 to 15	None

Based on the time interval that you configure, WinLC RTX starts the execution of the cyclic interrupt OB at the appropriate time. The optimum time interval for your application depends on the processing speed of your computer and the execution time of the cyclic OB. Jitter can cause an occasional overrun in the start event for a cyclic OB, which might cause WinLC RTX to go to STOP mode. Other factors that affect the execution of the OB include the following situations:

- The program in the OB takes longer to execute than the interval allows. If the execution of the program consistently overruns the start event of the cyclic OB, WinLC RTX can go to STOP mode (unless OB80 is loaded).
- Programs in other priority classes frequently interrupt or take longer to execute, which causes the controller to not execute the cyclic OB at the scheduled time. If this occasionally causes an overrun, WinLC RTX starts the cyclic OB as soon as the first OB finishes.
- STEP 7 performs some task or function that causes the controller not to execute the cyclic OB at the scheduled time.

The sleep time of the WinLC RTX scan cycle does not affect the execution of a cyclic interrupt OB: WinLC RTX attempts to execute the OB at the appropriate interval regardless of the amount of sleep time that you configure for the scan. WinLC RTX provides several types of free cycle sleep management for managing sleep time. If a cyclic interrupt OB runs too frequently or requires too much of the time allotted for the total scan, it could cause the watchdog timer to time out (calling OB80 or going to STOP mode).

## Configuring the I/O Addresses

### Assigning Addresses for the DP I/O

You use the Hardware Configuration tool of the STEP 7 programming software to specify elements and addresses for the PROFIBUS-DP configuration. You configure the following addresses for each DP slave device on the network:

- Node address and diagnostic address for each node of the network
- Logical address range for the data of the I/O modules on each node

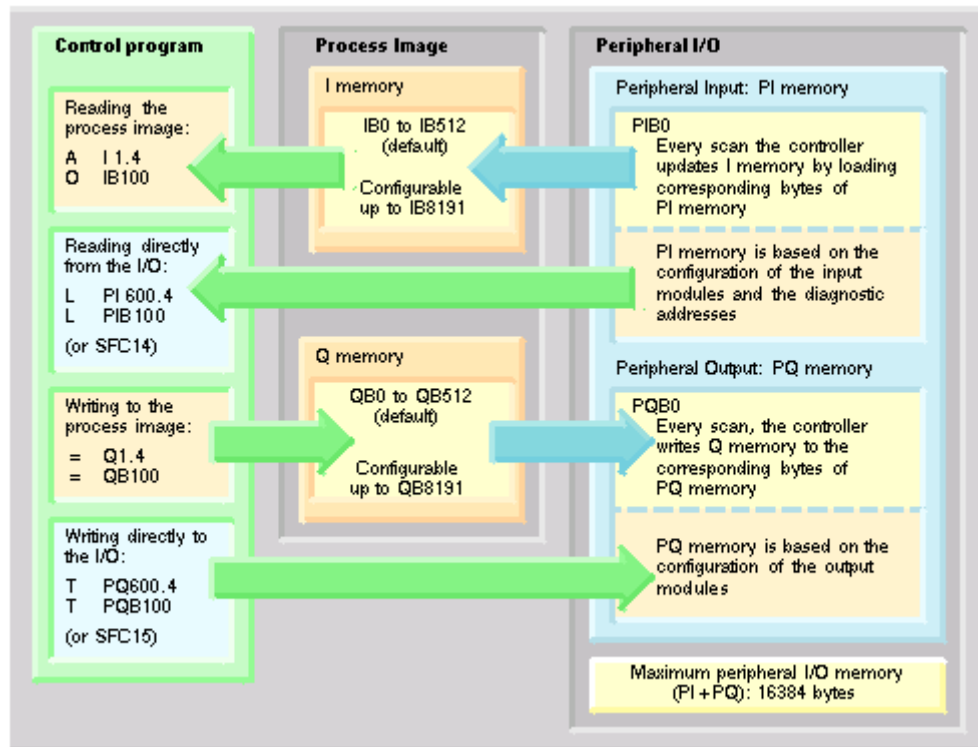
You must download the PROFIBUS-DP configuration to WinLC RTX before you attempt to operate the PROFIBUS network.

Each node of the DP network has a unique node address. The DP master uses this node address to communicate with its DP slaves. The control program generally does not use the node address to reference a data for the slave device. Your control program uses the logical address of the I/O and the diagnostic address for the DP slave that you configured in STEP 7. Like the other S7 controllers, WinLC RTX provides memory areas for accessing the inputs and outputs:

- Peripheral input area (PI) and peripheral output area (PQ): When you configure the DP I/O in STEP 7, you assign a range of the PI or PQ memory for each I/O module. You also assign a diagnostic address for the I/O modules in the PI memory. The amount of the PI and PQ memory is determined by your DP I/O configuration, but the maximum amount of peripheral I/O memory (PI + PQ) is 16 Kbytes (16384 bytes).
- Process-image input area (I) and process-image output area (Q): When you configure the operational parameters for WinLC RTX in STEP 7, you determine the size of the I and Q memory areas. You can configure a maximum of 8 Kbytes (8192 bytes) for both I and Q memory (up to 8 Kbytes for I memory, and up to 8 Kbytes for Q memory). As part of the scan cycle, WinLC RTX reads the PI memory into the corresponding I memory locations and writes the Q memory to the corresponding PQ memory locations.

Your control program can access the process image (reading from I memory and writing to Q memory). These values are updated every scan.

You can also access the peripheral I/O directly (reading from PI memory and writing to PQ memory) by using the Load (L) and Transfer (T) commands or by using SFC14 (DPRD\_DAT) and SFC15 (DPWR\_DAT).



The following table provides an overview of the addresses that can be assigned to the DP I/O.

Address Areas	Size
Process-image areas I and Q	<p><b>Inputs:</b> 0 to 8192 bytes (configurable) Addressed as IB0 through IB<math>n</math>, where <math>n</math> is the configured input process image size minus 1.</p> <p><b>Outputs:</b> 0 to 8192 bytes (configurable) Addressed as QB0 through QB<math>m</math>, where <math>m</math> is the configured output process image size minus 1</p>
Total amount for the distributed I/O (accessed by Load and Transfer instructions)	<p>16384 bytes</p> <p>This memory can be any mixture of peripheral inputs (PI) and peripheral outputs (PQ), based on the configuration of the distributed I/O (for both digital and analog I/O). However, the PI and PQ areas together cannot exceed the 16384-byte maximum size.</p> <p><b>Note:</b> The diagnostic address for a slave device is configured in the PI memory.</p> <p>Addressed as:</p> <p><b>Inputs:</b> PIB0 to PIB<math>n</math>, where <math>n</math> is the configured input size minus 1.</p> <p><b>Outputs:</b> PQB0 to PQB<math>m</math>, where <math>m</math> is the configured output size minus 1</p>
Total amount for consistent data (accessed by SFC14 and SFC15)	Up to 16384 bytes each for inputs and outputs
Maximum size per SFC14 or SFC15	244 bytes
Maximum Input/Output data for one node	Up to 244 bytes

## Accessing the Data in the DP I/O Modules

During the configuration of WinLC RTX, you allocate a logical address in the Input (I) or Output (Q) area for the data of each I/O module of the DP network. You use these addresses to access the data for the I/O module. WinLC RTX also uses the lowest logical base address for a module for reporting the module events to the control program.

The following table lists the methods for accessing the distributed I/O:

- To access data as bytes, words, or double words (that is, as 1 byte, 2 bytes, or 4 bytes), use the Load (L) and Transfer (T) instructions (for statement list) or the Assign Value (MOVE) instruction (for ladder logic) to read and write the distributed inputs and outputs. You can access the I/O data either from the process image (I) area or from the peripheral image (PI) area.
- To access data that has consistency of 3 bytes or more than 4 bytes (up to 244 bytes), use SFC14 (DPRD\_DAT) and SFC15 (DPWR\_DAT). SFC14 and SFC15 always access the peripheral image of the I/O module. Both SFC14 and SFC15 also allow you to access 1 byte, 2 bytes, and 4 bytes of data.

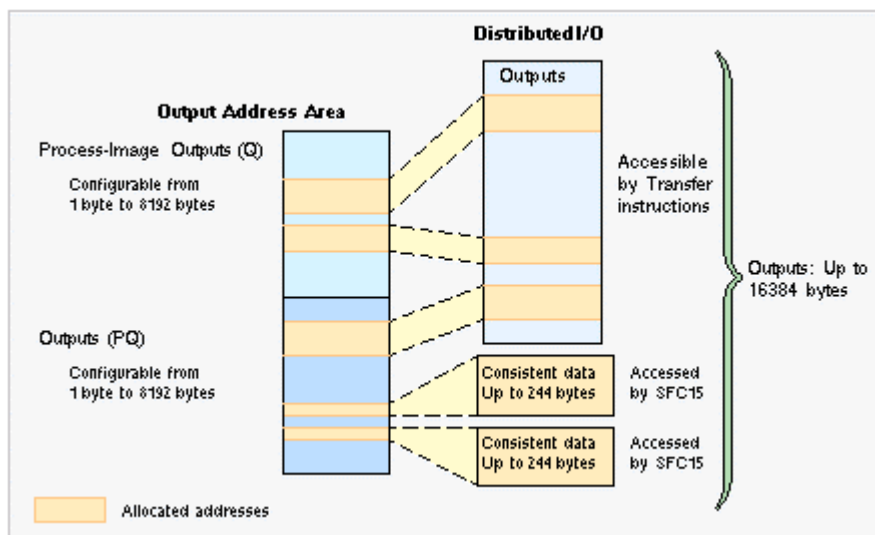
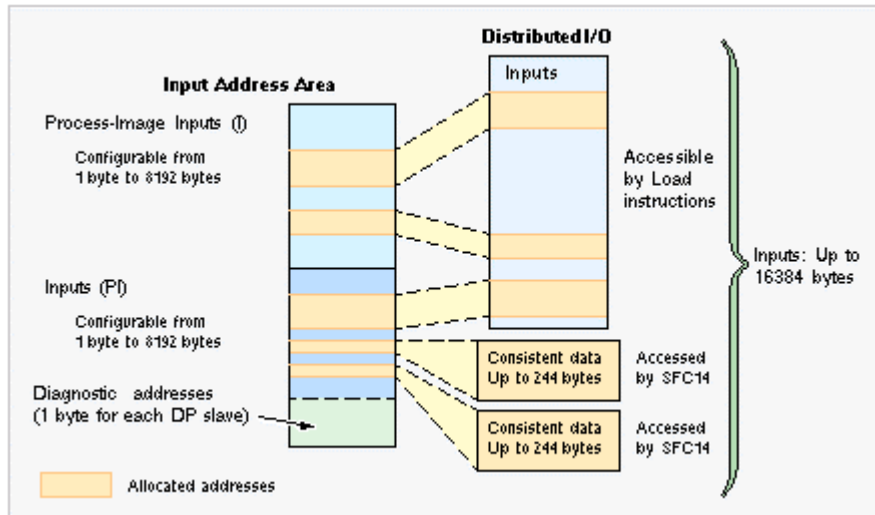
Type of Access	Method
Accessing data in byte, word (2-byte), or double-word (4-byte) units Data integrity is 2 bytes for accessing words, and 4 bytes for accessing double words.	Use the following instructions: <ul style="list-style-type: none"> <li>• The Load instruction reads 1, 2, or 4 bytes of inputs from the I or PI area.</li> <li>• The Transfer instruction writes 1, 2, or 4 bytes of outputs to the Q or PQ area.</li> </ul>
Accessing consistent data from a single I/O module in units other than 1 byte, 2 bytes and 4 bytes	Use the following SFCs: <ul style="list-style-type: none"> <li>• SFC14 copies all bytes from the inputs of a module to the I, Q, M, D or L area.</li> <li>• SFC15 writes all bytes from the I, Q, M, D, or L area to the outputs of a module.</li> </ul>

As shown in the following figures, your control program can access up to 16384 bytes (each) of inputs and outputs by using the Load (L) and Transfer (T) instructions (for statement list) or the Assign Value (MOVE) instruction (for ladder logic).

**Note:** You may access any byte of the Process Image (I or Q) area, whether the byte is assigned to physical I/O or not; however, you may only access addresses actually assigned to physical I/O when accessing the Peripheral Image (PI or PQ) or when using SFC14 or SFC15.

SFC14 and SFC15 can access blocks of data up to 244 bytes:

- SFC14 copies the complete block of data from the module's inputs to any of the specified memory areas.
- SFC15 writes the complete block of data from any of the specified memory areas to the module's outputs.



## Cross-Module Access Errors

Unlike hardware PLCs, WinLC does not allow a Load (L) or Transfer (T) instruction to access bytes of more than one module. Consider a configuration of two output modules, each containing five bytes. Module 1 is addressed from 10 to 14, and Module 2 is addressed from 15 to 19. OB1 contains the instructions shown below:

```
L 5
T PAW 14
```

In this example, OB122 is called because of an attempt to access bytes across a module boundary. A word instruction at address 14 attempts to access address 14 and 15, which is prevented because the addresses are not in the same module.

## Additional Information

For information about the Load (L) and Transfer (T) instructions, see the online help for the STEP 7 programming software and the *Statement List (STL) for S7-300 and S7-400 Programming Reference Manual*. If you are programming in ladder logic, see the Assign Value instruction (MOVE) in the *Ladder Logic (LAD) for S7-300 and S7-400 Programming Reference Manual*.

For information about SFC14 (DPRD\_DAT) and SFC15 (DPWR\_DAT), see the *System Software for S7-300 and S7-400 System and Standard Functions Reference Manual*. To view this manual from a computer where STEP 7 is installed, select the menu command **Start > Simatic > Documentation > English**, and double-click "STEP 7 - System and Standard Functions for S7-300 and S7-400".

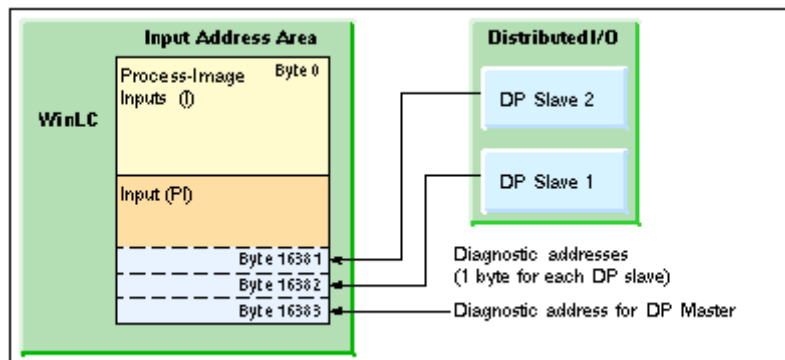
## Specifying the Diagnostic Addresses for the DP I/O Modules

During the configuration of WinLC RTX, you allocate a diagnostic address in the peripheral input (PI) area for each node of the DP network. You use the diagnostic address as a parameter for an SFC that accesses the diagnostic data for a node (for example, the LADDR parameter of SFC13). Additionally, this address is used by WinLC RTX to report node state changes (in OB86) to the control program.

**Note:** STEP 7 documentation sometimes refers to the diagnostic address for a node as the logical base address of the slave or station, as opposed to the logical base address of a module.

As you use the STEP 7 Hardware Configuration tool to configure WinLC RTX and the PROFIBUS-DP network, these diagnostic addresses are assigned above the process-image input (I) memory area. See the figure below.

If you do not enter a specific address, STEP 7 allocates IB16383 for the first DP slave, PIB16382 for the second, and so forth.



For more information about configuring the DP diagnostic addresses, see the online help for the STEP 7 programming software.

## Isochronous Mode for a Constant Bus Cycle

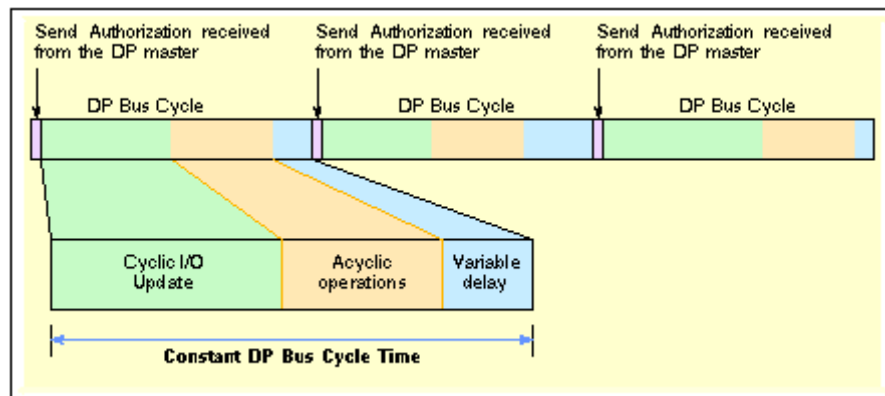
WinLC RTX allows you can operate the DP Master in an isochronous mode to maintain a constant bus cycle time.

**Note:** WinLC RTX allows you to use isochronous mode on more than one PROFIBUS-DP subnet; however, your computer must not share the interrupt (IRQ) of the PCI slots used by the CP cards with the Windows operating system. For example, the SINUMERIK PCU 50 provides two PCI slots that can be used for isochronous mode on two different PROFIBUS-DP subnets.

To implement an isochronous DP cycle, you assign a synchronous interrupt OB (OB61, OB62, OB63, or OB64) with an associated process image partition to the DP master for synchronous update.

Each isochronous DP cycle contains the following elements:

- A global control command (Send Authorization) notifies the slave devices of the start of the bus cycle.
- The cyclic inputs and outputs are updated.
- Any acyclic operations are performed.
- A variable delay allows the next DP cycle to start on the next multiple of the configured cycle time.



During the bus cycle, two events signal the control program:

- At the end of the I/O update, an interrupt schedules the synchronous OB for execution.
- At the start of the succeeding cycle (when the Send Authorization command is being transmitted to the slave devices), an event signals WinLC RTX that further execution of SFC126 and SFC127 should return an error.

Between the two events (between the interrupt and the transmission of the global control command), the synchronous OB can call SFC126 and SFC127 to execute the synchronous updating of the process image partition that was assigned to the synchronous OB. If these SFC calls execute without error, the I/O update is synchronized to the process image partition update and occurs at a constant interval between updates.

You configure the DP bus cycle when you configure network properties for the DP master.

## System Requirements for an Isochronous DP Cycle

For an isochronous DP cycle, you must have a CP 5613 card, revision 6 or higher operating in interrupt mode.



## STEP 7 Components

### Logic Blocks Supported by WinLC RTX

Like the other S7 PLCs, WinLC RTX provides several types of logic blocks for processing the user program: organization blocks (OBs), system functions (SFCs), and system function blocks (SFBs). These blocks are an integral part of WinLC RTX.

WinLC RTX supports the following STEP 7 logic blocks. For more information, see the online help for STEP 7 or refer to the *System Software for S7-300/400 System and Standard Functions Reference Manual*. To view this manual from a computer where STEP 7 is installed, select the menu command **Start > Simatic > Documentation > English**, and double-click "STEP 7 - System and Standard Functions for S7-300 and S7-400".

Organization Blocks (OBs)	System Functions (SFCs)	System Function Blocks (SFBs)
OB1	SFC0 to SFC6	SFB0 to SFB5
OB10	SFC11 to SFC15	SFB8 and SFB9
OB20	SFC17 to SFC24	SFB12 and SFB13
OB32 to OB36	SFC26 to SFC34	SFB14 and SFB15
OB40	SFC36 to SFC44	SFB22 and SFB23
OB52 to OB54	SFC46 and SFC47	SFB32
OB55 to OB57	SFC49 to SFC52	SFB52 to SFB54
OB61 and OB62	SFC54 to SFC59	SFB56001 and SFB65002
OB80	SFC62	
OB82 to OB86	SFC64	
OB100	SFC78 to SFC80	
OB102	SFC82 to SFC84	
OB121 and OB122	SFC126 and SFC127	

#### Note for SFC22 and SFC23

SFC22 and SFC23 return error code 8092 in the event of a Windows operating system failure ("blue screen"). Applications that need to continue operating after a Windows failure can check for this error code.

### Notes for SFC82, SFC83, and SFC84

In contrast to the S7-300, WinLC RTX supports an asynchronous interface for SFC82 to SFC84. WinLC RTX allows both the first call (with REQ = 1) and the second call (with REQ = 0) in STARTUP so the action can be completed in STARTUP.

The normal STEP 7 error codes apply for SFC82, SFC83, and SFC84, with the following additional considerations:

- WinLC RTX has a limit of 32 outstanding SFC82, SFC83, and SFC84 jobs. If this limit is exceeded, these SFCs return error code 80C3.
- SFC82, SFC83, and SFC84 return error code 8092 in the event of a Windows operating system failure ("blue screen"). Applications that need to continue operating after a Windows failure should check for this error code.

### Additional S7 Blocks

In addition to these system blocks, you can use these other S7 blocks to create the control program:

- Function (FC): WinLC RTX supports up to 65,536 FCs (FC0 to FC65535). Each FC can contain up to 65,570 bytes.
- Function block (FB): WinLC RTX supports up to 65,536 FBs (FB0 to FB65535). Each FB can contain up to 65,570 bytes.
- Data block (DB): WinLC RTX supports up to 65,535 DBs (DB1 to DB65535). (DB0 is reserved.) Each DB can contain up to 65,534 bytes.

The number and size of FCs, FBs, OBs, and DBs are also limited by the amount of available system memory.

For more information about the instruction list supported by WinLC RTX, see the sections on technical data, organization blocks, system functions, system function blocks, execution times of instructions and execution times of DP instructions.

## Peer-to-Peer Communication Functions

Like other S7 controllers, WinLC RTX provides peer-to-peer communications between controllers on the network. The controllers can be either hardware or software logic controllers. The table below lists the SFBs and SFCs that WinLC RTX supports for peer-to-peer communications:

SFB/SFC	Designation	Description
SFB8 SFB9	USEND URCV	Exchange data using a send and a receive SFB
SFB12 SFB13	BSEND BRCV	Exchange blocks of data of variable length between a send SFB and a receive SFB
SFB14 SFB15	GET PUT	Read data from a remote device Write data to a remote device
SFB22 SFB23	STATUS USTATUS	Specific query of the status of a remote device Receive status messages from a remote devices
SFC62	CONTROL	Query the status of a connection

For more information on these functions, refer to the *System Software for S7-300/400 System and Standard Functions Reference Manual*. To view this manual from a computer where STEP 7 is installed, select the menu command **Start > Simatic > Documentation > English**, and double-click "STEP 7 - System and Standard Functions for S7-300 and S7-400".

## PROFIBUS DPV1

DPV1 extensions to PROFIBUS-DP allow the enhanced communication required by complex slave devices. This enhanced communication includes acyclic data exchange, alarm and status messaging, and the transmission of complex data types. WinLC RTX provides support for the following DPV1 functionality:

- DP-Norm, DP-S7, DPV1, and DPV1 S7-compliant slaves
- Alarm and status OBs for processing DPV1-defined events, including:
  - OB40 (process alarm)
  - OB55 (status alarm)
  - OB56 (update alarm)
  - OB57 (manufacturer-specified alarm)
  - OB82 (diagnostic alarm)
  - OB83 (module pull/plug alarm)
- New data set read and write function blocks:
  - SFB52 (RDREC, Read Data Set)
  - SFB53 (WRREC, Write Data Set)
  - Execution of SFB54 (RALRM, read alarm data) in the context of the triggering alarm
- Station and interface address
- Buffering of alarms received in DP mode CLEAR

For WinLC RTX to support DPV1, configure the CP card to be a DP Master. To select DP Master, follow these steps from the SIMATIC Manager:

1. Open the Hardware Configuration for your PC Station.
2. Double-click your CP card in the corresponding submodule slot of your WinLC RTX.
3. Select the Operating Mode tab of the CP card Properties dialog.
4. Select DP Master and set the DP mode to DPV1.

## Organization Blocks (OBs)

Organization blocks (OBs) are the interface between the operating system of the controller and the control program. You can use OBs to execute specific components of the user program for the following events:

- When the controller starts and restarts
- Cyclically or at a specific time interval
- At certain times or on certain days
- After running for a specified period of time
- When errors occur
- When a hardware interrupt occurs

The control program in an OB can contain up to 65,570 bytes.

OBs are processed according to the priority assigned to them. A higher number indicates a higher priority class. The table below lists the OBs that are supported by WinLC RTX.

OB	Description	Priority Class
OB1	Main program cycle	1 (lowest)
OB10	Time-of-day interrupt	2 to 24
OB20	Time-delay interrupt	2 to 24
OB32 to OB36	Cyclic interrupts	2 to 24
OB40	Hardware interrupt	2 to 24
OB52 to OB54	ODK interrupt	15
OB61 and OB62	Synchronous cycle interrupts	25 (default)
OB80	Time error	26
OB82	Diagnostic interrupt	24 to 26 (or 28)*
OB83	Module remove/insert interrupt	24 to 26 (or 28)*
OB84	CPU hardware fault	26 (or 28)*
OB85	Priority class error	24 to 26 (or 28)*
OB86	Rack failure	24 to 26 (or 28)*
OB100	Warm restart	27
OB102	Cold restart	27
OB121	Programming error	Priority class of the OB where the error occurred
OB122	I/O access error	

\* Priority class 28 during STARTUP, user-configurable priority class (from 24 to 26) in RUN mode.

## OBs for the Main Program Cycle, Cold Restart, and Warm Restart

The table below shows OBs for the main program cycle and cold and warm restarts. WinLC RTX provides OB1 (main program cycle) for continuously executing the user program. On the transition from STOP mode to RUN mode (or RUN-P mode), WinLC RTX executes OB100 (warm restart) or OB102 (cold restart), based either on the hardware configuration for WinLC RTX or which restart option was selected from a dialog box displayed by the WinLC RTX control panel. After OB100 (or OB102) has been successfully executed, WinLC RTX executes OB1.

Organization Block (OB)		Start Event (in Hex)	Priority Class
Main program cycle	OB1	1101, 1103, 1104	1
Warm restart	OB100	1381, 1382	27
Cold restart	OB102	1385, 1386	27

## Interrupt OBs

WinLC RTX provides a variety of OBs that interrupt the execution of OB1. The table below lists the different interrupt OBs that are supported by WinLC RTX. These interrupts occur according to the type and configuration of the OB.

The priority class determines whether the controller suspends the execution of the user program (or other OB) and executes the interrupting OB. You can change the priority class for the interrupt OBs.

Interrupts		Start Event (in Hex)	Default Priority Class
Time-of-Day Interrupt	OB10	1111 (OB10)	2
Time-Delay Interrupt Range: 1 ms to 60000 ms	OB20	1101 (OB20)	3
Cyclic Interrupt Range: 1 ms to 60000 ms The practical minimum time is based on the performance of the computer and the size of the user program.	OB32	1133	9
	OB33	1134	10
	OB34	1135	11
	OB35	1136	12
	OB36	1137	13
Hardware interrupt	OB40	1141 (channel1)	16

If WinLC RTX has been configured to execute a particular interrupt OB, but that OB has not been downloaded, WinLC RTX reacts in the following manner:

- If OB10, OB20, OB40, OB55, OB56, or OB57 is missing and OB85 has not been downloaded, WinLC RTX changes operating mode (from RUN to STOP).
- WinLC RTX remains in RUN mode if a cyclic interrupt OB (OB32 to OB36) is missing. If these OBs cannot be executed at the specified time and OB80 has not been downloaded, WinLC RTX changes from RUN mode to STOP mode.

**Note:** If you schedule a cyclic interrupt OB (OB32 to OB36) to be executed at a specific interval, make certain that the program can be executed within the time frame and also that your control program can process the OB within the allotted time.

## Error OBs

WinLC RTX provides a variety of error OBs. Some of these error OBs have the configured (the user-assigned) priority class, while others (OB121 and OB122) inherit the priority class of the block where the error occurred.

The local variables for OB121 and OB122 contain the following information that can be used by the program to respond to the error:

- The type of block (byte 4) and the number (bytes 8 and 9) where the error occurred
- The address within the block (bytes 10 and 11) where the error occurred

If the start event occurs for a particular error OB that has not been downloaded, WinLC RTX changes operating mode from RUN to STOP.

WinLC RTX supports the following error OBs:

Error or Fault		Start Event (in Hex)	Default Priority Class
Time error	OB80	3501, 3502, 3505, 3507	26
Diagnostic Interrupt	OB82	3842, 3942	26
Insert/remove module interrupt	OB83	3861, 3863, 3864, 3961, 3865	26
CPU hardware fault (Windows "blue screen")	OB84	3985	26 (or 28)
Priority class error: <ul style="list-style-type: none"> <li>• Start event occurs for an OB that has not been downloaded.</li> <li>• WinLC RTX attempts to access a module or DP slave that is defective or not plugged in.</li> <li>• WinLC RTX attempts to access a block (such as a DB) that has not been downloaded or has been deleted</li> </ul>	OB85	35A1, 35A3, 39B1, 39B2	26
Rack failure (distributed I/O): a node in the PROFIBUS-DP subnet has failed or has been restored.	OB86	38C4, 39C4, 38C5, 39C5, 38C7, 38C8	26 (or 28)
Programming error (For example: the control program attempts to address a timer that does not exist.)	OB121	2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 253A; 253C, 253E	Same priority class as the OB in which the error occurred
I/O access error (For example: the control program attempts to access a module that is defective or is not plugged in.)	OB122	2942, 2943	



## System Functions (SFCs)

WinLC RTX provides SFCs, which are system functions that perform various tasks. The control program calls the SFC and passes the required parameters; the SFC performs its task and returns the result.

- WinLC RTX allows a maximum of 5 instances of the asynchronous system function SFC51 (index B1, B3) to be running.
- WinLC RTX allows a maximum of 20 asynchronous SFCs from the following set to be running: SFC11, SFC13, SFC55, SFC56, SFC57, SFC58, and SFC59.
- WinLC RTX allows a maximum of 32 asynchronous SFCs in any combination from the following set to be running: SFC82, SFC83, and SFC84.

### SFCs That Can Cause the Scan Cycle to Vary

The following SFCs can cause the scan cycle to vary ("jitter"):

- SFC22 (CREAT\_DB)
- SFC23 (DEL\_DB)
- SFC52 (WR\_USMG)

### Execution Times

The following table lists the execution times for the SFCs supported by WinLC RTX. Execution times for asynchronous SFCs refer to the time for the SFC call, not the time for the job to complete.

**Note:** The execution times were measured on a SINUMERIK PCU50 1.2 GHz computer. Tuning settings: 9000  $\mu$ s execution time limit, 90% maximum execution load, and 1000  $\mu$ s forced execution sleep. Actual execution times may vary, depending on your computer.

SFC	Name	Description	Execution Time
SFC0	SET_CLK	Sets the system clock	1.33 $\mu$ s
SFC1	READ_CLK	Reads the system clock	2.13 $\mu$ s
SFC2	SET_RTM	Sets the run-time meter	1.33 $\mu$ s
SFC3	CTRL_RTM	Starts or stops the run-time meter	1.74 $\mu$ s
SFC4	READ_RTM	Reads the run-time meter	0.77 $\mu$ s
SFC5	GADR_LGC	Queries the logical address of a channel	2.38 $\mu$ s
SFC6	RD_SINFO	Reads the start information of an OB	2.16 $\mu$ s
SFC11	DPSYNC_FR	Synchronize groups of DP slaves	1.44 $\mu$ s
SFC12	D_ACT_DP	Deactivating and activating of DP slaves	N/A
SFC13	DPNRM_DG	Reads the diagnostic data of a DP slave  DP configuration tested: one ET 200M slave with one 8-input/8-output module and one 16-output module	7.00 $\mu$ s

STEP 7 Operations

SFC	Name	Description	Execution Time
SFC14	DPRD_DAT	Reads the consistent data from a DP slave	2.27 µs
SFC15	DPWR_DAT	Writes the consistent data to a DP slave	2.29 µs
SFC17	ALARM_SQ	Generates an acknowledgeable block-related message	4.38 µs
SFC18	ALARM_S	Generates an unacknowledgeable block-related message	6.68 µs
SFC19	ALARM_SC	Queries the status for the last message (SFC17 or SFC18)	1.46 µs
SFC20	BLKMOVB	Copies variables	2.65 µs
SFC21	FILL	Initializes a memory area	
		1 word	2.5 µs
		50 words	3.18 µs
		100 words	3.84 µs
SFC22	CREAT_DB	Creates a data block in work memory	6.79 µs
SFC23	DEL_DB	Deletes a data block. WinLC RTX allows an application to delete a non-sequence relevant data block.	2.27 µs
SFC24	TEST_DB	Provides information about a data block. In WinLC RTX, SFC24 can return DB length and write protection flags for non-sequence relevant data blocks, although it returns error code 80B2 for non-sequence relevant data blocks.	1.18 µs
SFC26	UPDAT_PI	Updates the process-image input table  DP configuration tested: one ET 200M slave with one 8-input/8-output module and one 16-output module	3.00 µs
SFC27	UPDAT_PO	Updates the process-image output table	3.00 µs
SFC28	SET_TINT	Sets the time-of-day interrupt (OB10)	2.84 µs
SFC29	CAN_TINT	Cancels the time-of-day interrupt (OB10)	1.65 µs
SFC30	ACT_TINT	Activates the time-of-day interrupt (OB10)	1.17 µs
SFC31	QRY_TINT	Queries the time-of-day interrupt (OB10)	1.51 µs

SFC	Name	Description	Execution Time
SFC32	SRT_DINT	Starts the time-delay interrupt (OB20)	12.88 $\mu$ s
SFC33	CAN_DINT	Cancel the time-delay interrupt (OB20)	1.47 $\mu$ s
SFC34	QRY_DINT	Queries the time-delay interrupt (OB20)	1.52 $\mu$ s
SFC36	MSK_FLT	Mask synchronous errors	0.99 $\mu$ s
SFC37	DMSK_FLT	Unmask synchronous errors	1.00 $\mu$ s
SFC38	READ_ERR	Read the error register	0.99 $\mu$ s
SFC39	DIS_IRT	Disables the processing of all new interrupts	0.99 $\mu$ s
SFC40	EN_IRT	Enables the processing of new interrupts	1.01 $\mu$ s
SFC41	DIS_AIRT	Disables the processing of new interrupts with higher priority than the current OB	0.66 $\mu$ s
SFC42	EN_AIRT	Enables the processing of new interrupts with higher priority than the current OB	1.67 $\mu$ s
SFC43	RE_TRIGR	Retriggers the watchdog timer (monitoring the cycle time)	8.44 $\mu$ s
SFC44	REPL_VAL	Transfers a value to ACCU1 (accumulator 1)	8.69 $\mu$ s
SFC46	STP	Changes the operating mode to STOP	N/A
SFC47	WAIT	Delays the execution of the user program by the specified number of microseconds, rounded up to the nearest multiple of the HAL timer period.	248 $\mu$ s
SFC49	LGC_GADR	Queries the module slot belonging to a logical address	1.73 $\mu$ s
SFC50	RD_LGADR	Queries all of the logical addresses of a module	3.99 $\mu$ s
SFC51	RDSYSST	Reads all or part of a system status list	10.65 $\mu$ s
SFC52	WR_UMSG	Writes a user element to the diagnostics buffer	8.35 $\mu$ s
SFC54	RD_PARM	Read the defined parameter	2.67 $\mu$ s
SFC55	WR_PARM	Write the defined parameter	3.02 $\mu$ s
SFC56	WR_DPARM	Write the default parameter	1.69 $\mu$ s
SFC57	PARM_MOD	Assign the parameters to a module	1.68 $\mu$ s

SFC	Name	Description	Execution Time
SFC58	WR_REC	Write a data record	3.02 $\mu$ s
SFC59	RD_REC	Read a data record	3.01 $\mu$ s
SFC62	CONTROL	Check status of an SFB instance	N/A
SFC64	TIME_TCK	Reads the time from the system clock	5.3 $\mu$ s
SFC78	OB_RT	Reports OB run-time information, with resolution to the nearest multiple of the HAL timer period.	N/A
SFC79	SET	Set a range of outputs	1.18 $\mu$ s
SFC80	RESET	Reset a range of outputs	1.17 $\mu$ s
SFC82	CREA_DBL	Creates a block in load memory	N/A
SFC83	READ_DBL	Copies data from a block in load memory	N/A
SFC84	WRIT_DBL	Writes to Load Memory blocks so data is saved immediately. Load memory blocks that are used to recover from an abnormal termination can be updated while the program is running. Use SFC84 only for larger segments of a database, not for frequent variable processing.	N/A
SFC126	SYNC_PI	Synchronous update of process image partition of inputs	N/A
SFC127	SYNC_PO	Synchronous update of process image partition of outputs	N/A

## System Function Blocks (SFBs)

System Function Blocks are logic blocks (similar to SFCs) that perform basic tasks when called by the user program. The table below lists the execution times of the SFBs that are supported by WinLC RTX. You must provide a data block (DB) when you call an SFB.

**Note:** The execution times were measured on a SINUMERIK PCU50 1.2 GHz computer. Tuning settings: 9000  $\mu$ s execution time limit, 90% maximum execution load, and 1000  $\mu$ s forced execution sleep. Actual execution times may vary, depending on your computer.

SFB	Name	Description	Execution Time
SFB0	CTU	Provides a count-up counter	1.51 $\mu$ s
SFB1	CTD	Provides a count-down counter	1.51 $\mu$ s
SFB2	CTUD	Provides a count-up/down counter	11.88 $\mu$ s
SFB3	TP	Generates a pulse	6.01 $\mu$ s
SFB4	TON	Generates an on-delay timer	4.99 $\mu$ s
SFB5	TOF	Generates an off-delay timer	4.98 $\mu$ s
SFB8	USEND	Sends a data packet of CPU-specific length (two-way)	65242 $\mu$ s (65.242 ms)
SFB9	URCV	Receives a data packet of CPU-specific length (two-way)	77 $\mu$ s
SFB12	BSEND	Sends a data block up to 64 Kbytes (two-way)	42352 $\mu$ s (42.352 ms)
SFB13	BRCV	Receives a data block up to 64 Kbytes (two-way)	58 $\mu$ s
SFB14	GET	Reads data up to a CPU-specific maximum length (one-way)	59141 $\mu$ s (59.141 ms)
SFB15	PUT	Writes data up to a CPU-specific maximum length (one-way)	52818 $\mu$ s (52.818 ms)
SFB22	STATUS	Query the status of a remote device	43 $\mu$ s
SFB23	USTATUS	Receive the status from a remote device	43 $\mu$ s
SFB32	DRUM	Implements a sequencer	10.82 $\mu$ s
SFB52	RDREC	Read data set	N/A
SFB53	WRREC	Write data set	N/A
SFB65001	CREA_COM	(WinAC ODK)	N/A
SFB65002	EXEC_COM	(WinAC ODK)	N/A

## System Clock

Like a hardware S7 controller, WinLC RTX has a "real-time" system clock (based on the hardware clock of your computer).

**Note:** Setting the time for WinLC RTX does not affect the time setting for your computer.

To adjust and read the system clock, use the following SFCs.

SFC	Name	Description
SFC0	SET_CLK	Allows you to set the time and the date of the system clock. The clock then runs starting from the set time and set date.  Format: DT#1995-01-15-10:30:30
SFC1	READ_CLK	Allows you to read the current date or current time of the system clock of the controller.
SFC64	TIME_TCK	Allows you to read the system time of the controller. The system time is a "time counter" counting cyclically from 0 to a maximum of 2147483647 ms. In case of an overflow, the system time is counted again, starting at 0.  The time base (and therefore the accuracy) is 1 ms.  The system time is only influenced by the operating modes of the controller.

# Tuning the Performance of the Controller

## Scan Cycle for a PC-Based Controller

During one scan cycle, the controller updates the outputs, reads the inputs, executes the control program, performs communication tasks, and provides time for other applications to run. The following parameters affect the scan cycle:

- Execution Time (in milliseconds) is the actual amount of time used by the controller to update the I/O and to execute the control program.
- Scan Cycle Time (in milliseconds) is the number of milliseconds from the start of one cycle to the start of the next cycle. This value must be greater than the execution time of the scan to provide execution time for any application that has a lower priority than WinLC RTX.
- Sleep Time (in milliseconds) determines how much time is available during the free cycle (execution cycle for OB1) to allow higher priority OBs and other applications to use the resources of the computer.

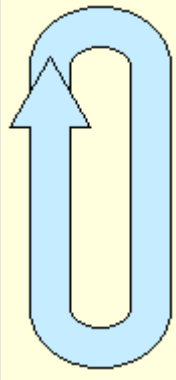
The Priority for the controller application also affects the scan cycle by determining when the controller runs or is interrupted by other Windows applications. You must ensure that the sleep time occurs every 50 milliseconds or less in order for other Windows applications, such as moving the mouse, to operate smoothly.

The tuning panel allows you to tune and test the performance of the controller by adjusting the parameters that affect the scan cycle (minimum cycle time, minimum sleep time, and priority) without affecting the system configuration for the controller. After testing tuning parameters, you use STEP 7 to configure the minimum scan cycle time for the controller when you create the system (hardware) configuration.

### Tasks Performed during the Scan Cycle

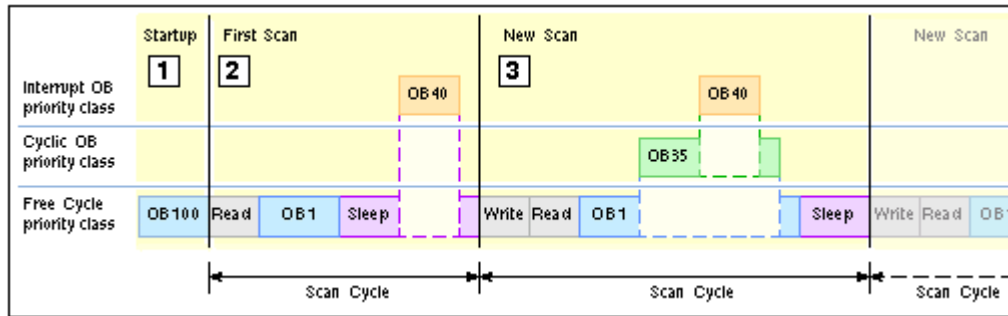
After you have used STEP 7 to create and download your control program to the controller, the controller starts executing the control program when you set the controller to RUN or RUN-P mode. Like any other S7 PLC, the controller executes your control program in a continuously repeated scan cycle.

In one scan, the controller performs the following tasks:

	1.	The controller writes the status of the OB1-assigned process-image output table (the Q memory area) to the I/O module outputs. For the first scan, the controller does not perform this task.
	2.	The controller reads the states of the I/O module inputs into the OB1-assigned process-image input table (the I memory area).
	3.	The controller executes the control program in OB1.
	4.	OB1 waits until the minimum sleep time requirement is met before starting another scan. Other OBs can execute at this time.

Because the PC-based controller shares the resources of your computer with other programs (including the operating system), you must ensure that the controller provides sufficient cycle time for other Windows applications to be processed. If the actual execution time for the scan cycle is less than the minimum scan cycle time that you configured with STEP 7, the controller suspends the free cycle (OB1) until the minimum scan cycle time is reached before starting the next scan. This waiting period, or sleep time, allows other applications to use the resources of the computer.

The following figure provides an overview of the tasks that are performed by the controller during different scan cycles.



**1** Startup  
On a transition from STOP mode to RUN mode, the controller loads the system configuration, sets the I/O to the default states, and executes the startup OB (OB100 or OB102).

The startup cycle is not affected by the minimum cycle time and minimum sleep time or watchdog parameters; however, it is affected by the execution time limit.

**2** First Scan  
The first scan following the startup OB does not write to the outputs, but starts by reading the inputs. An OB with a higher priority class can interrupt the free cycle at any time, even during the sleep time.

In the example above, the controller handles a hardware (I/O) interrupt that occurs during the sleep time by executing OB40. After OB40 has finished, the controller waits for the minimum cycle time to start the next scan.

**Note:** It is possible for the controller to use all of the sleep time for processing higher-priority OBs. In this case, other Windows applications may not have sufficient time to run. Refer to the techniques for managing sleep time listed below.

**3** New Scan  
The new scan starts by writing to the outputs. In the example above, the controller suspends the execution of OB1 to execute a cyclic OB (OB35), which has a higher S7 priority than OB1. The controller also suspends the execution of OB35 to handle another I/O interrupt (OB40).

After OB40 finishes, the controller resumes the execution of OB35, and after OB35 finishes, the controller resumes the execution of OB1.

The length of the scan cycle is determined by the execution time of all OBs executed during the scan, the minimum cycle time, and the minimum sleep time. If the execution time is less than the minimum cycle time that was configured in the system configuration, the controller suspends the free cycle until the minimum sleep time is met. During the sleep time, the computer runs any interrupt OBs and other Windows applications.





### **Warning**

Variation in the execution time or response time of the control program could potentially create a situation where the equipment or application being controlled can operate erratically and possibly cause damage to equipment or injury to personnel.

If the controller does not provide sufficient sleep time for the other applications to run, the computer can become unresponsive to operator input, or the controller and other applications can operate erratically. In addition, the execution of the control program can experience non-deterministic behavior (jitter) such that execution times can vary and start events can be delayed.

Always provide an external emergency stop circuit. In addition, always tune the sleep time and manage the performance of the controller so that your control program executes consistently.

## **Methods for Managing the Performance of WinLC RTX**

While executing the control program, WinLC RTX can experience a variation in the process execution time or response time that causes the scan times to vary or to exhibit non-deterministic behavior ("jitter"). You can use the following methods to manage the performance of WinLC RTX:

- Adjusting the priority for the controller: Affects when the operating system runs or interrupts the controller
- Adjusting the minimum sleep time and minimum cycle time parameters: Affects the execution of the free cycle or OB1 (OB priority class 1)
- Inserting sleep time into the control program (SFC47 "WAIT"): Affects the execution for the priority class of the OB that calls SFC47 (and any lower priority class)
- Adjusting the sleep-monitoring algorithm of the execution monitor: Affects the execution of all OB priority classes (if the other mechanisms do not meet the requirements for sleep time)

WinLC RTX provides a tuning panel for monitoring the performance and for modifying the parameters that affect the scan cycle.

## What Causes Jitter?

Because the PC-based controller must share the computer with other running processes, the execution of the control program can experience "jitter" when a higher-priority or active process uses the CPU or system resources of the computer. Jitter is a variation in the process execution time or response time that causes the scan times to vary or to exhibit non-deterministic behavior.

Jitter occurs when there is a delay in either the start or the finish of an OB. For example: the execution time can deviate by a few milliseconds between scans, or the start of an interrupt OB can be delayed. For some control applications, such time lapses do not disturb the proper operation of the controller, but in a highly time-sensitive process, a jitter of even 1 ms can be significant.

The following settings for WinLC RTX can cause jitter in the execution of the control programs:

- Priority settings for different applications
- Priorities among the WinLC RTX threads
- Execution Monitor (that measures the CPU usage)

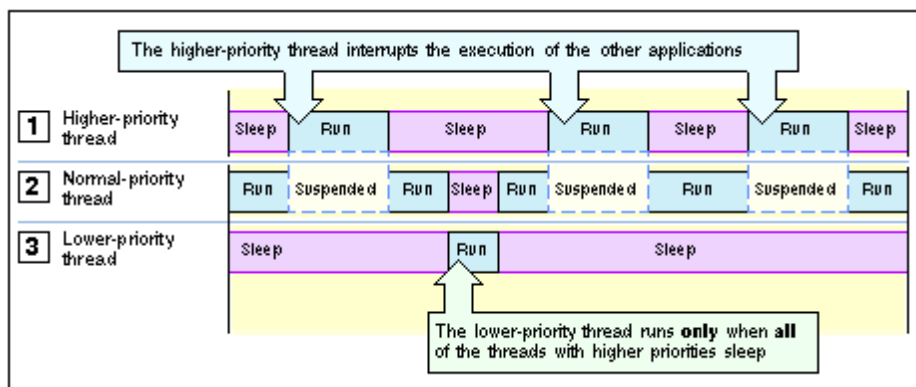
The tuning panel of WinLC RTX provides several tools for reducing jitter in the control program.

Jitter can also be caused by other sources than WinLC RTX:

- Jitter can be caused by the design of your control program. For example, different branches in the logic of the control program might cause the execution time to vary.
- Jitter can be caused by the computer hardware. For example, jitter can be caused by an operation with a long DMA cycle, such as a video card using the PCI bus. Jitter can also be caused by a driver, such as for a CD drive or a diskette drive. Hardware-induced jitter cannot be managed by software. For a uniprocessor system running WinLC RTX, Venturcom provides an application to help evaluate the suitability of the computer hardware for use with the RTX extensions.
- Jitter can be caused by an application that was created with the WinAC RTX Open Development Kit (ODK), such as when a synchronous process takes too long to execute. Refer to the documentation for WinAC RTX ODK for more information.

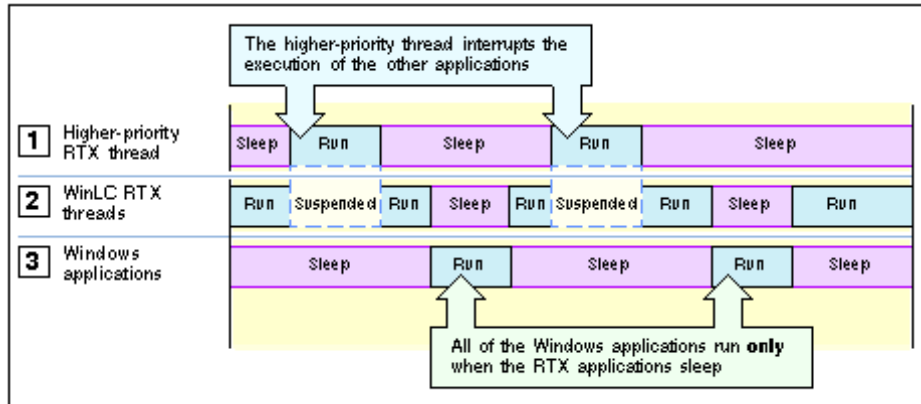
## Priority Settings for Different Applications Can Cause Jitter

Every application that is running on your computer has one or more threads (or tasks), and each thread has a priority. The Windows operating system executes the threads with the highest priority first and executes a lower-priority thread only when all of the higher priority threads are finished or suspended (for example, to wait for some other activity to complete or to "sleep" for a specified time). Threads with higher priorities interrupt and suspend the operations of threads with lower priorities. After the higher-priority thread finishes, the lower-priority thread resumes its operation.

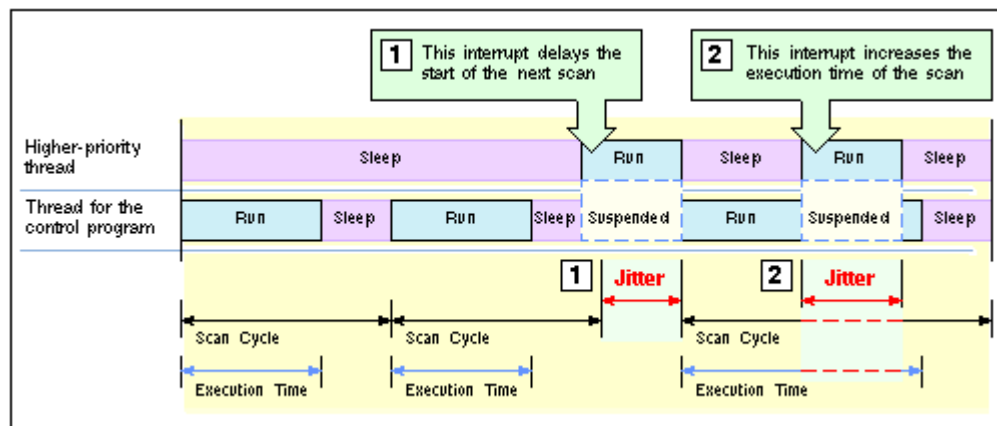


WinLC RTX operates in a real-time subsystem (RTSS) that provides a range of priorities above the typical Windows priorities. Although the threads of WinLC RTX have a higher priority than threads for a Windows application, the operation of WinLC RTX can still be interrupted by another RTX thread that has a higher RTSS priority.

You must also ensure that WinLC RTX and any other RTX application provide sufficient sleep time to allow the Windows applications to run.



Jitter can occur when a process of an application with a higher priority interrupts and suspends the execution of the controller. As shown in the following figure, jitter typically appears in two forms.



- 1 The higher priority threads can cause jitter by delaying the start of an OB. This could delay the start of the free cycle (OB1) or of an interrupt OB (such as OB35 or OB40).
- 2 The higher priority application can cause jitter by extending the execution time for an individual scan.

You can use the tuning panel to increase or decrease the priority for the WinLC RTX threads. The higher you set the priority for the WinLC RTX threads in relation to the threads of the other applications, the less jitter you typically encounter. However, you must also ensure that WinLC RTX provides enough sleep time for the other applications to run.

The tuning panel also provides information that allows you to monitor the amount of jitter in the scan cycle.

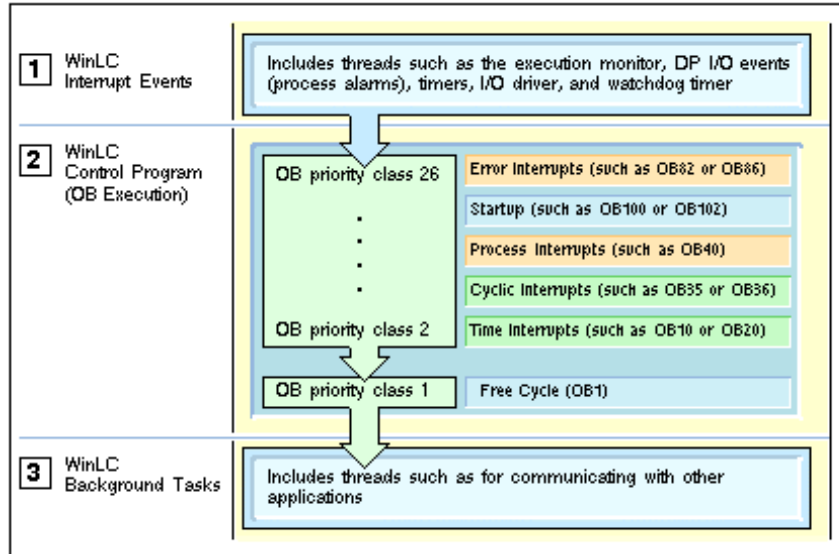
For more information about priorities, refer to the following topics:

- Adjusting the Priority
- Real-Time Subsystem Priorities

## Priorities among the WinLC Threads Can Cause Jitter

In addition to the thread that executes the OBs of the control program, WinLC RTX uses other threads, including some with higher priority than the OB Execution thread. Some examples of higher-priority threads are the execution monitor, the start event for an OB, the watchdog events, the timers, the PROFIBUS-DP driver, and the events for the DP I/O. Any of these higher-priority threads can induce jitter in the execution of the control program.

The relative priorities (priority classes) of the OBs in the control program itself can also cause jitter. For example, an error OB delays or interrupts the execution of all lower-priority OBs.

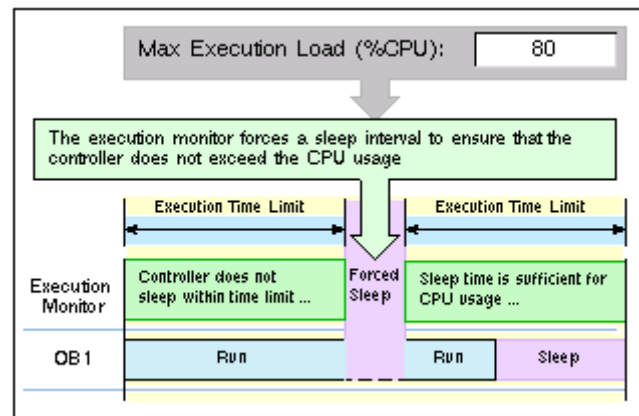


- 1** The threads of the interrupt events have a higher priority than the thread for execution the control program. These threads can cause jitter by interrupting the execution of the control program.
- 2** The OB Execution thread includes the different priority classes for the OBs of the control program. The interrupt OBs can cause jitter not only by interrupting the free cycle (OB1), but also by interrupting another interrupt OB with a lower priority class.
- 3** The background tasks for WinLC RTX includes the threads used for communicating with other applications, such as STEP 7. The OB Execution thread and the higher-priority threads affect the execution of these tasks.

## The Sleep Interval Forced by the Execution Monitor Can Cause Jitter

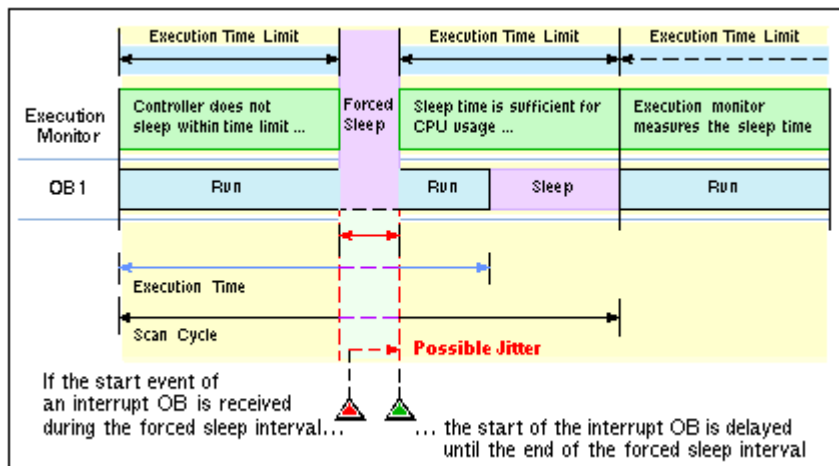
WinLC RTX must sleep (release the CPU) periodically in order for the other applications to run. The free cycle includes a sleep interval that follows the execution of OB1. However, this sleep interval can be interrupted by higher-priority OBs. Also, a scan cycle with a relatively long execution time could cause other applications to wait too long to access the CPU.

To ensure that the controller does not exceed a specified percentage of CPU usage, an execution monitor measures the sleep time within a fixed execution time limit. If the controller does not sleep for the specified amount of time within the execution time limit, the execution monitor forces a sleep interval.



Because the execution monitor runs in a higher priority class than any OB, the controller cannot interrupt the forced sleep interval. This could delay the start of an interrupt OB, such as OB35, until the end of the forced sleep interval. This delay in handling an interrupt OB results in jitter.

As a general rule for decreasing jitter, always design your control program to keep the execution time of the higher-priority OBs as short as possible.



WinLC RTX provides several options for managing the sleep time to avoid the uninterruptible forced sleep interval:

- You can increase the minimum sleep time parameter for managing the sleep time for the free cycle (priority class 1, or OB1).
- You can call SFC47 ("WAIT") to insert an extra, interruptible sleep interval into the control program for managing the sleep time for an application-defined priority class (priority classes 2 to 24).
- You can adjust the sleep-monitoring algorithm for the execution monitor for managing sleep time at a higher priority class than any OB.

## Adjusting the Priority of the Controller

If other RTSS applications are installed in addition to WinLC RTX, you can adjust the priority of the controller to improve performance. If not, you do not need to adjust the controller priority.

The priority of the controller determines how WinLC RTX runs in relation to other RTSS applications that are running on the computer.

Adjusting the priority of the controller can reduce or increase the amount of jitter in the scan time. The tuning panel allows you to change the priority for the controller application. When you use the tuning panel to change the priority, the controller automatically ensures that its interrupt activities, such as those which schedule interrupt OBs, are also set to an appropriate priority.

**Note:** WinLC RTX does not control priorities in customer software, such as asynchronous threads in WinAC RTX Open Development Kit (ODK) software, or other applications in the same environment.

While a PC-based controller must maintain the essential features of a SIMATIC S7 PLC, the PC-based controller must also allow the other applications to run on the computer. The operating system of the computer uses a concept of execution threads (or tasks) to run or execute the applications. Each application has one or more threads, and each thread has a priority. The operating system executes the threads with the highest priority first and executes a lower-priority thread only when all of the higher priority threads are suspended (for example, to wait for some other activity to complete or to “sleep” for a specified time). Threads with higher priorities interrupt and suspend the operations of other threads that have lower priorities. After the higher-priority thread finishes, the lower-priority thread resumes its operation.

To change the priority, follow these steps:

1. Use the Priority slider to choose a priority based on the priority levels for your operating system. The new priority is displayed as you move the slider.
2. Click Set to set the priority to the new value.

### Real-Time Subsystem Priorities

WinLC RTX provides real-time priorities for the most demanding control projects that are absolutely time-critical. Because WinLC RTX competes only with other RTSS applications, the controller provides the most deterministic behavior, with a possibility for reducing jitter in the scan cycle to less than 500 microseconds.

Because the controller runs with an RTSS priority above the Windows priorities, the sleep time for the control program determines the amount of time for other Windows activities and applications. You should provide sleep time that allows other application to run. Use the tuning panel to monitor the variation in scan times that occurs as the controller executes your control program.

Although the RTSS environment allows priorities from 1 to 127, WinLC RTX only runs up to priority 62. Another RTSS application thread could have a higher or lower priority than WinLC RTX.

The controller application installs with a default RTX priority of 50, which typically delivers satisfactory performance. If the controller competes with other RTSS applications for the computer resources, set the priority for the controller application to run either above or below the priority of the other RTSS applications.

## Managing the Sleep Time

### Sleep Management Techniques

During a sleep interval, the controller allows other applications to use the resources of the computer. By managing the sleep time, you can tune the performance of the controller in order to allow all applications on the computer to run with acceptable performance. You can use a variety of techniques for managing the sleep intervals for the controller:

- Adjusting the minimum sleep time parameter. The minimum sleep time determines the amount of sleep time that is added during the execution of the free cycle (OB1). This sleep time affects only OB priority class 1.
- Calling SFC47 from your control program. SFC47 inserts a sleep interval into the execution of your control program. This sleep time affects OB priority classes 2 to 24.
- Adjusting the execution monitor. The execution monitor uses a sleep-monitoring algorithm (based on the execution time limit and the maximum execution load parameters) to force a sleep interval. The execution monitor runs asynchronously to the scan cycle. This sleep time affects all OB priority classes.

#### Contents of this topic:

- Managing the Sleep Time of the Controller
- Tuning Strategy
- Sample Interaction of the Execution Monitor and the Minimum Sleep Time

### Managing the Sleep Time of the Controller

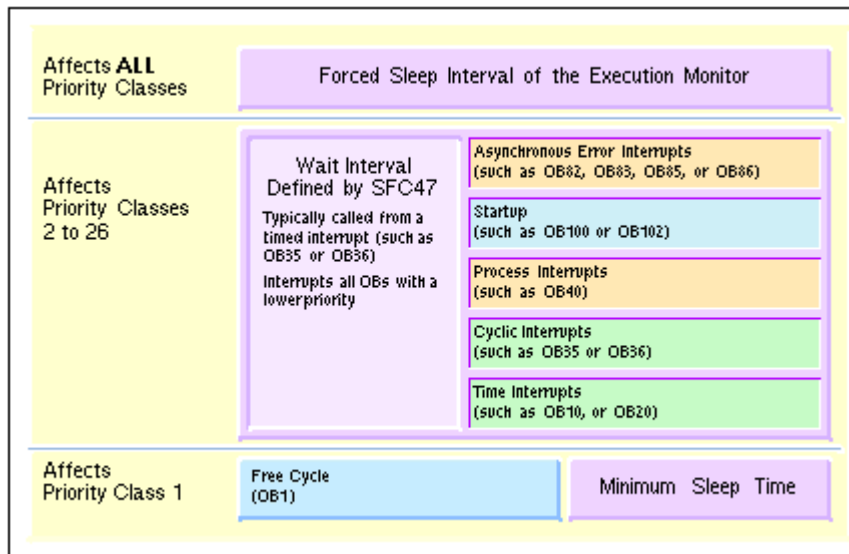
Because the controller shares the resources of your computer with other applications, you must ensure that the controller sleeps for a sufficient interval to allow the other applications to run.

#### Notice

The most effective method for granting time to other applications is to set the minimum sleep time parameter to the largest value that your control application allows. The other methods for managing the sleep time provide sufficient sleep time for the other applications to run, but may degrade the performance of the controller.

The controller provides the following techniques for managing the sleep time:

- The controller provides an execution monitor that enforces the maximum execution load on the resources of the computer. The execution monitor measures the amount of sleep time taken by the controller within an execution time limit, which is independent from the execution time of the scan cycle. If necessary, the execution monitor forces a sleep interval to achieve the specified execution load. This forced sleep interval suspends the execution of any OB and can also delay the start of an interrupt OB.
- The controller provides a minimum sleep time parameter that adds sleep time for the free cycle. This sleep interval occurs after the execution of OB1. The minimum sleep time affects only priority class 1. An OB in a higher priority class can interrupt this sleep interval. The controller does not adjust the minimum sleep time to compensate for the execution time of interrupt OB. However, any forced sleep interval (generated by the execution monitor) is subtracted from the sleep interval generated by the minimum sleep time.
- The controller supports SFC47 ("WAIT"), which inserts a specified sleep interval for the priority class of the OB that calls SFC47. This sleep interval the OBs at the same or lower priority class as the OB that calls SFC47, but an OB in a higher priority class can interrupt this sleep interval. You can use SFC47 to create sleep time that can be interrupted so that the controller can avoid jitter when handling any interrupts that are critical for the application.



## Tuning Strategy

As you test the performance of the controller during the development phase of your project, consider the following strategy for adjusting the sleep time:

1. Set the minimum sleep time parameter to 0 and run the control program. This allows you to determine whether there is unacceptable jitter in the scan cycle.
2. To reduce any unacceptable jitter, first use the tuning panel to increase the minimum sleep time and observe the effect on cycle time and CPU usage.
3. If the amount of jitter is still unacceptable, review the sections of the control program that are being affected by the jitter. If possible, have your control program call SFC47 to add sleep time.
4. To further reduce any jitter, increase the execution time limit to the maximum possible execution time for your control program.



If the sleep management techniques do not provide adequate improvement in reducing jitter, consider increasing the priority for the controller. (The priority of the controller is not the same as the priority class of an OB.)

### **Sample Interaction of the Execution Monitor and the Minimum Sleep Time**

To help explain the tools for managing the sleep time of the controller, the following example shows how the execution monitor and the minimum sleep time can interact:

- The first sample shows the sleep time that would be generated by the execution monitor alone, with no minimum sleep time added to the free cycle.
- The second sample shows how the execution of the free cycle is affected by adding a minimum sleep time to the scan cycle.

The following example describes the execution of a control program that uses OB1 to start a 1-second timer, and then check the timer after an elapsed time of 1 second (1000 ms). The controller has been configured with the following parameters:

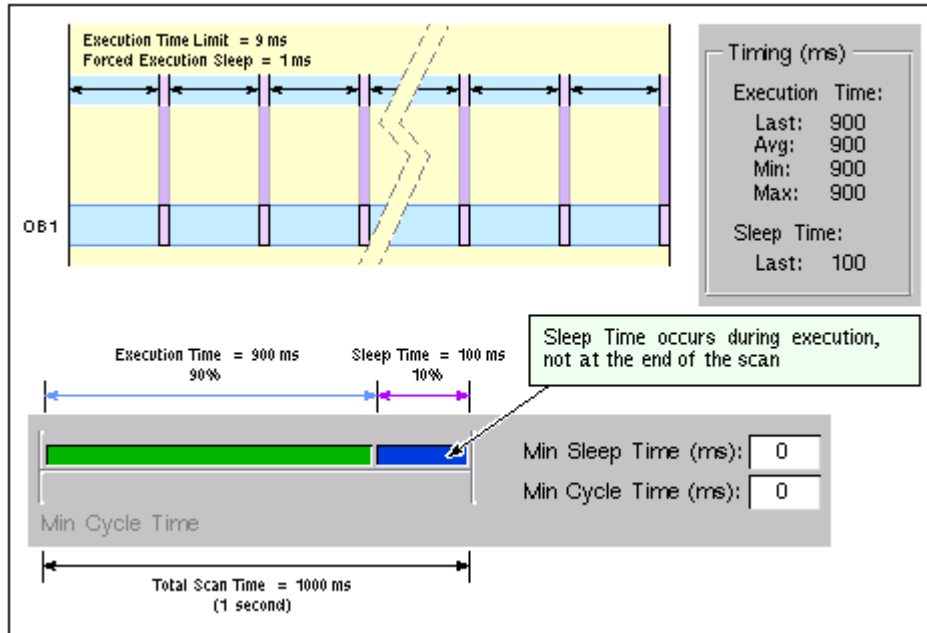
<b>Parameter</b>	<b>Value</b>
Execution Time	OB1 takes 900 ms to execute.
Minimum Sleep Time	0 ms
Minimum Cycle Time	0 ms
Maximum Execution Load	90% (uses the default wake/sleep algorithm)
Execution Time Limit	9 ms (uses the default value)
Forced Execution Sleep	1 ms (uses the default value)

### Sleep Time Generated by the Execution Monitor (Minimum Scan Time = 0)

If you set the minimum sleep time parameter to 0, the controller uses the execution monitor alone to provide sleep time. The figure shows the operation of the execution monitor, using the default values.

The execution monitor suspends the execution of OB1 for 1 ms after every 9 ms of execution by default in order to enforce a limit of 90% execution load (CPU usage). For every 1 second of elapsed clock time, the default execution time for OB1 is 900 ms, with forced sleep intervals totaling 100 ms.

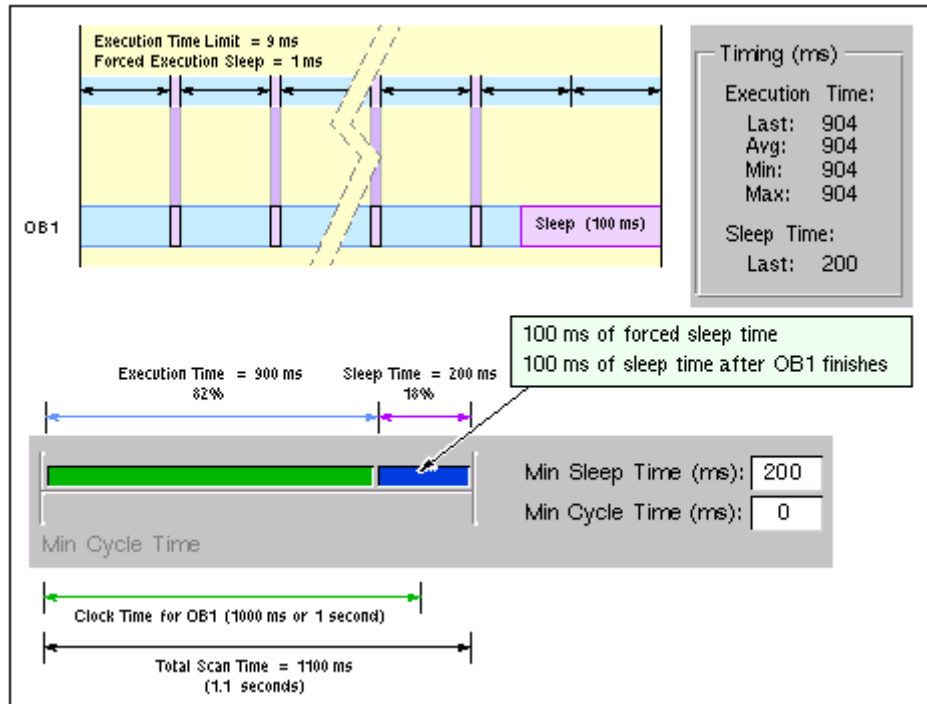
Notice that the sleep time occurs at intervals within the execution of OB1.



### Adding a Minimum Sleep Time for the Free Cycle

This figure shows how changing the minimum sleep time from 0 to 200 affects the execution of OB1. The execution monitor still forces 100 ms of sleep time to occur during the execution of OB1. With the minimum scan time parameter set to 200 ms, the controller then sleeps for only another 100 ms, for a combined total of 200 ms, before starting the next free cycle.

The total scan time increases to approximately 1100 ms: the execution time (900 ms) for OB1, the forced sleep time (100 ms), and the sleep time at the end of the scan cycle (100 ms).



## Adjusting the Minimum Sleep Time and Cycle Time

The tuning panel provides the following parameters that allow you to manage the sleep time of the free cycle (priority class 1, or OB1):

- Minimum Cycle Time (in milliseconds) sets the minimum number of milliseconds from the start of one free cycle to the start of the next free cycle. This value must be greater than the execution time before it causes any sleep time to occur within the free cycle. You use STEP 7 to configure the minimum cycle time for the controller when you create the system (hardware) configuration. You can use the tuning panel to adjust the minimum cycle time, but any changes are discarded when you shut down the controller. However, you must use STEP 7 to make the changes permanent.
- Minimum Sleep Time (in milliseconds) determines how much sleep time is available during the free cycle (OB1) for allowing higher priority OBs and other applications to use the resources of the computer. The controller automatically saves any changes to the minimum sleep time made with the tuning panel. You do not use STEP 7 to make any change to the minimum sleep time permanent.

### Contents of this topic:

- Parameters That Affect the Sleep Time for the Free Cycle
- Hints

The execution of the free cycle is affected by both the minimum sleep time and the minimum cycle time values.

- The minimum cycle time by itself results in a fixed scan cycle time with a variable sleep time (if the minimum cycle time is large enough to accommodate the execution time plus the sleep time).
- The minimum sleep time by itself results in a fixed sleep time with a variable scan time, depending on the length of the execution time.

The minimum sleep time value guarantees that a configured amount of sleep time occurs within each free cycle, even if the value for the minimum cycle time is too small. The controller releases control of the CPU for a sleep interval. This sleep interval is the larger of either the configured minimum sleep time value or a sleep time that is computed from the minimum cycle time parameter.



### Warning

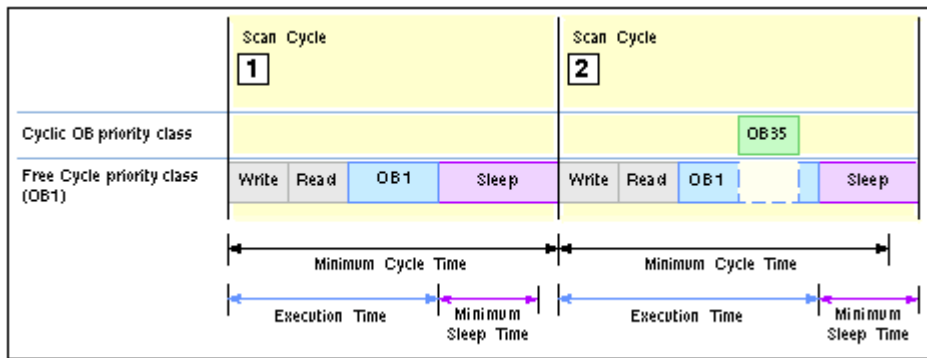
If you set the minimum scan time to a value larger than the watchdog time, WinLC RTX goes to STOP mode during the first scan at the end of the watchdog time interval.

Causing the controller to go to STOP mode unexpectedly can cause process equipment to function erratically and possibly cause damage to equipment or injury to personnel.

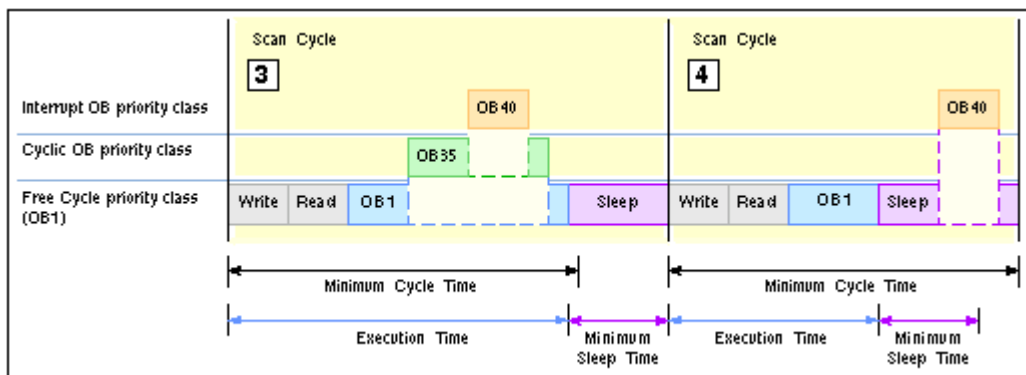
Do not set the minimum scan cycle time to be longer than the scan cycle monitoring time (the watchdog time) configured in the STEP 7 Hardware Configuration Editor.

## Parameters That Affect the Sleep Time for the Free Cycle

The following figures explain the interaction between the execution time, the minimum sleep time, and the minimum cycle time parameters.



- 1 For the first sample scan shown in the example above, the execution time plus minimum sleep time is less than the minimum cycle time. In this case, the controller increases the sleep time until the minimum cycle time is achieved.
- 2 For the second sample scan shown in the example above, the execution of OB35 increases the execution time, and the execution time plus the minimum sleep time is greater than the minimum cycle time. In this case, the controller waits the minimum sleep time before starting the next scan.



- 3 For the third sample scan shown in the example above, the controller executes both a cyclic interrupt (OB35) and an I/O interrupt (OB40). The execution time exceeds the minimum cycle time, and the controller waits the minimum sleep time before executing the next scan.
- 4 For the fourth sample scan shown in the example above, the controller executes OB40 during the sleep time after OB1 has finished. In this case, the controller waits until the minimum cycle time before starting the next scan.

Because the execution of OB40 does not reset the minimum sleep time counter, it is possible that the controller does not provide sufficient sleep time to allow other Windows applications to be processed. You must then use other methods for ensuring that the controller provides a sufficient amount of sleep time.

## **Hints**

You can use the following techniques to adjust controller performance using the minimum sleep time and minimum cycle time parameters:

- Use the tuning panel to test values for the minimum cycle time. After you have determined the optimum value for the minimum cycle time, use STEP 7 to update and download the system configuration for the controller.

Changing the operating mode from STOP to RUN deletes any value entered by the tuning panel and resets the minimum cycle time to the value stored in the system configuration.

- To ensure that the controller executes the scan cycle on a fixed schedule, use the minimum cycle time parameter.
- To ensure that there is always a sleep interval even if the execution time changes, set the minimum cycle time to 0 (the default value) and modify the minimum sleep time as needed. Modifying the minimum sleep time is especially useful during the development of your control program.

When you are tuning the operation of the controller, be aware that the following situations can increase the time required to complete the scan cycle:

- The controller executes other OBs (such as OB20 and OB35) with higher priorities than OB1.
- You use STEP 7 to monitor and debug the control program.
- You use a variable table (VAT) with STEP 7 to display the status of the control program.
- An application with a higher priority is running on your computer.
- The controller interacts with an HMI interface, such as WinCC, or with the controls supplied by SIMATIC Computing.

## **Additional Methods for Managing the Sleep Time**

- Using SFC47 to add sleep time in the control program
- Adjusting the sleep-monitoring algorithm of the execution monitor

## Using SFC47 to Add Sleep Time in the Control Program

SFC47 (WAIT) inserts sleep time into the execution of the control program, allowing you to manage the sleep time for a control program by inserting the sleep time in a specific priority class. When you call SFC47 from your control program, the controller suspends the execution of the OB for a specified number of microseconds and sleeps. During this sleep period, the controller can interrupt this sleep period to execute an interrupt OB. Because an OB with a higher priority class can interrupt the sleep time, your control program to handle higher priority OBs with less chance of jitter.

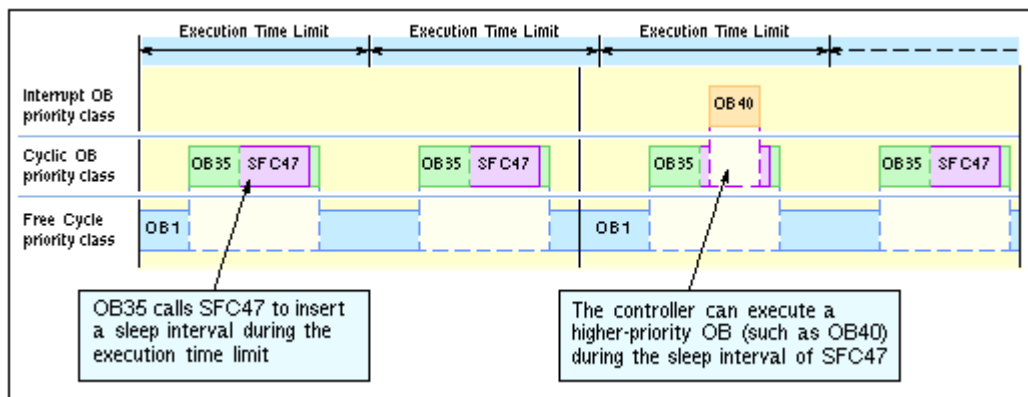
Typically, you call SFC47 from a cyclic OB (such as OB35) that starts within the execution time limit of the execution monitor.

For more information, refer to the example: Avoiding Jitter in the Start Time of an OB

To provide greater control over when the sleep time occurs, you can use SFC47 to insert sleep time into your control program. Calling SFC47 in the control program also allows you to define which OBs are affected by setting the priority class of the OB that calls SFC47.

As shown in the following figure, you can use SFC47 to insert a sleep interval that can satisfy the execution monitor and still allow the controller to handle an interrupt OB. By using a cyclic OB (such as OB35) to call SFC47, you can ensure that the sleep interval occurs within the execution time limit of the execution monitor.

The sleep time parameter is rounded up to the nearest multiple of the HAL timer period defined in the RTX properties dialog. For example, if the HAL timer period is 500 microseconds (the default), and the sleep time parameter is 1200 microseconds, WinLC RTX rounds up the sleep time to 1500 microseconds. To access the RTX Properties dialog, select the menu command **Start > Settings > Control Panel** and double-click RTX Properties. The HAL timer period is specified under the Settings tab.



### Additional Methods for Managing the Sleep Time

- Adjusting the Minimum Sleep Time and Cycle Time
- Adjusting the Sleep-Monitoring Algorithm of the Execution Monitor

## Adjusting the Sleep-Monitoring Algorithm of the Execution Monitor

The execution monitor uses a sleep-monitoring algorithm to ensure that the controller does not exceed a configurable maximum execution load for the CPU usage within a configurable execution time limit. If there is sufficient sleep time within the execution time limit, the execution monitor does not affect the execution of the program. Otherwise, the execution monitor forces a sleep interval. The default execution load is 90%, and the default execution time limit is 9 ms. For the default settings, the execution monitor determines that the controller must sleep for at least 1 ms in order to achieve the execution load within the execution time limit.

The execution monitor runs asynchronous to the scan cycle and measures the amount of sleep time that occurs within the execution time limit and enforces a minimum sleep interval.

- If the scan cycle (execution time plus sleep time) is shorter than the execution time limit and the sleep time is greater than or equal to the forced sleep value: The execution monitor does not force a sleep interval.
- If the scan cycle is longer than the execution time limit: The execution monitor forces the controller to sleep for the required amount of time. Because the execution monitor runs in a higher priority class than any OB, the controller cannot interrupt the forced sleep interval. This could delay the start of an interrupt OB, such as OB35 or OB40.

Use the tuning panel to configure the parameters for the sleep-monitoring algorithm of the execution monitor.

For more information, see the example: [Avoiding Jitter in the Start Time of an OB](#)

### Contents of this topic:

- Operation of the Execution Monitor
- Parameters of the Sleep-monitoring Algorithm
- Configuring the Parameters of the Sleep-Monitoring Algorithm
- Situations That Cause the Execution Monitor to Force a Sleep Interval

In addition to the sleep time that is added to the scan cycle (based on the minimum sleep time and minimum cycle time parameters), an execution monitor uses a sleep-monitoring algorithm that is based on a maximum execution load (percentage of CPU usage). For the default execution load (90% CPU usage), the execution monitor measures the length of time that the controller sleeps during the execution time limit of 9 ms and ensures that the controller sleeps for at least 1 ms.

By measuring the sleep time, the execution monitor ensures that the controller allows the other applications to access the computer resources for the specified execution load. The execution monitor also provides the safety net in cases where there are programming errors (for example, an infinite loop in OB100) that are not handled with other mechanisms.

The difference between the forced sleep intervals and the minimum sleep time is that the controller can interrupt the minimum sleep time to handle interrupts (such as OB35 or OB40), but cannot interrupt the forced sleep intervals.

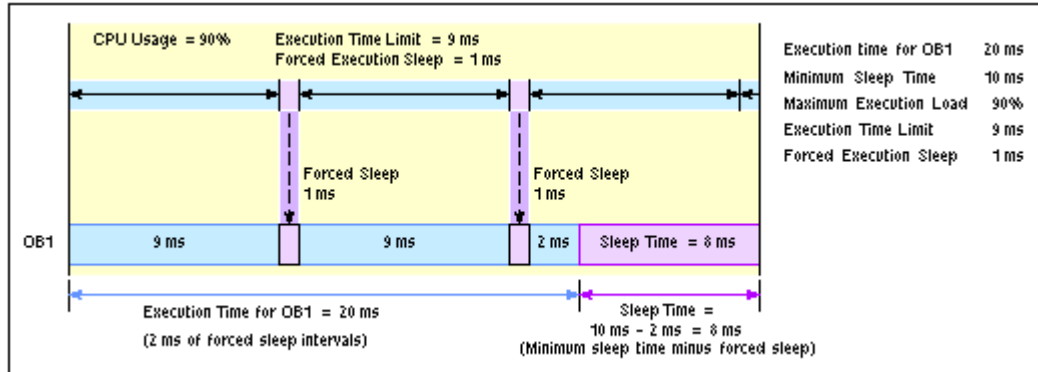
When the execution monitor forces a sleep interval, the following actions occur:

- The controller immediately suspends the execution of the OB for the forced sleep interval. By forcing a sleep interval, the execution monitor increases the actual time between starting and finishing the OB being executed.
- The controller cannot respond to the start event for any interrupt OB until the end of the forced sleep interval. Delaying the start of the OB (for example, OB35 or OB40) until the end of the forced sleep interval creates jitter or latency in the actual start time for the OB.



## Operation of the Execution Monitor

The following figure shows how the execution monitor might affect a control program. Because the execution time for OB1 in this example is greater than the execution time limit, the execution monitor inserts a 1-ms sleep interval after the first two 9-ms intervals. However, the execution monitor does not insert a forced sleep interval for the third 9-ms interval because the controller sleeps longer than the required sleep interval.



## Parameters of the Sleep-Monitoring Algorithm

The sleep-monitoring algorithm of the execution monitor uses the following parameters:

Parameter	Description
Execution Time Limit	<p>This value defines the interval (in microseconds) that the execution monitor uses to measure the execution load (CPU usage) caused by the execution of the control program.</p> <p>To determine the CPU load caused by the execution of the control program, the execution monitor measures the time that the controller sleeps during this interval. If the controller does not sleep time a sufficient amount of time (indicating that the CPU load exceeds the maximum execution load), the execution monitor forces the controller to sleep for the remainder of the required sleep time.</p> <p>The default value is 9000 microseconds (or 9 ms).</p>
Maximum Execution Load	<p>This value defines the maximum percentage of CPU usage that is allowed for the controller during each execution time limit.</p> <p>The default value is 90%.</p>
Forced Execution Sleep	<p>This read-only field shows how much sleep time (in microseconds) is required during the execution time limit to satisfy the requirement for the maximum execution load.</p> <p>The forced execution sleep time is a calculated number based on the execution time limit and the maximum execution load. The execution monitor corrects this value as required, depending on the capability of the operating system configuration to have timers operate at the specified intervals. For example, if the HAL timer period (in the RTX properties dialog) is set to 500 microseconds, you cannot have a forced execution sleep time of 1200 microseconds. It would be rounded up to 1500 microseconds. To access the RTX Properties dialog, select the menu command <b>Start &gt; Settings &gt; Control Panel</b> and double-click RTX Properties. The HAL timer period is specified under the Settings tab.</p> <p>The default value is 1000 microseconds (or 1 ms).</p>

The execution monitor uses the execution time limit and the maximum execution load to calculate the forced execution sleep. For example, the execution monitor uses the 90% usage rate and the 9-ms execution time limit to calculate a 1-ms sleep interval.

During the interval defined by the execution time limit, the execution monitor measures the actual amount of time that no OBs are executing (the sleep time).

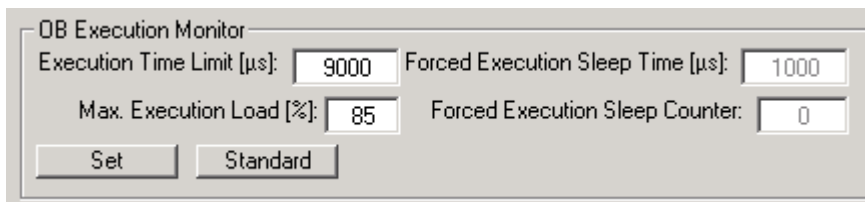
- If the controller sleeps **longer** than the sleep interval (forced execution sleep time), then the execution monitor restarts another execution time limit interval and does not affect the control program.
- If the controller sleeps **less** than the sleep interval (forced execution sleep time), then the execution monitor blocks the execution of any OBs for the **remainder** of the sleep interval.

Any control program sleep time imposed because of the sleep-monitoring algorithm is subtracted from the sleep time configured for the end of the free cycle using the minimum sleep time parameters.

The default value for the “Execution Time Limit” interval is 9000 microseconds (or 9 milliseconds) and the default value for the “Forced Execution Sleep” interval is 1000 microseconds (or 1 millisecond). This ratio ensures that the control program execution cannot use more than 90% of the CPU time in any of the worst case situations described above.

### Configuring the Parameters of the Sleep-Monitoring Algorithm

The parameters of the sleep-monitoring algorithm of the execution monitor are configurable from the tuning panel:



OB Execution Monitor

Execution Time Limit [μs]:  Forced Execution Sleep Time [μs]:

Max. Execution Load [%]:  Forced Execution Sleep Counter:

To change the sleep-monitoring parameters, follow these steps:

1. Enter values in the Execution Time Limit and the Max. Execution Load fields. You can change one of the fields or both.
2. Click Set to set the parameters.

To restore the default sleep-monitoring parameters, follow these steps:

1. Click Standard to display the default parameters.
2. Click Set to set the default parameters.

Changes to the sleep-monitoring parameter take effect when the controller is in RUN/RUN-P mode.

## Situations That Cause the Execution Monitor to Force a Sleep Interval

The controller must relinquish control of the CPU long enough to satisfy the maximum execution load. Typically, the sleep time that is added to the end of the scan cycle allows sufficient time for the operating system to process the other Windows applications. However, some situations may require that the execution monitor force a sleep interval.

Condition	Description
Execution time for the startup OB (OB100 or OB102) exceeds 50 ms	<p>During startup, the controller turns the watchdog timer off and cannot handle a program error, such as a loop in the logic of the OB or an excessively long initialization routine.</p> <p>Because the scan cycle does not provide any sleep time for the startup OB (such as OB100), the forced sleep interval from the execution monitor keeps your computer from locking up.</p>
Execution time for the control program) exceeds 50 ms	<p>Whenever the operating system has to wait more than 50 ms to process the other Windows applications, the performance of those applications can be noticeably affected. This can be a problem for an OB1 with a long execution time, especially if other OBs (such as OB35 or OB40) extend the execution of OB1. Because the sleep time is added at the end of the scan cycle, the sleep intervals are then spaced too far apart for the other Windows applications to perform naturally.</p> <p>The execution monitor ensures that the controller provides adequate sleep time within the execution time limit.</p> <p>You can also use SFC47 “WAIT” to insert sleep time into the execution of the control program. See SFC47: Adding Sleep Time in the Control Program</p>
Execution time for the control program exceeds the execution time limit	<p>The sleep time for the free cycle occurs after OB1 finishes. If the execution time is longer than the execution time limit, the execution monitor forces a sleep interval because the controller did not sleep for the required amount within the execution time limit.</p>
Minimum sleep time is insufficient for the maximum execution load	<p>Even when the scan cycle is less than the execution time, the minimum sleep time may not provide enough sleep time. In this case, the controller would exceed the maximum execution load. The execution monitor forces an additional sleep interval to ensure that the operating system can run the other applications.</p>
Interrupt OBs reduce the sleep time	<p>To process an interrupt OB (such as OB35, OB40, or OB85), the controller can interrupt the sleep time for the scan cycle. This reduces the time that the controller actually sleeps and can cause the controller to exceed the maximum execution load, which affects the performance of the other Windows applications.</p> <p>By forcing a sleep interval, the execution monitor ensures that the other Windows application can be processed.</p>

### Additional Methods for Managing Sleep Time

- Adjusting the minimum sleep time and minimum cycle time parameters
- Inserting sleep time into the control program (SFC47 “WAIT”)

### Example: Avoiding Jitter in the Start Time of an OB

The following example discusses two possible solutions for a program that experiences jitter in the start of a cyclic interrupt (OB32 to OB36).

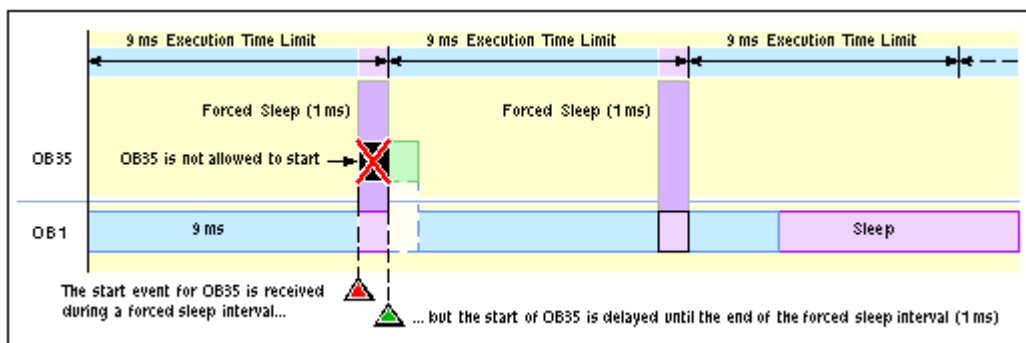
- Inserting a sleep interval into the execution of your control program. For this solution, you call SFC47 (“WAIT”) and specify the length of time to sleep. The controller can interrupt this sleep interval to process other OBs.
- Changing the sleep-monitoring algorithm of the execution monitor. For this solution, you use the tuning panel to change the execution time limit.

#### Scenario

The following example describes the execution of a control program that consists of OB1 and OB35. OB1 takes 20 ms to execute, and OB35 starts every 100 ms and takes 1 ms to execute. The controller has been configured with the following parameters:

Parameter	Value
Execution Time for the Control Program	OB1: 20 ms OB35: 1 ms
Minimum Sleep Time	10 ms (uses the default value)
Minimum Cycle Time	0 ms (uses the default value)
Maximum Execution Load	90% (uses the default wake/sleep algorithm)
Execution Time Limit	9 ms (uses the default value)
Forced Execution Sleep	1 ms (uses the default value)

The sleep time (10 ms) is added to the scan cycle after OB1 has finished. However, because the execution time for OB1 (20 ms) exceeds the execution time limit (9 ms), the controller exceeds the configured maximum execution load (90%) by not sleeping during the execution time limit. Therefore, the sleep-monitoring algorithm forces the controller to sleep for 1 ms after every 9 ms that OB1 executes. As shown in the following figure, this forced sleep can cause a variance or jitter of up to 1 ms between time that the start event and the time that the controller starts to execute OB35. This jitter happens because all controller operations are suspended during a forced sleep interval. Similarly, OB35 could be suspended for 1 millisecond if the end of the execution time limit interval occurs while OB35 is executing.



For many applications, a 1-ms jitter might be acceptable. However, you have several options for removing this jitter:

- You can modify the control program to call SFC47 and insert sleep time that can be interrupted by OB35.
- You can adjust the parameters for the sleep-monitoring algorithm to avoid the jitter caused by the execution monitor.

### Solution 1: Insert a sleep interval into the execution of your control program

You could avoid the forced sleep interval by using SFC47 to add a periodic sleep interval that occurs within the execution time limit (for this example, 9 ms). This sleep interval not only ensures that the sleep-monitoring algorithm does not force the controller to sleep, but also allows the controller to suspend this sleep interval and execute any OB that has a higher priority than the OB that called SFC47.

For this example, you can use SFC47 to remove the jitter in OB35:

- By ensuring that SFC47 executes at a specified time. The control program calls SFC47 from an OB (such as OB36) that has a priority greater than OB1.
- By ensuring that OB35 executes as scheduled. You configure OB36 to have a lower priority than OB35.
- By ensuring a sufficient sleep interval during the execution time limit. You configure SFC47 to wait for 3 ms, which ensures a sleep interval of at least 2 ms.

To maintain a 50% ratio for CPU usage (20 ms execution time for OB1 with a 10 ms minimum sleep time), configure OB36 to run every 6 ms (so that OB1 executes for 6 ms, then sleeps for 3 ms). You can then change the minimum sleep time to 0 ms, unless you want to decrease the ratio for CPU usage.

To create an OB36 that calls SFC47 to create a 3 ms sleep interval:

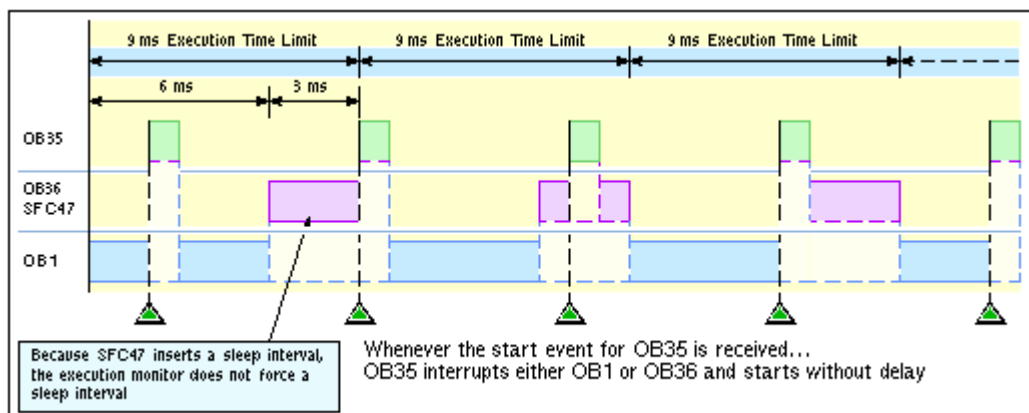
1. Using the STEP 7 Program Editor: Create an OB36 for your control program, and enter the following program:

```
CALL "WAIT" // SFC47 wait function
WT: 3000 // 3000 microseconds or 3 milliseconds
```

2. Using the STEP 7 Hardware Configuration tool, configure the priority level and execution time for OB36:

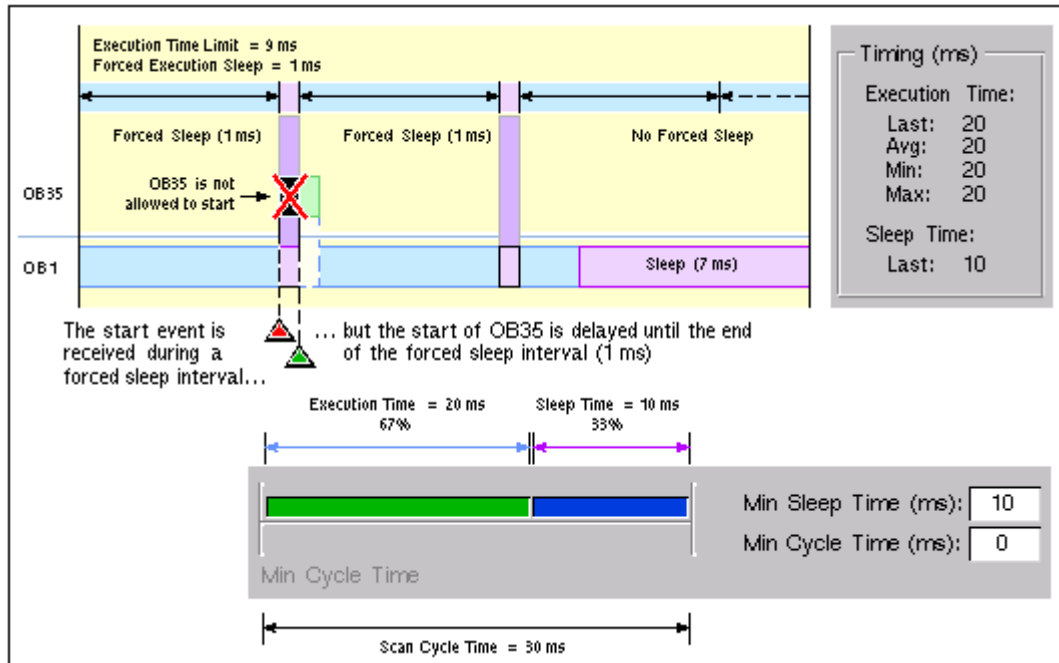
- Open the WinLC Properties dialog box and select the Cyclic Interrupt tab.
- Set the priority for OB36 to 2 (or any other priority lower than the priority for OB35).
- Configure OB36 to execute every 6 ms (by entering 6 in the Execution field).

The following figure shows how SFC47 affects the execution of the control program. Because OB36 ensures that the controller sleeps at least 1 ms within the 90% wake interval, the execution monitor does not insert a forced sleep interval. Therefore, OB35 executes without any delay or jitter.



### Solution 2: Change the sleep-monitoring algorithm to eliminate the forced sleep interval

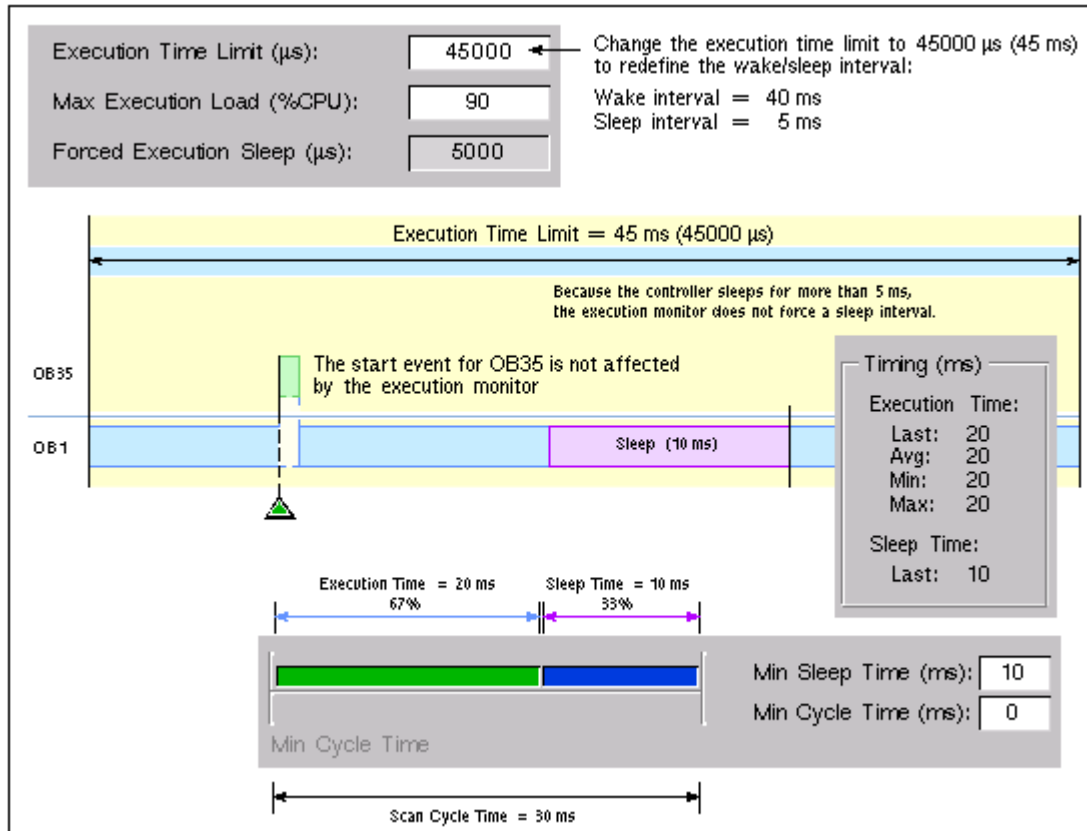
The following figure shows the jitter in the start time of OB35 and also shows the values displayed by the tuning panel. Notice that the tuning panel shows only the information about OB1. The tuning panel does not display information about OB35. For this example, the execution time for OB1 is 20 ms. With the minimum sleep time of 10 ms, the total free cycle time is 30 ms. OB35 and other interrupt OBs can make the total scan time more than this, depending on how fast the interrupt OBs execute.



By changing the parameters of the sleep-monitoring algorithm, you can configure the execution monitor to use the minimum sleep time in the free cycle. For example: if the longest total scan time for this example is less than 45 ms, change the execution time limit to 45000 microseconds (45 ms):

1. Open the tuning panel.
2. Change the execution time limit to 45000 (microseconds). For this example, do not change the value for the maximum execution load.
3. Apply the new value.

The following figure shows the effect of the changed execution time limit.







# Reference Information

## Technical Data

### Order Number

WinLC RTX is a component of the WinAC RTX package: 6ES7 671-0RC03-0YA0.

### Features

WinLC RTX provides the following features:

- Accumulators: 4 (ACCU 1 to ACCU 4)
- Communications: PROFIBUS-DP master device
- Supports an isochronous mode, which allows WinLC RTX to operate in constant bus cycle mode to help eliminate jitter
- Work memory and Load memory: limited by the amount of non-paging memory supported by the computer (PC) and the operating system, which is less than the physical memory (RAM) in the computer
- Distributed I/O only, no local I/O:

You can configure the size of the process-image I/O areas (I and Q memory areas) to be either 512 bytes or 1024 bytes. These memory areas can be accessed directly by the instructions in the user program.

Using Load (L) and Transfer (T) instructions (for statement list) or the Assign Value (MOVE) instruction (for ladder logic) to the peripheral I/O (PI and PQ memory areas), you can access up to 16384 bytes of inputs and 16384 bytes of outputs.

WinLC RTX communicates with the distributed I/O as a PROFIBUS-DP master device. As a master device, WinLC RTX can communicate with up to 125 slave devices (either S7-DP slaves or other DP slaves).

## Technical Specifications

The following table lists the technical information about WinLC RTX.

WinLC RTX	Description
Work memory Load memory	Limited by the amount of non-paging memory configured in Windows. The following factors affect this amount: <ul style="list-style-type: none"> <li>• Amount of physical memory (RAM) installed in the computer</li> <li>• Other Windows drivers and RTSS programs being executed at the same time as WinLC RTX</li> <li>• Virtual memory configuration in Windows (accessed by the Performance Options button under the Advanced tab of System Properties in the Control Panel)</li> </ul>
Accumulators	4 (ACCU 1 to ACCU 4)
Local data	16 Kbytes per priority class (determined by HW Config, Memory tab)
Clock	Real-time system clock, based on the hardware clock of the computer
I/O (digital and analog)	16384 bytes total I/O, addressable over a range of 0 to 16383  You can freely assign the I/O between digital and analog inputs and outputs. For example, you can assign all of 16384 bytes to the inputs or all of the 16384 bytes to the outputs. However, the total amount allocated to all of the inputs and outputs cannot exceed the maximum of 16384 bytes.
Process image I/O (user configurable)	
Inputs	512 bytes (default) or configurable from 0 bytes to 8192 bytes I 0.0 to I 8191.7
Outputs	512 bytes (default) or configurable from 0 bytes to 8192 bytes Q 0.0 to Q 8191.7
Memory bytes	2 Kbytes
Retentive range (configurable)	Up to 2048 bytes (MB0 to MB2047)
Preset as retentive	16 bytes (MB0 to MB15)

WinLC RTX	Description
<p>Counters</p> <p>Retentive range (configurable)</p> <p>Preset as retentive</p>	<p>512</p> <p>C0 to C511</p> <p>8 (C0 to C7)</p>
<p>Timers</p> <p>Retentive range (configurable)</p> <p>Preset as retentive</p>	<p>512</p> <p>T0 to T511</p> <p>None</p>
<p>Clock memory</p> <p>Bits of the clock memory byte toggle at specific times and are accessible from the control program.</p>	<p>8 bits of clock memory (1 byte)</p> <p>8 frequencies within 1 byte of M memory: address is configurable</p>
<p>Address ranges for logic blocks:</p> <p>FB</p> <p>FC</p> <p>DB</p>	<p>FB0 to FB65535</p> <p>FC0 to FC65535</p> <p>DB1 to DB65535 (DB0 is reserved)</p>
<p>Number of connections</p>	<p>64</p>
<p>Nesting depth</p>	<p>24 per sequence layer (OB priority class)</p> <p>At any one time, a priority class can have one OB and up to two synchronous OBs (OB121 and OB122). The total nesting depth of 24 applies for all of the OBs being executed in the priority class.</p>
<p>Total number of blocks that can be downloaded to WinLC RTX</p>	<p>No fixed limit: The number of blocks that can be downloaded is based on the memory requirements and the number of blocks in the program</p>

**Caution**

Downloading a control program that is too large for the memory of the computer can lock up the computer or cause the operation of WinLC RTX to become unstable. Non-responsive or non-deterministic operations can cause damage to equipment and/or injury to personnel.

Although STEP 7 and WinLC RTX do not limit the number of blocks or the size of the control program, your computer does have a limit, based on the available disk space and RAM memory. The limit for the size of the control program and number of blocks for your computer can only be determined by testing a configured system against the requirements of your control application.

The following table lists specific information about the PROFIBUS-DP interface, as supported by WinLC RTX.

<b>PROFIBUS-DP interface</b>	<b>Description</b>
DP address area	16384 bytes (inputs) and 16384 bytes (outputs)
Number of DP slaves supported for each submodule CP card	Dependent on the CP card <ul style="list-style-type: none"> <li>• CP 5613: 125</li> </ul>
Baud rate	Up to 12 Mbaud  (9.6 KBPS, 19.2 KBPS, 45.45 (31.25) KBaud, 93.75 KBPS, 187.5 KBPS, 500 KBPS, 1.5 MBPS, 3 MBPS, 6 MBPS, 12 MBPS)
Baud rate search (as a DP slave)	Not applicable
Transfer memory (as a DP slave)	Not applicable
Maximum distance	Dependent on the baud rate

## Execution Times

### Execution Times of Instructions

The execution times listed in the two tables below (execution times for math operations and execution times for instructions) reflect the average execution times for STEP 7 programs running on WinLC RTX. Actual execution times may vary, depending on your system.

**Note:** The execution times were measured on a SINUMERIK PCU50 1.2 GHz computer. Tuning settings: 9000 microseconds execution time limit; 90% maximum execution load; 1000 microseconds forced execution sleep.

Math Operation	Integer	Real	Double Word
Addition ( + )	0.09 $\mu$ s	0.09 $\mu$ s	0.09 $\mu$ s
Subtraction ( - )	0.09 $\mu$ s	0.09 $\mu$ s	0.09 $\mu$ s
Multiplication ( * )	0.09 $\mu$ s	0.09 $\mu$ s	0.12 $\mu$ s
Division ( / )	0.12 $\mu$ s	0.12 $\mu$ s	0.12 $\mu$ s

Instructions			Direct Addressing	Indirect Addressing
Boolean Operations: A, AN, O, ON, X, XN	Memory areas:	I	0.06 $\mu$ s	0.07 $\mu$ s
		M	0.05 $\mu$ s	0.08 $\mu$ s
		L	0.67 $\mu$ s	0.07 $\mu$ s
		DB	0.07 $\mu$ s	0.07 $\mu$ s
		T	4.5 $\mu$ s	4.6 $\mu$ s
		C	0.05 $\mu$ s	0.09 $\mu$ s
Boolean operations (on the accumulator): ==I, <>I, >I, <I, >=I, <=I			0.05 $\mu$ s	
Operations on the bits of the status word: A==0, A<>0, A>0, A<0, A>=0, A<=0			0.05 $\mu$ s	
Transitional contacts	Edge Positive	FP	0.11 $\mu$ s	
	Edge Negative	FN	0.12 $\mu$ s	

	Instructions		Direct Addressing	Indirect Addressing
Set/Reset operations (bit operands)	Set	S	0.08 $\mu$ s	0.07 $\mu$ s
	Reset	R	0.07 $\mu$ s	0.087 $\mu$ s
RLO Operations	Negate RLO	NOT	0.03 $\mu$ s	
	Set RLO	SET	0.03 $\mu$ s	
	Clear RLO	CLR	0.02 $\mu$ s	
	Save RLO	SAVE	0.03 $\mu$ s	
Operations on Timers	Pulse Timer	SP	4.6 $\mu$ s	4.7 $\mu$ s
	Reset timer	R	0.04 $\mu$ s	0.07 $\mu$ s
	Extended pulse timer	SE	4.7 $\mu$ s	4.65 $\mu$ s
	On-delay timer	SD	4.7 $\mu$ s	4.64 $\mu$ s
	Retentive on-delay timer	SS	4.7 $\mu$ s	4.65 $\mu$ s
	Off-delay timer	SF	4.7 $\mu$ s	4.70 $\mu$ s
Miscellaneous	Open DB	OPN	0.003 $\mu$ s	
	Load	L	0.003 $\mu$ s	
	Transfer	T	0.002 $\mu$ s	
	SFC126	SYNC_PI	N/A	
	SFC127	SYNC_PO	N/A	

## Execution Times of the DP Instructions

The table below lists the execution times for the SFCs used with the distributed I/O for WinLC RTX.

**Note:** The execution times were measured on a SINUMERIK PCU50 1.2 GHz computer. Tuning settings: 9000 microseconds execution time limit; 90% maximum execution load; 1000 microseconds forced execution sleep.

SFC	Name	Description	CP 5613
SFC11	DPSYNC_FR	Synchronize groups of DP slaves	1.44 $\mu$ s
SFC13	DPNRM_DG	Reads the diagnostic data of a DP slave DP configuration tested: one ET 200M slave with one 8-input/8-output module and one 16-output module	7.00 $\mu$ s
SFC14	DPRD_DAT	Reads the consistent data from a DP slave	2.27 $\mu$ s
SFC15	DPWR_DAT	Writes the consistent data to a DP slave	2.29 $\mu$ s
SFC26	UPDAT_PI	Updates the process-image input table DP configuration tested: one ET 200M slave with one 8-input/8-output module and one 16-output module	3.00 $\mu$ s
SFC27	UPDAT_PO	Updates the process-image output table	3.00 $\mu$ s

## Troubleshooting

### Additional Requirements for Venturcom RTX

The real-time extensions of Venturcom RTX provide the determinism and performance of a real-time operating system within the Windows 2000 or Windows XP environment. However, not all computer configurations (hardware and software) support the installation and operation of Venturcom RTX version 5.1.2.

When testing the operation of Venturcom RTX and WinLC RTX on your computer, check the following items:

- Venturcom RTX installs and runs. Make certain that you have administrator (ADMIN) privileges for the computer. Make certain that your computer meets the hardware and software requirements and supports the correct Hardware Abstraction Layer (HAL) types.
- Venturcom RTX allows a free interrupt for the CP card (varies for different manufacturers). If free interrupt is not available, the CP card operates only in Polled mode and not in Interrupt mode.
- Venturcom RTX is able to operate without interference from hardware components installed in the computer. Some components (such as the video card) can cause problems that affect the performance of real-time control with Venturcom RTX.



## Requirements for Installing Venturcom RTX

**Note:** You must have administrator (ADMIN) privileges in order to install, uninstall, or use Venturcom RTX.

The following table lists the software and hardware required or supported by Venturcom RTX.

Computer Hardware	<p>Some hardware configurations do not support installation or operation of Venturcom RTX. The following computers are known to not support Venturcom RTX:</p> <ul style="list-style-type: none"> <li>• Compaq AP400</li> <li>• Dell 7000 portables</li> <li>• HP Kayak</li> <li>• Alpha systems.</li> </ul>
Operating System	<p>Venturcom RTX requires one of the following operating systems:</p> <ul style="list-style-type: none"> <li>• Microsoft Windows 2000 Professional edition, Service Pack 3</li> <li>• Microsoft Windows XP Professional, Service Pack 1</li> </ul>
Additional Software Requirements	<p>Venturcom RTX requires Internet Explorer 5.01 or higher</p>
HAL Types	<p>In order to be installed on a multiprocessor (MP) system, Venturcom RTX requires either that at least two processors are installed or that the standard HAL types are loaded. Refer to the release notes for Venturcom RTX.</p> <p>To run Venturcom RTX on a multiprocessor system with only one processor installed, you must change the HAL type:</p> <ul style="list-style-type: none"> <li>• If the HAL type for the computer is set to either ACPI Multiprocessor PC or ACPI Uniprocessor PC: Select ACPI PC.</li> <li>• If the HAL type for the computer is set to either MPS Multiprocessor PC or MPS Uniprocessor PC: Select Standard PC.</li> </ul> <p>You may need to use the Device Driver wizard to change the HAL type.</p>

### Running the CP Card in Interrupt Mode

On some computers, Venturcom RTX allows a free interrupt for the CP card. (This varies for different manufacturers.) If a free interrupt is not available, the CP card operates only in Polled mode and not in Interrupt mode. This can affect the performance of the CP card.

Refer to the topic on improving the performance of a CP 5613 card.

### Some Hardware Configurations Degrade the Performance of Venturcom RTX

On some computers, some components of the computer (such as the video card) can cause problems with Venturcom RTX that affect the performance of real-time control.

For a uniprocessor system (single processor), you can use the RTX Platform Evaluation utility to determine if your computer has any hardware installed (such as that video card) that may introduce jitter or latencies.

## Troubleshooting Network Problems

WinLC RTX helps you diagnose DP network problems. The CPU panel provides two status indicators (EXT1 and BUSF1) that can be used to diagnose problems with the PROFIBUS-DP network. The table below describes the activity of the EXTF and BUSF1 indicators to help you determine the type of problem and a possible solution.

EXTF	BUSF1	Description	Action
Off	Off	No configuration	Ensure that the DP configuration has been entered into your STEP 7 project. Download the project's System Data container to WinLC RTX.
		Normal operation	The configured DP slaves are responding. No action is required.
On	Flashing	Station failure	Check to see that the bus cable is connected to WinLC RTX (the CP card) and that all segments are correctly terminated at powered nodes. Check to see that the bus is not interrupted.
		At least one of the DP slaves could not be accessed	Wait for WinLC RTX to complete the power-on cycle. If the indicator continues to flash, check the DP slaves or evaluate the diagnostic data for the DP slaves.
--	On	Bus fault (hardware failure)	Check the bus cable for an electrical short, or a broken wire or connection.
On	Off	Diagnostic error	Indicates that a fault condition has not been cleared or that a DP module with diagnostic capability has initiated OB82.

In addition to these visual indicators, you can use the Diagnose Hardware feature of the STEP 7 programming software to determine which nodes are experiencing problems and to determine the nature of the problem.

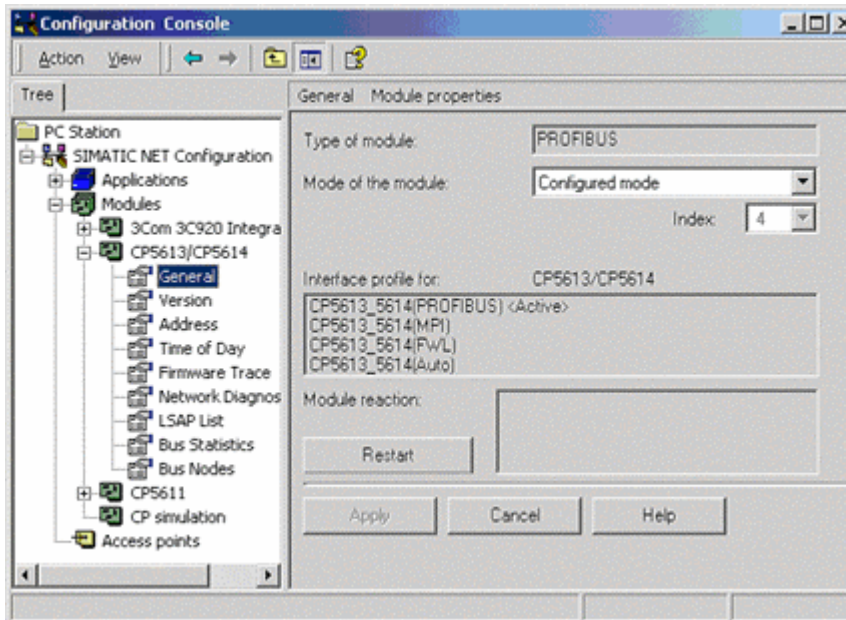
## Checking the Configuration of the CP Card

**Purpose:** To verify the configuration of the CP card.

**Tool:** You use the Configuration Console of SIMATIC NET.


The Configuration Console allows you to view the list of components in the configured PC station. Use this dialog to check the configuration of your CP card:

1. Select the **Start > SIMATIC > SIMATIC NET > Settings > Configuration Console** menu command to display the Configuration Console. (The Configuration Console appears automatically when you click Finish in the Commissioning Wizard.)
2. Navigate to the module for your CP card.
3. Select the General icon to display the general module properties sheet.



4. You can modify the name and index for your CP card in the Configuration Console. Remember that the name and index in the PC station must match the name and index that you configure in STEP 7.
5. Verify that the CP card is set to Configured mode. If it is not, select "Configured mode" from the list box for the "Mode of the module" field.
6. If you changed the configuration, click Apply to confirm your changes.
7. Close the Configuration Console.

If you have configuration errors:

- Double-click the  icon in the Windows taskbar to open the Station Configuration Editor, and click the Diagnostics tab to review the diagnostic messages.
- Check that you have created the submodule correctly.

## Improving the Performance of the CP 5613 Card

**Purpose:** To change the configuration of the CP 5613 card. To use isochronous mode, you must configure the CP 5613 card for Interrupt mode.

**Note:** WinLC RTX allows you to use isochronous mode on more than one PROFIBUS-DP subnet; however, your computer must not share the interrupt (IRQ) of the PCI slots used by the CP cards with the Windows operating system. For example, the SINUMERIK PCU 50 provides two PCI slots that can be used for isochronous mode on two different PROFIBUS-DP subnets.

**Tool:** You use the Windows Device Manager.

WinLC RTX accesses the CP 5613 card in either Interrupt mode or Polled mode. Interrupt mode provides improved performance over Polled mode.

**Note:** To implement isochronous DP, you must configure the CP 5613 card to operate in Interrupt mode.

In order for WinLC RTX to use the Interrupt mode for accessing the CP 5613, you must configure your computer so that the CP 5613 card does not share an IRQ with a Windows-controlled device.

Use the following procedure to determine whether the IRQ assignment for the CP 5613 card is shared with an IRQ assignment for a Windows-controlled device:

1. Right-click the My Computer icon and select the Manage menu command.
2. Click Device Manager, and then select the **View > Resources by Type** menu command.
3. Expand the Interrupt request (IRQ) folder.
4. Locate the CP5613\_5614 entry in the device list. If the IRQ assigned to this entry is assigned to any other device, the CP 5613 card is sharing an interrupt with that device. If this other device is Windows-controlled, the CP 5613 card will be operated in Polled mode if it is configured as a submodule of WinLC RTX. Otherwise, the CP 5613 card operates in Interrupt mode.

To determine whether a device is Windows-controlled (as opposed to being RTX-controlled), use the following procedure:

1. Right-click the device entry CP5613\_5614 in the Device Manager list, and select Properties.
2. Select the General tab on the Properties dialog, and check the Device type value. If it is RTX Drivers, the device is RTX-controlled. Otherwise, it is Windows-controlled.

If the CP 5613 card shares the IRQ number with a Windows-controlled device, use one of the following methods to change the system configuration for your computer and to assign a different IRQ number to the CP 5613 card:

- Use the BIOS setup utility for your computer to assign a unique IRQ to the CP 5613 card.
- Install the CP 5613 card in a different PCI expansion slot of your computer. Because the PCI slots are often assigned different IRQ numbers, installing the card in a different slot may eliminate the conflict. However, changing the slot may also result in a new conflict.
- If the IRQ conflict is due to a built-in device (for example, an Ethernet or SCSI controller), consider using the BIOS setup utility to disable the conflicting built-in device, if possible. This may require you to use an equivalent expansion card to replace the functionality for the disabled device.

Using these methods may be an iterative process, and you may find that there is no solution that assigns a suitable IRQ number to the CP 5613 card. If no configuration can be found which eliminates the IRQ conflict, you must either select a different PC platform or you must use the polled mode of operation for the CP 5613 card.

## Responding to Diagnostic Events

If an error is detected by the controller, the error condition is logged in the diagnostic buffer as a diagnostic event. The diagnostic events that are typically associated with distributed I/O can cause the controller to execute the following OBs:

- OB40 responds to hardware interrupts (process alarms) generated by an I/O module with configured interrupt capability.
- OB82 responds to diagnostic interrupts generated by an I/O module with configured diagnostic interrupt capability.
- OB83 responds to module removal/insertion at a DP Slave, (for example, ET200M), which has been configured for module pull/plug support.
- OB85 responds to a priority class error. There are multiple causes for OB85 relating to the DP I/O system. If the controller attempts to copy a module's inputs to (or outputs from) the process image during the I/O cycle, and the module is not operational, then an OB85 is executed.
- OB86 responds to a station failure or some other interruption of the physical network (such as a short circuit).
- OB122 responds to an I/O access error by the user program. If OB122 is not programmed, the controller goes to STOP mode.

You can use SFC39 to SFC42 to disable, delay, or re-enable any of these OBs. If an OB is requested and the OB has not been downloaded to WinLC RTX, the controller goes to STOP mode.

The local variables for these OBs contain startup information indicating the cause for executing the OB. The program for the OB can use this information for responding to the event. You can also use SFC13 (DPNRM\_DG) to read the diagnostic information from a DP slave.

For information about using OBs and SFC13, refer to the *System Software for S7-300 and S7-400 System and Standard Functions Reference Manual*. To view this manual from a computer where STEP 7 is installed, select the menu command **Start > Simatic > Documentation > English**, and double-click "STEP 7 - System and Standard Functions for S7-300 and S7-400".

## System Status List (SSL)

STEP 7 stores read-only information about the controller in the system status list (SSL) as a set of sublists.

You use SFC51 (RDSYSST) to access the entries in the system status list. You supply the input parameters `SSL_ID` and `Index` to access the records stored in the sublist. SFC51 returns a two-word header and a sublist or partial sublist. The header provides the following information about the sublist:

- The first word defines the length (size in bytes) of a record for the sublist.
- The second word defines the number of records contained in the sublist.

The sublist that follows contains all of the information requested. The size of the sublist in bytes is the record length times the number of records.

For more information about the system status list, see the *System Software for S7-300 and S7-400 System and Standard Functions Reference Manual*. To view this manual from a computer where STEP 7 is installed, select the menu command **Start > Simatic > Documentation > English**, and double-click "STEP 7 - System and Standard Functions for S7-300 and S7-400".

The table below provides an overview of the SSL sublists supported by WinLC RTX, sorted according to the SSL ID. The `SSL_ID` and `Index` are represented as hexadecimal (16#) numbers.

SSL_ID (hex)	Sublist	Index (hex)	Record Contents
0000	<b>SSL ID</b> All available SSL-IDs	Examples:	Information on all available SSL IDs
0100	Sublist with all sublist excerpts	00xy	List of SSL IDs supported by WinLC RTX in group 00xy (Example: 0024, CPU Operating Status)
0200	A sublist excerpt	0xyz	SSL ID 0xyz if supported by WinLC RTX, 0 if not
0300	All available indices for an SSL_ID	0xyz	List of indices corresponding to SSL ID 0xyz
0F00	Header information only		Number of all SSL IDs of the module
	<b>CPU identification</b>		WinLC RTX type and version number
0011	All records of the sublist		
0111	One record of the sublist	0001	Identification of the module
		0007	Identification of the firmware
0F11	Header information only		

SSL_ID (hex)	Sublist	Index (hex)	Record Contents
	<b>CPU characteristics</b>		
0012	All characteristics		
0112	One group of characteristics	0000	MC7 processing unit
		0100	Time system in WinLC RTX
		0200	System response
		0300	Language description of WinLC RTX
0F12	Header information only		
	<b>Memory areas</b>		
0013	All memory areas		
0113	One memory area	0001	User memory
		0002	Load memory integrated
		0003	Load memory inserted
		0004	Maximum insertable load memory
		0005	Size of backup memory
		0006	Size of PBC memory assigned on the system-side (shadow memory)
0F13	Header information only		

SSL_ID (hex)	Sublist	Index (hex)	Record Contents
	<b>Operating system areas</b>		
0014	All system areas of a module		
0114	One system area	0001	Process-image input area (bytes)
		0002	Process-image output area (bytes)
		0003	Memory (bits)
		0004	Number of timers
		0005	Number of counters
		0006	I/O address area (bytes)
		0007	Total local data area of CPU (bytes)
0F14	Header information only		
	<b>Block types</b>		
0015	All block types of a module		
0115	One block type	0800	OBs (number and size)
		0A00	DBs (number and size)
		0B00	SDBs (number and size)
		0C00	FCs (number and size)
		0E00	FBs (number and size)
0F15	Header information only		



SSL_ID (hex)	Sublist	Index (hex)	Record Contents
	<b>Status of the module LEDs</b>		
0019	All LEDs		
0119	One LED	0002	INTF Internal failure
		0003	EXTF External failure
		0004	RUN Run
		0005	STOP Stop
		0006	FRCE Force
		0007	CRST Complete restart
		000B	BUSF1 Bus fault
		000C	BUSF2 Bus fault
		0011	BAF Battery failure
		0012	BUSF3 Bus fault
		0013	BUSF4 Bus fault
0F19	Header information only		
	<b>Interrupt/error assignment</b>	not applicable	not applicable
0021	All possible interrupts		
0A21	All assigned interrupts		
0F21	Header information only		
	<b>Interrupt status</b>		
0222	One specific interrupt	0001	Event that started OB1
		0050	Event that started OB80

SSL_ID (hex)	Sublist	Index (hex)	Record Contents
	<b>Priority class</b>		
0023	All priority classes	Priority class	Priority of possible OBs
0123	One specific priority class		
0223	All configured priority classes		
0F23	Header information only		
	<b>Operating status of the CPU</b>		
0124	Last executed operating status transition	4520 5000 5010 5020 5030	Defective status STOP status Startup status RUN status HALT status
0424	Current operating status		
0524	Specified operating status		
0F24	Header information only		
	<b>Communications performance</b>		
0131	Parameters of the communications type specified	0001	Number of connections and baud rates
		0002	Test and startup parameters
		0003	Operator interface parameters
		0004	Object management system (operating system function)
		0005	Diagnostics functions and diagnostics entries
		0006	PBC performance parameters
		0009	Number of run-time meters
		0010	PMC event parameters
0F31	Header information only		

SSL_ID (hex)	Sublist	Index (hex)	Record Contents
0132	<b>Communications status information</b> Parameters of the communications type specified	0001	Number and type of connections
		0002	Number of test jobs set up
		0004	CPU protection level
		0005	Diagnostics
		0006	PBK status data
		0008	Time system, correction factor, run-time meter, date and time of day
		0009	Baud rate (set by means of the MPI)
		000A	Baud rate (set by means of the S7-300 backplane bus)
		0010	PMC S7-SCAN Part 1
0F32	Header information only		
0033	<b>Diagnostic Station List</b> All entries	not applicable	not applicable
0782	<b>Start-up events</b> Start-up events of all OBs of a priority class before processing	Priority class	Event ID, priority class, and OB number

SSL_ID (hex)	Sublist	Index (hex)	Record Contents
	<b>Module status information</b>		
0A91	All DP subsystems and DP masters		
0C91	One module	Logical base address	Features and parameters of the module
0D91	One station	Rack, or DP master system ID, or DP master system ID and station number	All the modules of a station in the PROFIBUS-DP network
0F91	Header information only		
	<b>Status information of the stations in a DP network</b>		Status information for the stations connected to a PROFIBUS-DP network
0092	Expected status of nodes in a DP master system	0 / DP master system ID	
0192	Activation status of the stations of a DP master system ID		
0292	Actual status of the nodes in a subnetwork	0 / DP master system ID	
0692	DP slaves indicating failure of one or more modules	0 / DP master system ID	
0F92	Header information only		
	<b>Expanded DP Master system information</b>		Status information regarding synchronicity for the nodes connected to a PROFIBUS-DP network.
0095	All DP master systems known to the CPU	0 / DP master system ID   L-Byte=00H	
0195	One DP master system		
0F95	Header information only		

SSL_ID (hex)	Sublist	Index (hex)	Record Contents
00A0 01A0 0FA0	<b>Diagnostics buffer</b>  All entries (event information)  Specified number of entries  Header information only	Number	Event information (dependent on the event)
00B1 00B3 00B4	<b>Module diagnostics</b>  First four diagnostic bytes of one module (data record 0)  All diagnostic data of one module (data record 1)  Diagnostic data of a DP slave	Logical base address  Logical base address  Configured diagnostic address	Module-dependent diagnostics information

## Terminology

**Cold Restart** The controller executes OB102 before starting the free cycle (OB1). Like a warm restart, a cold restart deletes the peripheral I/O (PI and PQ), deletes the non-retentive memory bits (M), timers (T) and counters (C), and changes the peripheral outputs to a pre-defined safe state (default is 0). A cold restart does not save the retentive memory bits, timers, counters and data blocks (DBs), but sets these areas to their default (initial) values.

**Control Program** The control program is the application program created with STEP 7 and downloaded to the controller for execution. The control program includes all organization blocks (such as OB1 or OB35) and the other logic blocks that they call, including functions (FCs), system functions (SFCs), function blocks (FBs), and system function blocks (SFBs).

**Execution Monitor** The execution monitor of the controller measures the time that the controller sleeps and ensures that the controller does not exceed the maximum execution load. The execution monitor uses the maximum execution load and the execution time limit to calculate the forced execution sleep time.

**Execution Time** The execution time is the actual time the controller takes to complete one pass through the instructions of the user program. This includes executing OB1 and updating the I/O.

**Execution Time Limit** The execution time limit defines the maximum amount of time allowed for the controller to execute the control program. The execution monitor uses this value and the maximum execution load to calculate the forced execution sleep time.

**Forced Execution Sleep Time** This read-only field shows how much sleep time (in microseconds) is required during the execution time limit to meet the maximum execution load requirement

**Free Cycle** The free cycle consists of the basic tasks for priority class 1: writing to the outputs, reading the inputs, executing OB1, and completing the sleep time requirement before triggering the next free cycle. The controller executes these tasks at the base, or lowest, internal priority level for executing the OBs. (Priority level in this context refers to OB priority classes, not the operating system priority level.)

**Jitter** Jitter is the difference in the actual scan cycle time from the configured minimum scan time.

**Maximum Execution Load** The maximum execution load is the maximum percentage of CPU usage that is allocated for the controller. The execution monitor uses this value and the execution time limit to calculate the forced execution sleep time.

**Minimum Cycle Time** The minimum cycle time is the minimum number of milliseconds from the start of one cycle to the start of the next cycle. You enter a value for the minimum cycle time when you use STEP 7 to configure the system data for the controller. You can use the tuning panel to adjust this value as you test the performance of the controller. After you have tuned the performance of the controller, use STEP 7 to enter the optimum cycle time value and download the new system data. Any value for the cycle time that you enter with the tuning panel is overwritten by the value in the system data when the controller changes from STOP mode to RUN mode.

**Minimum Sleep Time** The minimum sleep time is the specific amount of time that the controller must wait before starting the next scan cycle. You use the tuning panel to configure this parameter. The controller uses the minimum sleep time and the minimum cycle time parameters to calculate the start of the next scan cycle.

**Organization Block (OB)** The OBs represent the interface between the operating system and the user program. Called by the operating system, they control cyclic and interrupt-driven program execution, startup behavior of the PLC and error handling.

**Priority** The priority of an application determines the order in which the operating system executes or interrupts an application in relation to the other applications that are running on the computer. An application with a higher priority interrupts and suspends the execution of an application with a lower priority. After the application with the higher priority finishes, the application with the lower priority resumes. A higher number indicates a higher priority.

**Priority Class** The priority class determines the order in which the controller executes the individual sections of the control program. Organization blocks (OBs) are ranked by priority class. Higher priority OBs interrupt lower priority OBs. The free cycle (OB1) has the lowest priority. You can use STEP 7 to change the priority class for an OB. A higher number indicates a higher priority class.

**Restart Method** The restart method determines which startup OB is executed whenever the controller changes from STOP mode to RUN mode. The startup OB allows you to initialize your control program and variables. The two restart methods are Cold restart (OB102) and Warm restart (OB100).

**Scan Cycle** The scan cycle includes writing to the outputs, reading the inputs, executing OB1 and all other OBs, and completing the sleep time requirement.

**Scan Cycle Time** The scan cycle time is the time required to execute the complete scan cycle, which includes the execution of OB1 and the minimum sleep time.

**Sleep Time** The sleep time is the difference between the execution time of the free cycle and the total scan time. Sleep time measures the time between the completion of OB1 and the start of the next scan cycle, and ensures that the next scan cycle does not start until the end of the sleep interval. However, if the start event for an interrupt OB (such as OB40) occurs during the sleep time, the controller executes that OB.

**System Function Block (SFB)** An SFB is a function block that is integrated as a part of the operating system of WinLC RTX and is not downloaded as part of the control program. Like a function block (FB), an SFB is a block "with memory." You must also create an instance data block (DB) for the SFB. The instance DB is then downloaded to WinLC RTX as part of the control program.

**System Function (SFC)** An SFC is a preprogrammed function that is integrated as a part of the operating system of WinLC RTX and is not downloaded as part of the control program. You can call the SFC in your control program. Like a function (FC), an SFC is a block "without memory."

**Wait Time** The wait time, or sleep time, is the time that the controller is not using the CPU. During this time, the operating system can run other applications.

**Warm Restart** The controller executes OB100 before starting the free cycle (OB1). A warm restart deletes the peripheral I/O (PII and PIQ), deletes the non-retentive memory bits (M), timers (T) and counters (C), and changes the peripheral outputs to a pre-defined safe state (default is 0). A warm restart saves the retentive memory bits, timers, counters and data blocks (DBs).





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