

EcoStruxure Control Expert

PLC Simulator

Original instructions

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Safety Information

Important Information

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.



The addition of this symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER

DANGER indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

WARNING

WARNING indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

CAUTION

CAUTION indicates a hazardous situation which, if not avoided, **could result in** minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

Please Note

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

Before You Begin

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

WARNING

UNGUARDED EQUIPMENT

- Do not use this software and related automation equipment on equipment which does not have point-of-operation protection.
- Do not reach into machinery during operation.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

This automation equipment and related software is used to control a variety of industrial processes. The type or model of automation equipment suitable for each application will vary depending on factors such as the control function required, degree of protection required, production methods, unusual conditions, government regulations, etc. In some applications, more than one processor may be required, as when backup redundancy is needed.

Only you, the user, machine builder or system integrator can be aware of all the conditions and factors present during setup, operation, and maintenance of the machine and, therefore, can determine the automation equipment and the related safeties and interlocks which can be properly used. When selecting automation and control equipment and related software for a particular application, you should refer to the applicable local and national standards and regulations. The National Safety Council's Accident Prevention Manual (nationally recognized in the United States of America) also provides much useful information.

In some applications, such as packaging machinery, additional operator protection such as point-of-operation guarding must be provided. This is necessary if the operator's hands and

other parts of the body are free to enter the pinch points or other hazardous areas and serious injury can occur. Software products alone cannot protect an operator from injury. For this reason the software cannot be substituted for or take the place of point-of-operation protection.

Ensure that appropriate safeties and mechanical/electrical interlocks related to point-of-operation protection have been installed and are operational before placing the equipment into service. All interlocks and safeties related to point-of-operation protection must be coordinated with the related automation equipment and software programming.

NOTE: Coordination of safeties and mechanical/electrical interlocks for point-of-operation protection is outside the scope of the Function Block Library, System User Guide, or other implementation referenced in this documentation.

Start-up and Test

Before using electrical control and automation equipment for regular operation after installation, the system should be given a start-up test by qualified personnel to verify correct operation of the equipment. It is important that arrangements for such a check are made and that enough time is allowed to perform complete and satisfactory testing.

▲ WARNING

EQUIPMENT OPERATION HAZARD

- Verify that all installation and set up procedures have been completed.
- Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.
- Remove tools, meters, and debris from equipment.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Follow all start-up tests recommended in the equipment documentation. Store all equipment documentation for future references.

Software testing must be done in both simulated and real environments.

Verify that the completed system is free from all short circuits and temporary grounds that are not installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to prevent accidental equipment damage.

Before energizing equipment:

- Remove tools, meters, and debris from equipment.

- Close the equipment enclosure door.
- Remove all temporary grounds from incoming power lines.
- Perform all start-up tests recommended by the manufacturer.

Operation and Adjustments

The following precautions are from the NEMA Standards Publication ICS 7.1-1995:

(In case of divergence or contradiction between any translation and the English original, the original text in the English language will prevail.)

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer's instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer's instructions and the machinery used with the electrical equipment.
- Only those operational adjustments required by the operator should be accessible to the operator. Access to other controls should be restricted to prevent unauthorized changes in operating characteristics.

About the Book

Document Scope

This document describes the PLC Simulator tool for EcoStruxure™™ Control Expert. It is referred to as “PLC Simulator” in the rest of the document.

Validity Note

This document has been updated for the release of EcoStruxure™™ Control Expert 15.3.

The technical characteristics of the devices described in the present document also appear online. To access the information online, go to the Schneider Electric home page www.se.com/ww/en/download/.

The characteristics that are described in the present document should be the same as those characteristics that appear online. In line with our policy of constant improvement, we may revise content over time to improve clarity and accuracy. If you see a difference between the document and online information, use the online information as your reference.

Related Documents

Title of documentation	Reference number
EcoStruxure™™ Control Expert, System Bits and Words, Reference Manual	EIO0000002135 (ENG) EIO0000002136 (FRE) EIO0000002137 (GER) EIO0000002139 (SPA) EIO0000002138 (ITA) EIO0000002140 (CHS)
EcoStruxure™™ Control Expert, Program Languages and Structure, Reference Manual	33002539 (ENG) 35006145 (FRE) 35006146 (GER) 35006147 (SPA) 35013361 (ITA) 35013362 (CHS)
Modicon M580, Safety System Planning Guide	QGH60283 (ENG) QGH60284 (FRE) QGH60285 (GER) QGH60287 (SPA) QGH60286 (ITA) QGH60288 (CHS)

Title of documentation	Reference number
EcoStruxure™ Control Expert, Operating Modes	33003101 (ENG) 33003102 (FRE) 33003103 (GER) 33003104 (SPA) 33003696 (ITA) 33003697 (CHS)
EcoStruxure™ Control Expert, System, Block Library	33002539 (ENG) 33002540 (FRE) 33002541 (GER) 33002542 (SPA) 33003688 (ITA) 33003689 (CHS)

Product Related Information

⚠ WARNING

LOSS OF CONTROL

- Perform a Failure Mode and Effects Analysis (FMEA), or equivalent risk analysis, of your application, and apply preventive and detective controls before implementation.
- Provide a fallback state for undesired control events or sequences.
- Provide separate or redundant control paths wherever required.
- Supply appropriate parameters, particularly for limits.
- Review the implications of transmission delays and take actions to mitigate them.
- Review the implications of communication link interruptions and take actions to mitigate them.
- Provide independent paths for control functions (for example, emergency stop, over-limit conditions, and error conditions) according to your risk assessment, and applicable codes and regulations.
- Apply local accident prevention and safety regulations and guidelines.¹
- Test each implementation of a system for proper operation before placing it into service.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

¹ For additional information, refer to NEMA ICS 1.1 (latest edition), *Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control* and to NEMA ICS 7.1 (latest edition), *Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems* or their equivalent governing your particular location.

▲ WARNING

UNINTENDED EQUIPMENT OPERATION

- Only use software approved by Schneider Electric for use with this equipment.
- Update your application program every time you change the physical hardware configuration.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Terminology Derived from Standards

The technical terms, terminology, symbols and the corresponding descriptions in this manual, or that appear in or on the products themselves, are generally derived from the terms or definitions of international standards.

In the area of functional safety systems, drives and general automation, this may include, but is not limited to, terms such as *safety*, *safety function*, *safe state*, *fault*, *fault reset*, *malfunction*, *failure*, *error*, *error message*, *dangerous*, etc.

Among others, these standards include:

Standard	Description
IEC 61131-2:2007	Programmable controllers, part 2: Equipment requirements and tests.
ISO 13849-1:2015	Safety of machinery: Safety related parts of control systems. General principles for design.
EN 61496-1:2013	Safety of machinery: Electro-sensitive protective equipment. Part 1: General requirements and tests.
ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN 60204-1:2006	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
ISO 14119:2013	Safety of machinery - Interlocking devices associated with guards - Principles for design and selection
ISO 13850:2015	Safety of machinery - Emergency stop - Principles for design
IEC 62061:2015	Safety of machinery - Functional safety of safety-related electrical, electronic, and electronic programmable control systems
IEC 61508-1:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems: General requirements.
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems: Requirements for electrical/electronic/programmable electronic safety-related systems.
IEC 61508-3:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems: Software requirements.
IEC 61784-3:2016	Industrial communication networks - Profiles - Part 3: Functional safety fieldbuses - General rules and profile definitions.
2006/42/EC	Machinery Directive
2014/30/EU	Electromagnetic Compatibility Directive
2014/35/EU	Low Voltage Directive

In addition, terms used in the present document may tangentially be used as they are derived from other standards such as:

Standard	Description
IEC 60034 series	Rotating electrical machines
IEC 61800 series	Adjustable speed electrical power drive systems
IEC 61158 series	Digital data communications for measurement and control – Fieldbus for use in industrial control systems

Finally, the term zone of operation may be used in conjunction with the description of specific hazards, and is defined as it is for a hazard zone or danger zone in the Machinery Directive (2006/42/EC) and ISO 12100:2010.

NOTE: The aforementioned standards may or may not apply to the specific products cited in the present documentation. For more information concerning the individual standards applicable to the products described herein, see the characteristics tables for those product references.

Simulating a Controller

Overview

This chapter describes simulating a controller.

Introduction

General Description

PLC Simulator is supplied prior to a physical controller deployment for test purposes only. It does not replace the physical controller and the application based only on simulation cannot be used in a production environment without physically testing and commissioning that application, nor can you use the PLC Simulator as a virtual controller.

Installation

PLC Simulator is automatically installed with Control Expert (**PLC Simulation** functionality).

It is located in the Control Expert repository.

Refer to [Differences Between the PLC Simulator and a Physical Controller](#), page 23 of this guide for further information.

Area of Use

PLC Simulator allows you to simulate a controller.

The use of Breakpoints, Stepping and the GoTo function enable you to test your program in the simulated controller.

Structure of the PLC Simulator

The Simulator Dialog box, page 29 provides the following indications:

- Type of simulated controller.

- Status of the simulated controller.
- Name of the loaded project.
- IP address and DNS name of the host PC for PLC Simulator.
- IP addresses and DNS names of connected client PCs.
- Dialog box to simulate IO events.
- **Reset** button to simulate a cold start.
- **Power Cycle** button to simulate a warm start.
- Shortcut menu (right mouse button) to control PLC Simulator.

The PLC Simulator symbol shown in the task bar offers the following features:

- Display of the status of the simulated controller, page 20.
- QuickInfo (Tooltips) shows the IP address of the host PC for PLC Simulator, the port number used and the name of the loaded project.
- Shortcut menu (right mouse button) to control PLC Simulator.

PLC Simulator Cyber Security

At a Glance

Refer to the **Simulator Panel Options**, page 63 chapter to get the list of Cyber Security settings to apply while using PLC Simulator. PLC Simulator does not embed the same level of protection as that of Control Expert software programming a physical controller.

The following rules are applied to PLC Simulator:

- PLC Simulator only starts with a loaded application.
- PLC Simulator does not allow the upload of a password-protected application in monitoring mode.

PLC Simulator Only Starts with a Loaded Application

The **Simulator Panel Options** supplies a new check box **Use default application to start simulator (enforce security)** and a new field to give the application path:

- If the **Use default application to start simulator (enforce security)** box is selected, an application with a password is accessible by the path given in the field.

It is the default option.

- If the **Use default application to start simulator (enforce security)** box is cleared, a message is displayed to inform that the PLC Simulator use is not secured on its 502 Port.

At first start of PLC Simulator, the box is selected but the path is empty. A popup message informs that:

- A valid Control Expert application is mandatory to start PLC Simulator.
- To help enforce security, it is necessary to use an Application Password.

NOTE: A password-protected application is necessary to help enforce security on Ethernet port of your computer which is by default port 502.

When PLC Simulator is started from Control Expert (the menu **PLC > Connect**) or from Windows menus with **Use default application to start simulator (enforce security)** box selected:

- If there is no application with a password in the PLC Simulator or the application path is not valid, the **Simulator Panel Options** window appear and PLC Simulator does not start unless a valid path is set or the option is cleared.
- If the application path is valid, the PLC Simulator starts.

No Upload of a Password-Protected Application in Monitoring Mode

In Monitoring mode, the **PLC > Transfer Project from PLC** option is grayed for password-protected application. The related icon is also grayed.

As a result, the PLC Project from PLC Simulator cannot be uploaded.





Loading a Project in PLC Simulator

Introduction

The process for loading a project to PLC Simulator is identical in principle to loading a project on a physical PLC.

Loading a Project

Loading a project in PLC Simulator

Step	Action						
1	In Control Expert, enable the simulator mode using the menu command PLC > Simulation mode or the following symbol on the toolbar: 						
2	Execute the menu command Rebuild > Rebuild All Project .						
3	Create a connection to PLC Simulator using the menu command PLC > Connect , see also <i>Creating a Connection</i> , page 18 for creating a remote connection. Result: <ul style="list-style-type: none"> The PLC Simulator icon, page 20 appears in the toolbar:  see also <i>Possible Error Messages</i>, page 19 NOTE: Usually, PLC Simulator is installed on the same PC as Control Expert (Local Host). The project can also be loaded on PLC Simulator on another PC via a TCP/IP connection.						
4	Execute the menu command PLC > Transfer project to PLC . Result: A transfer dialog box appears. <div data-bbox="314 777 1056 1065" style="border: 1px solid gray; padding: 5px; margin: 10px 0;"> <div style="background-color: #000080; color: white; padding: 2px; border: 1px solid gray;">Transfer project to PLC ✕</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border: 1px solid gray; padding: 5px;"> PC Project Name: <input style="width: 80%;" type="text" value="Station"/> Version: <input style="width: 80%;" type="text" value="0.0.84"/> Last generation: <input style="width: 80%;" type="text" value="25.10.02 15:34:50"/> </td> <td style="width: 50%; border: 1px solid gray; padding: 5px;"> Overwritten PLC Name: <input style="width: 80%;" type="text" value="Station"/> Version: <input style="width: 80%;" type="text" value="0.0.83"/> Last generation: <input style="width: 80%;" type="text" value="28.08.02 10:52:12"/> </td> </tr> <tr> <td colspan="2" style="padding: 5px;"> <input type="checkbox"/> Start PLC after transfer </td> </tr> <tr> <td colspan="2" style="text-align: center; padding: 5px;"> <input type="button" value="Transfer"/> <input type="button" value="Cancel"/> </td> </tr> </table> </div>	PC Project Name: <input style="width: 80%;" type="text" value="Station"/> Version: <input style="width: 80%;" type="text" value="0.0.84"/> Last generation: <input style="width: 80%;" type="text" value="25.10.02 15:34:50"/>	Overwritten PLC Name: <input style="width: 80%;" type="text" value="Station"/> Version: <input style="width: 80%;" type="text" value="0.0.83"/> Last generation: <input style="width: 80%;" type="text" value="28.08.02 10:52:12"/>	<input type="checkbox"/> Start PLC after transfer		<input type="button" value="Transfer"/> <input type="button" value="Cancel"/>	
PC Project Name: <input style="width: 80%;" type="text" value="Station"/> Version: <input style="width: 80%;" type="text" value="0.0.84"/> Last generation: <input style="width: 80%;" type="text" value="25.10.02 15:34:50"/>	Overwritten PLC Name: <input style="width: 80%;" type="text" value="Station"/> Version: <input style="width: 80%;" type="text" value="0.0.83"/> Last generation: <input style="width: 80%;" type="text" value="28.08.02 10:52:12"/>						
<input type="checkbox"/> Start PLC after transfer							
<input type="button" value="Transfer"/> <input type="button" value="Cancel"/>							
5	Press the Transfer button. Result: The project is loaded on PLC Simulator and the PLC Simulator icon looks as follows in the toolbar: 						
6	Select the menu command PLC > Start . Result: The project is launched on PLC Simulator and PLC Simulator icon looks as follows in the toolbar: 						

Using an Application Password

PLC Simulator and a physical controller behave the same way relative to security with projects protected with an application password.

Connecting Control Expert to PLC Simulator, downloading, or uploading such projects from or to Control Expert requires to enter the application password.

NOTE: If you want to download a non-protected project to PLC Simulator which is already loaded with a project protected with an application password, you need to enter the password at the connection step, or clear PLC Simulator before the connection step. See *Clear*, page 62

For further information on password protection of projects, refer to the chapter *Application Protection* (see EcoStruxure™ Control Expert, Operating Modes).

Creating a Connection

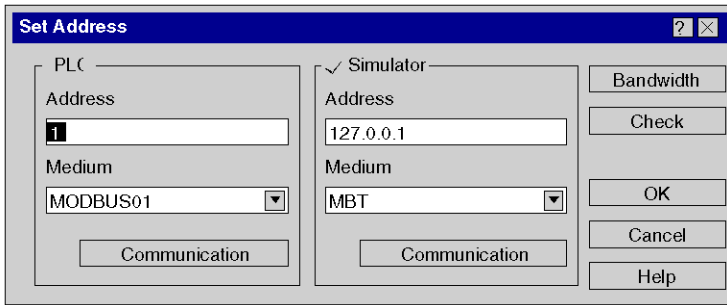
Usually, PLC Simulator is installed on the same PC as Control Expert (Local Host). When the menu command **PLC > Connect** is selected, a connection to the Local Host PC on the default port 502 (Schneider Port) is automatically created. The project can also be loaded on PLC Simulator on another PC via a TCP/IP connection or on PLC Simulator running on a different port.

In this case you must specify the TCP/IP address and port number of the target PC when following the *Loading a project* procedure before carrying out Step 3 in the step-action table above (creating a connection). See *Loading a Project*, page 16.

Then select the Control Expert menu command **PLC > Set Address**, and in the **Address** text box of the **Simulator** options, enter the TCP/IP address and the optional port number of the target PC (for example: 139.158.106.127:123 where 123 is the port number). After that, continue with Step 3 in the step-action table above.

If you want to load the project in the Local Host PC PLC Simulator running on the default port 502 (Control Expert and simulator on the same PC), you do not have to carry out this step as the Local Host PC address and the port number are automatically entered.

Representation of the default dialog box:



Multiple Instances

As of Control Expert version 15.0, multiple instances of PLC Simulator on the same Local Host PC are supported. However, each PLC Simulator instance on the same Local Host PC connects to a unique port number. If one instance is already running with the default port 502, start a new instance with a different port number. For example, enter `127.0.0.1:503` as a port number for the port 503 in the **Address** text box of the **Simulator** options.

Starting PLC Simulator with Command Line

To start an instance of PLC Simulator with a specific port number, you can execute the command `start sim /PORT<port number>` in the Command Prompt console from the PLC Simulator installation folder. For example, `start sim /PORT503` for the port 503.

The default destination directory of the PLC Simulator at Control Expert software installation is `C:\Program Files (x86)\Schneider Electric\Control Expert \PLC_Simulator\`

Possible Error Messages

The following error messages can occur when launching PLC Simulator:

Error message	Cause	Solution
Can't register Simulator. Already running!	One active PLC Simulator instance use the same port than the PLC Simulator instance you are trying to activate.	Acknowledge the error message with OK and set another port than the PLC Simulator instances already active.
Version information from xxx cannot be read (err=0)!	invalid file in the PLC Simulator directory	Reinstall Control Expert after uninstalling it.
The DLL xxx is incompatible (...)! 	invalid file in the PLC Simulator directory	Reinstall Control Expert after uninstalling it.
At least one Simulator DLL is incompatible. Simulation not possible!	invalid file in the PLC Simulator directory	Reinstall Control Expert after uninstalling it.

Exiting PLC Simulator

The procedure for exiting PLC Simulator is as follows:

Step	Action
1	Call the menu command Exit Simulation from the shortcut menu for the PLC Simulator icon in the toolbar or the PLC Simulator dialog box. Result: PLC Simulator is closed.

PLC Simulator Icon in the Toolbar




Introduction

After launching the PLC Simulator instance(s), the PLC Simulator icon(s) appear(s) in the toolbar. The icon(s) identify(ies) the active PLC Simulator and display(s) the different states of the simulated controller(s).


General Structure

The PLC Simulator icon is composed according to the following rules.





The background color represents the operational state.

Example	Color	Description
	green	normal operation
	yellow	controller in HALT state
	red	controller in ERROR state



A frame around the icon shows the active debug mode

Example	Color	Description
	blue	Debug mode is active, for example at least one breakpoint is set in the project, or there is at least one user task in debug mode.

The inner symbol shows the controller state, such as NOCONF, IDLE, STOPPED, RUN.



Symbol	The simulated controller is in state...	Description
	NOCONF (no configuration)	No user project loaded or the loaded project is invalid or removed with the Clear command.
	IDLE	The project loaded on the controller has not been started or reset with the Reset command button.
	STOPPED	No project is running.
	RUN	A project with at least one task is running.

The color of the inner symbol shows the connection state.

Example	Color	Description
	black	No TCP/IP client is connected.
	red	At least one TCP/IP client is connected.




Error States

Meaning of the symbols

Symbol	The simulated controller is in state...	Description
	HALT	An error has occurred in the project. The simulated controller must be re-initialized or reset using the Reset command button.
	ERROR	An unrecoverable error is detected in the project. This means communication is no longer possible. The simulated controller must be reset using the Reset command button.

Internal States

The following symbols represent internal exception states. It is not possible to recover from these states, so the PLC Simulator must be closed and restarted again.

Symbol	The simulated controller is in state...	Description
	POWER OFF	An internal error has occurred during the simulation of a controller reset or power cycle.
	INIT	An internal error has occurred during the initialization of PLC Simulator.
	UNKNOWN	PLC Simulator has entered an indeterminable state.

Differences Between the PLC Simulator and a Physical Controller

Overview

This chapter describes the difference between PLC Simulator and a physical controller.

Limitations of the PLC Simulator

General

General limitations

- The PLC simulator allows to test a complete project with its user tasks through a CPU simulation. However, the runtime behavior of the simulator cannot be compared to that of a real PLC and cannot be used to draw conclusions about the behavior of a real PLC. This includes Multitasking behavior and time information.
- The PLC Simulator does not support any form of I/O. Although the simulation contains project components for I/Os, they are not processed by the PLC simulator. Inputs and outputs can only be accessed via the project or via the Control Expert online functions (read, write, force, animate, ...).
- With the PLC simulator I/O events can not be triggered by setting/forcing %I bits.
- For limitations concerning the memory card please refer to *Memory Card for Modicon M580 CPU*, page 38 and *Memory Card for Modicon M340 CPU*, page 54.
- The PLC Simulator does not support any Hot Standby feature.
- The PLC Simulator does not embeds the same level of protection as that of the standard Control Expert software.

PLC OS System Services

The PLC simulator supports the most PLC OS system services on a variety of platforms. These services are only implemented as dummy services.

This means that functions and function blocks can be used in the loaded project, but they do not work as expected and/or they return an error message.

This mainly affects functions and function blocks that accessed special platforms, such as I/O blocks, communication and hardware specific functions.

The following PLC OS system services are supported:

- diagnostics functions
- functions to read the date and time
- propagation delay time
- object access (except network variables)
- Premium DFBs
- SFC

The following PLC OS system services are not supported:

- closed loop control (CLC)
- Fip IO
- BusX IO
- Quantum IO
- configuration
- communication
- functions to set the date and time

Memory Structure

The different PLC families vary in memory structure.

NOTE: It is possible that the alignment of data are not the same when the projects is transferred from the PLC simulator to a Modicon M340, M580, or Momentum PLC. So check the structure of the data of the project.

For detailed information about memory alignment refer to chapter *DDT: Mapping rules* (see EcoStruxure™ Control Expert, Program Languages and Structure, Reference Manual).

For detailed information about storage principles and memory structure refer to chapter *Application Memory Structure* (see EcoStruxure™ Control Expert, Program Languages and Structure, Reference Manual).

Communication

Communication limitations

- The PLC simulator only supports TCP/IP based communication (Schneider Port 502). In other cases a Modbus exception code is returned.
- Modbus, Modbus Plus or Uni-TE are not supported by the PLC simulator.
- For Control Expert V14.1 and earlier the PLC simulator does not support communication to other PCs or PLC simulators, neither remote nor local.
- For Control Expert V14.1 and earlier, the PLC simulator has no communication timeout.
- Communication network, such as Uni-Telway, Ethway, Fipway, Modbus, Modbus Plus, etc., are not supported by the PLC simulator.

NOTE: Communication function blocks that require PLC client and PLC server are supported with multiple instances of PLC simulator, for details, refer to *IP Address and Communication Port Simulation*, page 26.

The PLC simulator supports the following native Modbus commands:

Function Code (in hex)	Description
01	Read Coil Status (0x)
02	Read Input Status (1x)
03	Read Holding Registers (4x)
04	Read Input Registers (3x)
05	Force Single Coil (0x)
06	Preset Single Register (4x)
0F	Force Multiple Coils (0x)
10	Preset Multiple Registers (4x)
16	Mask Write Registers (4x)

Mapping a %MW to a Boolean Element

Regarding the use of %MW mapped on a boolean element in structured data type, the PLC simulator and a real PLC behave different.

When a %MW is mapped on a boolean element in structured data type, only the first row is animated by the PLC simulator. On a real PLC both rows (zero and one) are animated. Row one is used to get the information about the history value.

M580 Safety Project Limitations

The PLC simulator has no double code execution of the logic and comparison of the results. It only simulates the logic but not the safety behavior of the PLC.

Debugging Limitations

The PLC simulator could enter HALT state when executing the **Step Info** or **Step Over** debugging command in textual languages.

If the current element is a complex instruction (i.e. copying a huge array from one variable to another), the execution of this instruction takes a very long time, because it will be executed in single step mode on the PLC simulator.

Setting a breakpoint on the next instruction and executing the **Go** command avoids this problem.

IP Address and Communication Port Simulation

Overview

The following communication function blocks require a PLC client and a PLC server:

- READ_REMOTE and WRITE_REMOTE
- DATA_EXCH
- READ_VAR and WRITE_VAR

The multiple instances capability of PLC simulator on the same Local Host PC allows to simulate the PLC client and PLC server.

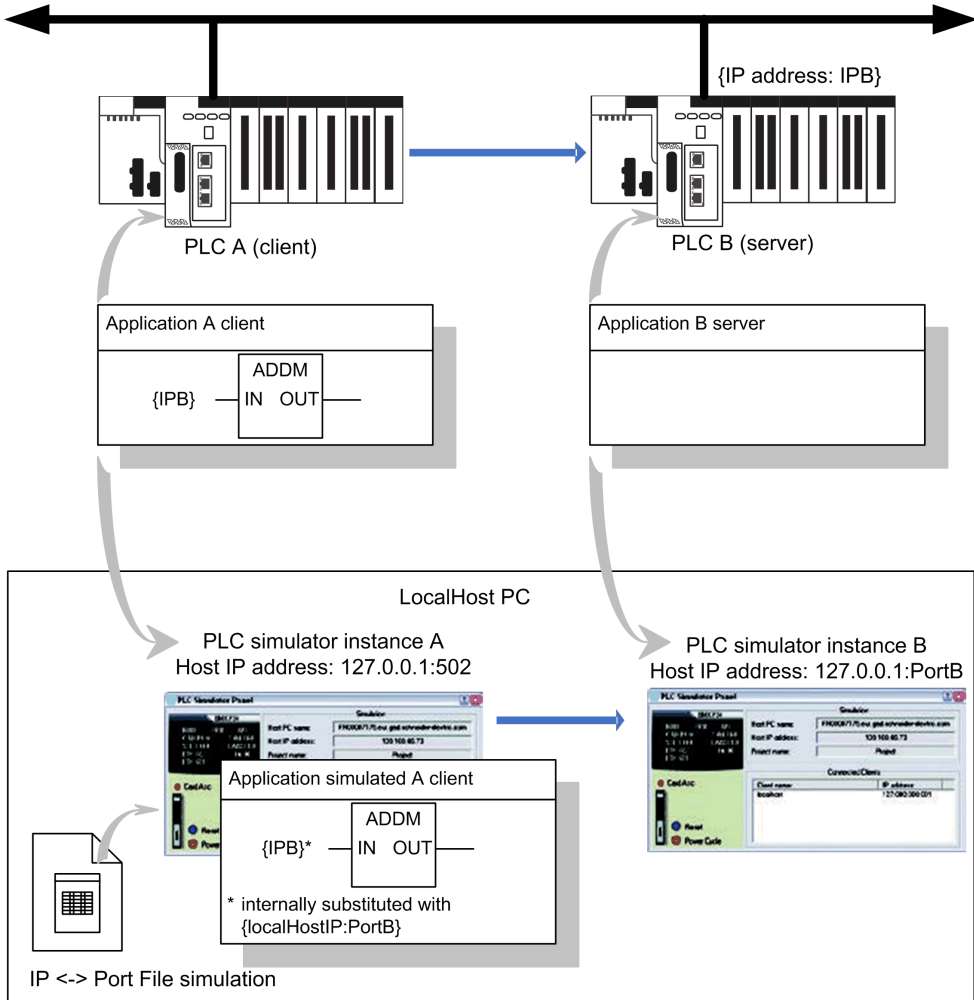
Principle

In PLC application (client), the targeted PLC (server) is addressed using its IP address as input parameter IN of ADDM function block. In these function blocks, the communication port is not defined as in the PLC, only the port 502 is always used.

After loading PLC application (client) in a first PLC simulator instance of the Local Host PC, to simulate the targeted PLC (server) in a second PLC simulator instance, it could only be addressed through another TCP/IP communication port. See *Starting PLC Simulator with Command Line*, page 19.

Instead of rewriting the IP address of the targeted PLC (server) in the PLC application (client) the PLC simulator instance can substitute IP address of the targeted PLC (server) with a TCP/IP communication port provided in a port simulation file. This file contains a correspondence between the IP address and the Local Host TCP/IP communication port.

As illustrated below, when the PLC application (client) calls a targeted PLC (server) using the {IPB} IP address, the PLC simulator instance A substitutes the {IPB} address with {localHostIP:PortB} address corresponding to the PLC simulator instance B connection.



Port Simulation File

The correspondences between an IP address and a communication port to simulate is provided in a port simulation file (*.xml) with the following syntax:

```
<EquiList>  
<PLCAdressSim Address="172.168.12.0" Port="503"></PLCAdressSim>  
<PLCAdressSim Address="192.168.0.2" Port="504"></PLCAdressSim>  
</EquiList>
```

Where `Address` is the IP address in ADDM block and `Port` is the simulator port to use for simulation.

NOTE: Provide that the port simulation file is unique for one PC.

You can change the location and the name of the file in the [Options, page 63 Dialog Box](#).

In the input parameter syntax of the ADDM function block, the IP address is prefixed by the communication port topological location, that is `0.0.3{168.127.0.1}` for M580 CPU port. This typical syntax is ignored and not checked by the simulator.

If an IP address in the ADDM function block is not found in the port simulation file, there is no substitution and the IP address is used by the PLC simulator. It allows to test real PLC server.

Limitation

The use of `READ_VAR`, `WRITE_VAR`, or `DATA_EXCH` by the PLC simulator requires Libset version 15.0 or any subsequent supporting version.

System Bits and System Words

PLC Simulator supports subsets of %S system bits and %SW system words (see EcoStruxure™ Control Expert, System Bits and Words, Reference Manual).

Menu Commands and Dialog Boxes in the PLC Simulator

Overview

This chapter describes the menu commands and dialog boxes in the PLC simulator.

Simulator Control

Description

You can open and close the simulator dialog using:

- The menu command **Simulator Control** in the context menu of the simulator symbol in the task bar or the simulator symbol.
- A double-click with the left mouse button on the simulator symbol in the task bar.

One of the following dialog boxes is open or closed depending on the project loaded:

- Unknown CPU, page 29
- Modicon M580 CPU, page 32
- Modicon Quantum CPU, page 42
- Modicon Quantum Safety CPU, page 45
- Modicon Premium CPU, page 49
- Modicon M340 CPU, page 51
- Modicon Momentum CPU, page 58

Simulator Control for Unknown CPU

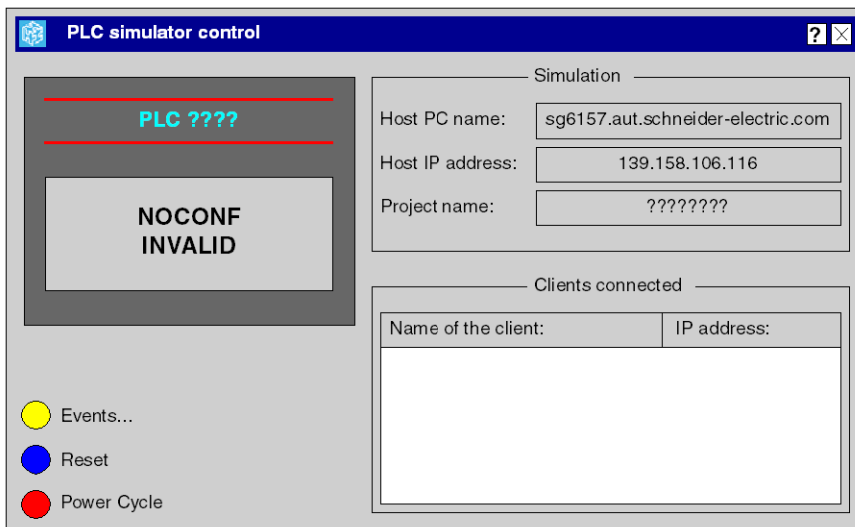
Introduction

This dialog box is shown if the simulator does not know which CPU type should be simulated.

This is the case for example in the following situations:

- Directly after the simulator is started and before a project is loaded.
- If the simulated CPU is in NOCONF state (in other words a valid project is not loaded in the simulator).

Representation of the dialog box:



CPU Front Plate

The virtual CPU front plate shows the current state of the CPU and the project in a two line display.

The first line shows the current state of the CPU and can contain the following texts:

Text in the first line	The simulated CPU is in state...	Meaning
NOCONF	NOCONF (no configuration)	No user project loaded or the loaded project is invalid.
IDLE	IDLE	The project loaded on the CPU has not been started or reset with the Reset button.
STOP	STOPPED	No project is running. However, the loaded project was in RUN state at least once.
RUN	RUN	A project with at least one task is running.

Text in the first line	The simulated CPU is in state...	Meaning
HALT	HALT	An error has occurred in the project. The simulated CPU must be reinitialized or reset using the Reset button.
ERROR	ERROR	An unrecoverable detected error has occurred in the project. This means communication is no longer possible. The simulated CPU must be reset using the Reset button.

The second line shows the current state of the project and can contain the following texts:

Text in the Second Line	Meaning
INVALID	No user project loaded or the loaded project is invalid.
CHECKED	The project was checked formally and found to be valid. However, the CPU has not been configured using this project.
CONF	The project was checked formally and found to be valid. The CPU has been configured using this project.

Events

With this button, you can open and close the event dialog box, page 60.

The button is shown if I/O events are defined in the project currently loaded (if the project uses event tasks).

Reset

With this button, you can reset the simulated CPU. This corresponds to a cold start of the CPU (the connection between Control Expert and the simulator is broken, project variables are reset).

This button corresponds to the reset button on a real CPU.

Power Cycle

With this button, you simulate a warm start of the CPU. It means that the connection between Control Expert and the simulator is broken, the current project variables remain and the simulator goes into the state RUN (autostart active) or STOP (autostart deactivated).

A power cycle corresponds to a power off and power on of a real power supply.

Simulation

Dialog box fields:

Host PC name:	DNS name of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Host IP address:	TCP/IP address of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Project name:	Name of the project loaded in the simulator.

Clients Connected

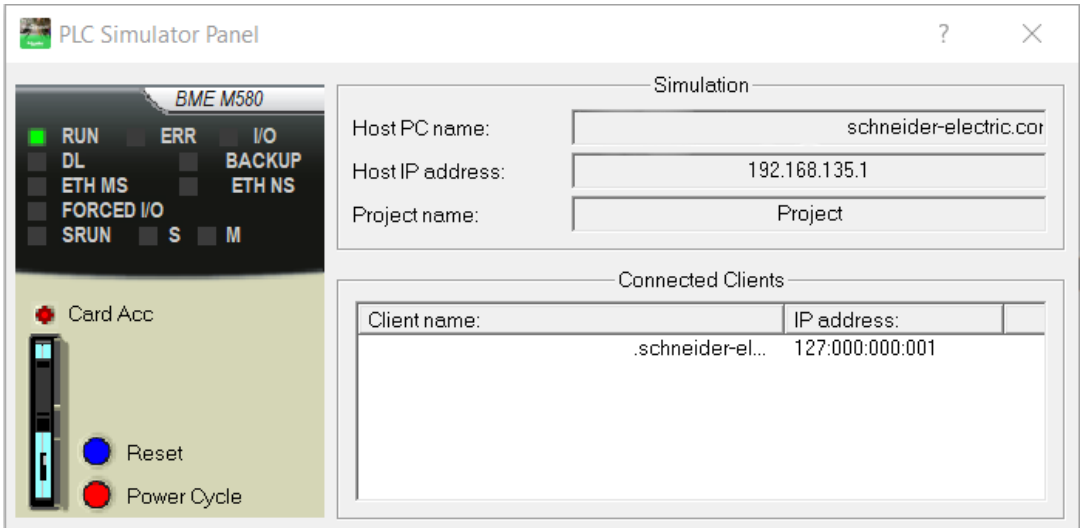
The list shows current clients connected with the PC (PCs which are connected via TCP/IP with the host PC of the simulator, page 18). The DNS name and TCP/IP address are shown for each client.

Simulator Control for Modicon M580 CPU

Introduction

The dialog box is shown if the simulator is simulating a CPU from the Modicon M580 family.

Representation of the dialog box:



CPU Front Plate

The virtual CPU front plate shows the current state of the CPU in a multi-line display using combinations of the **RUN** and **ERR** LEDs:

RUN LED	ERR LED	The simulated CPU is in state...	Meaning
–	–	NOCONF	The LED display is replaced with NOCONF - INVALID display. No user project loaded or the loaded project is invalid.
flashing	off	STOP	The project loaded on the PLC has not been started or has been reset with the Reset button.
on	off	RUN	A project with at least one task is running.
flashing	flashing	HALT	A detected error has occurred in the project. The simulated CPU must be reinitialized or reset using the Reset button.
off	on	–	An unrecoverable detected error has occurred in the project. This means communication is no longer possible. The simulated CPU must be reset using the Reset button.

The **BACKUP** LED is **on** if a problem occurs during simulated card access or if the simulated memory card is removed.

The **I/O**, **DL**, **ETH MS**, **ETH NS**, and **FORCED I/O** LEDs are not supported by the simulator.

Card Acc

The **Card Acc** LED is **on** when the card is accessible.

Memory Card

Simulated features of a memory card for the Modicon M580 CPU, page 38:

- Files on the memory card generated by the data storage function blocks.
- Remove/insert memory card.
- Memory card full.
- Write protection.

Reset

With this button, you can reset the simulated CPU. This corresponds to a cold start of the CPU where the connection between Control Expert and the simulator is broken, project variables are reset and the simulator goes in RUN (if auto start is activated) or in STOP (if auto start is deactivated)).

Power Cycle

With this button, you execute a power cycle (power off/ power on) for the simulated CPU. This corresponds to a warm start of the CPU (the connection between Control Expert and the simulator is broken and the current project variables remain).

A power cycle corresponds to a power off and power on of a real power supply.

Simulation

Dialog box fields:

Host PC name:	DNS name of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Host IP address:	TCP/IP address of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Project name:	Name of the project loaded in the simulator.

Clients Connected

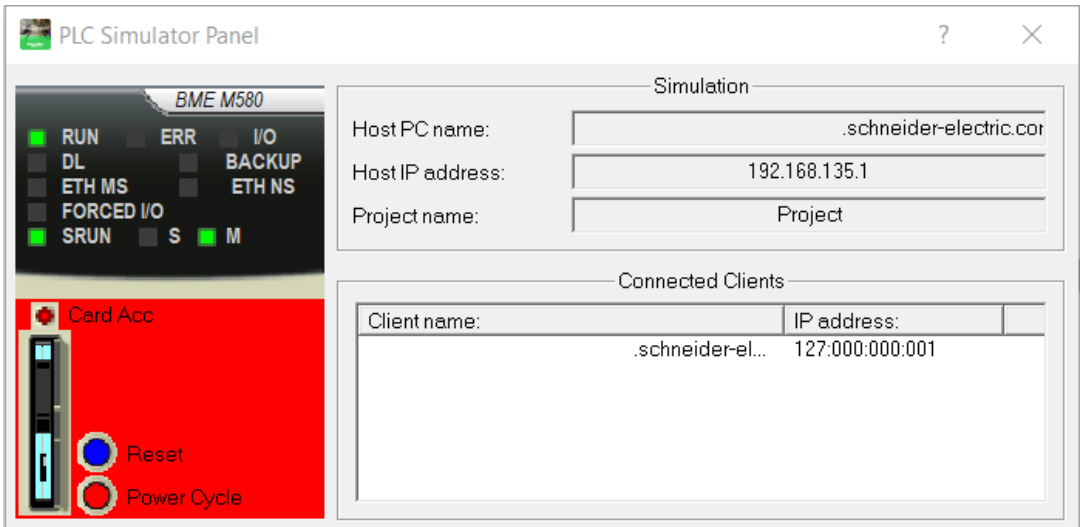
The list shows current clients connected with the PC (PCs which are connected via TCP/IP with the host PC of the simulator, page 18). The DNS name and TCP/IP address are shown for each client.

Simulator Control for Modicon M580 Safety CPU

Introduction

The dialog box is shown if the simulator is simulating a Modicon M580 Safety CPU.

Representation of the dialog box:



CPU Front Plate

The virtual CPU front plate shows the current state of the CPU in a multi-line display using combinations of the **RUN** and **ERR** LEDs:

LEDs					The simulated CPU is in state...	Meaning
RUN	ERR	SRUN	S	M		
–	–	–	–	–	NOCONF	The LED display is replaced with NOCONF - INVALID display. No user project loaded or the loaded project is invalid.
flashing	off	on: SAFE task running off: SAFE task stopped.	on: Safety mode	off	STOP	The project loaded on the PLC has not been started or has been reset with the Reset button.
			off	flashing: Maintenance mode		
on	off	on: SAFE task running off: SAFE task stopped.	on: Safety mode	off	RUN	A project with at least one task is running.
			off	flashing: Maintenance mode		
flashing	flashing	on: SAFE task running off: SAFE task stopped.	on: Safety mode	off	HALT	A detected error has occurred in the project. Reinitialize the simulated CPU or reset it using the Reset button.
			off	flashing: Maintenance mode		
off	on	off	off	off	SAFE	An unrecoverable detected error has occurred in the project. This means communication is no longer possible. Reset the simulated CPU using the Reset button.

The **BACKUP** LED is **on** if a problem occurs during simulated card access or if the simulated memory card is removed.

The **I/O**, **DL**, **ETH MS**, **ETH NS**, and **FORCED I/O** LEDs are not supported by the simulator.

Card Acc

The **Card Acc** LED is **on** when the card is accessible.

Memory Card

Simulated features of a memory card for the Modicon M580 CPU, page 38:

- Files on the memory card generated by the data storage function blocks.
- Remove/insert memory card.
- Memory card full.
- Write protection.

Reset

With this button, you can reset the simulated CPU. This corresponds to a cold start of the CPU where the connection between Control Expert and the simulator is broken, project variables are reset and the simulator goes in RUN (if auto start is activated) or in STOP (if auto start is deactivated)).

Power Cycle

With this button, you execute a power cycle (power off/ power on) for the simulated CPU. This corresponds to a warm start of the CPU (the connection between Control Expert and the simulator is broken and the current project variables remain).

A power cycle corresponds to a power off and power on of a real power supply.

Simulation

Dialog box fields:

Host PC name:	DNS name of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Host IP address:	TCP/IP address of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Project name:	Name of the project loaded in the simulator.

Connected Clients

The list shows current clients connected with the PC (PCs which are connected via TCP/IP with the host PC of the simulator, page 18). The DNS name and TCP/IP address are shown for each client.

Memory Card for Modicon M580 CPU

Overview

The Modicon M580 PLC simulator panel displays a memory card in the bottom left corner of the virtual front plate, for both M580 PLCs and M580 Safety PLCs. See, for example, Simulator control for Modicon M580 CPU, page 32.

The memory card is inserted by default after the startup of the PLC Simulator.

No Backup/Restore

On a real Modicon M580 CPU, the memory card is separated in 2 parts:

- A part for the OS, where the application is stored persistent (backup/restore mechanism).
- A part for the application, where the application can store data by using data storage function blocks.

NOTE: The simulator does not simulate the backup/restore part of the memory card.

Not Simulated Features of a Memory Card

The following features of a real memory card are not supported:

- Backup/restore to/from memory card.
- Operating modes for memory cards.
- %S66 (APPLIBCK).

Simulated Features of a Memory Card

The following features of a memory card can be simulated for the Modicon M580 CPU:

- Files on the memory card generated by the data storage function blocks.
- Remove/insert memory card.
- Memory card full.
- Write protection.

File Management Function Blocks

The simulator supports the file management function blocks and simulates the generation of the files on the PC.

A directory on the PC simulates the file management part of the memory card. In this directory, the files created by the user application are stored.

The directory used for memory card simulation is either the default one (*C:\Documents and Settings\USERNAME\Local Settings\Temp\DataStorage*) or the directory used during the last simulation. The last used directory is stored persistent in the registry.

The files written by the application can be accessed by normal tools like an editor or Office tools.

The simulator never deletes the application written files. If an application needs to have a blank empty memory card, the system word `%SW93` (Memory Card File System Format) has to be used in STOP state of the CPU.

NOTE: There is no tracking of the size and number of files written into the memory card.

Limitations for File Management Function Blocks

- Error codes generated by these functions/function blocks may be different between PLC simulator and a real CPU.
- With the PLC simulator, it is not possible to delete a file that is opened (neither with the `DELETE_FILE` function, nor by FTP command).

It is mandatory to close the file before deleting it, in order to delete the file descriptor.

Trying to delete a file that is opened generates a general error code (-1).

- The `SET_FILE_ATTRIBUTES` function is not supported by the PLC simulator.

Trying to call this function generates a general error (-1).

For detailed information about the file management functions/function blocks please refer to the *System Block Library* documentation.

Remove Memory Card

By default the memory card is inserted at simulator start.

The procedure for removing the memory card is as follows:

Step	Action
1	Set the system bit %S65 (CARDIS). Result: After a potential card access has finished the Card Acc LED goes out.
2	Open the context menu by clicking the memory card with the right mouse button.
3	Select Remove Memory Card.... Result: The virtual front plate shows an empty memory card slot and the CARDERR LED is on.

NOTE: Removing the memory card has no influence on the used directory and the files, but the access to the files is disabled inside the simulator.

Insert Memory Card

The procedure for inserting the memory card is as follows:

Step	Action
1	Open the context menu by clicking the memory card with the right mouse button.
2	Select Insert Memory Card.... Result: A Windows standard file selection dialog opens. The selection is pre-initialized with the last used memory card directory. Note: The file selection box also has a Write protected check box to insert a write protected virtual memory card.

Step	Action
3	<p>Proceed with one of the 2 following possibilities:</p> <ul style="list-style-type: none">Use the preinitialized directory. Result: The last removed memory card is inserted.Select another directory. Result: Another memory card (for example different in content or empty) is inserted. Result: The CARDERR LED turns off.
4	<p>Reset the system bit %S65 (CARDIS).</p> <p>Result: The virtual front plate shows a memory card and the Card Acc LED goes on.</p>

Since a directory and its content represent the memory card, exchanging the content of the directory can simulate the exchange of a memory card. This can be done by normal Windows means (cut/copy/paste of files or renaming/moving folders).

Memory Card Full

By default the memory card is not full at simulator start.

Since there is no size tracking, at any time it is possible to simulate that the memory card is full.

This is done by opening the context menu (right-click the memory card) and selecting the menu command **Memory Card Full**.

After this menu command is selected:

- New data writing is not possible.
- Read accesses are possible.
- Overwrite actions are possible.

This state is indicated by the check mark in the context menu command.

Write Protection

By default the memory card is not write protected at simulator start.

At any time, it is possible to simulate that the memory card is write protected.

This is done by opening the context menu (right-click the memory card) and selecting the menu command **Write Protection**.

After this menu command is selected:

- Data writing is not possible.
- Read accesses are possible.

This state is indicated by the check mark in the context menu command.

Control Expert adds some restrictions linked with the memory card (for example program modification is forbidden if the card is write protected). The simulator supports these restrictions too.

To simulate the write protection feature the following system bits and words are supported by the simulator:

- %S65 (CARDIS)
- %S96 (BACKUPPROGOK)
- %SW97 (CARDSTS)

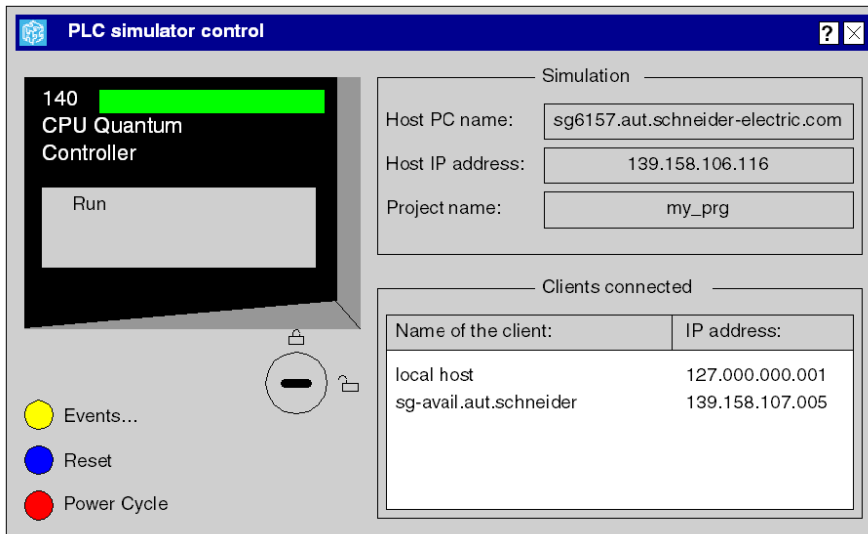
NOTE: It is not possible to access the files via an FTP client through the simulator since the files are directly accessible by Windows features.

Simulator Control for Modicon Quantum CPU

Introduction

The dialog box is shown if the simulator is simulating a CPU from the Modicon Quantum family.

Representation of the dialog box:





CPU Front Plate

The virtual CPU front plate shows the current state of the CPU in a one line display:

Text in the display	The simulated CPU is in state...	Meaning
Init	INIT (Initialization)	This display is shown for a very short time while the simulator is starting. It is quickly replaced by one of the following displays.
UnCfg	NOCONF (no configuration)	No user project loaded or the loaded project is invalid.
Idle	IDLE	The project loaded on the CPU has not been started or reset with the Reset button.
Stop	STOPPED	No project is running. However, the loaded project was in RUN state at least once.
Run	RUN	A project with at least one task is running.
Halt	HALT	An error has occurred in the project. The simulated CPU must be reinitialized or reset using the Reset button.
Err	ERROR	An unrecoverable detected error has occurred in the project. This means communication is no longer possible. The simulated CPU must be reset using the Reset button.

Key Switch

By clicking the switch symbol, various switch positions can be simulated:

Switch position	Switch position on real CPU	Meaning
	Start	CPU unlocked: <ul style="list-style-type: none"> • Project can be loaded. • CPU can be started or stopped.
	Mem Prt	CPU locked: <ul style="list-style-type: none"> • Project cannot be loaded. • As opposed to the key switch on a real CPU, the CPU can be started or stopped in this position.
-	Stop	This switch position of a real CPU is not supported by the simulator.

Events

With this button, you can open and close the event dialog box, page 60.

The button is shown if I/O events are defined in the project currently loaded (if the project uses event tasks).

Reset

With this button, you can reset the simulated CPU. This corresponds to a cold start of the CPU (the connection between Control Expert and the simulator is broken, project variables are reset and the simulator goes in RUN (if auto start is activated) or in STOP (if auto start is deactivated)).

Reset corresponds to the reset button on a real CPU.

Power Cycle

With this button, you execute a power cycle (power off / power on) for the simulated CPU. This corresponds to a warm start of the CPU (the connection between Control Expert and the simulator is broken and the current project variables remain).

A power cycle corresponds to a power off and power on of a real power supply.

Simulation

Dialog box fields:

Host PC name:	DNS name of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Host IP address:	TCP/IP address of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Project name:	Name of the project loaded in the simulator.

Clients Connected

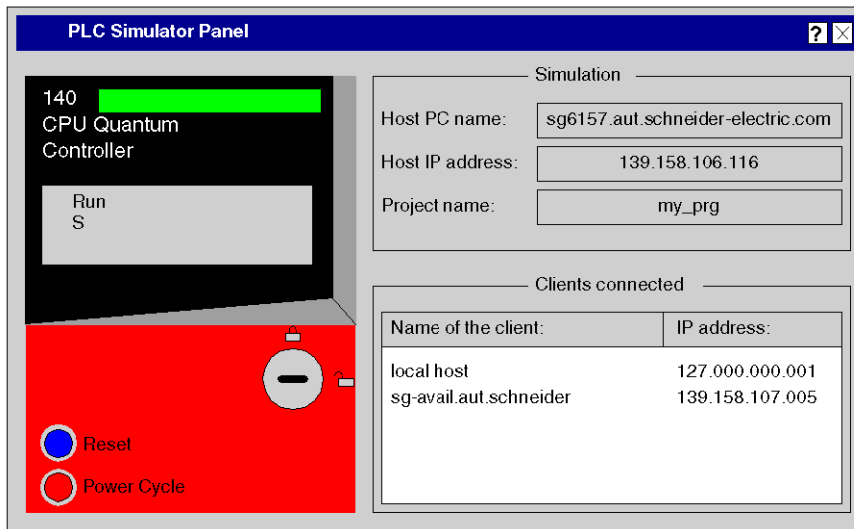
The list shows current clients connected with the PC (PCs which are connected via TCP/IP with the host PC of the simulator, page 18). The DNS name and TCP/IP address are shown for each client.

Simulator Control for Modicon Quantum Safety CPU

Introduction

The dialog box is shown if the simulator is simulating a CPU from the Modicon Quantum safety family.

Representation of the dialog box:



CPU Front Plate

The virtual CPU front plate shows the current state of the safety CPU in a display:

Text in the display	The simulated CPU is in state...	Meaning
Init	INIT (Initialization)	This display is shown for a very short time while the simulator is starting. It is quickly replaced by one of the following displays.
UnCfg	NOCONF (no configuration)	No user project loaded or the loaded project is invalid.
Idle	IDLE	The project loaded on the CPU has not been started or reset with the Reset command button.
Stop	STOPPED	No project is running. However, the loaded project was in RUN state at least once.
Run	RUN	A project with at least one task is running.
Halt	HALT	An error has occurred in the project. The simulated CPU must be reinitialized or reset using the Reset command button.
Err	ERROR	An unrecoverable detected error has occurred in the project. This means communication is no longer possible. The simulated CPU must be reset using the Reset command button.

Text in the display	The simulated CPU is in state...	Meaning
S	Safety Mode	The project is running in safety mode. For further information on the different modes please refer to the <i>Unity Pro XLS Software Specifics</i> manual.
M	Maintenance Mode	The project is running in maintenance mode. For further information on the different modes please refer to the <i>Unity Pro XLS Software Specifics</i> manual.

Safety/Maintenance Mode (Safety Projects)

For switching between safety and maintenance mode please pay attention to the following special features:



- Switching from safety to maintenance mode in Control Expert XLS Software is only possible, if the simulator key switch is unlocked (see table below).
- Switching from maintenance to safety mode can be done by setting the key switch position of the simulator to locked.
- If the simulator is in maintenance mode and Control Expert XLS Software is disconnected from the simulator, it is automatically set to safety mode.

NOTE: The CPU simulator has no double code execution of the logic and comparison of the results. Therefore the execution behaves the same in safety and maintenance mode.

For further information on the different modes please refer to the *Unity Pro XLS Software Specifics* manual.

Key Switch

By clicking the switch symbol, various switch positions can be simulated:

Switch position	Switch position on real CPU	Meaning
	Start	CPU unlocked: <ul style="list-style-type: none"> • Project can be loaded. • CPU can be started or stopped.
	Mem Prt	CPU locked: <ul style="list-style-type: none"> • Project can not be loaded. • As opposed to the key switch on a real CPU, the CPU can be started or stopped in this position.
-	Stop	This switch position of a real CPU is not supported by the simulator.

Reset

With this button, you can reset the simulated CPU. This corresponds to a cold start of the CPU (the connection between the Control Expert and the simulator is broken, project variables are reset).

This command button corresponds to the reset button on a real CPU.

Power Cycle

With this button, you simulate a cold start of the CPU as a safety CPU does not support warm start. The connection between Control Expert and the simulator is broken, the simulator goes into the state RUN (autostart active) or STOP (autostart deactivated).

This command button corresponds to the power off and power on of a real power supply.

Simulation

Dialog box fields:

Host PC name:	DNS name of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Host IP address:	TCP/IP address of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Project name:	Name of the project loaded in the simulator.

Clients Connected

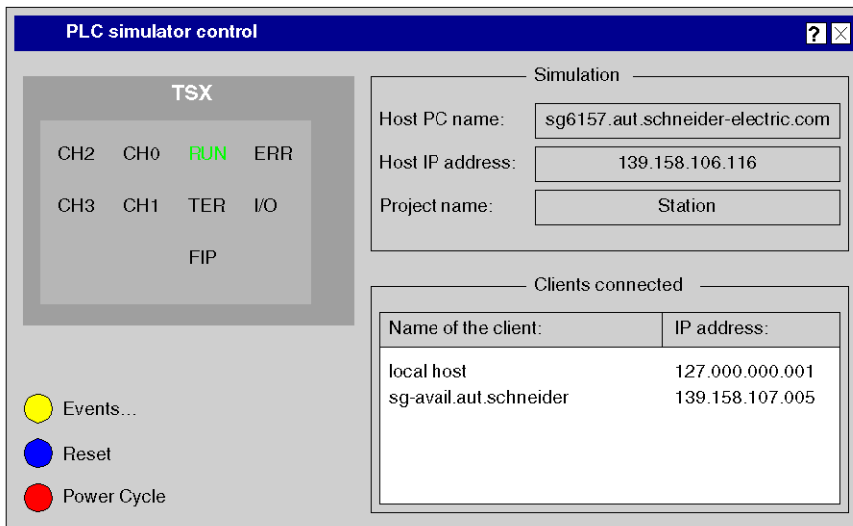
The list shows current clients connected with the PC (PCs which are connected via TCP/IP with the host PC of the simulator, page 18). The DNS name and TCP/IP address are shown for each client.

Simulator Control for Modicon Premium CPU

Introduction

The dialog box is shown if the simulator is simulating a CPU from the Modicon Premium family.

Representation of the dialog box:



CPU Front Plate

The virtual CPU front plate shows the current state of the CPU in a multi-line display using combinations of the **RUN** and **ERR** LEDs:

RUN LED	ERR LED	The simulated CPU is in state...	Meaning
off	flashing	NOCONF (no configuration)	No user project loaded or the loaded project is invalid.
flashing	off	IDLE	The project loaded on the CPU has not been started or reset with the Reset button.
flashing	off	STOPPED	No project is running. However, the loaded project was in RUN state at least once.
on	off	RUN	A project with at least one task is running.
off	flashing	HALT	An error has occurred in the project. The simulated CPU must be reinitialized or reset using the Reset button.
off	on	ERROR	An unrecoverable detected error has occurred in the project. This means communication is no longer possible. The simulated CPU must be reset using the Reset button.

When data is being exchanged between Control Expert and the simulator, the **TER LED** is flashing.

The **CH0**, **CH1**, **CH2**, **CH3**, **I/O**, and **FIP** LEDs are not supported by the simulator.

Events

With this button, you can open and close the event dialog box, page 60.

The button is shown if I/O events are defined in the project currently loaded (if the project uses event tasks).

Reset

With this button, you can reset the simulated CPU. This corresponds to a cold start of the CPU where the connection between Control Expert and the simulator is broken, project variables are reset and the simulator goes in RUN (if auto start is activated) or in STOP (if auto start is deactivated)).

Reset corresponds to the reset button on a real CPU.

Power Cycle

With this button, you execute a power cycle (power off/ power on) for the simulated CPU. This corresponds to a warm start of the CPU (the connection between Control Expert and the simulator is broken and the current project variables remain).

A power cycle corresponds to a power off and power on (or pressing the reset button) of a real power supply.

Simulation

Dialog box fields:

Host PC name:	DNS name of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Host IP address:	TCP/IP address of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Project name:	Name of the project loaded in the simulator.

Clients Connected

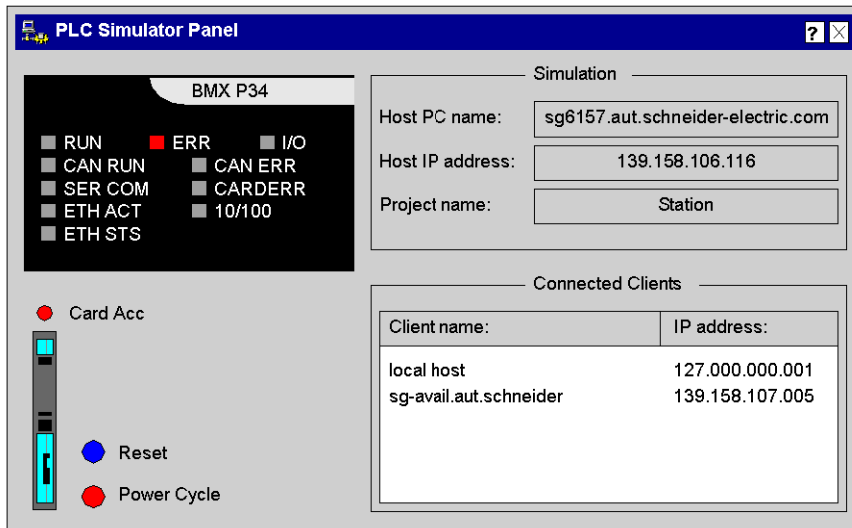
The list shows current clients connected with the PC (PCs which are connected via TCP/IP with the host PC of the simulator, page 18). The DNS name and TCP/IP address are shown for each client.

Simulator Control for Modicon M340 CPU

Introduction

The dialog box is shown if the simulator is simulating a CPU from the Modicon M340 family.

Representation of the dialog box:



CPU Front Plate

The virtual CPU front plate shows the current state of the CPU in a multi-line display using combinations of the **RUN** and **ERR** LEDs:

RUN LED	ERR LED	The simulated CPU is in state...	Meaning
off	flashing	NOCONF (no configuration)	No user project loaded or the loaded project is invalid.
flashing	off	IDLE	The project loaded on the CPU has not been started or reset with the Reset button.
flashing	off	STOPPED	No project is running. However, the loaded project was in RUN state at least once.
on	off	RUN	A project with at least one task is running.
off	flashing	HALT	An error has occurred in the project. The simulated CPU must be reinitialized or reset using the Reset button.
off	on	ERROR	An unrecoverable detected error has occurred in the project. This means communication is no longer possible. The simulated CPU must be reset using the Reset button.

When data is being exchanged between Control Expert (or other clients) and the simulator, the **SER COM** LED is flashing.

The **CARDERR** LED is ON if a problem occurs during card access or if the memory card is removed.

The **I/O**, **CAN RUN**, **CAN ERR**, **ETH ACT**, **ETH STS**, and **10/100** LEDs are not supported by the simulator.

Card Acc

The **Card Acc** LED is on when the card is accessible.

Memory Card

The following features of a memory card can be simulated for the Modicon M340 CPU, page 54:

- Files on the memory card generated by the data storage function blocks.
- Remove/insert memory card.
- Memory card full.
- Write protection.

Reset

With this button, you can reset the simulated CPU. This corresponds to a cold start of the CPU where the connection between Control Expert and the simulator is broken, project variables are reset and the simulator goes in RUN (if auto start is activated) or in STOP (if auto start is deactivated)).

Power Cycle

With this button, you execute a power cycle (power off/ power on) for the simulated CPU. This corresponds to a warm start of the CPU (the connection between Control Expert and the simulator is broken and the current project variables remain).

A power cycle corresponds to a power off and power on of a real power supply.

Simulation

Dialog box fields:

Host PC name:	DNS name of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Host IP address:	TCP/IP address of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Project name:	Name of the project loaded in the simulator.

Clients Connected

The list shows current clients connected with the PC (PCs which are connected via TCP/IP with the host PC of the simulator, page 18). The DNS name and TCP/IP address are shown for each client.

Memory Card for Modicon M340 CPU

Overview

The Modicon M340 PLC simulator panel displays a memory card in the bottom left corner of the virtual front plate. See *Simulator Control for Modicon M340 CPU*, page 51.

The memory card is inserted by default after the startup of the PLC Simulator.

No Backup/Restore

On a real Modicon M340 CPU, the memory card is separated in 2 parts:

- A part for the OS, where the application is stored persistent (backup/restore mechanism).
- A part for the application, where the application can store data by using data storage function blocks.

NOTE: The simulator does not simulate the backup/restore part of the memory card.

Not Simulated Features of a Memory Card

The following features of a real memory card are not supported:

- Backup/restore to/from memory card.
- Operating modes for memory cards.
- %S66 (APPLIBCK).

Simulated Features of a Memory Card

The following features of a memory card can be simulated for the Modicon M340 CPU:

- Files on the memory card generated by the data storage function blocks.
- Remove/insert memory card.
- Memory card full.
- Write protection.

File Management Function Blocks

The simulator supports the file management function blocks and simulates the generation of the files on the PC.

A directory on the PC simulates the file management part of the memory card. In this directory, the files created by the user application are stored.

The directory used for memory card simulation is either the default one (*C:\Documents and Settings\USERNAME\Local Settings\Temp\DataStorage*) or the directory used during the last simulation. The last used directory is stored persistent in the registry.

The files written by the application can be accessed by normal tools like an editor or Office tools.

The simulator never deletes the application written files. If an application needs to have a blank empty memory card, the system word %SW93 (Memory Card File System Erasing) has to be used in STOP state of the CPU.

NOTE: There is no tracking of the size and number of files written into the memory card.

Limitations for File Management Function Blocks

- Error codes generated by these functions/function blocks may be different between PLC simulator and a real CPU.
- With the PLC simulator, it is not possible to delete a file that is opened (neither with the `DELETE_FILE` function, nor by FTP command).
It is mandatory to close the file before deleting it, in order to delete the file descriptor.
Trying to delete a file that is opened generates a general error code (-1).
- The `SET_FILE_ATTRIBUTES` function is not supported by the PLC simulator.
Trying to call this function generates a general error (-1).

For detailed information about the file management functions/function blocks please refer to the EcoStruxure™ Control Expert, System, Block Library documentation.

Remove Memory Card

By default the memory card is inserted at simulator start.

The procedure for removing the memory card is as follows:

Step	Action
1	Set the system bit %S65 (CARDIS). Result: After a potential card access has finished the Card Acc LED goes out.
2	Open the context menu by clicking the memory card with the right mouse button.
3	Select Remove Memory Card... Result: The virtual front plate shows an empty memory card slot and the CARDERR LED is on.

NOTE: Removing the memory card has no influence on the used directory and the files, but the access to the files is disabled inside the simulator.

Insert Memory Card

The procedure for inserting the memory card is as follows:

Step	Action
1	Open the context menu by clicking the memory card with the right mouse button.
2	Select Insert Memory Card...

Step	Action
	<p>Result: A Windows standard file selection dialog opens. The selection is pre-initialized with the last used memory card directory.</p> <p>Note: The file selection box also has a Write protected check box to insert a write protected virtual memory card.</p>
3	<p>Proceed with one of the 2 following possibilities:</p> <ul style="list-style-type: none">• Use the preinitialized directory. Result: The last removed memory card is inserted.• Select another directory. Result: Another memory card (for example different in content or empty) is inserted. <p>Result: The CARDERR LED turns off.</p>
4	<p>Reset the system bit %S65 (CARDIS).</p> <p>Result: The virtual front plate shows a memory card and the Card Acc LED goes on.</p>

Since a directory and its content represent the memory card, exchanging the content of the directory can simulate the exchange of a memory card. This can be done by normal Windows means (cut/copy/paste of files or renaming/moving folders).

Memory Card Full

By default the memory card is not full at simulator start.

Since there is no size tracking, at any time it is possible to simulate that the memory card is full.

This is done by opening the context menu (right-click the memory card) and selecting the menu command **Memory Card Full**.

After this menu command is selected:

- New data writing is not possible.
- Read accesses are possible.
- Overwrite actions are possible.

This state is indicated by the check mark in the context menu command.

Write Protection

By default the memory card is not write protected at simulator start.

At any time, it is possible to simulate that the memory card is write protected.

This is done by opening the context menu (right-click the memory card) and selecting the menu command **Write Protection**.

After this menu command is selected:

- Data writing is not possible.
- Read accesses are possible.

This state is indicated by the check mark in the context menu command.

Control Expert adds some restrictions linked with the memory card (for example program modification is forbidden if the card is write protected). The simulator supports these restrictions too.

To simulate the write protection feature the following system bits and words are supported by the simulator:

- %S65 (CARDIS)
- %S96 (BACKUPPROGOK)
- %SW97 (CARDSTS)

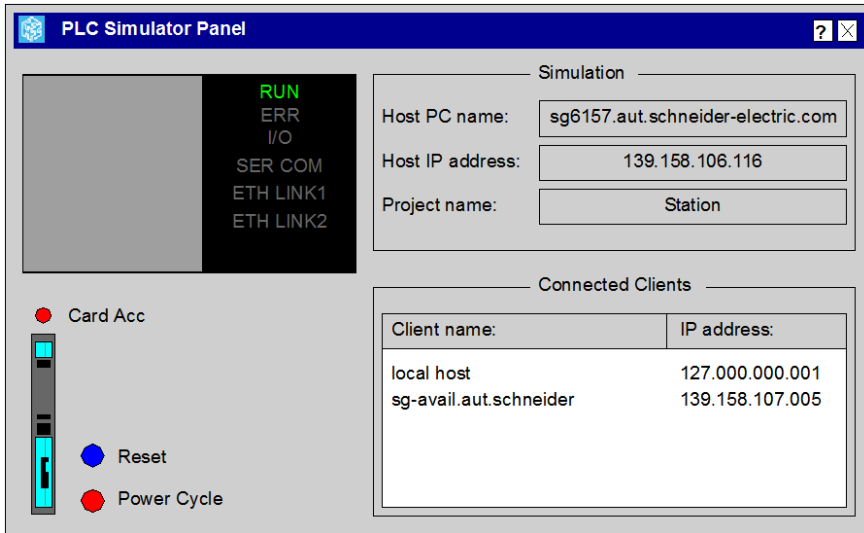
NOTE: It is not possible to access the files via an FTP client through the simulator since the files are directly accessible by Windows features.

Simulator Control for Modicon Momentum CPU

Introduction

The dialog box is shown if the simulator is simulating a CPU from the Modicon Momentum family.

Representation of the dialog box:



CPU Front Plate

The **RUN** display is always on, green when a project is loaded in the simulator.

The **SER COM** display is flashing yellow when data is exchanged between Control Expert (or other clients) and the simulator.

The other grayed displays of the front plate are not supported by the simulator.

Card Acc and Memory Card

The **Card Acc** and memory card are represented but they do not concern Modicon Momentum CPUs.

Reset

The **Reset** button is represented but it does not concern Modicon Momentum CPUs.

Power Cycle

With this button, you simulate a warm start of the CPU. It means that the connection between Control Expert and the simulator is broken, the current project variables remain and the simulator goes into the state RUN (autostart active) or STOP (autostart deactivated).

A power cycle corresponds to a power off and power on of a real power supply.

Simulation

Dialog box fields:

Host PC name:	DNS name of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Host IP address:	TCP/IP address of the host PC for the simulator. If the PC has multiple network cards, only the first is shown.
Project name:	Name of the project loaded in the simulator.

Clients Connected

The list shows current clients connected with the PC (PCs which are connected via TCP/IP with the host PC of the simulator, page 18). The DNS name and TCP/IP address are shown for each client.

Event Dialog

Introduction

You can open and close the event dialog with

- the menu command **Event dialog** in the context menu of the simulator symbol in the task bar or the simulator symbol
- the command button **Events** in the simulator dialog (only open)

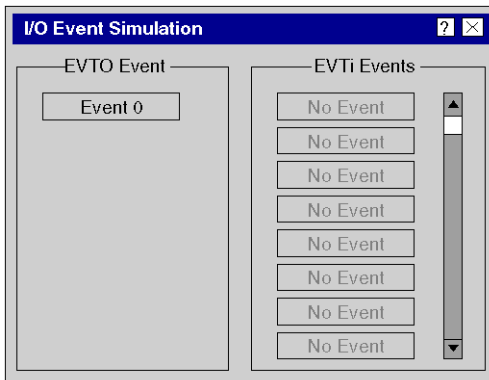
This dialog is not available for safety PLCs.

Selection Condition

The menu command and the command button are enabled if IO events are defined in the project currently loaded, i.e. if the project uses event tasks.

Representation

Event dialog:



EVT0 Event

Possible events for the EVT0 task are shown here. This user task has the highest priority in the system and can only contain one IO event.

If this task is part of the project, the event command button is enabled.

EVTi IO Event

Possible events for the EVTi IO task are shown here. The maximum number of tasks depends on the PLC simulated.

The event command buttons are enabled according to the number of events defined in the project.

Clear

Introduction

With **Clear**, you can remove the currently loaded project from the simulator memory and put the simulated PLC (and the simulator) into NOCONF status.

This corresponds to a cold start of the PLC without valid project loaded (the connection between Control Expert and the simulator is broken).

You can execute **Clear** with the menu command **Clear** in the context menu of the simulator symbol in the task bar.

Reset

Introduction

With **Reset**, you can reset the simulated PLC (and the simulator). This corresponds to a cold start of the PLC (the connection between Control Expert, the simulator is broken, project variables are reset and the simulator goes in RUN (if auto start is activated) or in STOP (if auto start is deactivated)).

Reset corresponds to the reset button on a real CPU.

You can execute reset with

- the menu command **Reset** in the context menu of the simulator symbol in the task bar or the simulator symbol
- the command button **Reset** in the simulator dialog.

NOTE: %S0 is not set to 1 using **Reset** with the PLC simulator (in contrast to a real PLC).

Power Cycle

Introduction

With **Power Cycle**, you execute a power cycle (power off/ power on) for the simulated PLC (and the simulator). This corresponds to a warm start of the PLC (the connection between Control Expert and simulator is broken and the current project variables remain).

A power cycle corresponds to the reset button of a Premium power supply or the unplugging and plugging in of a power supply.

You can execute a power cycle with

- the menu command **Power Cycle** in the context menu of the simulator symbol in the task bar or the simulator symbol
- the command button **Power Cycle** in the simulator dialog

NOTE: In case of a safety PLC, power cycle simulates a cold start. Project variables are reset.

Simulator Panel Options

Introduction

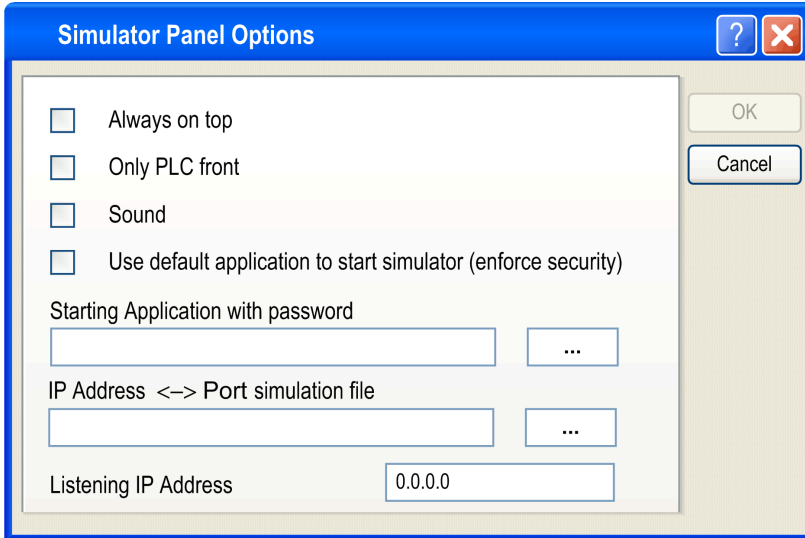
This chapter provides information on special settings for the PLC Simulator, including cyber security settings.

Description

In this dialog box, you can define special settings for PLC Simulator.

You can open the dialog box with the menu command **Options** in the context menu of the PLC Simulator symbol in the task bar or the PLC Simulator icon.

Representation



Always on top

If you activate this check box, the PLC Simulator control window is always on top of other dialog boxes and windows.

Only PLC front

If you activate this check box, the PLC Simulator control window is minimized and only the front plate of simulated controller is shown.

Sound

If you activate this check box, PLC Simulator plays a sound in the following situations:

- Starting and exiting PLC Simulator.
- Error in project.

Use default application to start simulator (enforce security)

If you activate this check box, the PLC Simulator needs an application with password to start, page 15.

NOTE: To help enforce security, you must select this checkbox. Otherwise, you may be vulnerable to cyber security issues.

Starting application with password

Path and name of the application with password used to start PLC Simulator.

NOTE: If you enter a path and application name, and the application does not contain a password, the PLC Simulator will not start.

IP Address <-> Port simulation file

Path and name of the port simulation file (*.xml) used to substitute IP address with port communication in a PLC Simulator instance, page 26.

Listening IP Address

When PLC Simulator runs on the same PC as the Control Expert instance, you should limit, for security reasons, to the following IP address: 127.0.0.1.

Use a Listening IP address of 0.0.0.0 to set PLC Simulator to listen to another Control Expert instance or controller on the network.

Timing (simulator)

Description

With this menu command, you can open and close the timing dialog box. This dialog box shows simulator statistics for CPU use, process priority and user scan time. Additionally, you can change the priority and the sleep time in this dialog box, to optimize simulator timing and adjust the PC load.

Representation of the dialog box

The dialog box 'Simulator Timing' is divided into four main sections:

- CPU Usage:** A list of processes with their respective CPU usage percentages and times. 'Mast' is selected with 0% usage and 1477s time. Other processes like 'Fast', 'Aux0-3', 'Evt0-3', and 'Safe' all show 0% usage and 0s time.
- User Task Data:** Contains two graphs. The first graph, 'Scantime for: MAST', shows a peak at 60% usage over a 5.0 ms period. The second graph, 'Sleeptime for: MAST', shows a peak at 45% usage over a 160.0 ms period. Below the graphs is a numerical value of 59301 and a 'Reset' button.
- Simulator Priority:** Radio buttons for 'Realtime (use with care)', 'High', 'Normal', and 'Low'. 'High' is selected. An 'Actual:' field shows 'HIGH' and an 'Apply' button is present.
- Minimum Sleep Time [ms]:** An 'Actual:' field shows '25' and a 'Set Point:' field also shows '25'. An 'Apply' button is present.

The dialog box consists of 4 main areas:

- Processor Load, page 66
- Priority of the Simulator, page 68
- Data in the User Task, page 69
- Minimum Sleep Time, page 71

Processor Load

Introduction

The processor load (on the PC) caused by the entire simulation and the individual user tasks is shown here.

Process

This bar graph shows the actual processor load caused by the simulator process in percent.

Unlike the display in the Windows task manager which only indicates the current value, this bar graph indicates the average value over the time shown at the end of the bar graph.

The time entry at the end of the bar graph is the time that has passed since the simulator was started or since the last time **reset** was pressed.

Overhead

This bar graph shows the average processor load caused by the simulator process overhead in percent.

The overhead is calculated as follows:

`load caused by the entire process - load caused by the user tasks`

This can be an absolute or relative value for the processor load caused by the simulator. This setting can be made in the **Display** area.

The time entry at the end of the bar graph is the time that has passed since the simulator was started or since the last time **Reset** was pressed.

Mast ... Ev1T, Safe

The bar graph shows the average processor load caused by the individual user tasks in percent.

These can be absolute or relative values for the processor load caused by the simulator. The representation method can be set in the **Display** area.

The option button at the beginning of the bar graph can be used to select a user task. The details for this user task will be displayed in the **User Task Data** area.

The time entry at the end of the bar graph is the time that has passed since the individual tasks were started or since the last time **Reset** was pressed.

NOTE: In case of a safety PLC, only the Mast and Safe tasks are enabled

Display: Absolute

If you activate this option button, the actual value is shown in the bar graph. This is shown as a percentage of the entire processor load for the PC.

Display: Relative

If you activate this option button, the relative processor load is shown in the bar graph. This is shown as a percentage of the processor load caused by the simulator.

Reset

If you press this command button, time measurements in this area are reset.

This is required to achieve a consistent representation of the times which have passed because the individual times are not started simultaneously when opening the simulator.

Priority of the Simulator

Introduction

In this area, you can define the priority of the simulator process.

It may be necessary to assign a high priority to the simulator because the cycle times of the individual user tasks can deviate greatly if there is a heavy load on the PC. These deviations are directly caused by the Windows operating system and can reach 100 ms with **Normal** priority. In most cases, the watchdog timer is also affected. In this case, setting the simulator priority higher can prevent the watchdog from being triggered.

Real-time

In this priority, user task cycle times only deviate by a few milliseconds.

NOTE: This priority should be used with care because the simulator has the highest possible priority in this case and interrupts the Windows system. If you use this priority with a very small sleep time and a cyclic user task, the PC may cease proper operation.

High

In this priority, user task cycle times normally do not deviate by more than 10 ms.

Normal

In this priority, user task cycle times can deviate up to several 100 ms.

Low

This priority quickly causes the watchdog to be triggered and should only be used on a PC with nearly no load.

Apply

If you press this command button, settings in this area are applied and used immediately.

Data in the User Task

Introduction

2 histograms are shown in this area

- the cycle time histogram for the selected user task
- the sleep time histogram for the selected user task

Structure of the Histograms

The histograms automatically adjust their ranges to the current values.

The percent scale (y-axis) is adjusted to the maximum percent value.

If a new value is not in the range for the time scale (x-axis), the range is increased by a factor of 2 until the new value is in the range. In this case, the previous values are recalculated for the new range.

If a value occurs so seldom that it does not create a peak in the histogram, then a one pixel peak is created so that the value can be seen.

Cycle time

This histogram shows the relative frequency of cycle time values in the user task currently selected. See also [Minimum Sleep Time](#), page 71

The counter to the left under the histogram counts the number of cycles in RUN mode represented in this histogram.

Sleep time

This histogram shows the relative frequency of sleep time values in the user task currently selected. See also [Minimum Sleep Time](#), page 71

For cycle tasks, normally a single value is shown with 100 %. This is the minimum sleep time for user tasks. If you change the value for the minimum sample time, a second peak is created for the new value.

User tasks cycles are included in this histogram (regardless of the PLC mode).

Cycle Counter

The counter to the left under the histogram counts the number of cycles in RUN mode represented in the cycle time histogram.

This counter has no meaning for the sleep time histogram because cycles are included there (regardless of the PLC mode).

Reset

If you press this command button, the histograms for the user task currently selected is reset and a new statistic is started.

Minimum Sleep Time

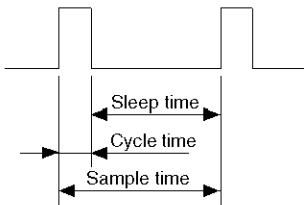
Description

The simulator is not the only thing running on the PC, therefore the other programs must be given a chance to be executed. Therefore the user task is assigned a fixed sleep time.

The sample time is calculated according to the following formula:

$$\text{Sample Time} = \text{Cycle Time} + \text{Sleep Time}.$$

Time of the user task



Legend

Time	Meaning
Sample time	Time which is made available for running the user task.
Cycle time	Time which is actually required for running the user task.
Sleep time	Time in which the other programs on the PC can be executed.

Minimum sleep time (ms)

A minimum sleep time of 10 to 100 ms can be set.

Apply

If you press this command button, the minimum sleep time is applied to the selected user task and used immediately.

Info

Description

With this menu command, you can open and close the info dialog box. This dialog box shows the current version of the simulator and its components.

Help

Description

With this menu command, you can open the online help for the simulator.

Ending the Simulation

Description

With this menu command, you can exit the simulator.

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