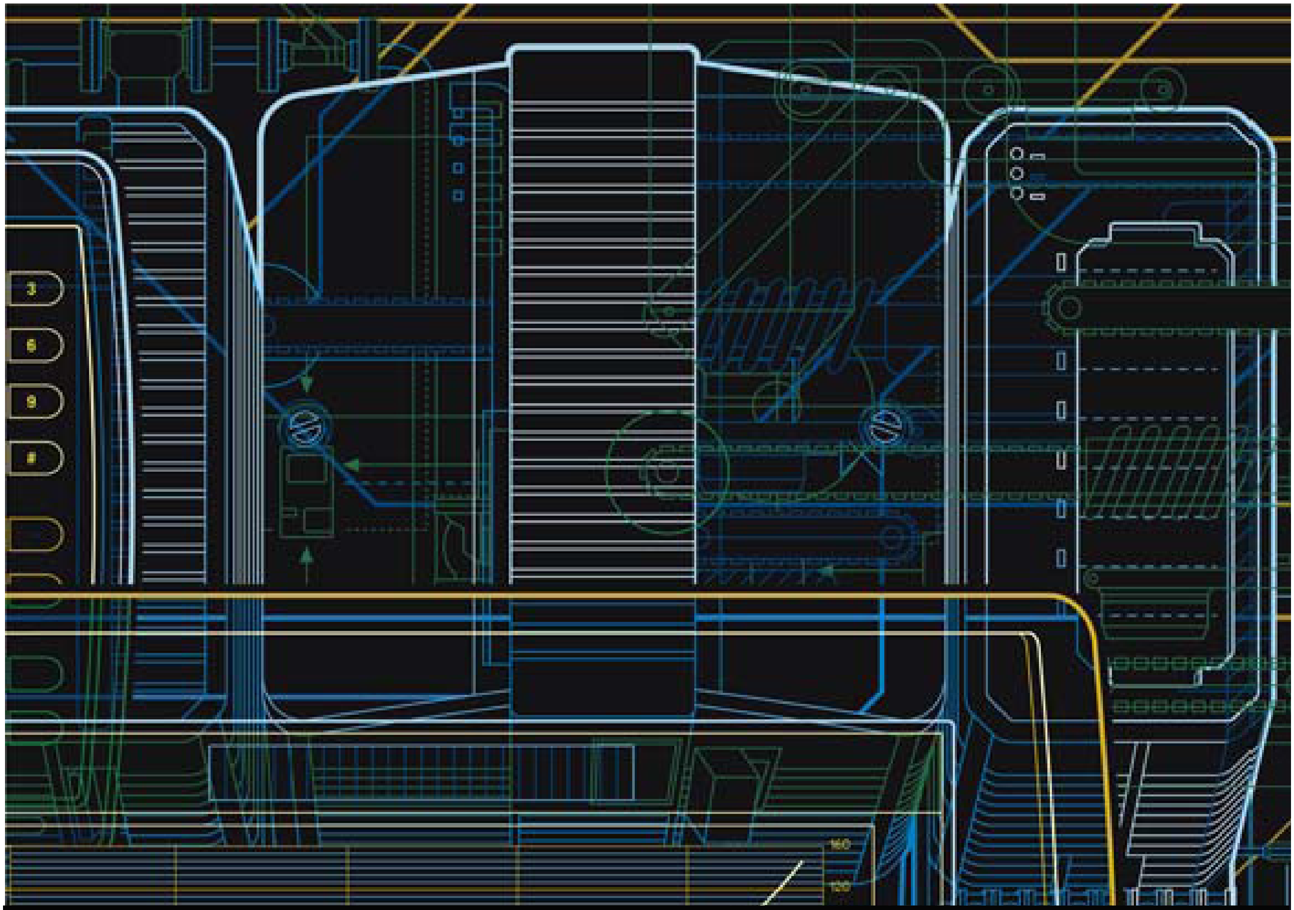

Compact Control Builder AC 800M

Configuration

Version 5.1.1

Power and productivity
for a better world™

Compact Control Builder AC 800M

Configuration

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Release: April 2013
Document number: 3BSE040935-511

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About This Book

General

This manual describes how to use the basic programming and configuration functions that can be accessed via the Project Explorer interface.

The libraries described in this manual conform to the IEC 61131-3 Programming Languages standard, except for control modules and diagrams, which are not supported by this standard.

- Section 1, Basic Functions and Components, describes all the basic functions that are available via system functions, Basic library, and commands in the Control Builder interface. This section also describes the type and object concept, and how variables and parameters are used.
- Section 2, Alarm and Event Handling, describes the types in the Alarm and Event library and how to use them to add alarm and event functions to objects that do not have alarm functionality built into them.
- Section 3, Communication, describes the types in the Communication libraries and how to use them to establish communication between controllers.
- Section 4, Online Functions, describes Control Builder functions in online mode.
- Section 5, Maintenance and Trouble-Shooting, describes Control Builder maintenance functions. It also describes how to write an error report, the location of various log files, how to read these log files, and how to fix some common problems.
- Appendix A, Array, Queue and Conversion Examples contains some examples on how to use queues and arrays, and how to convert numbers from one format to another.
- Appendix B, System Alarms and Events describes system alarms and system simple events from a controller perspective.

Document Conventions

Microsoft Windows conventions are normally used for the standard presentation of material when entering text, key sequences, prompts, messages, menu items, screen elements, etc.

Warning, Caution, Information, and Tip Icons

This publication includes **Warning**, **Caution**, and **Information** where appropriate to point out safety related or other important information. It also includes **Tip** to point out useful hints to the reader. The corresponding symbols should be interpreted as follows:

Electrical Warning icon indicates the presence of a hazard which could result in *electrical shock.*

Warning icon indicates the presence of a hazard which could result in *personal injury.*

Caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in *corruption of software or damage to equipment/property.*

Information icon alerts the reader to pertinent facts and conditions.

Tip icon indicates advice on, for example, how to design the project or how to use a certain function

Although **Warning** hazards are related to personal injury, and **Caution** hazards are associated with equipment or property damage, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, **fully comply** with all **Warning** and **Caution** notices.

Terminology

The following is a list of terms associated with Compact Control Builder. The user must be familiar with these terms before reading this manual. The list contains terms and abbreviations that are unique to ABB or have a usage or definition that is different from standard industry usage.

Term/Acronym	Description
Application	Applications contain program code to be compiled and downloaded for execution in a controller.
Control Builder	A programming tool with a compiler for control software. Control Builder is accessed through the Project Explorer interface.
Control Module (Type)	A program unit that supports object-oriented data flow programming. Control modules offer free-layout graphical programming, code sorting and static parameter connections. Control module instances are created from control module types.
Firmware	The system software in the PLC.
Hardware Description	The tree structure in the Project Explorer, that defines the hardware’s physical layout.
Industrial^{IT}	ABB’s vision for enterprise automation.
Interaction Window	A graphical interface used by the programmer to interact with an object. Available for many library types.
MMS	Manufacturing Message Specification, a standard for messages used in industrial communication.
OPC/DA	An application programming interface defined by the standardization group OPC Foundation. The standard defines how to access large amounts of real-time data between applications. The OPC standard interface is used between automation/control applications, field systems/devices and business/office application.

Term/Acronym	Description
Process Object	A process concept/equipment such as valve, motor, conveyor or tank.
Project Explorer	The Control Builder interface. Used to create, navigate and configure libraries, applications and hardware.
Type	A type solution that is defined in a library or locally, in an application. A type is used to create instances, which inherit the properties of the type.

Section 1 Basic Functions and Components

Introduction

Control Builder is a programming tool that contains:

- Compiler
- Graphical programming editors that provide graphical representation of the whole logic.
- Programming editors for IEC-61131 languages
- Standard libraries for developing controller applications
- Standard hardware types (units) in libraries for configuring the controller

The Control Builder tool also includes system firmware and common functions such as control system templates and task supervision. Most of the application development can be accomplished using the basic functions and components presented in this section.

This section is organized in the following manner:

- Control Project Templates on page 19 describes the different templates that can be used to create a project.
- Program Organization Units, POU on page 19 introduces the Program Organization Unit (POU) concept.
- System Firmware Functions on page 20 describes firmware functions included in the system, which can be used in any application.
- Hardware on page 22 describes the standard libraries for hardware types.
- Basic Library for Applications on page 28 describes the objects of the Basic library, which can be included in any project.

- Application Types and Instances on page 30 introduces the very important, object-oriented, types and objects concept. This subsection also describes how to add user defined types and how to create objects (instances) from types.
- Variables and Parameters on page 69 describes how to use parameters and variables to store and transfer values in the control system.
- Library Management on page 109 describes how to work with libraries.
- Hide and Protect Control Module Types, Function Block Types, Diagram Types, and Data Types on page 126 describes how to hide and protect objects and types, using the Hidden and Protected attributes.
- Task Control on page 129 describes how to set up tasks to control the execution of the applications.
- Overrun and Latency on page 142 describes how to configure latency control for the tasks.
- Task Analysis on page 150 describes the Task Analysis tool that detects the possible task overrun/latency problems in an application before its download to the controller.
- Search and Navigation on page 157 describes how to use the search and navigation function to find all instances of a type or to find out where a certain variable is used.
- Analog Input and Output Signal Handling on page 173 describes how to enable over and under range for input and output objects.
- Backup Media on page 176 describes how to use the Backup Media as a removable storage.
- Compiler Switches on page 187 describes how to use Compiler Switches to control the behavior of compiler.
- Reports on page 190 describes the function of the Difference Report and Source Code Report.
- Performance Management on page 200 describes how to gather information of the applications using the Compiler Statistics tool.

- Project Documentation on page 202 describes how to use the Project Documentation function to document standard libraries, user defined libraries, and applications in MS Word format.

Control Project Templates

A control project template sets up the necessary features required to build a project. The project consists of system firmware functions, basic library functions, application functions and a pre-set of hardware functions.

The Compact Control Builder provides the following project templates:

- **AC800M**
  Template for normal use, and for running applications.
- **EmptyProject**
  Template that requires a minimum configuration, with only the System folder inserted. This template is rarely used.
- **SoftController**
  Template for developing software for simulating applications without a controller.

Program Organization Units, POU

The IEC 61131-3 standard describes programs, function blocks, and functions as Program Organization Units (POUs). The Control Builder also considers control modules and diagrams as POUs. All these units are helpful in organizing the control project into code blocks, minimizing code writing, and optimizing the code structure and code maintenance.

A POU is an object type that contains an editor to write code and declare parameters and variables.

All POUs can be repeatedly used in a hierarchical structure, except for diagrams and programs that can only be a 'top-level' POU, inside an application.

1. Right-click the project name, and select **Refresh Project**.

System Firmware Functions

All system firmware functions are stored in the System folder, which is located at the top of the library branch (in Project Explorer).

The System folder is not a library, even though it is always shown in the library branch, together with the libraries (Basic library, Icon library, etc.)

The System folder contains fundamental IEC 61131-3 data types and functions, along with other firmware functions, which can be used in firmware in the controller. They are all protected and automatically inserted via the selected control system templates.

The System folder cannot be changed, version handled or deleted from a control project.

The system firmware functions that can be used in the application depends on the Firmware version. To upgrade the Firmware, replace the BasicHWLib with the latest version.

Table 1 contains the System firmware data types and functions. Refer the Control Builder online help for more information and description.

💡 To access the detailed online help and how-to-do instructions for a system firmware function, select the data type or function, and press the F1 key.

Table 1. System Function Overview

System Functions	Examples
Simple Data Types	bool, dint, int, uint, dword, word, real, etc.
Structured Data Types	time, Timer, date_and_time, etc.
Common Library Data Types	Open structured data types like, BoolIO, DintIO, DwordIO, RealIO, HWStatus, SignalPar, etc.
Bit String Operations	and, or, xor, etc.
Relational and Equality Functions	Equal to, Greater than, etc.
Mathematical Functions	Trigonometric, Logarithmic, Exponential and Arithmetic Functions.
Data Type Conversion	Conversion of bool, dint, etc.
String Functions	Handles strings like, inserts string into string, deletes part of a string, etc.
Exception Handling	Functions for handling zero division detection integer and real values.
Task Functions	SetPriority, GetPriority, etc,. Handles the priority of the current task.
System Time Functions	Exchanging time information between different systems.
Timer Functions	Functions to Start, Stop and Hold Timers.
Random Generation Functions	Functions for generating random numbers or values.
Variable Handling Functions	Reads and writes variable values. Provides status information of communication variables.

Table 1. System Function Overview (Continued)

System Functions	Examples
Array Functions	Handles arrays.
Queue Functions	Handles queues.

Hardware

All hardware is defined as hardware types (units) in Control Builder. The hardware types reflect the physical hardware in the system.

Hardware types are organized and installed as libraries. This makes it possible to handle hardware types independently, with the following advantages:

- Since the libraries are version handled, different versions of the same hardware type exist in different versions of the library. This makes it easy to upgrade to newer system versions and also allows coexistence of new and old hardware units.
- The new versions of a library (along with the hardware types) can be easily delivered and inserted to the system.

  A number of standard libraries with hardware types are delivered with the system. A standard library is write protected and cannot be changed
- Only used hardware types allocate memory in the controller.

Standard System Libraries with Hardware

The standard system libraries with hardware are delivered by the system. Table 2 describes the standard libraries with hardware.

Table 2. Standard system libraries with hardware

Library	Description
ABBDrvFenaCI871HwLib	Optional device for ABB drives, which enables the connection of the drive to a PROFINET IO network.
ABBDrvNpbaCI854HwLib	ABB Drive NPBA and subunits for PROFIBUS
ABBDrvRetaCI871HwLib	Optional device for ABB drives, which enables the connection of the drive to a PROFINET IO network.
ABBDrvFpbaCI854HwLib	ABB Drive FPBA and subunits for PROFIBUS DP
ABBDrvRpbaCI854HwLib	ABB Drive RPBA and subunits for PROFIBUS
ABBMNSiSCI871HWLIB	Motor control center solution that can be used in PROFINET IO network.
ABBPnl800CI854HwLib	ABB Panel 800 for PROFIBUS
ABBProcPnlCI854HwLib	ABB Process Panel for PROFIBUS
BasicHWLib	Basic controller hardware types for AC 800M and SoftController
CI853SerialComHwLib	RS-232C serial communication interface
CI854PROFIBUSHwLib	Communication interface PROFIBUS DP-V1
CI855Mb300HwLib	Communication interface MasterBus 300
CI856S100HwLib	Communication interface S100 I/O system and S100 I/O units
CI857InsumHwLib	Communication interface INSUM
CI858DriveBusHwLib	Communication interface DriveBus

Table 2. Standard system libraries with hardware

Library	Description
CI865SattIOHwLib	Communication interface for remote I/O connected via ControlNet
CI867ModbusTcpHwLib	Communication interface MODBUS TCP
CI868IEC61850HwLib	Communication interface IEC 61850
CI869AF100HwLib	Communication interface for AF 100
CI871PROFINETHwLib	Communication interface CI871
CI872MTMHwLib	Communication interface for MOD5-to-MOD5
CI873EthernetIPHWLib	Communication interface EtherNet/IP
ModemHwLib	Modem unit
PrinterHwLib	Printer unit
S200IoCI854HwLib	S200 adapter and S200 I/O units for PROFIBUS
S800CI830CI854HwLib S800CI840CI854HwLib S800CI801CI854HwLib	S800 adapters and S800 I/O units for PROFIBUS
S800IoModulebusHwLib	S800 I/O units for ModuleBus
S900IoCI854HwLib	S900 adapter and S900 I/O units for PROFIBUS
SerialHwLib COMLIHWLib ModBusHWLib S3964HWLib TCPHwLib UDPHwLib	Hardware libraries for direct controller communication with external hardware, using different communication protocols

For a complete list of the hardware types in the standard libraries, see Control Builder online help.

Customized Hardware Types

Customized hardware types can be created in user-defined libraries, using the Device Import Wizard. This is useful when the hardware types found in the standard system libraries or the Device Integration Library are not sufficient.

The Device Import Wizard imports a device capability description file (for example, a *.gsd file), converts the file to a hardware type, and inserts the type into the user-defined library (See Create Libraries on page 114. Also see Device Import Wizard on page 120 and Supported Device Capability Description Files on page 120).

In exceptional cases, it may be relevant to insert individual external customized hardware types to a user-defined library (for example, to use a specific hardware type, which have been converted and used in an earlier version of Control Builder).

The Source Code Report can be used to view the hardware types loaded in the project. See Source Code Report on page 194.

Configuring the Controller

Before configuring the controller:

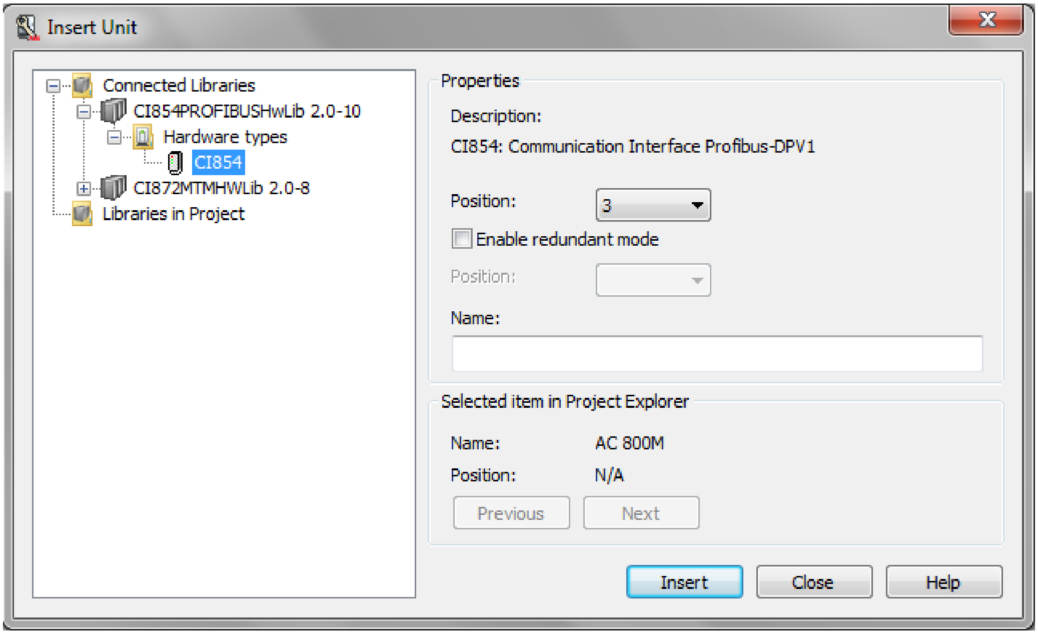
1. Insert the libraries, which contain the hardware types (units) to be used in the controller configuration, into the control project.
2. Connect the libraries to the controller.

See Connect Libraries on page 110 for information on how to insert and connect libraries.

Add Unit to Hardware in Controller Configuration

Perform the following steps to add a new hardware unit into the controller configuration in Project Explorer:

1. Make sure that the library, which contains the hardware type to be added, is inserted to the project and connected to the controller.
2. Right-click the unit to which a new hardware unit is to be added, and select **Insert Unit** to open the Insert Unit dialog.



Insert Unit

- Connected Libraries
  - CI854PROFIBUSHwLib 2.0-10
    - Hardware types
      - CI854
  - CI872MTMHWLib 2.0-8
- Libraries in Project

Properties

Description:

CI854: Communication Interface Profibus-DPV1

Position: 3

□ Enable redundant mode

Position:

Name:

Selected item in Project Explorer

Name: AC 800M

Position: N/A

Figure 1. Insert Unit dialog for inserting hardware in a controller configuration

It is not possible to select **Insert Unit** if the unit cannot contain any sub-units or if no more positions are available.

3. Expand the relevant library folder under **Connected Libraries**, and select the hardware type to be included.

The **Libraries in Project** contains libraries that are added to the project but not yet connected to the controller. If a unit is selected under **Libraries in Project**, the option to connect the library to the controller appears.

4. From the **Position** drop-down list, select a position for the hardware unit.

   By default, the first available position is chosen. If no more positions are available, the Position drop-down list is empty and the **Insert** button is disabled.

5. For units supporting redundancy, check the **Enable redundant mode** check box, and select a position for the backup unit.

Some redundant units have a fixed position offset. For these units, the backup position is automatically calculated, and the user cannot change this position.

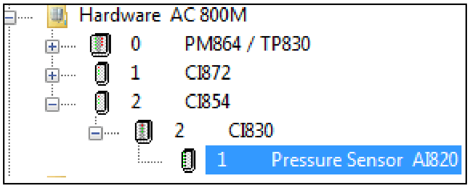
Click **Previous** or **Next** to navigate to another unit in the Project Explorer hardware tree.

6. In the **Name** field, enter a name for the unit. After the unit is inserted in the hardware tree, this name appears along with the name of the selected type.

7. Click **Insert** to apply the changes made.

8. Click **Close** to close the dialog.

To rename the unit after it is inserted, right-click the unit, and select **Rename Unit**.



```
Hardware  AC 800M
    0   PM864 / TP830
    1   CI872
    2   CI854
        2   CI830
            1   Pressure Sensor  AI820
```

Figure 2. Example of a hardware tree with a name for the AI820 unit

Replace Hardware in a Controller Configuration

Perform the following steps to replace a hardware unit in a controller configuration:

1. Make sure that the library, which contains the hardware type to be added, is inserted to the project and connected to the controller.

2. Right-click on the unit to be replaced, and select **Replace Unit** to open the Replace Unit dialog.

The Replace Unit dialog works in the same way as the Insert Unit dialog, except that it is not possible to change the position of the unit in the Replace Unit dialog.

While the hardware unit is being replaced in a controller configuration, the system retains the settings and connections, and also retains the units in the existing subtrees. For example, replacing a CPU with a similar one can be done without any connection loss or data loss.

Basic Hardware

The BasicHwLib contains standard system hardware types that are used when configuring the AC 800M controller and SoftController. The standard system hardware types are installed along with the Control Builder.

Only one version of BasicHwLib can be connected to a controller.

The BasicHwLib contains the following basic controller hardware:

- Controllers (AC 800M and SoftController)
- Compact Flash (CF) units
- Secure Digital (SD) units
- CPU units (PM8xx and CPU)
- Ethernet links, serial Com ports, and PPP ports
- ModuleBus
- IP
- IAC MMS

Basic Library for Applications

The Basic library contains basic building blocks for AC 800M control software. It contains data types, function block types and control module types with extended functionality, designed by ABB.

The contents inside the Basic library can be categorized as follows:

- IEC 61131-3 Function Block Types.
- Other Function Block Types.
- Control Module Types.

For a complete list of data types, function block types, and control module types in the Control Builder standard libraries, refer to the manual *Compact 800 Engineering Compact Control Builder AC 800M Configuration (3BSE040935*)*

Table 3. Basic Library Overview

Basic Functions	Examples
IEC 61131-3 Function Block Types	Standard bistable function block types (SR, RS). Standard edge detection function block types (R_TRIG, F_TRIG). Standard counter function block types (CTU, CTD, etc.) Standard timer function blocks type (TP, TOn, etc.)
Other Function Block Types	ACOF (Automatic Check Of Feedback) functions, converters, pulse generators, detectors, system diagnostics, timers, compares, etc.
Control Module Types	Connection module for group start sequences (GroupStartObjectConn), ControlConnection inputs and outputs, Error Handler, Forced Signals, and acknowledgment of ISP values for communication variables.

Application Types and Instances

Types and instances form the basis of the application structure. This subsection contains an overview of the following:

- The type and instances concept, see Types and Instances - Concept on page 31.
- The editors that are used to create and configure the types, see Define a Type in the Editor on page 32.
- Important differences between control module types, function block types, and diagram types, see Control Module Types, Function Block Types, and Diagram Types on page 41.
- How to create types directly in an application, and how to create types in the library for re-use in applications. See Types in Applications on page 43 and Types in User defined Library on page 44.
- How to create complex types so that they are flexible enough for future upgrades, see Modify Complex Types on page 45.
- What to consider and what to set up before creating types and using them, see Decisions When Creating Types on page 53.
- How to create objects from types and connect the object to the surrounding application or type, see Create and Connect Instances on page 54.
- Details about diagrams and diagram types, see Diagram and Diagram Types on page 46.
- How different objects are executed, see Function Block Execution on page 59, Control Module Execution on page 62, and Diagram Execution on page 63.
- How to use single control modules as containers for control modules, see Single Control Modules on page 65.

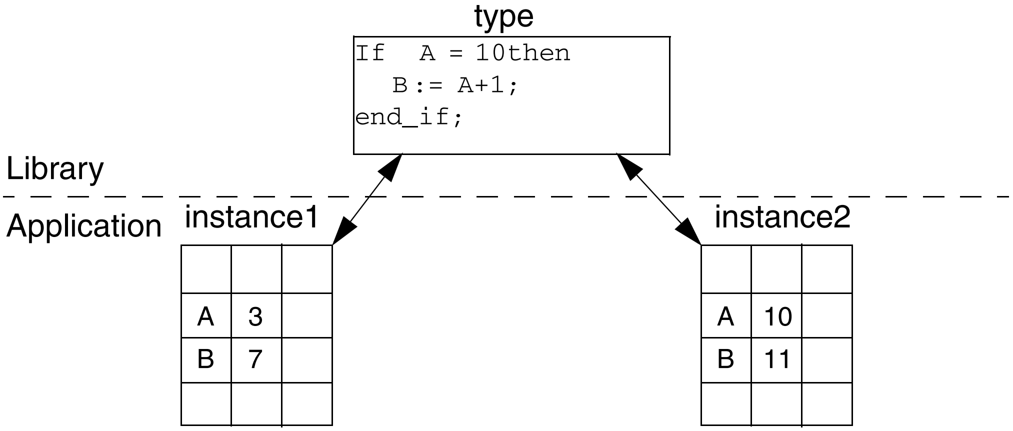
Types and Instances - Concept

Types are used to represent motors, valves, tanks, etc. that are located in a plant area, and then turn them into manageable units in a control project (for example, motor types, valve types, mixer types, and so on). Instances are created based on each of these types.

A type is the source (the blue print) for a unit (motor, valve, tank, etc), while an instance represents the unit(s) in libraries and applications. There is an inherited mechanism between a type and all its instances, where all instances have the same performance as the type, and changes performed in the type affect all instances simultaneously.

A type is a generic solution, which can be used by many instances, and contains programming code with variables, functions, connection parameters (textual and graphical), graphical instances, and formal instances[1].

Figure 3 shows the relationship between a type located in a library and two instances created in an application.



```
If  A = 10then
   B := A+1;
end_if;
```

A	3	
B	7	

A	10	
B	11	

Figure 3. Relationship between a type and two instances.

The type contains the code, whereas each instance contains a list of computed variable values. The instance does not contain any code; it uses the code inside the type for manipulating its own local variable values.

[1] Formal instances are instances of another type located inside a type. These, along with instances based on that type are executed in applications.

A type is always static and cannot run by itself in applications. To execute the code inside the type, an instance based on the type (an instance) must be created. The instance executes the code located inside the type. To create an instance, point to a type either in a library or in an application.

All instances based on the same type have the same characteristics, which means they have equal access to everything in the type. An instance does not contain a programming editor or code blocks; hence the code cannot be written inside an instance. All logic must be created in the type.

The allocated memory for creating a type solution (for example, a motor type solution that contains one motor type and 20 motor instances) is distributed mainly on the programming code inside the type. Therefore, the cost (allocated memory) for each new instance (motor) is very small, compared to the type itself. The instance only needs to allocate memory for variables, as the code is located and executed from the type. However, the number of instances are relevant for considering the total CPU memory.

It is easier to update the application while working with newer version of types, since the inherited mechanism takes care of changes that often concern hundreds of instances. A code change (for example, declaring additional connection parameters) can be done once for the type, and this change is inherited by all instances simultaneously.

Control Builder also contains a number of structured data types. For more information, refer to the Application Programming manual. A type described in this sub-section is a function block type, a control module type, or a diagram type.

Define a Type in the Editor

Select the type from Project Explorer and open the corresponding Editor to declare the necessary parameters for the type.

The editor of a type contains several declaration panes that can be opened from the following tabs:

- Parameters
- Variables
- Function Blocks

- Control Modules (only for diagram type editors)
- Diagrams (only for diagram type editors)

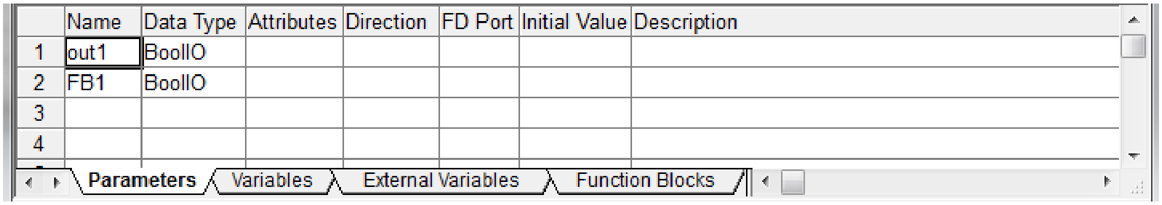
Apart from the declaration panes, the editor contains:

- Programming editor for programming the code using IEC-61131 languages (see Figure 10).
- Graphical editor called CMD Editor (only for control module types, see Figure 13).
- Graphical programming editor for FD (Function Diagram) (only in diagram type editor, see Figure 12)

Declaration Pane for Parameters

To open the declaration pane for parameters, double-click the type (to open the editor), and then select the **Parameters** tab.

Figure 4 shows the editor for My_MotorType, with the declaration pane for parameters selected. These parameters can be used for connecting variables outside the instance.



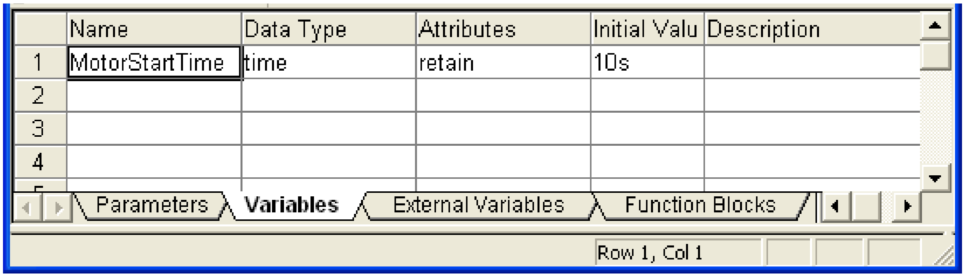
	Name	Data Type	Attributes	Direction	FD Port	Initial Value	Description
1	out1	BoolIO					
2	FB1	BoolIO					
3							
4							

Figure 4. Declaration pane for creating connection parameters

Declaration Pane for Local Variables

To open the declaration pane for variables, double-click the type (to open the editor), then select the **Variables** tab. If the editor is already open, simply select the **Variables** tab.

Figure 5 shows the declaration pane for creating local variables inside the type. The local variables can be used by the code inside the type.



	Name	Data Type	Attributes	Initial Valu	Description
1	MotorStartTime	time	retain	10s	
2					
3					
4					

Figure 5. The declaration pane for creating local variables

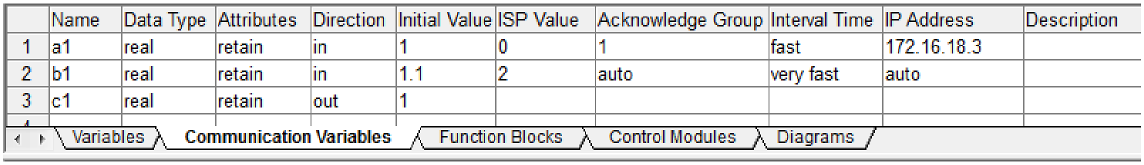
Declaration Pane for External Variables

External variables are pointers to global variables. An instance can declare an external variable locally and then use this variable to access the value in a global variable located in the application. External variables and global variables are discussed in External Variables on page 81.

Declaration Pane for Communication Variables

Communication variables are declared in top level Diagram editor, Program editor, or top level Single Control Module editor. For details about communication variables, see Communication Variables on page 86.

Figure 6 shows the declaration pane for communication variables in a Diagram editor.



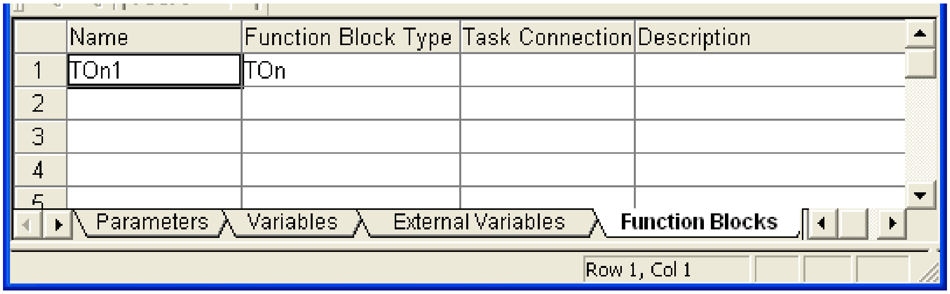
	Name	Data Type	Attributes	Direction	Initial Value	ISP Value	Acknowledge Group	Interval Time	IP Address	Description
1	a1	real	retain	in	1	0	1	fast	172.16.18.3	
2	b1	real	retain	in	1.1	2	auto	very fast	auto	
3	c1	real	retain	out	1					

Figure 6. Declaration pane for communication variables

Declaration Pane for Function Blocks

To open the declaration pane for function blocks, double-click the type (to open the editor), and select the **Function Blocks** tab. If the editor is already open, simply select the **Function Blocks** tab.

Figure 7 shows the declaration pane for declaring function blocks inside the type.



	Name	Function Block Type	Task Connection	Description
1	TOn1	TOn		
2				
3				
4				
5				

Figure 7. Declaration pane for creating function blocks inside a type

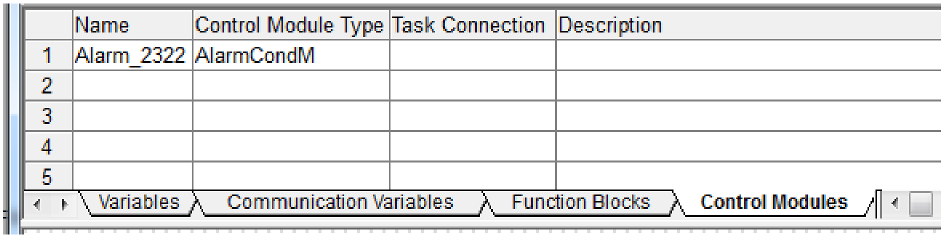
Enter the name of the function block in the Name column, and select the cell in the Function Block Type column. Press CTRL+J to open a context menu with all function block types available.

Connect all libraries with the required function blocks types to the application. Only then, the available function block types are listed in the context menu (CTRL+J)

Declaration Pane for Control Modules

To open the declaration pane for control modules, double-click the diagram or diagram type (to open the editor), and select the **Control Modules** tab. If the editor is already open, select the **Control Modules** tab.

Figure 8 shows the declaration pane for declaring control modules inside the diagram or diagram type.



	Name	Control Module Type	Task Connection	Description
1	Alarm_2322	AlarmCondM		
2				
3				
4				
5				

Figure 8. Declaration pane for creating control modules inside a diagram type

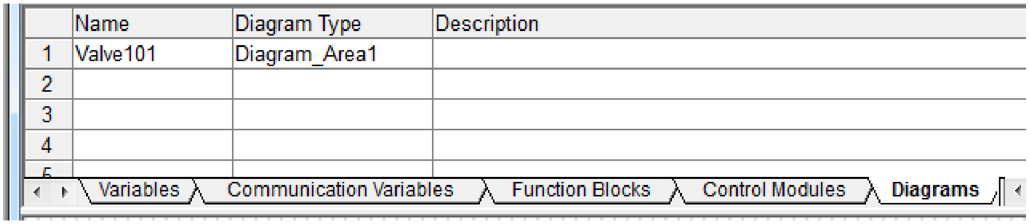
Enter the name of the control module in the Name column, and select the cell in the Control Module Type column. Press CTRL+J to open a context menu with all control module types available.

Connect all libraries with the required control module types to the application. Only then, the available control module types are listed in the context menu (CTRL+J).

Declaration Pane for Diagrams

To open the declaration pane for diagrams, double-click the diagram type or diagram (to open the editor), and select the **Diagrams** tab. If the editor is already open, select the **Diagrams** tab.

Figure 9 shows the declaration pane for declaring diagrams inside the diagram type or diagram.



	Name	Diagram Type	Description
1	Valve101	Diagram_Area1	
2			
3			
4			
5			

Figure 9. Declaration pane for creating diagrams inside a diagram type

Enter the name of the diagram in the Name column, and select the cell in the Diagram Type column. Press CTRL+J to open a context menu with all diagram types available.

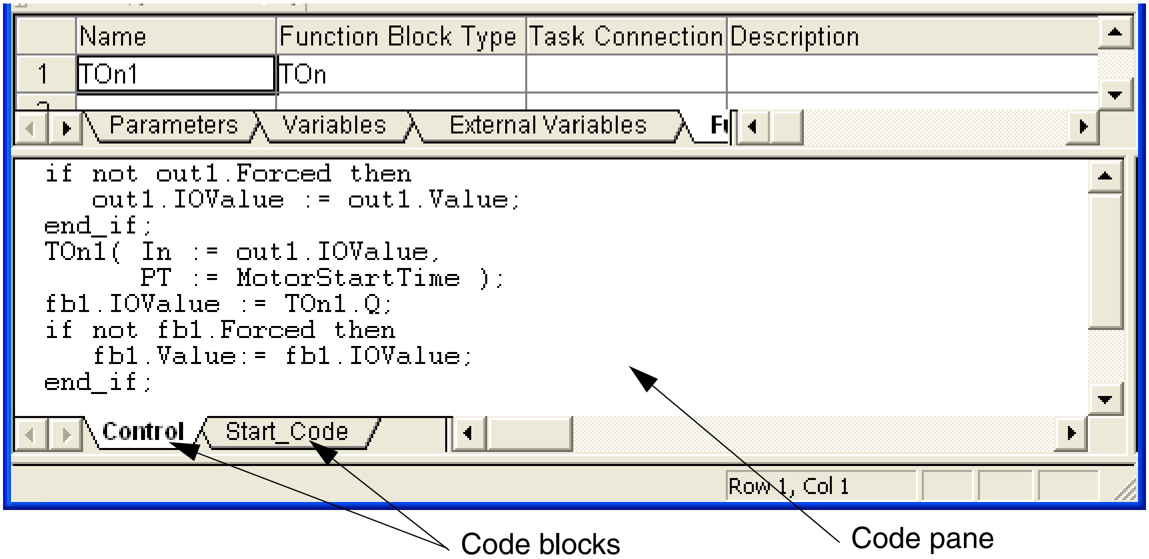
Connect all libraries with the required diagram types to the application. Only then, the available diagram types are listed in the context menu (CTRL+J).

Code Pane for Control Module Types and Function Block Types

The code pane in the editor for programs, control module types, function block types, and single control modules supports five programming languages that conforms to the IEC 61131-3 standard. The code pane is always active, and can be accessed irrespective of which tab is selected (parameters, variables, function blocks, etc.).

The code pane can be expanded using more code blocks for structuring the code. These code blocks are then executed either in a predetermined order as decided by the compiler (control modules), or from left to right (function blocks).

Figure 10 shows a part of the code pane of a control module type editor. This code block uses Structured Text (ST) as the language. This editor contains two code blocks: Control and Start_Code.



	Name	Function Block Type	Task Connection	Description
1	TOn1	TOn		

```
if not out1.Forced then
   out1.IOValue := out1.Value;
end_if;
TOn1( In := out1.IOValue,
      PT := MotorStartTime );
fb1.IOValue := TOn1.Q;
if not fb1.Forced then
   fb1.Value:= fb1.IOValue;
end_if;
```

Figure 10. A code pane with two code blocks.

A brief description of code blocks in general and *Start_* code blocks :

- Code blocks are very useful for structuring the code. Dividing the programming code into a number of code blocks, improves the overall code structure and readability. Examples of code blocks are Control, Object Error, Operators, etc.

Code block names cannot contain certain characters. See Online help for information on characters that cannot be used in code block names.

- There is no limit to the number of code blocks that can be created in a type. Create only the required number of code blocks, since each code block affects the memory consumption and the execution time of the type.
- *Start_*

  A code block with the prefix *Start_* is always executed first in an application and only once, at the application startup (after a warm and cold start, but not after a power failure).

The *Start_* code block is valid only for single control modules and control module types.

  This code block must be used for initiating alarm strings, converting project constants to strings, etc.

  However, there are some limitations while using the *Start_* code block:

  – It is not suitable to place functions, function blocks, etc, in a *Start_* code block.

  – It is valid only for the code blocks in control modules, and not for the code blocks in SFC (Sequential Function Chart).

  – The FirstScanAfterApplicationStart function must not be used in the block.

  – Function blocks for communication must not be used in the block.

If the application contains a very large chunk of code that has to be run in the first scan (for example, alarms in the *Start_* code block), the execution time can be so high that overrun occurs. This leads to the eventual shut-down of the controller.

Code Block Context Menu

Right-click a code block tab to access the code block context menu.

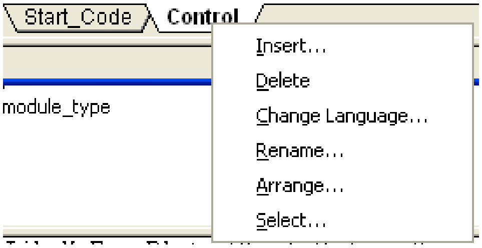


Figure 11. Code block context menu

Graphical Code Pane for Diagram Types

The code pane in the editor for diagram type supports the FD (Function Diagram) language. The FD code block in this editor allows mixing of functions, function blocks, control modules and other diagrams, through graphical connections, to create the logic. Variables and parameters can also be connected graphically. This represents a complete graphical overview of the whole logic.

The FD code block is always active, and can be accessed irrespective of which tab is selected in the declaration pane (parameters, variables, function blocks, control modules or diagrams).

The logic created in the default FD code block can be expanded using optional ST and SFC code blocks, which can be invoked in the FD code block or sorted separately.

To open this editor, right-click the diagram type, and select Editor. Figure 12 shows an example logic created in the FD code block of diagram type editor.

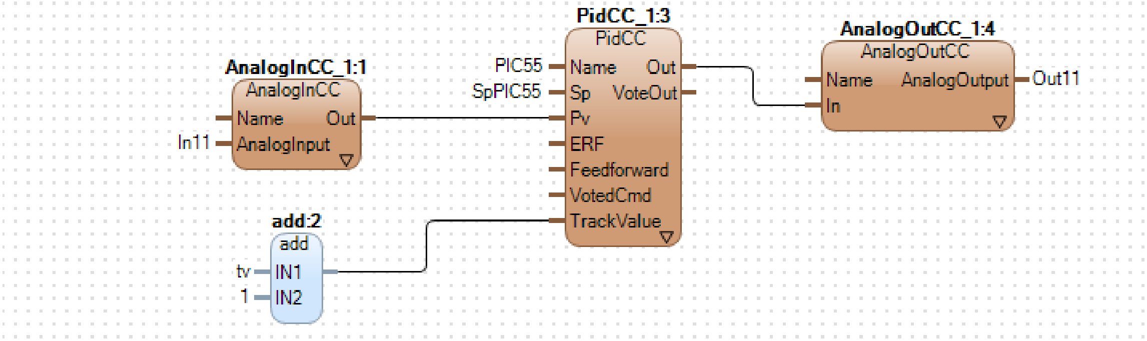


Figure 12. Example logic created in the graphical code pane of diagram type editor

Graphical Editor - CMD Editor

The graphical editor, Control Module Diagram Editor (CMD Editor) is also a combined editor for drawing and programming. The term ‘diagram’ refers to the graphical view of control modules and connections.

Use this editor to create and edit control modules, code, and graphics, and to connect variables and parameters.

To open the CMD Editor, right-click the control module type and select CMD Editor. Figure 13 shows part of the graphical editor (CMD Editor).

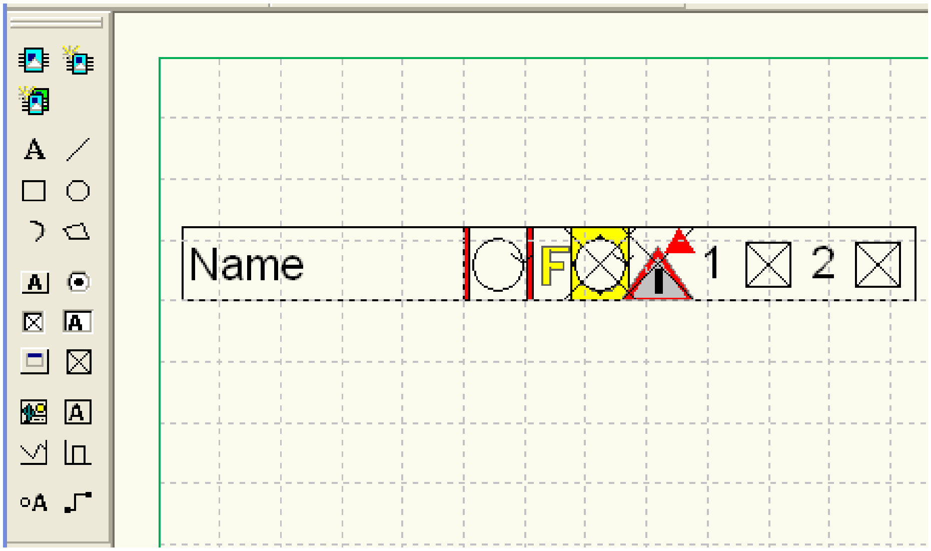


Figure 13. Graphical objects created in the CMD Editor.

The drawing functions in the CMD editor include basic auto shapes (lines, rectangles, etc.), ready-to-use interaction instances (option buttons, check boxes, etc.), and composite instances (trend graphs, string selectors, etc.). The graphical instances are dynamic, that is, with changing variable values, the points move, colors change, and numerical values are presented.

Control Module Types, Function Block Types, and Diagram Types

A type can be a control module type, a function block type or a diagram type. The usage of different types can be mixed. For example, a control module can be created inside a function block type (to add graphics), or a function block can be created inside a control module type (to execute a list of basic functions). In a diagram type, it is possible to create function blocks, control modules, and diagrams, to define the entire logic.

Table 4. Differences between types

Property	**Differences**		
	Function Block Type	**Control Module Type**	**Diagram Type (supports mixing function blocks, control modules, and nested diagrams)**
Container POU inside the application	Programs, Diagrams or Single Control Modules	Diagrams or Single Control Modules	Diagrams
Graphical connections between objects	Yes	Yes	Yes, including graphical connection to parameter/variable objects.
Code sorting	No	Yes	Yes. All code blocks, in control modules inside the diagram type, are sorted together with the code blocks outside the diagram type in the container Diagram.
Execution	Function blocks are executed from code. Therefore, a function block is executed once or several times per scan, or it is not executed at all.	Control modules are executed only once per scan.	The execution order shown in the diagram is followed. Codeblocks from control modules are sorted into the diagrams execution order according to control module sorting rules (writing into a variable is sorted before a read).

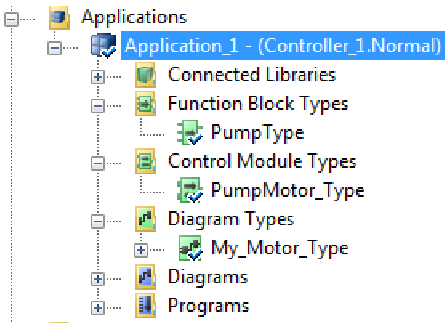
Additionally, the following properties apply to function block types:

- Parameter values on function block types are copied (except In_Out parameters and parameters having by_ref attribute, see Function Block Execution on page 59).
- Function block types are required when using extensible parameters (see Extensible Parameters in Function Blocks on page 107).

The choice between control module types, function block types, and diagram types depends on the context and environment. For guidelines about the use of control modules, function blocks and diagrams, refer to the Application Programming manual.

Types in Applications

Creating a type in an application is the quickest and easiest way to get started. Before creating types in an application, no new libraries need to be created; use the available methods like connect libraries, create user defined data types, and select the object type to use (see Decisions When Creating Types on page 53). However, if a type is created directly in an application, it can only be used inside that application.



- Applications
  - Application_1 - (Controller_1.Normal)
    - Connected Libraries
    - Function Block Types
      - PumpType
    - Control Module Types
      - PumpMotor_Type
    - Diagram Types
      - My_Motor_Type
    - Diagrams
    - Programs

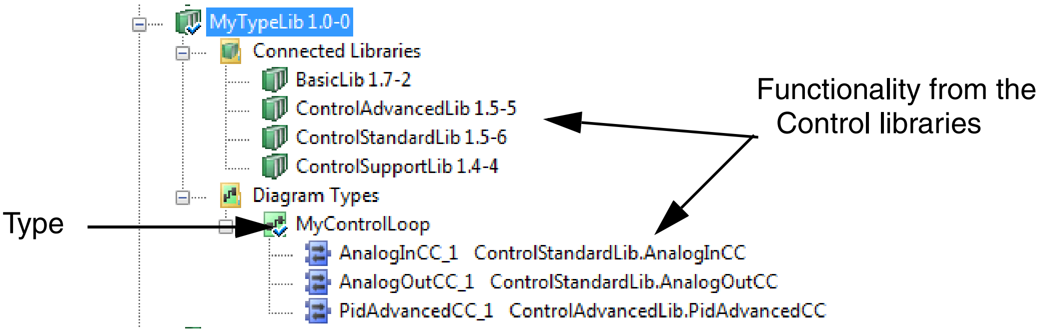
Figure 14. Types created under an application

To gain access to standard libraries (or user defined libraries), insert them into the control project (see Library Management on page 109), and connect them to the application. This allows the creation of instances in the application, from existing types in the connected libraries.

Types in User defined Library

The advantage of creating types inside a library, instead of creating them directly in an application, is the possibility to re-use them in other applications. If the types are created in a library, all the necessary functionality can be stored in this library. The library can then be connected to any application.

If a new library is created, user defined types can be created in that library (Compact Control Builder does not allow creation of types in a standard library).



MyTypeLib 1.0-0
Connected Libraries
BasicLib 1.7-2
ControlAdvancedLib 1.5-5
ControlStandardLib 1.5-6
ControlSupportLib 1.4-4
Diagram Types
MyControlLoop
AnalogInCC_1 ControlStandardLib.AnalogInCC
AnalogOutCC_1 ControlStandardLib.AnalogOutCC
PidAdvancedCC_1 ControlAdvancedLib.PidAdvancedCC

Type

Functionality from the
Control libraries

Figure 15. A Type (MyControlLoop) created in MyTypeLib library. This example shows a control loop created as a diagram type, while the components are ready-made instances from the standard libraries

Modify Complex Types

This subsection describes a use case where it is preferable to copy two types, instead of keeping a single and very large type in a library.

Refuse Incinerator Type - Problem

In this example, assume that a plant area has two identical refuse incinerators.

A type solution like this is manageable if a Refuse Incinerator type is created in a library with several underlying types. This type can then be re-used twice (as two objects), in two separate applications, by connecting the library to each application.

The following are the examples of underlying types inside the Refuse Incinerator type:

- A Feeder type containing 10 conveyors.
- A Combustion type.
- An Ash Handling type.
- A Flue Gas type.

After building the Refuse Incinerator type in the library, connect the library to both Application_1 and Application_2. This helps in creating an Incinerator1 instance in Application_1 and an Incinerator2 instance in Application_2.

If the Incinerator2 instance running in Application_2 suddenly needs an individual change (for example, 20 conveyors instead of 10 conveyors), edit the library and change the Feeder type inside the Refuse Incinerator type. But, changing anything inside the Refuse Incinerator type affects both incinerators due to the type and instance inherit mechanism.

By changing the Feeder type to include 20 conveyors, both the Incinerator instances are changed suddenly to contain 20 conveyors, which is not the intended use.

Refuse Incinerator Type - Solution

To avoid the problem, once the type is ready, consider the possible individual (instance) changes in the future. If an individual instance needs to be changed, copy the type on the highest type level (in this example, Refuse Incinerator Type1 and Refuse Incinerator Type2).

Create an Incinerator10 instance in Application_1, based on Refuse Incinerator Type1, and then create an Incinerator20 instance in Application_2, based on the new type copy, Refuse Incinerator Type2. This increases the memory consumption in the controller, but allows individual changes. For example, the number of conveyors in the feeder for one of the applications can be changed, without affecting the other.

Diagram and Diagram Types

Diagrams are created under an application, and diagram types (which can be reused as instances in a diagram) are created under a library or under the same application as the diagram.

The FD code blocks in diagrams and diagram types allow mixing of functions, function blocks, control modules, and other diagrams, and graphically connect them to achieve a particular logic.

Figure 16 shows the workflow for using diagrams and diagram types.

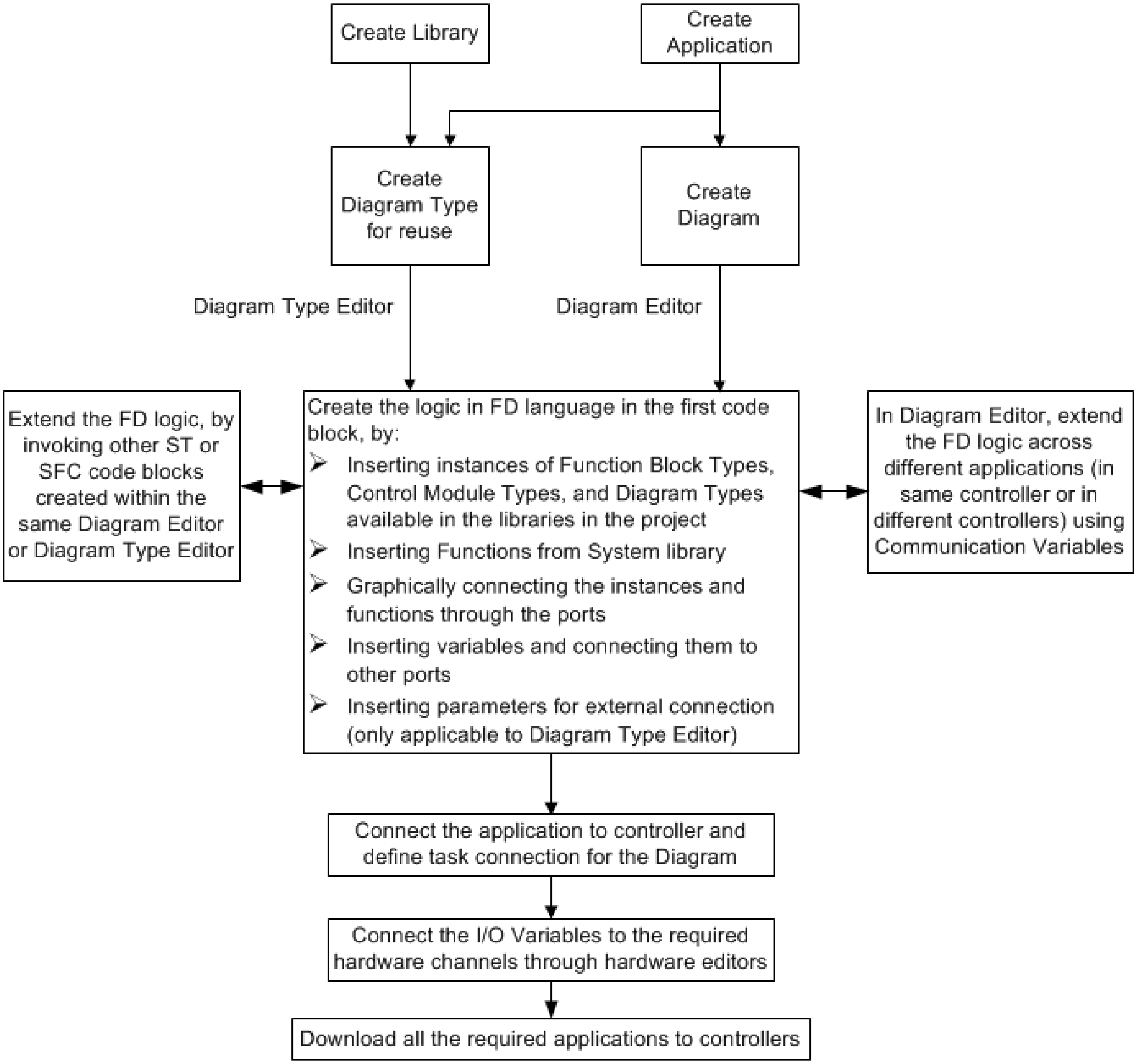
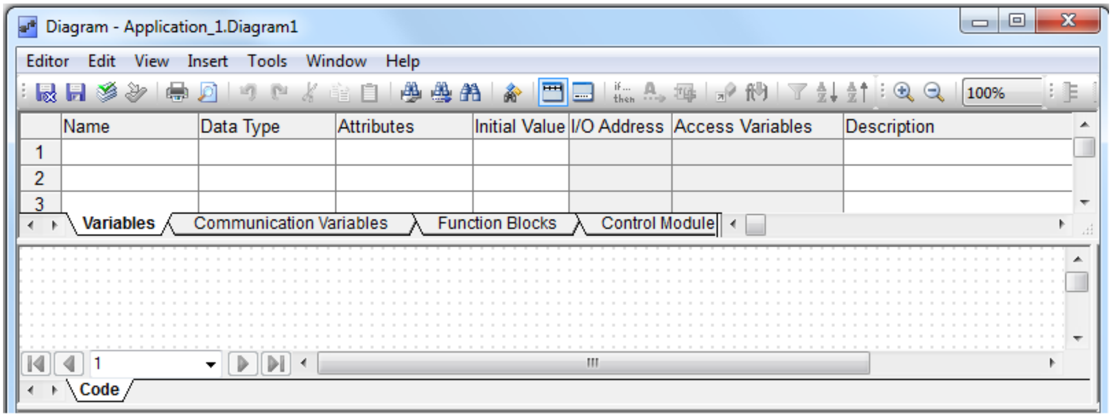

Create Library
Create Application
Create Diagram Type for reuse
Create Diagram
Diagram Type Editor
Diagram Editor
Extend the FD logic, by invoking other ST or SFC code blocks created within the same Diagram Editor or Diagram Type Editor
Create the logic in FD language in the first code block, by:
Inserting instances of Function Block Types, Control Module Types, and Diagram Types available in the libraries in the project
Inserting Functions from System library
Graphically connecting the instances and functions through the ports
Inserting variables and connecting them to other ports
Inserting parameters for external connection (only applicable to Diagram Type Editor)
In Diagram Editor, extend the FD logic across different applications (in same controller or in different controllers) using Communication Variables
Connect the application to controller and define task connection for the Diagram
Connect the I/O Variables to the required hardware channels through hardware editors
Download all the required applications to controllers

Figure 16. Workflow for using Diagrams and Diagram Types

Figure 17 shows the editor for a diagram POU under an application.



	Name	Data Type	Attributes	Initial Value	I/O Address	Access Variables	Description
1							
2							
3							

Figure 17. Editor for Diagram POU

The diagram editor consists of declaration pane and code pane. The code pane contains a grid area where you add the objects and create graphical connections.

The editor for diagram type also looks similar.

The editor for a top level diagram (under the application) differs from a Program editor in following ways:

- The first code tab is always a FD language tab.
- Additional code block tabs can be created, but only for ST and SFC.
- Two additional tabs – **Control Modules** and **Diagrams** – are available in the declaration pane.

The editor for a diagram type (under the application or library) differs from a diagram editor in following ways:

- There is a **Parameter** tab instead of a Communication Variables tab in the declaration pane.
- There are no I/O Address or Access Variables columns in the **Variables** tab.

The diagram editor or diagram type editor has one mandatory FD code block. Only one FD code block is allowed within this POU. It is allowed to have several optional ST and SFC code blocks in the diagram editor or diagram type editor.

Figure 18 shows the editor for a diagram after it is edited (to create an example logic).

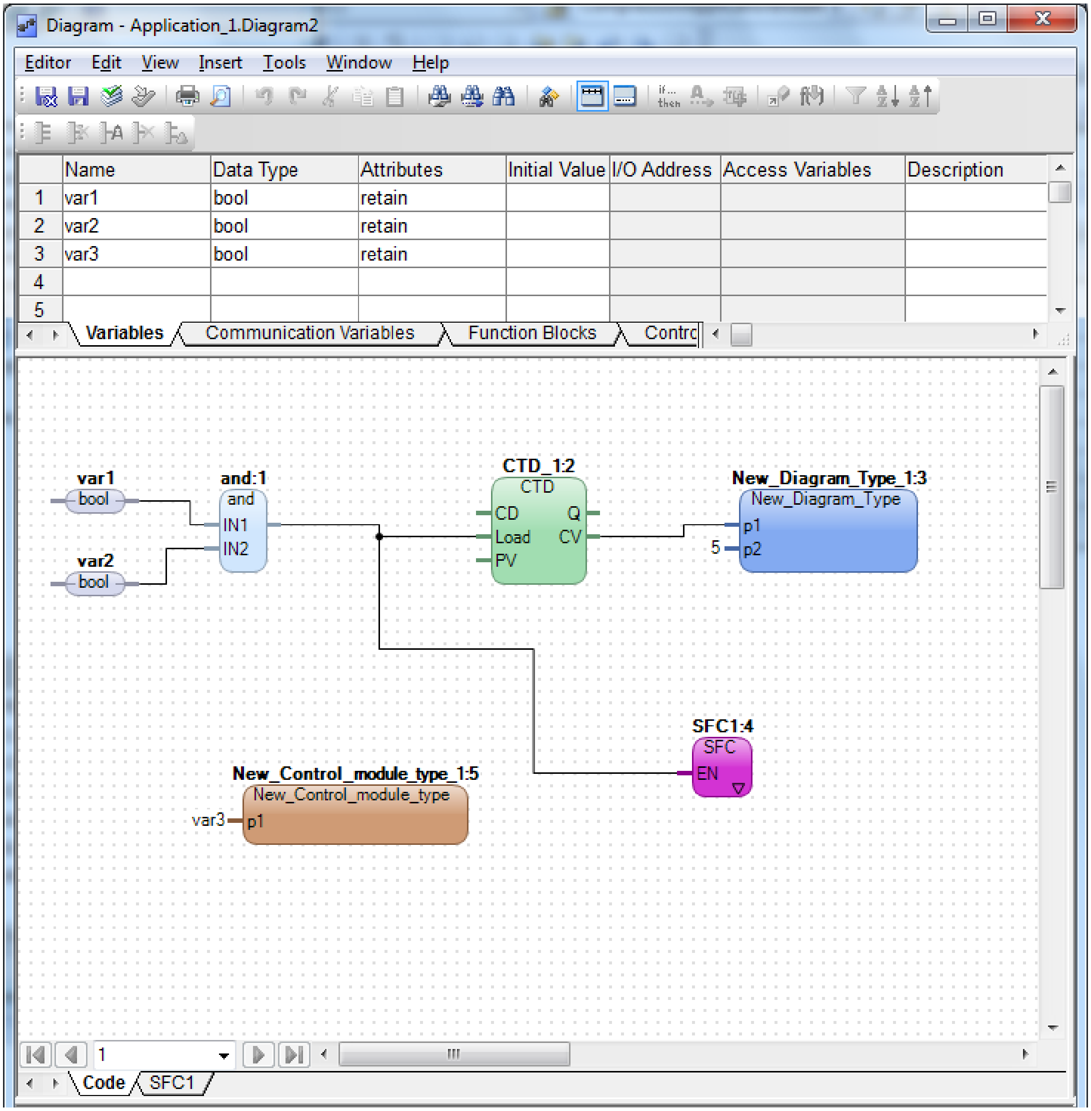


Diagram - Application_1.Diagram2
Editor Edit View Insert Tools Window Help

	Name	Data Type	Attributes	Initial Value	I/O Address	Access Variables	Description
1	var1	bool	retain				
2	var2	bool	retain				
3	var3	bool	retain				
4							
5							

Figure 18. Editor for diagram POU with an example logic created

Characteristics of Diagrams and Diagram Types

The following are the main characteristics of diagrams and diagram types:

- A diagram or diagram type can contain other diagrams (which are the instances of other diagram types), in addition to functions, function blocks, and control modules.
- The objects inserted in the diagram editor or diagram type editor can be connected graphically through ports, to create the logic.
- The port of an object inserted in the diagram editor or diagram type editor can be connected to variable by entering the name of the variable or by graphically connecting the port to the variable object.
- The FD code block in the editor also supports Split blocks and Join blocks to work with objects having structured data types:
  - A Split block splits the structured data type variable, connected as its input, to its components that are displayed as output connection ports. These output connection ports can be connected to variables based on the data types.
  - A Join block displays input connection ports, which are the components of the structured data type, and these can be connected to variables. The output connection port is connected to the structured data type variable.

Split and Join blocks does a copy of the variable in run-time. To avoid a copy, create a variable and make the components visible, or do component connections directly.

Split and Join blocks must not be used if the structured data type has components with *reverse* attribute.
For the Split block, if *reverse* components are used, a change in the extracted (split) data of a *reverse* component does not result in a change of this component in the structured variable. For the Join block, if *reverse* components are used, it is not possible to write to an *out* variable using Join, even if the attribute is *reverse*.

- The FD code pane supports creation of additional pages for adding more objects and connects the objects graphically across pages. This helps to extend the logic from the default page.

- The logic created in the FD code pane can be extended through connections to other ST and SFC code blocks in the editor.
- The FD logic can be extended across different applications by using communication variables declared in the diagram editor. These variables support cyclic communication between the top level diagrams, top level single control modules and programs in different applications.

Decisions When Creating Types

This subsection describes the decisions to be made about the types before programming the code, and declaring parameters and variables. Many functions and type solutions have been developed already, and the Control Builder helps to set up and access these options before programming. Read more about design analysis in the Application Programming manual.

The following decisions must be made before creating the types:

- Whether there is a need to create instances in user defined type(s).

  These types are based on other types located in external libraries. In that case, those external libraries must be connected to the library or application.

- Whether there is a need to create self-defined structured data types for passing parameters through several layers of instances.

  The data types are automatically connected to the library or application. Structured data types are often useful in more complex type solutions, with a deep hierarchical structure.

- Whether a function block type or a control module type or a diagram type should be used.

  – If the code is programmed in the Program POU[1] only, select function block types.

  – If a graphical editor is preferred for programming the code, and automatic code sorting is also preferred, select control module types.

  – If a graphical editor is preferred for programming the code, and automatic code sorting as well as mixing of functions, function blocks, control modules and nested diagrams are also preferred, select diagram types. This helps you to overcome the limitations when using a single type.

For information on how to access these methods, refer to the Control Builder online help. Select one of the folders in Project Explorer and press F1.

[1] See Program Organization Units, POU on page 19.

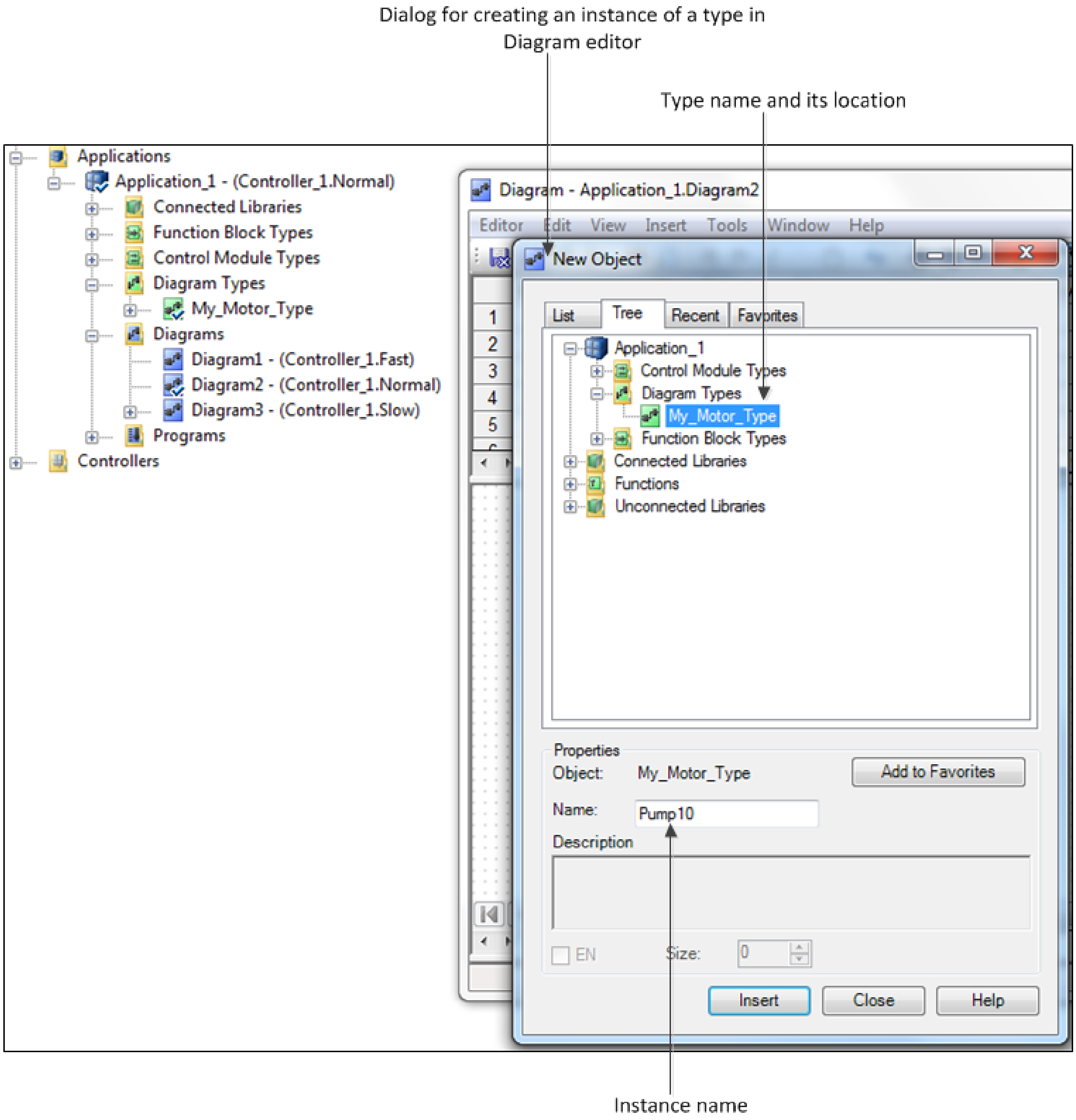
Create and Connect Instances

An instance is a function block, control module or diagram, based on a type.

Each time a new instance is created, the Control Builder prompts for a type. The type can be located in an inserted library (inserted into the control project), user defined library, or directly in an application. In any case, a type and its location must always be selected.

Once the type is selected, connect the connection parameters.

Figure 19 shows the creation of an instance (Pump10) based on My_MotorType, which is a diagram type located in the application. The instance needs the location (Application_1) and the type (My_MotorType).



Object: My_Motor_Type

Name: Pump10

Figure 19. Creating instance of a diagram type in Diagram editor

Connections Using Parameters

The instances can be connected either through graphics or through text, using the parameters in their respective types.

Control Modules

For control modules (instances of control module types), graphical connections are done directly in the Control Module Diagram (CMD) editor and textual connections are implemented in the Connection editor.

Diagrams

For diagrams (which support instances of diagram types, function block types, and control module types), both graphical connections and textual connections of instances are done directly in the FD code block of the diagram editor.

Graphical Connections in CMD Editor

Graphical nodes and graphical connections in CMD editor connects the control modules effectively.

The control module parameters, which can be graphically connected, contains NODE in the beginning of the parameter description. This is the standard for all control modules located inside the standard libraries.

Nodes for graphical connections can also be created for self-designed control modules. Graphical connections are suitable for obtaining a comprehensive view of main flows, for example, in a PID controller or for group start of several motors. Figure 20 shows three graphical connections for group starting motors. The modules are connected using the Graphical Connection function (located in the CMD Editor).

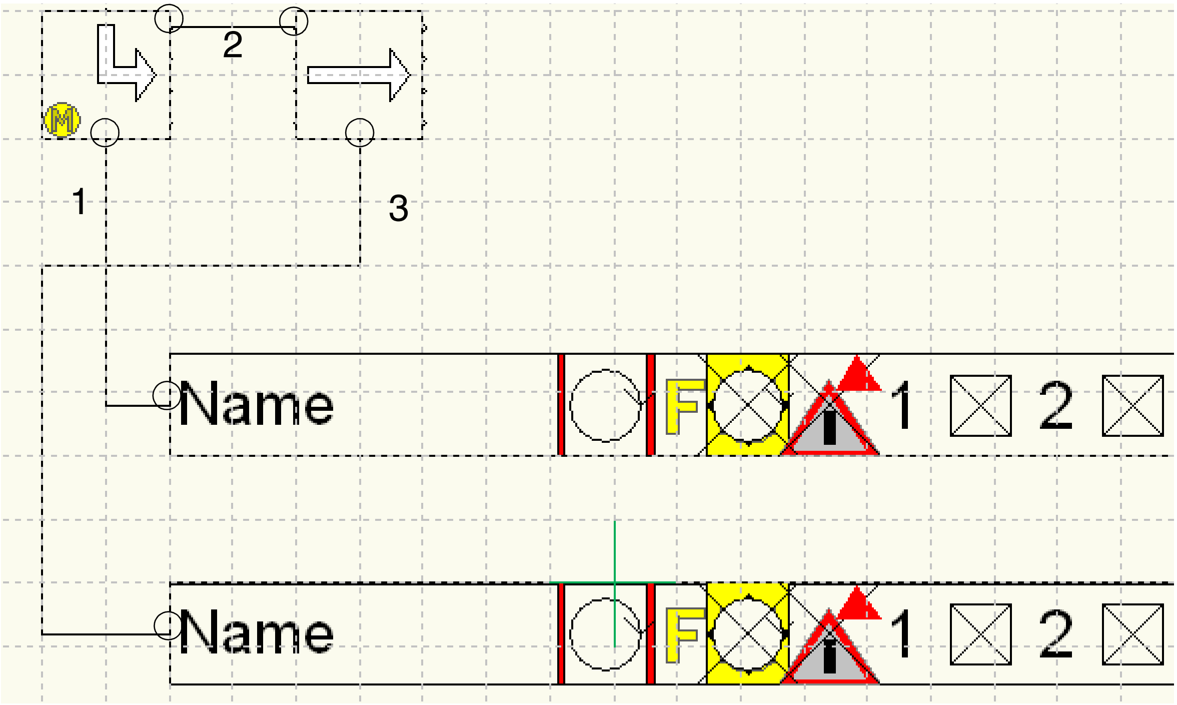


Figure 20. Two motor instances that have been graphically connected with a Start and Next instance located in the Group Start library. The circles symbolize the connection nodes

Textual Connection for Control Modules

To open the Connections editor via the Connections entry, right-click the control module (instance of control module type) and select **Connections**.

Parameters can be connected to the actual variables presented in the Connections editor. Textual connection is the only way to connect parameters when the control module is subordinate to a function block, since there are no surrounding graphics.

It is not possible to connect the same parameter both graphically and textually.

Connect an instance of Control Module in Connections Editor

The Connections editor is a parameter/variable interface between the instance and its closest surrounding. The Connections editor displays the parameters that are declared in the type, with reference to the control module instance, and connects the surrounding parameters/variables to the instance.

If a control module instance is created in an application (see Figure 21), then the application can be seen as the closest surrounding, and the variables in the application must be connected to the instance.

If a control module instance is created in a type (located in a library), then the type can be seen as the closest entity, and parameters/variables in the type must be connected to the instance.

To connect the parameters to instances located several hierarchical layers away (not the closest), use structured data types that simplifies the connections (instead of passing corresponding parameters). For more information on structured data types, refer to the *Compact 800 Engineering Compact Control Builder AC 800M Planning (3BSE044222*)*

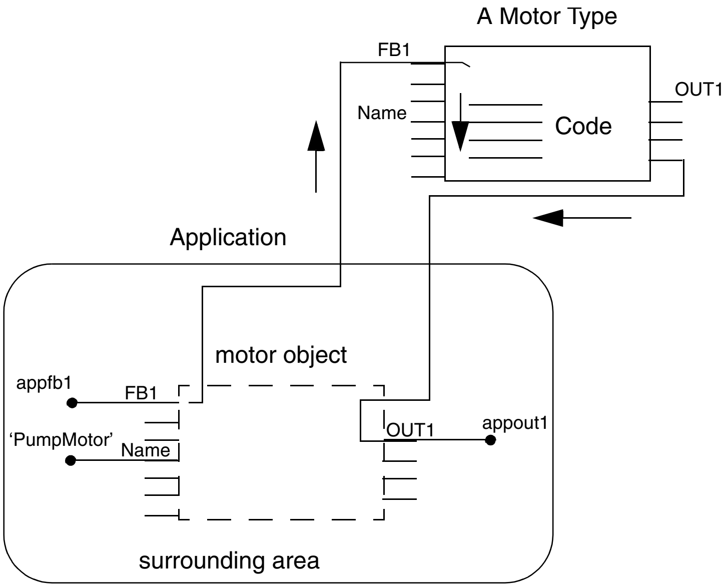


Figure 21. A control module instance connected to variables in an application. The application is the 'surrounding area' with the variables appfb1, Name (initial value 'PumpMotor') and appout1 connected to the instance.

In Figure 21, the connection parameters for the motor instance connect the parameters (*FB1*, *Name* and *OUT1*) to the variables (*appfb1*, *appout1*, *Name*; *Name* has the initial value PumpMotor) that have been declared in the application.

Function Block Execution

There are three types of function block parameters: In, Out, and In_out.

The input and output parameters are passed by value, which means that the function block creates copies of each variable value, before and after the function block is executed. The *In_Out* parameters are passed by reference, which means only a reference to the actual variable outside the function block is passed to and from the function block.

Input parameters create a copy of each variable before the function block executes, and the output parameters create a new copy after the function block is executed and pass the new values to the surrounding variables outside the function block.

For complex data types and strings, a reference to the data instance can be passed in the function block call. This is achieved by setting the attribute of the parameter to *by_ref*.

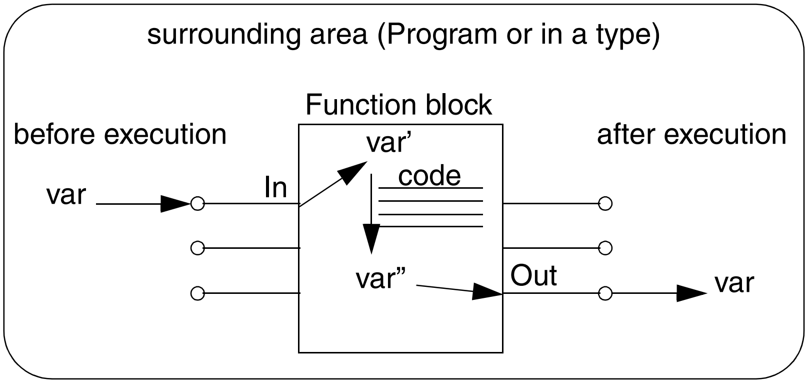


Figure 22. In and Out parameters for a function block. This example illustrates how In and Out parameters copies the variable (var).

Using *by_ref* on parameters enhances the performance. It takes a lot of execution time to copy parameters in each scan.

There are some limitations when using *by_ref*:

- It is not possible to connect expressions or literals to a reference parameter.
- If a reference parameter is not connected in one invocation, it cannot be connected in other invocation (if the instance has multiple invocations).
- It is not possible to read or write the parameter from outside the function block (except in the invocation). The example expressions like fb.par_in := 2; or k := fb.par_out; are not allowed for reference parameters.

By using *by_ref*, it is still possible to use *init* values, in which case the *init* value is the default value. If the parameter is not connected, the default value is used.

The code generated for connecting *by_ref* parameter is identical to an *in_out* parameter; but they differ in what is allowed inside the function block.

For example, it is not allowed to write onto an *in* parameter regardless of whether it is a reference or value parameter. The ownership analysis detects that a variable is read only if an *in* parameter by reference is used instead of *in_out*. It is therefore preferable to use direction=*in* and attribute=*by_ref* (instead of *in_out)*, if the parameter is actually an *in* parameter.

The *In_Out* parameters are passed by reference, and only a reference to the actual variable outside the function block is passed to and from the function block. The local representation of the parameter does not exist inside the function block. Performing operations on an *In_Out* parameter inside a function block means performing operations directly on the actual variable connected to the function block. See also Connecting Variables to I/O Channels on page 102.

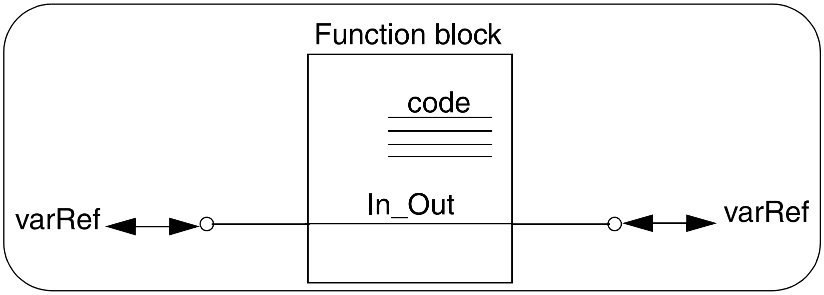


Figure 23. In_Out parameter for a function block. This example illustrates how the In_Out parameter points as reference to the value in the variable varRef.

A structured data type having components with *reverse* attribute must not be used for communication between function blocks. The components with *reverse* attribute does not work as intended when used with function blocks.

Control Module Execution

Control modules provide data flow-driven execution, which makes the code design much easier for solutions where several types and formal instances are needed. All control modules communicate with each other, and can therefore determine when each individual instance can send and receive information. A data flow-driven design prevents possible mistakes, when trying to foresee the correct execution order, since the compiler rearrange or sort all the code behind the scenes. This is called code sorting.

Direction for Control Modules

In control module types, a parameter can have any of the following direction:

- In
- Out
- In_out
- Unspecified.

These control module parameters follow different access rules from the code inside the control module and offer limitations to the methods used to connect them.

All of them are passed by reference, which means only a reference to the actual variable outside the control module is passed to and from the Control module.

The rules governing their functioning are as follows:

- Input parameters are read only.
- Out, In_Out and Unspecified are read and edit.
- Control modules on the same level can connect only In to Out.
- A sub control module inside could only connect its In parameters to In parameters in the surrounding control module and so on.
- In_out must be connected to a variable (on any level). This is not the case if the control module is used in FD code block in a diagram.

- If the control module is used in FD code block in a diagram, the In_out parameters can be connected to each other in FD code block. It is also possible to connect one Out parameter to an In_Out parameter, and an In_Out to an In parameter.
- One Out can be connected to Several In parameters. But, it is not possible to have multiple data connections from the same source on control module parameters of structured data types that have *reverse* components. See Table 9.
- A control module is allowed to write to an output parameter. An exception is the case of output parameters that are of structured data type containing components with the *reverse* attribute. It is an error if a control module writes to a *reverse* component of an output parameter.
- A control module is not allowed to write to an input parameter. An exception is that it is allowed for a control module to write to a *reverse* component of an input parameter.

These rules apply to connecting parameters to communication variables as well. Communication Variable In should be connected to In parameters and the corresponding for Out. The compiler (and check) warns if rules are broken.

Unspecified parameters can be used without limitations for compatibility reasons.

For more information on Code Sorting, see the *Compact 800 Engineering Compact Control Builder AC 800M Planning (3BSE044222*)* manual.

Diagram Execution

The execution of the content in a diagram or diagram type is mainly configured using the Data Flow Order of different invocations within the FD (Function Diagram) code block. The Data Flow Order is a number that specifies the intended order of execution. In the FD code block, the Data Flow Order is given to invoke functions, function blocks, diagram instances, control modules, code blocks, split blocks and join blocks.

Control modules in a diagram are sorted based on access of variables to enable both forward and backward calculations and data flows to be executed in the same task scan. Therefore code blocks in invoked control modules will not always be executed in the order specified by the Data Flow Order.

The Structured Text and SFC code blocks can be defined without invoking them from the FD code block. These code blocks are then sorted together with code blocks of invoked control modules.

Direction for Diagram Types

In diagram types, a parameter can have any of the following direction:

- In
- Out
- In_out

The diagram type parameters are shown as ports when the type is instantiated in the diagram editor.

All of them are passed by reference, which means only a reference to the actual variable outside the diagram type is passed to and from the diagram type.

The rules governing their functioning are as follows:

- Each port has an attribute that determines if it is visible in the diagram or not.
- Input ports are shown on the left side.
- Output ports are shown on the right side.
- In_out ports are normally shown on both sides with a connecting line through the block. They can also be shown on the left side only, depending on the FD Port property on the corresponding parameter declaration.
- One Out can be connected to Several In parameters. But, it is not possible to have multiple data connections from the same source on diagram type parameters of structured data types that have *reverse* components. See Table 9.
- A diagram type is allowed to write to an output parameter. An exception is the case of output parameters that are of structured data type containing components with the *reverse* attribute. It is an error if a diagram type writes to a *reverse* component of an output parameter.
- A diagram type is not allowed to write to an input parameter. An exception is that it is allowed for a diagram type to write to a *reverse* component of an input parameter.

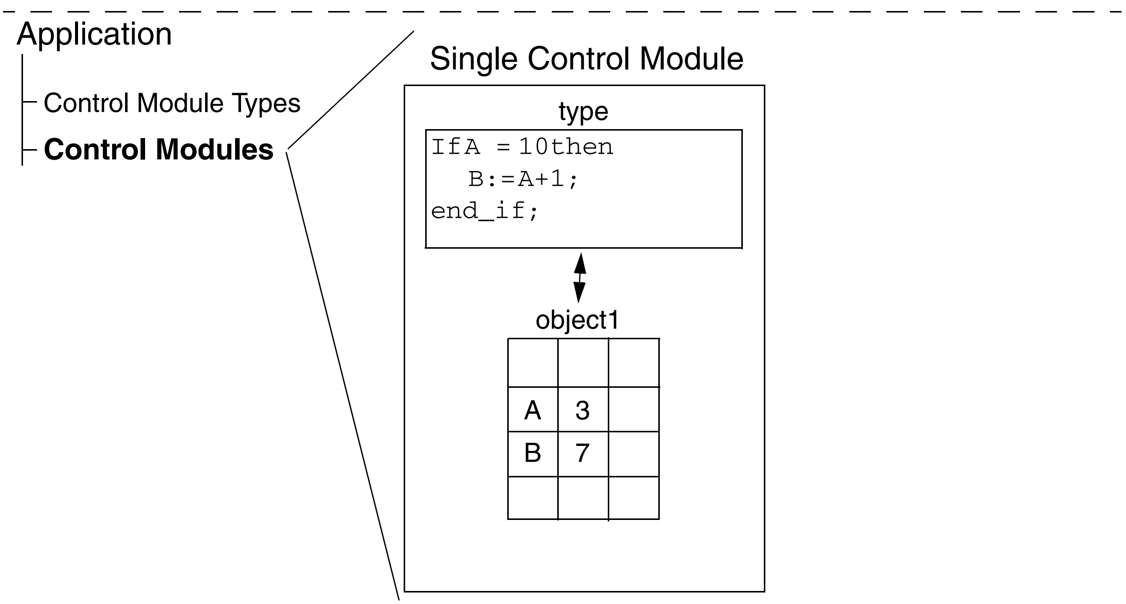
These rules apply to connecting the parameters to communication variables as well. Communication Variable In should be connected to In parameters and the corresponding for Out. The compiler (and check) warns if rules are broken.

Single Control Modules

A special kind of control module type, the single control module, provides a way of grouping graphical instances, variables, parameters, and control modules into a single unit.

Compared to the previous discussions about types and instances, a single control module can be considered as a hybrid of them both (see Figure 24). First of all, create a single control module as an instance under the control module folder (not the control module type folder) in an application.

Once a single control module is created, it starts acting as both a type and an instance. It contains code, editors for declaring parameters, function blocks, instance information, etc. just like a regular type or instance. A single control module can never be reusable as a type that can be used to create many instances. However, it can be copied to a new single control module, and then be modified.

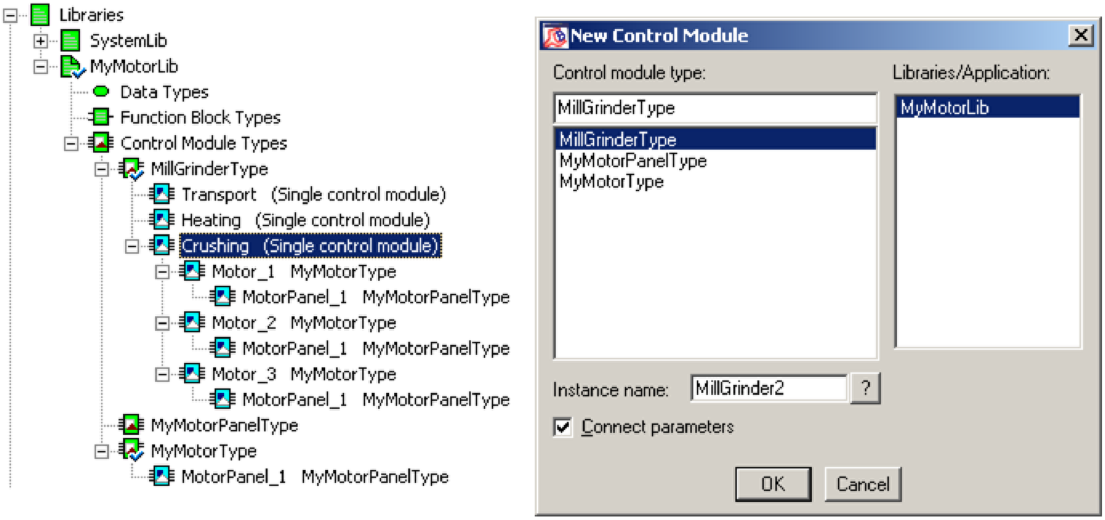


```
IfA = 10then
  B:=A+1;
end_if;
```

A	3	
B	7	

Figure 24. A single control module. This module is not reusable, hence intended to be used only once for grouping instances into a single unit.

Single control modules can be used as a framework and attach control module instances inside, like an application does with instances. Figure 25 illustrates this, where three single control modules (Transport, Heating, and Crushing) form the framework for the control modules (Motor_1, etc.).



Control module type: MillGrinderType

Instance name: MillGrinder2

☑ Connect parameters

Figure 25. Single control modules form the framework for the control modules.

FD Port

The FD Port column appears in the editor for function block types, control module types, and diagram types. This column is only significant for the types that are instantiated in a Function Diagram (FD) code block.

The normal choice is *Yes* or *No*. The value specifies if the parameter shall be visible when the function block type, control module type, or diagram type is instantiated in an FD code block. The default value is *Yes*.

There are extra choices (*Left* or *Right*) for control module parameters with direction *unspecified* and parameters with direction *in_out*. These choices are related to the placement of the parameter port in the FD code block.

Unspecified parameters are placed on the left side by default, and *in_out* parameters are placed on both sides by default.

There are some types with structured parameters that are mostly output, but also contain some input components. Such a parameter must be either an Unspecified parameter (control module types only) or an In_Out parameter.

The following list of alternatives are available for parameters of direction *unspecified*:

- *No* - Not visible as a port. The parameter will be placed on the left side of the object if the user decides to show it later on.
- *No Left* - Not visible as a port. The parameter will be placed on the left side of the object if the user decides to show it later on.
- *No Right* - Not visible as a port. The parameter will be placed on the right side of the object if the user decides to show it later on.
- *Yes* - Visible as a port on the left side of the object.
- *Yes Left* - Visible as a port on the left side of the object.
- *Yes Right* - Visible as a port on the right side of the object.

The following list of alternatives are available for parameters of direction *in_out*:

- *No* - Not visible as a port. The parameter will be placed on both sides of the object if the user decides to show it later on.
- *No Left* - Not visible as a port. The parameter will be placed on the left side of the object if the user decides to show it later on.
- *No Right* - Not visible as a port. The parameter will be placed on the right side of the object if the user decides to show it later on. This is only available for parameters of function block types.
- *Yes* - Visible as a port on both sides of the object.
- *Yes Left* - Visible as a port on the left side of the object.
- *Yes Right* - Visible as a port on the right side of the object. This is only available for parameters of function block types.

It is **not** recommended to use a function block type parameter of direction *in_out* with its FD Port property set to *Yes Right*. In this case, it is only possible to connect this type of parameter to a variable, parameter, or communication variable.
Therefore, it is recommended to use parameter with direction *out* and attribute *by_ref*, instead of *in_out* with *Yes Right* option, so that this parameter can be connected to input port of another object.

Variables and Parameters

Variables and parameters are the carriers of data throughout the system. This section describes how to use parameters and variables in the best way possible:

- Variable and Parameter Concept on page 71 gives an overview of variables and parameters and how they are used.
- Variables on page 72 gives an overview of the different variable types.
- Variable Entry on page 73 describes how to declare variables.
- External Variables on page 81 describes how to define external variables.
- Access Variables on page 82 describes how to define and use access variables.
- Communication between Applications Using Access Variables on page 84 and Communication in an Application Using Global Variables on page 85 describe how communicate between applications.
- Communication Variables on page 86 describes how to define communication variables.
- Control the Execution of Individual Objects on page 92 describes how to use variables and parameters to control the execution of objects.
- Link Variables in Diagrams on page 96 describes the use of link variables for graphical connections in diagram editor.
- Project Constants on page 96 describes the use of project constants and how to update them.
- I/O Addressing Guidelines on page 101 describes the rules for addressing I/O channels.

- Connecting Variables to I/O Channels on page 102 describes how to connect I/O variables to I/O channels.
- Extensible Parameters in Function Blocks on page 107 describes extensible parameters (these can only be used in function blocks).
- Keywords for Parameter Descriptions on page 108 describes keywords used in description in editors to identify the function of a parameter.

Variable and Parameter Concept

Variables

Variables are used in Control Builder to store and compute values.

Variables are the carriers of values at object level, application level, and network level:

- Local variables – These are mainly used inside objects as carriers of local values. They belong to the code and can only be accessed within the same function block, control module, diagram or program.
- Global variables – These are declared in the application and holds values that can be accessed by any object (function block, control module, diagram or program) in the application. However, to reach a global variable, each object that intends to use a global variable must have declared a corresponding External variable, see also External Variables on page 81).
- Access variables and Communication variables are used as carriers for communication between several applications and controllers in a network:
  - Access variables allow data exchange between controllers, that is, access variables can be accessed by other controllers. See Communication between Applications Using Access Variables on page 84.
  - Communication variables are used for cyclic communication between top level diagrams, programs, and top level single control modules. Communication variables support both inter application communication and inter controller communication in a system network. For more information, see Communication Variables on page 86.

All variables are defined by their names and data types. The data type (dint, bool, real, string, and so on) defines the characteristics of the variable.

Parameters

Parameters cannot store any values, but the variables are assigned to parameters of function blocks, control modules, diagrams and functions. Variables store the value of the corresponding (connection) parameters.

Use parameters for connecting objects and to point to variable values that need to be read into code blocks and written from code blocks.

When function blocks read from a variable and write to a variable, they use input and output parameters that temporarily copy the variable value, before and after execution. In this case, one may claim that parameters can temporarily hold a value. See Function Block Execution on page 59 for more details.

Variables

Table 5 lists available variables in Control Builder.

Table 5. Variable types in Control Builder.

Variable type	Scope	Where to declare
Local variable	**Object level.** Can only be accessed within the function block, control module or program in which it is declared.	Application editor (for passing parameters between control modules) or, Programs editor (for access in the program). Function block editor (for access inside the function block). Control module editor (for access inside the control module).
Global variable	**Application level.** Can be accessed from anywhere in the code within an application, except from diagrams. An object that intends to use a global variable must declare an external variable locally that will point at the corresponding global variable.	In the application editor. See also Communication in an Application Using Global Variables on page 85.

Table 5. Variable types in Control Builder. (Continued)

Variable type	Scope	Where to declare
Access variable	**Network level.** Variable that can be accessed by remote systems for communication between controllers. See also Access Variables on page 82 and Communication between Applications Using Access Variables on page 84.	Access Variable editor of a controller.
Communication Variable	**Project Level**. Variable that can be accessed by remote systems for communication between applications and controllers. See Communication Variables on page 86	Editor for top level Diagram, Program, or top level Single Control Module.

Variable Entry

Control Builder helps the user to declare variables in applications, programs, function block types and control module types. This section covers the entries: Name, Data Type, Attributes, Initial Value and Description.

Name

It is recommended that variables are given simple and explanatory names, and that they begin with a capital letter. Names consisting of more than one word should have capital letters at the beginning of each new word. Examples of recommended variable names are DoorsOpen, PhotoCell.

Certain names, however, are reserved by the system and cannot be used for other purposes, for example *true*. An error message appears if such a word is used. For naming guidelines and information on relevant tools, refer to the *Compact 800 Engineering Compact Control Builder AC 800M Planning (3BSE044222*)* manual.

Data Types

A data type defines the characteristics of a variable type. There are both simple and structured data types in Control Builder. A variable of simple data type contains a single value, while a structured data type contains a number of components of simple or structured data types.

Table 6 presents the most common simple data types and the initial value when the variable is declared.

Table 6. Simple data types

Data type	Description	Bytes allocated by variable	Initial value (default)
bool	Boolean	4	False, 0
dint	Double integer	4	0
int	Integer	4	0
uint	Unsigned integer	4	0
string	Character string(1)	10 bytes + string length [n]	“
word	Bit string	4	0
dword	Bit string	4	0
time	Duration	8	T#0s
date_and_time	Date and time of day	8	1979-12-31-00:00:00
real	Real number	4	0.0

(1) String length is 40 characters by default, but can be changed by entering string[n] as the data type, where n is the string length. The number of bytes allocated for string[40] will be (40 +10) 50. The maximum string length is 140.

Comparison of variables of unsigned data types (uint, word, and dword) will not work properly if the most significant bit is set. Internally, they are handled as signed, where the most significant bit is used as the sign. This means that a word variable with a value above 32767 will be considered to be smaller than a word variable with a value below 32768.

When declaring variables or parameters of the data type string, always define the required length within square brackets (for example, string[20]), to minimize allocated memory. If the string length is not defined, then Control Builder automatically allocates memory for a 40 character string length.

Use variables of data type string with care. Strings occupy a great deal of memory, and require much execution time to be copied or concatenated.

A structured data type contains a number of components of simple or structured data type. For bidirectional communication using structured data types, a `reverse` attribute must be set to indicate which components communicate in the opposite direction (see also Bidirectional Communication Variable on page 90).

There are a number of predefined data types in Control Builder (for example BoolIO and RealIO) that are structured data types. User-defined structured data types can also be created, see Decisions When Creating Types on page 53.

The word “default” can be used as an initial value for a parameter in a control module type or diagram type. This works for both simple and structured data types. For a structured data type, the initial value “default” gives the default value of the data types for all components.

This is useful when creating types; for input parameters of a structured data type that do not have to be connected, and for output data types that do not have to be connected.

More information is given in Control Builder online help. Search the index for “structured data type”.

Attributes

Attributes are used to define how variable values should be handled at certain events, such as after cold restart, warm restart, etc. Variables that are supposed to hold values over several downloads must for example, have a retain attribute in order to keep their values after a warm start. Any of the attributes in Table 7, can be given to a variable. For parameter attributes see Table 8.

Table 7. Variable attributes

Name	Description
no attribute	The variable value is not maintained after a restart, or a download of changes. Instead, it is set to the initial variable value. If the variable has no initial value assigned, it will be assigned the default data type value, see Table 6 on page 74.
retain	The variable value is maintained after a warm restart, but not after a cold restart. Control Builder sets retain on all variables by default. To override this, the attribute field must be left empty in declaration pane.
coldretain	The variable value is saved on disk, and retained after warm or cold restart.[1] Coldretain overrides the retain attributes in a structured data type.
constant	The user cannot change the value online once assigned. This attribute overrides the coldretain and retain attributes in a structured data type.
hidden	The variable will be hidden for an OPC client connected to an OPC server for AC 800M. This attribute is used for variable values not necessary to a supervisory system.
nosort	This attribute suppresses the code sorting feature for control module types. It is advisable not to use the nosort attribute if the user do not know the data flow characteristics in detail.
state	This attribute will let the variable retain its old value between two scans for control module types. The old and new value can be read by adding *:old* and *:new* to the variable name.

[1] When an application is downloaded the very first time, variables will get their initial data type values, even though they have been declared with the attribute coldretain, and, that the controller has done a cold restart. Hence, no variables can receive their coldretain values before they have been stored on disk. Correspondingly, will variables that have been declared later on, contain their initial values until they have been saved on disk.

Table 8. Parameter attributes

Name	Description
no attribute	The parameter value is not maintained after a restart, or a download of changes. Instead, it is set to the initial parameter value. If the parameter has no initial value assigned, it will be assigned the default data type value, see Table 6 on page 74.[1]
retain	The parameter value is maintained after a warm restart, but not after a cold restart.[1]
coldretain	The parameter value is saved on disk, and retained after warm or cold restart.[1] Coldretain overrides the retain attributes in a structured data type.
hidden	The parameter will be hidden for an OPC client connected to an OPC server for AC 800M. This attribute is used for variable values not necessary to a supervisory system.
by_ref	This attribute is used for controlling the passed value. For in and out parameters the value is usually copied into the called instance at the invocation. But for non simple data types and strings it is time consuming. In that case, a reference to the data instance is passed in the function block call. This is achieved by setting the attribute of the parameter to by_ref.

[1] These attributes are valid if the parameter is not connected, if connected it is the attributes of connected variables.

It is possible to assign several attributes to a variable for example, retain, nosort, and hidden can be assigned as (retain nosort hidden) attribute.

An intermediate variable (a variable which is automatically generated when making a graphical connection between function blocks) in FBD or LD is always assigned the attribute retain (even if the parameters on both sides of the graphical connection have the attributes coldretain).

In addition to the general attributes, the data type editor supports two special attributes for the components (see Table 9).

Table 9. Special attributes for data types

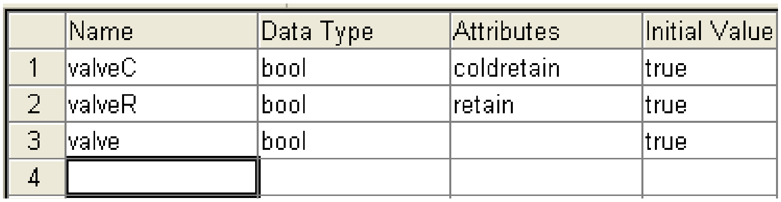
Name	**Description**
displayvalue	This attribute is applicable for a component in a structured data type, which is used in the FD code block of a diagram. In the FD code block, the online value label is not shown for graphical connections of structured data type. However, if one of the components of the structured data type is marked with the *displayvalue* attribute, the online value label is shown for this component. **Note**: The *displayvalue* attribute can be assigned to only one component in a structured data type. It also possible to assign this attribute through a combination of other attributes (for example, *coldretain displayvalue*, *nosort retain displayvalue*, and so on). In this case also, only one component can have this type of attribute (with *displayvalue*). If a nested structured variable is used, the *displayvalue* attribute is needed on each level down to the value that should be shown.

Table 9. Special attributes for data types

reverse	The *reverse* attribute can be used while declaring sub elements in a structured data type. This attribute is used when declaring structured data types that are intended to represent a connection between different program organization units in the applications. The signals in the connection can pass data in different directions, and the *reverse* attribute specifies that the direction of this signal (component) is *opposite* to the normal flow (forward or backward). It is an error if a sub element of a structured data type has the *reverse* attribute and the sub element itself is of a structured data type containing a *reverse* attribute at any sub level in that sub element. The *reverse* attribute affects the usage of control module parameters, diagram parameters and communication variables. **Note:** All components that have the *reverse* attribute must be placed consecutively in the data type editor.
	Restrictions with reverse attribute for Split and Join blocks in FD code block In the FD code block in Diagram and Diagram Type POUs, the Split and Join blocks must not be used for structured data types with *reverse* components. **Restrictions with reverse attribute for function blocks** If structured data type is used for communication between function blocks, ensure that the type does not contain any *reverse* components. **Restrictions with reverse attribute for data exchange between control modules or diagrams using Access Variables** It is also not possible to write to *out* direction variables using Access Variables in Structured Text, even if the attribute is *reverse*.

Attribute Example

The following example tries to illustrate how a variable will be handled, depending on different attribute settings. Suppose the variable valveC has the attribute coldretain, valveR has the attribute retain and valve has no attribute. Also, suppose that these three variables have the initial value = True (see Figure 26 for the variable declaration).



	Name	Data Type	Attributes	Initial Value
1	valveC	bool	coldretain	true
2	valveR	bool	retain	true
3	valve	bool		true
4				

Figure 26. Three variables with different attributes settings

According to the attribute settings in Figure 26, the variables will be read or written on different occasions in the given code example below, (read the comments under each IF statement):

```
IF valveC THEN
  (*Code in this position is only executed once after the very
    first cold restart*)
  valveC := false;
END_IF

IF valveR THEN
  (*Code in this position is only executed once after a cold
    restart*)
  valveR := false;
END_IF

IF valve THEN
  (*Code in this position is only executed once after a cold restart
    and once after a warm restart*)
  valve := false;
END_IF
```

Note that execution does not have to take place during the first scan after restart, for example, when IF valve is embedded in another IF statement.

Variables and parameters should have the attribute retain, unless they are written at each scan. When a change has been made to the application, the entire application will be (warm) restarted and in doing so, variables without the attribute retain will be set to their initial values, and there is a chance that the change will not be totally bumpless. It is recommended that In and Out parameters to function blocks always have the attribute retain.

More information is given in Control Builder online help. Search the index for "attribute".

Initial Values

It is possible to give the variable an initial value, which will be assigned to the variable the first time the application is executed. This setting overrides the default data type value. Table 6 shows default initial values for the most common data types.

Descriptions

The description field describes and provides information about the variable. A short descriptive text may include an explanation of the cause of a condition or a simple event, for example "Pump 1 is running". Since the description is not downloaded to the controller, the size of the description is irrelevant.

- Diagrams and instances of diagram types

External Variables

External variables are not really variables, in the sense that they carry a value. Instead, external variables work like parameters, that is, they point to a variable value (in this case a global variable). In order for an object to reach a global variable (located at the top of the application) it must use a pointer, or more specifically, an external variable. By declaring an external variable inside an object, it is possible to access global variables efficiently from a deep code design, without having to pass variable values through parameters.

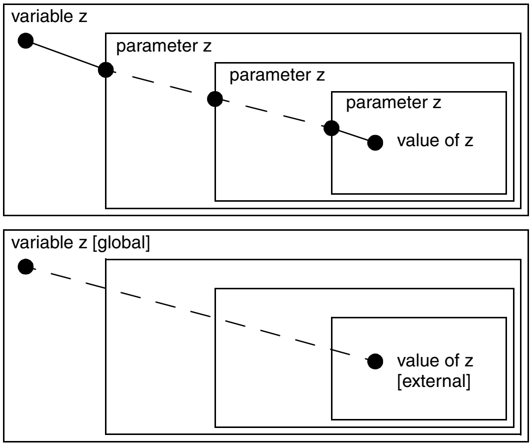


Figure 27. The variable z can be accessed deep down in the structure, using several parameters. (Bottom): Using external (and global) variables, the variable z is accessed directly, without having to use parameters.

Access Variables

Access variables are needed when the system works as a server. Allowed protocols are MMS, COMLI, MODBUS TCP and SattBus. MMS and SattBus variables are declared in the Access Variable Editor under the corresponding tab, COMLI and MODBUS TCP variables under the Address tab. The variable name must be unique within the physical control system.

Open the Access Variable Editor by right-clicking the ‘Access Variables’ icon under the respective Controller and select **Editor**.

To limit the access to a variable, set the attribute to ReadOnly. If the attribute is left blank, it is possible to both read and write.

MMS

MMS variables can only be accessed by name.

An MMS access variable name can be up to 32 characters long and contain letters, digits and the characters dollar($) and underscore(_). However, an access variable name cannot begin with a digit or the dollar ($) character.

All data types for single and structured variables are allowed, with the exception of ArrayObject and QueueObject.

To limit the access to an MMS variable, set the Attribute to ReadOnly. If the attribute is left blank, both read and write is possible.

SattBus

SattBus variables can be accessed in three ways:

- Standard SattBus name such as Valve:
  - the name must consist of exactly five ASCII characters, but may not begin with a percentage sign (%).
- COMLI direct addressing (see Address),
- IEC 61131-3 standard representation for variables.
  - IEC61131-3 address must be entered under the COMLI tab

Allowed data types for a single variable are, bool, dint, int, uint, real or string. Whereas a structured variable does not allow string data type.

Address

Address variables can be accessed in two ways only, either direct addressing with capital X and the number for boolean, or capital R and the number for registers (R0-R65535 for PA controller) beginning with a percentage sign or not, or according to IEC 61131-3 standard representation for variables.

Allowed data types for a single variable are bool, dint, int, or uint, whereas structured variables must all be of same data type. A structured variable is allowed to contain more than 512 booleans and contain more than 32 components of integer data type. Overlapping areas are not allowed.

Example

An access variable name "X0" is defined and connected to a variable which contains 544 Boolean components at octal address 0-1037. The next available address is then 1040 to ensure that areas do not overlap.

At least one of the variables in the access variable table has to be defined. For missing variables, requested data of boolean data type will be returned with the value False and requested data of integer data type will be returned with the value "0". Writing to undefined variables is ignored.

Communication between Applications Using Access Variables

Two applications may communicate with each other via variables, but these variables must be declared as access variables (see, Access Variables on page 82). This also applies when two applications are downloaded to the same controller (see Figure 28).

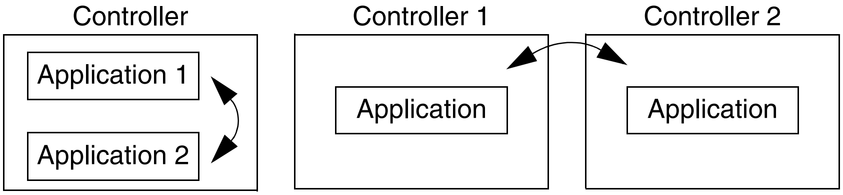


Figure 28. Variables for communication between applications must always be declared as access variables.

When transferring access variables, it is important to use the same data type range for the client (*dint*), as for the server (*dint*).

It is, however, possible to connect variables with different ranges, such as a *dint* variable on the server and an *integer* variable on the client.

As long as the variable values are within the range of an integer, this will work, but once the value goes outside the integer range, it will not.

If an access variable is the only user of a variable that is connected to an I/O channel, this variable is by default updated every second. To update this variable with another interval, create a statement that involves the variable, but is never executed.

A statement that is never executed, but still updates the variable x could look like this:

```
if false then
   x:=x;
end_if;
```

Connect this program to a task that executes with the desired interval. The variable is updated every time the task is executed.

Communication in an Application Using Global Variables

In Programs

Global variables are declared at application level, in the Global Variables tab of the application editor. They can be accessed directly, without any declaration in the program editor. Variables that are not declared in the declaration pane in the program editor are assumed to be global variables. A global variable can be used in any program, without having external variables declared in a program.

In Function Blocks or Control Modules

In order to reach a global variable from either a function block type or a control module type, each type must have either an external variable declared or a parameter. Thus, the types access the global variable value by using an external variable or a parameter to point at the global variable located in the application.

Communication Variables

The communication variables are used for cyclic communication between top level diagrams, top level single control modules, and programs, in the project that uses MMS communication protocol.

Communication variables are declared in the Program editor, top level Single Control Module editor, or top level Diagram editor. Communication variables support both inter application communication and inter controller communication in a project.

Communication variables are not supported in distributed applications. If an application that contains communication variables is running in a controller, it is not possible to download the same application to another controller.

A communication variable can be either a communication input variable or a communication output variable.

If the direction of a communication variable is `in` in a POU, the POU can read the variable, but cannot write to the variable. If the direction of a communication variable is `out` in a POU, the POU can write to the variable and read the variable.

A communication variable can be either an elementary type or a structured data type. It cannot be a generic or built-in type.

If a communication variable is of structured data type, it must not contain components that are declared with the CONSTANT type qualifier and it must not contain CONSTANT components at any sub-level of the variable.

Communication variables use a name based resolution to connect a communication output variable to one or several communication input variables.

In a project, all communication output variables must be declared with unique names.

Communication variables cannot be connected to the channels of an I/O unit. Therefore an application code has to be entered to transfer values between communication variables and local variables, which are connected to I/O.

Declaration pane for communication variable

The declaration pane for communication variables consists of:

- Name

  The name of the communication variable. For communication output variables (direction - `out`), the name must be unique on the project to resolve the IP-address during compilation.

- Data Type
- Attributes

  Possible attributes to specify are:
  - retain
  - coldretain
  - hidden
  - hidden retain
  - hidden coldretain

  If no attribute is specified when the communication variable is declared, `retain` is filled in automatically by the editor.

- Direction

  The possible values are `in` or `out`. If no direction is specified when the communication variable is declared, `in` is automatically filled in by the editor.

- Initial Value

  An initial value is assigned to the variable when the application is executed first time. This setting overrides the default data type value.

- ISP Value

  Applicable only to communication input variables. This field defines the ISP (Input Set as Predetermined) value to be set for the `in` variable. This value can only be set for simple data types.

  For structured data types, the ISP values can only be set in the data type for each individual component (in the Data Type editor). Hence, it is not possible to configure instance specific ISP values for structured data types.

ISP could be used in a structured variable to detect communication failure or bad quality, by using a Boolean Valid component with ISP set to false.

- Interval Time

  Communication cycle time for peer-to-peer communication. The possible values are fast, normal, slow, very fast, and very slow. The default value is normal.

  The time interval (in milliseconds) for each of these cycle times is defined in the hardware editor for IAC MMS in the Control Builder. The IAC MMS object is located at position 5.1 under the controller object in the hardware tree in Control Builder.

- IP Address

  Applicable to communication input variables, and also applicable for communication output variables if bidirectional. This field defines the IP address of the controller that contains the corresponding communication output variable (with the same name) in any of its applications.

  When no value for the IP address is entered, the editor automatically fills in the default value auto. This means that the IP address is resolved during compilation.

- Acknowledge Group

  Applicable to communication input variables, and also applicable for output variables if bidirectional. Acknowledge group is used to categorize the communication variables in different groups for acknowledgement purpose after their ISP values get latched. This avoids unexpected restart of communication after fault detection. The possible settings are *auto* or a group ID.
  - **auto** - The communication resumes automatically after the error situation is resolved. This is the default value.
  - Specifying a **group ID** - This enables the communication variable for an acknowledgement after fault detection. If a group ID is specified, the acknowledgment is performed through the CVAckISP control module, for a particular group or cascaded groups.The CVAckISP control module is available in BasicLib.

  A maximum of 32 Communication Variables can be grouped together with the same group ID per application. This is also checked during application compilation.

  One control module instance of CVAckISP is used to reset all the latches in one group of communication variables. If several such groups are to be reset simultaneously, the control module instances of CVAckISP for each group may be interconnected in a cascade configuration. The reset order is distributed to all members in the configuration.

- Description

  User documentation of the variable.

Source and Sink for Communication Variables

The term ‘source’ is used for the POU that declares a communication output variable. The term ‘sink’ is used for the POU that declares a communication input variable.

If a sink is located in one application, a source can be located in any of the following:

- In the same application as the sink.
- In another application but in the same controller as the sink.

- In another application and in another controller.

Multiple sinks can be linked to the same source.

For example, for every communication output variable with a unique name, there can be multiple communication input variables with the same name as the communication output variable. The communication input variables can reside in a different POU, in a different application, or in a different controller.

There is no need to declare the location of the source (communication output variable) while configuring the sink (communication input variable). This is because the binding between them is based on the name of the communication variable.

The Control Builder checks whether the name of a communication output variable is unique in the project, only during the download of the application. The download is aborted if the variable name is not unique.

Unresolved Communication Variable

A communication input variable is unresolved if there is no communication output variable (source) with the same name, during compilation.

> The Control Builder allows the execution of an application that contains unresolved communication variable. When a reconfiguration of the system is done (for example, at a warm restart), the source can be created and the unresolved communication variable becomes resolved.

A resolved communication variable does not become unresolved if the source is removed. It gets unresolved the next time, when that particular application is reconfigured.

Bidirectional Communication Variable

Bidirectional communication variables have communication in both directions and can be configured for one-to-one connections only. These variables can be created for structured data types only.

The configuration parameters that are used for the `in` variables can also be specified for the `out` variables, if bidirectional. This allows the configuration of a communication variable with a different communication setup in either directions (for example, different interval times).

Reverse attribute

For bidirectional communication using structured data types, a `reverse` attribute must be set to indicate which components communicate in the opposite direction to the in/out declaration of the communication variable.

The `reverse` attribute is configured in the data type editor.

The `reverse` attribute can only be set such that all `in` variables are located consecutively and also all `out` variables are located consecutively in memory. Hence, it is not possible to configure `reverse` for every other component in a data type.

The reverse attribute can be set in both top level and sublevel of a structured data type, but cannot be nested.
This means, the reverse attribute cannot be set for a structured data type component *Struct2* inside a structured data type *Struct1*. But, *Struct2* can have reverse components inside it.
For example, for a ControlConnection data type, which consists of one forward structure and one backward structure, the reverse attribute is set on the whole backward structure. All components in the backward structure inherits the reverse attribute automatically.

Interval Time

Out of the five different cyclic categories (VerySlow, Slow, Normal, Fast, VeryFast), the default interval time for a communication variable is Normal.

The interval time for a communication variable can be changed only when the Control Builder is offline. The changes takes effect during the download.

The time interval (in milliseconds) for each cyclic category is defined using the hardware editor for IAC MMS. The IAC MMS object is available at position 0.5.1 under the controller object. Position 5 contains the IP object.

Hardware Simulation with Communication Variables

It is possible to use hardware simulation for IAC.When using hardware simulation, the communication variables use real communication and real copying of input variables. This is also the case when downloading a simulated AC 800M to a Soft Controller.

Application Download

The communication variable configuration is downloaded when the application is downloaded to the controller. It is possible to download an unresolved *In* (or bidirectional) communication variable, even though the communication will not happen. To resolve an unresolved communication variable that already exists in a controller, the new configuration with the Out variable must be downloaded.

When an out variable is removed, only *in* variables that are defined in applications which are downloaded, shows communication variables as unresolved. Other communication variables (in other applications) will timeout.

To support multi user engineering, all the affected controllers are reserved during last step of the communication variable analysis, until the configuration is downloaded.

Control the Execution of Individual Objects

Sometimes there is a need to execute specific sub function blocks and/or sub control modules, with a time interval and priority different from the task connected to the application. Depending on the requirement, this can be done in two ways:

1. To create a new task and connect this task to all the following objects, read the sub-section 'Using a Global Variable Connected to an External Variable on page 92.
2. To choose a new task for each individual object (and for that object only), read the sub-section 'Using a Global Variable Connected to a Parameter on page 94.

Using a Global Variable Connected to an External Variable

Assume that the user has added a new task, for example **SuperFast**, to the other tasks in the Project Explorer.

Steps to use global variable:

1. Declare a global variable (for example *Speed*) of data type *string*, with the attribute *constant* and the initial value *'SuperFast'*.

2. To reach objects that have been created in the application, start by declaring an external variable in the type (open the type editor and select the external variable tab).
3. Declare an external variable with the same name, data type and attribute as the global variable. In this example, an external variable called *Speed* of data type *string* and with the attribute *constant* is used.

Finally, connect the new task **SuperFast** to the object by right-clicking the object and selecting **Task connection**. Type the variable name *Speed* in the task field. All the following objects that are created will have this task connection, that is, **SuperFast**.

The advantages with this method of using a global variable connected to an external variable (declared in the type) is that every following object will be connected to the same task (SuperFast). If the user later on need to change the task connection for all the objects (perhaps hundreds of objects), change only the initial value for the global variable in the application (see Figure 29). The present task connection for all objects will point, via the external variable to the task declared by the global variable.

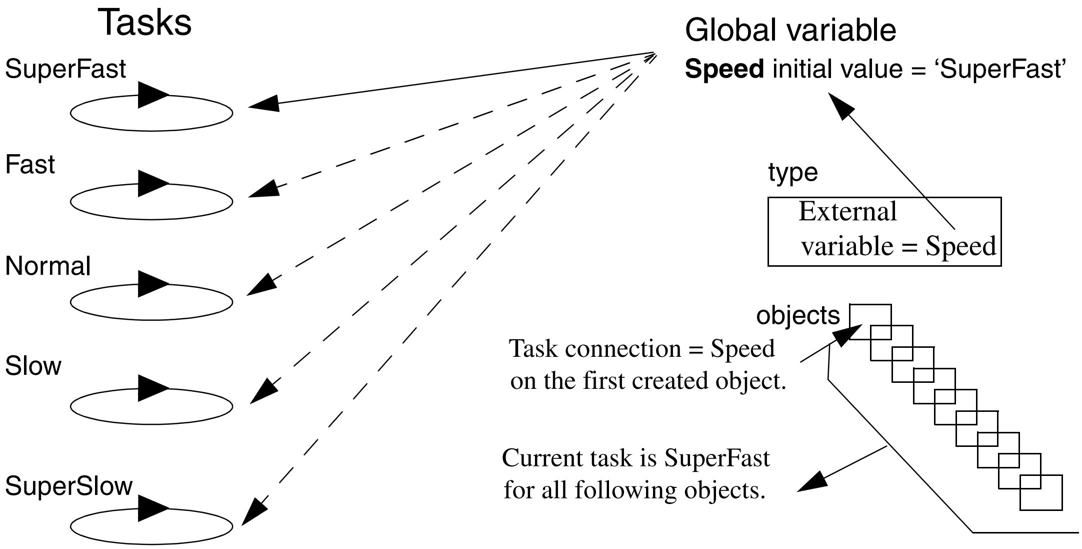

Tasks
SuperFast
Fast
Normal
Slow
SuperSlow
Global variable
Speed initial value = 'SuperFast'
type
External
variable = Speed
objects
Task connection = Speed
on the first created object.
Current task is SuperFast
for all following objects.

Figure 29. All objects will have the same task connected (SuperFast), once the first object has connected Speed.

Using a Global Variable Connected to a Parameter

Assume that the user has added a new task, for example **SuperSlow**, to the other tasks in the Project Explorer.

The main advantage of this method, compared to the previous method with external variables, is that the user can change the task connection on each following formal instance, by simply connecting a parameter to a different global variable. (See Figure 30).

For more information on formal instances, see Types and Instances - Concept on page 31.

This method is based on declaring two global variables (for example, *Slowly* and *Learning*) of the data type *string*, with the attribute *constant,* and the initial values **'SuperSlow'** and **‘Slow’**, respectively.

In order to reach the following objects that have been created in the application, start by declaring a parameter in the type (open the type editor and select the parameter tab). Declare a parameter, for example *Sleepy*, of data type *string*. Select the formal instance (object) inside the type:

1. Right-click the object and select **Property > Task connection**.
2. Type Sleepy in the task field.

Every created object that is based on the type (containing the formal instance) can be connected via the connection parameter *Sleepy* and one of the global variables *Slowly* or *Learning,* located in the application.

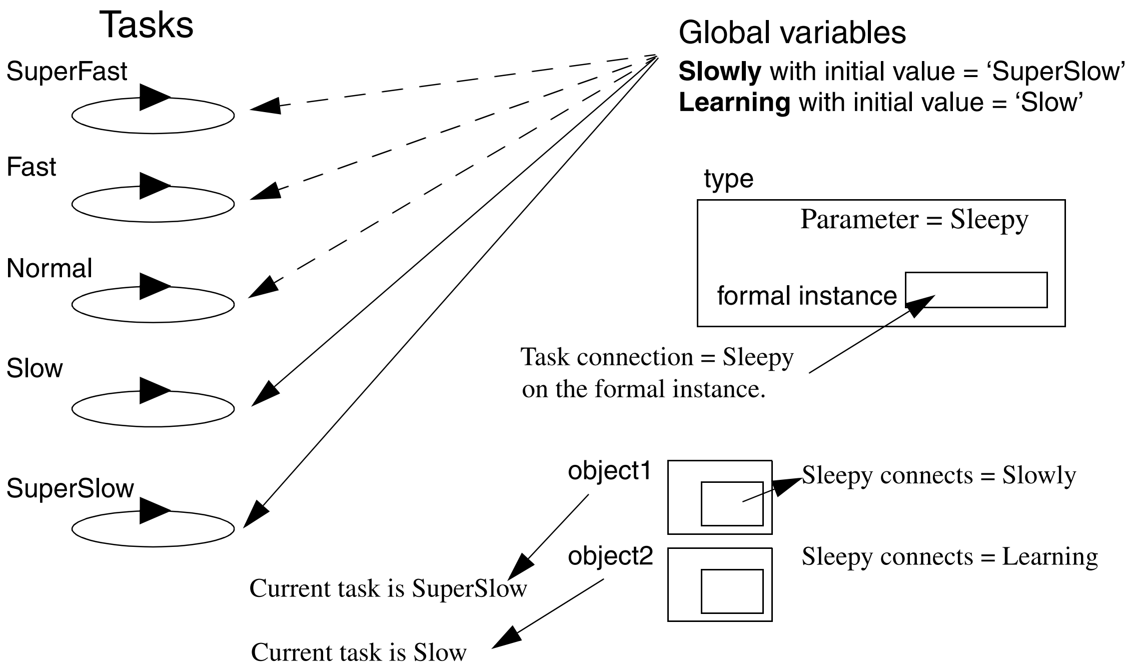


Figure 30. Each object can be connected to a different task via the parameter Sleepy declared in the type and task connected in the formal instance.

The advantage of this method is that the objects of the formal instance, located inside the type can be connected to different tasks (global variables with a different task name as init value).

Link Variables in Diagrams

For a graphical data connection in a diagram editor, it is possible to set a link variable. A local variable of the same data type as the connected ports can be used.

To create a link variable, right-click the required graphical connection to open the context menu, and select **Link Variable**. Enter the name of the link variable.

The link variable name is not displayed in the graphics; it is only visible if you open the Link Variable dialog.

Normally, link variables are not needed. The compiler auto-generates variables when necessary. But, if it is needed to access the intermediate value via OPC, a link variable is required. The declared link variables are available via OPC.

If an output port has multiple graphical connections, all these connections share the same link variable (if any).

If a block has an *in_out* port that is graphically connected on both sides, both connections share the same link variable (if any). This means that if several blocks have graphically interconnected in_out ports and a link variable is set for one of the graphical connections, the link variable is forwarded and set to all the graphical connections in the *in_out* chain.

Project Constants

Project constants are declared at the top level of libraries and projects. They are globally visible, and can be used wherever a constant value is permitted, for example, in program code and for variable initialization. With project constants, it is possible to create settings for an individual project, without having to modify any source code, or having to introduce parameters which have to be passed on to all concerned types.

Project constants are suitable to use for library items that the user wants to change. Examples are, date and time formats, logical colors and logical names. Do not use project constants to change the functionality of an object, for example, initial values and comparisons in code.

Typically, project constants are declared in a library and given default values. They are then used, for example, in code located inside types.

Project constants are allowed to have the same names as variables and parameters. Control Builder will, however, choose the variable or parameter name if a name conflict exists. This must be considered when adding, renaming or deleting variables or parameters in an already running application.

Follow the naming convention, which says that project constants should begin with the letter “c” (for example “cColors”). Use structured project constants, if possible.

Note that project constants cannot be used to control the execution of function blocks or control modules. Use a global variable or a parameter instead. For more information see, Control the Execution of Individual Objects on page 92.

If a project constant connected to a retain parameter (or variable) is changed online, then the change does not effect on existing instances until a cold restart is performed.

Project constants declared at library level (user-defined libraries) can only be edited and deleted from the library, that is, they cannot be deleted from the Project constant dialog that is reach by right-click the control project folder (root object). To edit or delete a library-declared project constant, right-click the library in Project Explorer and select **Project Constants**.

Naming conflicts between project constants appears when the same project constant name exists in more than one library at the same time.

The only way to avoid a naming conflict is either to delete one of the constants or not using the constant at all. A type conflict can never be overridden.

Structured Project Constants

It is advisable to create one single structured project constant for an entire project or library, where the project constant name is a concatenation of “c” and the project name (or library name).

An example:
If the project name is “ACMEToothpaste”, the structured project constant should be named “cACMEToothpaste”. Using a structured project constant makes sure that there is little chance of conflict with variable and parameter names. Using a structured project constant (“cACMEToothpaste”) enables the user to, for example, use “Max” without causing problems due to a variable or parameter called “Max”, since the full path to the project constant “Max” would be “cACMEToothpaste.Max”.

Define only one project constant per library. This project constant can, and should, be a structured project constant the concatenation of “c” and the library name in which it is contained. For example, if the library name is “ACMEValveLib” the (structured) project constant should be “cACMEValveLib”.

All project constants defined in libraries and projects must have been given unique names.

Typical Use

There are two typical use cases for project constants:

1. To satisfy the need for constant values in all project applications.

   Some values might have to be constant throughout the entire project. To change such a “constant” value, change it once. There is no need to change it at every occurrence. For such cases, use a project constant. The project constant is defined in one place only, and can be used throughout the project. Changes to the project constant will be reflected throughout the project.

   An example:
   To be able to change the severity for all “High level alarms” in the entire project, set up a project constant that defines the severity and use the project constant in all alarm blocks in all applications. To change the severity, just change the value of the project constant.

   In this case, project constants should be defined on control project level, not in a library.

2. To be able to change library type solutions without having to make changes in the library itself.

   A method commonly used in control application engineering/programming is to construct libraries, in which re-usable code is placed. It is good practice to make the library as general as possible, to maximize its usefulness. The use of project constants is an excellent solution for such situations.

Example 1: Easy Translation

Assume that the user has created a library that makes extensive use of text strings. Instead of including strings (in the user’s native language) statically in the library, use project constants. This allows another engineer to change the values of these project constants and to translate the strings to another language.

For example, a project constant that was originally set to “Stop” can easily be translated by a German engineer to “Halt”, simply by changing the value of the project constant. This would not be the case if the user had typed “Stop” in the library. Such string constants that are to be translated are best stored as a structured project constant under the component *.Settings*.

The string “Stop” would, for example, be defined as the structured project constant “cACMEValveLib.Settings.StopLabel” or, even more levels; “cACMEValveLib.Settings.Labels.Stop”.

Example 2: Combination of Dynamic and Static String Constants

Consider the following function block, in Figure 31, that controls high alarms. *Signal* is of *RealIO* type, *Alarmlevel* is of *real* type, and *Message* is of *string* type.

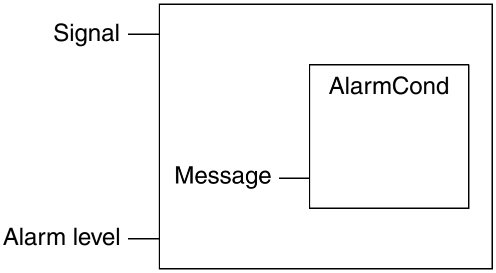


Figure 31. The function block AlarmCond located in the Alarm library.

Now, we want a “customized” message to be passed to *Message*, such as

High Level (> 75 ºC)

The message consists of five important elements that make up the message.

1. “High Level”
2. “(> “(note the spaces)
3. 75 (a value set by Alarm level)
4. ºC (a value set by Signal.parameters.unit)
5. “)”

All in all, three strings (1, 2, and 5) and two values (3 and 4).

Defining these 3 strings locally would be poor design, since the strings would be defined for every object that is created from the type. To create a dynamic environment, use project constants, or, more specifically, structured project constants.

In the example above, we actually have different string categories – **“High Level”**, **“(> “**, and, **“)”**.

The first one is a (dynamic) string that a user may want to translate, depending on target customer nationality, whereas the other two are static and independent of language. This calls for two different views of project constant.

Using structured project constants, and the naming convention mentioned earlier in this section, a defined structured project constant for “High Level” could be: cACMEValveLib.Settings.HighLevelLabel.

As described in the first example (Example 1 above), we make use of the component “Settings” in the structure. Underneath this component, we define the constants that are to be translated, or changed, depending on circumstances.

Next, we define the structured project constant cACMEValveLib.Internal.Str1 and cACMEValveLib.Internal.Str2 to contain “(> “and “)”. Note the component “Internal”, which implies that components (constants) under this level are not to be changed by the user. Of course, the user can use the structure cACMEValveLib.Settings.Labels.HighLevel, as described earlier, if the user prefers more levels.

I/O Addressing Guidelines

A good I/O variable structure is the key to being able to debug and change an application. A good structure also makes the connection of the application to system I/O easier to read and understand.

Below are some hints and tips to ensure that the I/O connections have a good structure.

- A good I/O connection structure requires a good application program structure, and also a realistic translation of the process to be controlled, into the application program.
- Try to collect I/O of the same process object in the same controller, and even in the same object in the application program.

- Try to divide the application program into process cells, with contents similar to the real process.

These hints are basic rules for object-based programming for real processes, and once the application has a good structure, it is easier to divide I/O signals into groups or cells of the process.

Connecting Variables to I/O Channels

Only one variable can be connected to each I/O signal, and vice versa. This is not a problem for output signals, but for input signals it may be necessary to read the same input signal from different programs, or even from different places in the same program. This can be done by placing the connected IO variables in a common area, for example, in the application. Then the variables can be read by the program(s).

Note that the result of an IO copying is different depending on whether the parameter is IN or IN_OUT. An IN parameter will result in a copy of the value, whereas an IN_OUT parameter will result in a reference to the current value. While different tasks can copy the same I/O signal, a task with a higher priority may update the signal value in the middle of a scan. See also Function Block Execution on page 59.

If the same I/O signal must be read by different applications, the I/O copying must be done from one of the applications. The copied value can then be moved to other applications through ordinary communication services. See also Communication between Applications Using Access Variables on page 84.

The address for a hardware unit is composed of the hardware tree position numbers of the unit and its parent units, described from left to right and separated by dots. For example, channel 1 on the I/O unit DO814 in Figure 32 has the address Controller_1.0.11.1.1.

Figure 32 illustrates an example of a controller hardware position.

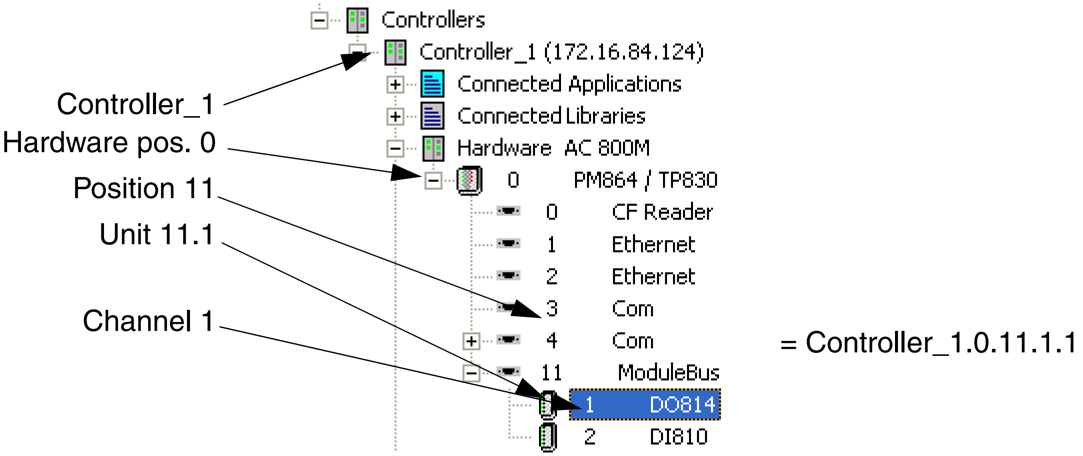


Figure 32. An example of how IO channel addresses are created in a control project.

All I/O access is done via variables connected to I/O channels and these variables are connected in the hardware configuration editor. The Connections tab displays all channels that can be connected.

I/O Data Types

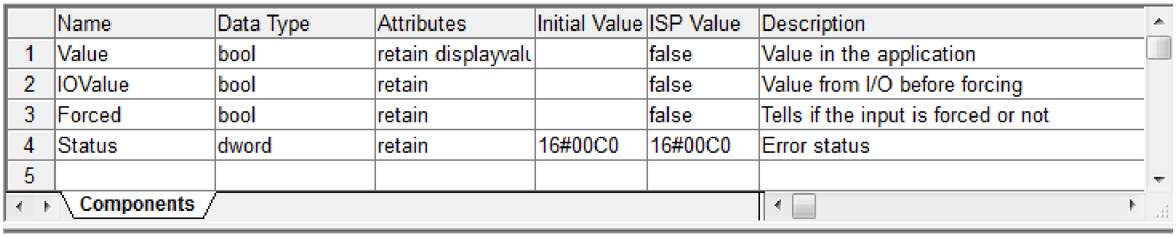
Variables connected to I/O can be of any of the simple data types, *bool*, *dint*, *dword* or *real*, or any of the system-defined I/O data types. For example, an IO unit input can be connected to a variable of *bool* data type or a variable of *BoolIO* data type. For applications that only require a simple channel value, it is enough to connect a variable of simple data type. But for applications that need comprehensive information like forcing IO channels, reading status, or validate analog channel values, must connect variables that is of system defined (structured) IO data type.

It is possible to force I/O values, and display forced and non-forced values from an engineering station, regardless of whether the channel is of a simple data type or an I/O data type.

The user can always choose a variable that is of the simple data type bool, dint, dword, or real, and connect it directly to the I/O channel, as long as the user is content with a simple value in return. However, such a connection does not take advantage of certain auxiliary signals which come with structured data types. A predefined structured data type includes signals for I/O forcing, analog signal status, maximum and minimum values, etc.

Always use In_Out parameters when writing to output I/O variables from a function block. This will prevent unintentional overwriting of I/O variable component values, such as scaling. Do not use Out parameters for this purpose.

Figure 33 presents as an example the available components inside the structured data type *BoolIO*.



	Name	Data Type	Attributes	Initial Value	ISP Value	Description
1	Value	bool	retain displayvalu		false	Value in the application
2	IOValue	bool	retain		false	Value from I/O before forcing
3	Forced	bool	retain		false	Tells if the input is forced or not
4	Status	dword	retain	16#00C0	16#00C0	Error status
5						

Figure 33. Components inside the structured data type BoolIO

A structured data type (for example, the *BoolIO* data type) contains four components. Declare a local variable MyIOVar as a *BoolIO* data type, and then connect MyIOVar to an IO channel to automatically access these four component values at the same time.

By declaring a structured data type, more information can be accessed from the IO channel, which can be read/written in code.

Declaring MyIOVar as a simple data type, *Bool*, provides access to the channel value. In other words, the user cannot read or write other values from the code.

When connecting a structured data type to an I/O channel, always connect the data type (like MyIOVar). Do not try to connect one of the components inside (like Value, I/O Value, Forced etc.) directly on the I/O channel.

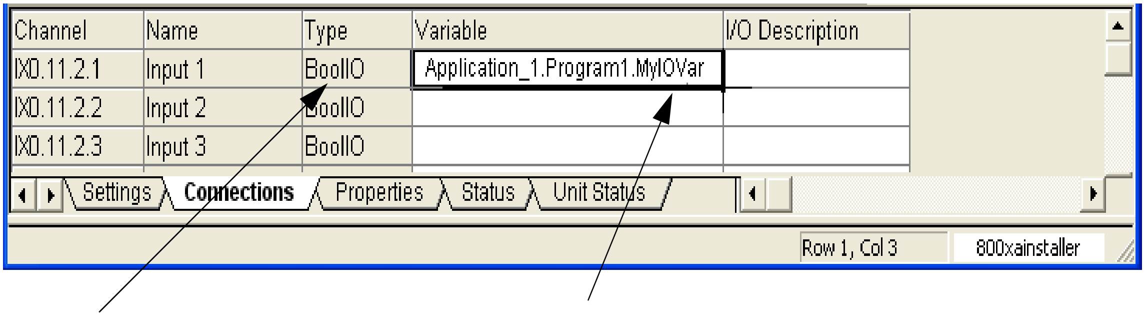
Table 10 shows the (hardware editor) entries to different IO channels. The Type column presents the IO channel data type in the hardware editor, whereas the Variable column presents possible data type connections (simple, structured).

Table 10. Possible variable (data types) connections to IO channels.

Channel	**Name**	**Type**	**Variable**
IX, QX	Boolean. input (IX) and output (QX)	*BoolIO*	*bool, BoolIO*
IW, QW	Non-boolean. input (IW) and output (QW)	*RealIO*	*real, RealIO*
IW, QW	Non-boolean. input (IW) and output (QW)	*DintIO*	*dint, DintIO*
IW, QW	Non-boolean. input (IW) and output (QW)	*DwordIO*	*dword, DwordIO*
IW0, QW0	[1]All Inputs, All Outputs	*DwordIO*	*dword, DwordIO*
IW0	Channel status	*DwordIO*	*dword, DwordIO*
IW0	UnitStatus	*HWStatus*	*dint, HWStatus*

[1] ISP and OSP values are not set for variables connected to All Inputs/All Outputs! For more information see also *Access All Inputs and All Outputs* on page 298.

See Figure 34 and the corresponding structured data types in Table 10.



Channel	Name	Type	Variable	I/O Description
IX0.11.2.1	Input 1	BoolIO	Application_1.Program1.MyIOVar	
IX0.11.2.2	Input 2	BoolIO		
IX0.11.2.3	Input 3	BoolIO		

IO channel of type boolIO.

MyIOVar of BoolIO (correct connection).

Figure 34. A correct way of connecting IO variables. The structured data type MyIOVar connected to an IO channel.

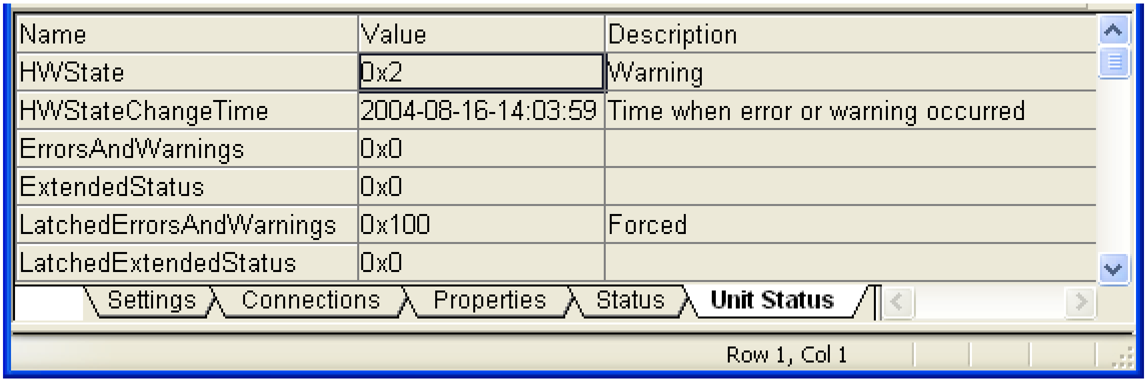
Example of I/O Channel Representation

The IO channel in Figure 34, IX0.11.1.1, interpreted from Table 10, gives the following: IX is a Boolean input, whereas 0.11.1 represents the hardware address and .1 represents the I/O channel.

Monitoring the Status for Hardware and I/O

UnitStatus is a hardware connection to individual hardware and I/O units in the Project Explorer. The user can connect a variable to Unit Status by selecting the Unit Status tab in the hardware editor.

If the user chooses to connect a variable to Unit Status this must be either of a dint data type or of an HWStatus structured data type. The simple data type dint will return one of the unit status value 0 (OK), 1 (Error) or 2 (Warning). Whereas, a variable of HWStatus provides more extended unit status information. See the contents inside the Unit Status tab in Figure 35.

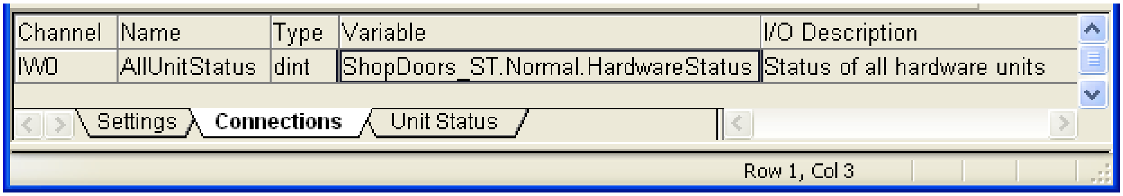


Name	Value	Description
HWState	0x2	Warning
HWStateChangeTime	2004-08-16-14:03:59	Time when error or warning occurred
ErrorsAndWarnings	0x0	
ExtendedStatus	0x0	
LatchedErrorsAndWarnings	0x100	Forced
LatchedExtendedStatus	0x0	

Figure 35. The components available inside the HWStatus.

In addition to the Unit Status there is a 'collective' hardware connection, AllUnitStatus, which contains errors and warnings regarding all hardware units connected to the controller.

Similar to Unit Status, the user can choose to connect a variable of simple data type dint or a variable of the structured data type HWStatus. The simple data type dint will return one of the unit status value 0 (OK), 1 (Error) or 2 (Warning). Whereas, a variable of HWStatus provides more extended unit status information.



Channel	Name	Type	Variable	I/O Description
IW0	AllUnitStatus	dint	ShopDoors_ST.Normal.HardwareStatus	Status of all hardware units

Figure 36. The AllUnitStatus connection gives access to the status of all units.

For information about supervising IO channels and unit status in online mode, see Supervising Unit Status on page 296.

Extensible Parameters in Function Blocks

Some function block types have extensible parameters, such as MMSRead, COMLIRead, etc. This means that the number of input/output parameters is changeable, and must be specified while declaring the function block in the function block tab.

The editor automatically inserts [1] when the user specifies a function block type with extensible parameters. Change the number within the brackets to the required number of parameters.

To see which function block types can have extensible parameters and the maximum number of parameters for each type, see the Control Builder online help.

In the Function Block Diagram (FBD) and Ladder Diagram (LD) languages, a maximum of 32 extensible parameters per function block can be shown.

There is no support for online values on Extensible Parameters. No such values will be presented in online editors or in the project documentation and consequently it is not recommended to trust these values.

Keywords for Parameter Descriptions

Types that are located in standard libraries contain keywords in the description column for parameters. These keywords help the user to organize the parameters and document the purpose of parameters.

Table 11. Type description keywords.

Keyword	Description
IN	The parameter direction is IN (read).
OUT	The parameter direction is OUT (write).
IN(OUT)	The parameter direction is both IN and OUT, but mainly IN (read).
OUT(IN)	The parameter direction is both IN and OUT, but mainly OUT (write).
NODE	Applies only to control modules. Used to indicate that the parameter has a graphical connection.
EDIT	Applies only to IN parameters. The parameter, which must have a value, is only read following changes to the application, warm restart or cold restart. Be careful not to connect a variable to a parameter with the keyword EDIT. Use a literal instead.

Library Management

From the user point of view, there are two main types of library:

- Standard libraries, that are installed with the product. These are protected and cannot be changed.
- User-defined libraries, in which users can add their own types. Copies of template types (data types, function block types, control module types, and diagram types), from the standard libraries can be modified and also added into the user-defined libraries.

The following operations are relevant to both library types:

- Libraries must be inserted into the control project in which they are used, see Insert Libraries into Control Projects on page 111.
- A library that contains types for applications must be connected to all libraries and applications that use types from the library. Libraries containing the hardware types (units) used in the controller configuration have to be connected to the controller. See Connect Library to Application, Library or Controller on page 111.
- A library can be disconnected from, an application, library or controller, see Disconnect Libraries on page 113.

The following operations are relevant to non-standard libraries only, since standard libraries are protected and cannot be changed:

- A new library can be created, see Create Libraries on page 114.
- The state of a library can be changed, see Library States on page 114.
- The version of a library with hardware types can be changed, see Library Password Protection on page 115.
- Types can be added to a library with hardware types, as long as its state is Open, see Add Types to Libraries Used in Applications on page 116 and Add Customized Hardware Types to Library on page 118.
- A library with hardware types can only be deleted if it is not connected to any application, library or controller.
- A library can be password-protected, see Library Password Protection on page 115.

Connect Libraries

In Project Explorer, libraries connected to a control project are stored in the Libraries folder, while libraries connected to applications and libraries are stored in the Connected Libraries folder, see Figure 37.

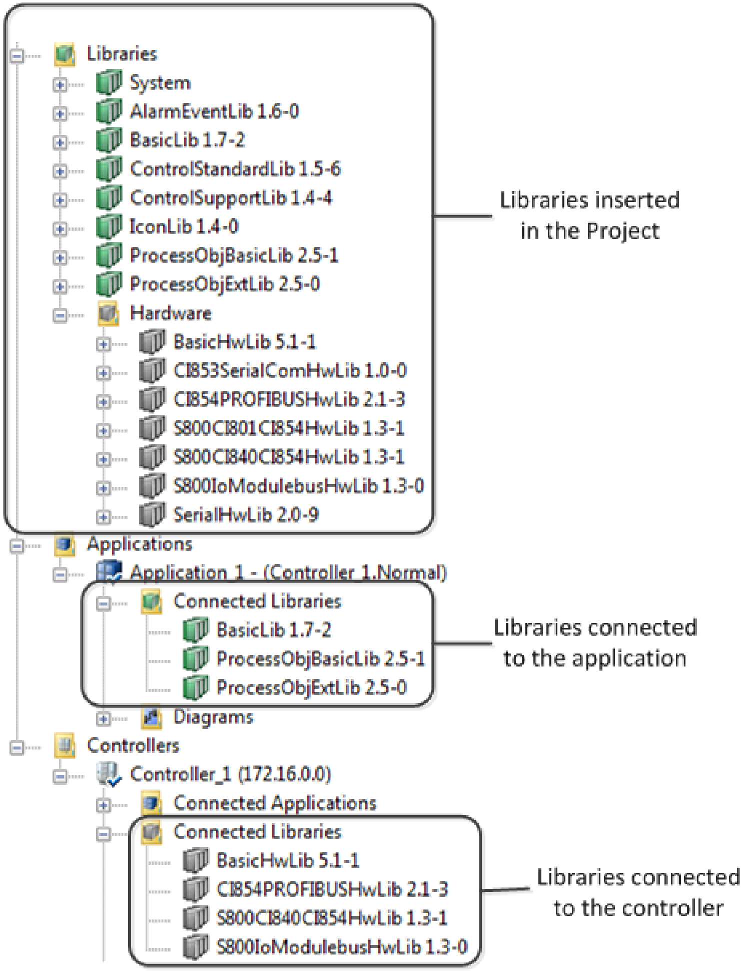


Figure 37. Libraries in Project Explorer

Insert Libraries into Control Projects

A library always has to be inserted into the control project before it can be connected to an application or a controller. To connect a library to a control project:

1. In Project Explorer, expand the Project folder.
2. Select the Libraries/Hardware folder, right-click it and select **Insert Library**.

Connect Library to Application, Library or Controller

To connect a library to an application, a library or a controller:

1. In Project Explorer, expand the corresponding Library, Application or Controller folder.
2. Select the corresponding Connected Libraries folder, right-click and select **Connect Library**.

It is also possible to connect a library using drag-and-drop operation. Select the library to be connected, and drag it to the required application, library, or controller folder.

Replace Connected Library

A connected library can be replaced, for example, when the user wants to update to a newer library version. Replacing to a newer version, results in that all instances of a type in the new library will be used instead of the type in the old version.

To replace a connected library:

1. In the corresponding Connected folder, right-click the library and select **Replace Library**.
2. Press the **Yes** button and select a library from the drop-down list in dialog box.
3. Click the **Replace** button to confirm.

Library Usage

The Library Usage function displays the list of places where a library is used, and where it is connected. For ordinary libraries the Library Usage function searches applications and other libraries. For libraries with hardware, it searches controllers.

1. Right-click the library and select Library Usage as inFigure 38. The Library Usage dialog box is displayed with list of applications where the library is connectedas in Figure 39.

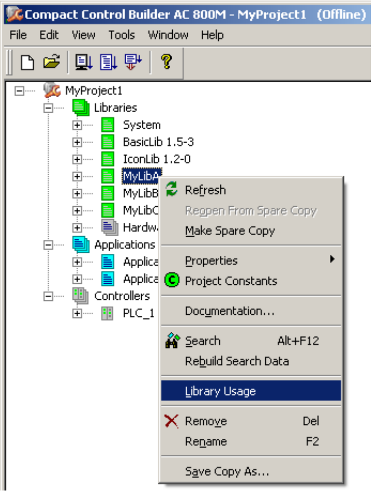
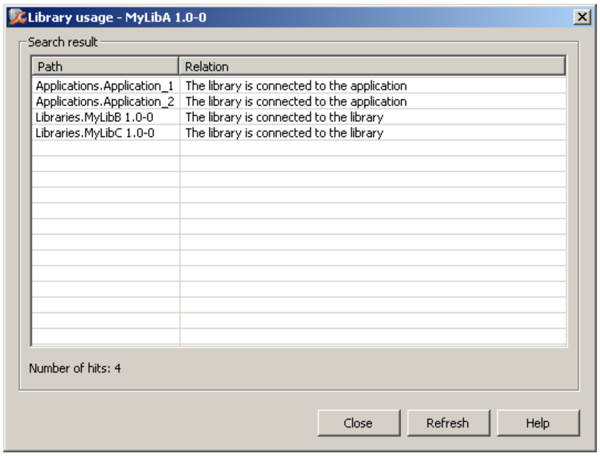


Figure 38. Library Usage



Path	Relation
Applications.Application_1	The library is connected to the application
Applications.Application_2	The library is connected to the application
Libraries.MyLibB 1.0-0	The library is connected to the library
Libraries.MyLibC 1.0-0	The library is connected to the library

Number of hits: 4

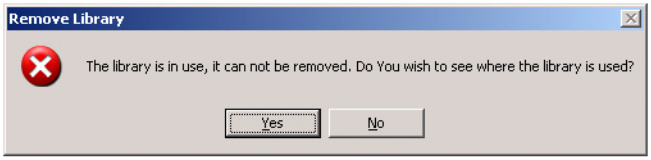
Figure 39. Library Usage dialog showing connected Libraries

Disconnect Libraries

A library can only be removed if the library and its types are not used within the project.

To remove a library from a control project:

- In the Libraries/Hardware folder, right-click the library and select **Remove**. The library is removed from the control project.
- If the Library is in use the following dialog box displays.



The library is in use, it can not be removed. Do You wish to see where the library is used?

- Click Yes to see the Library Usage dialog box.

Libraries can be disconnected from both applications, libraries and controllers:

- In the corresponding Connected folder, right-click the library and select **Disconnect (Library)**. The library is disconnected, but it can be re-connected at any time, since it is still inserted to the control project.

Create Libraries

To create a new library:

1. In Project Explorer, right-click **Libraries** or **Hardware** and select **New Library...** The New Library dialog box is displayed.

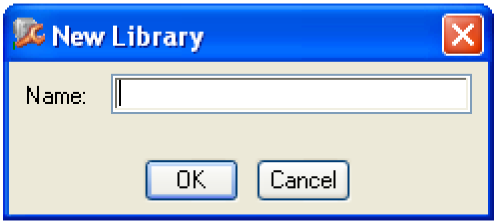


Figure 40. New Library dialog box

2. Enter the name of the new library and click **OK**. The new library is created and inserted into the control project.

Library States

A library is always in one out of three possible states:

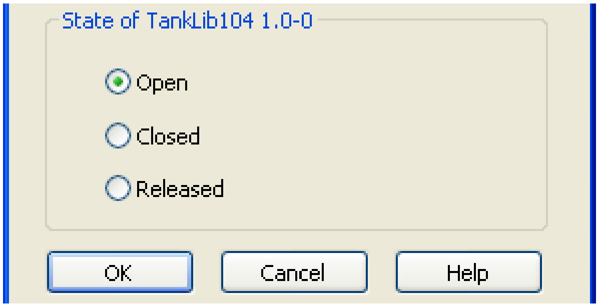
- **Open**
  The contents of the library can be changed. This is the normal state for a library when it is under development.
- **Closed**
  The contents of the library cannot be changed. However, the state can still be changed back to Open.

Released
The contents of the library cannot be changed after it is set to released state.

New library versions cannot be made in Compact Control Builder. A library set to released state cannot be changed again.

To change the library state:

1. In Project Explorer, right-click the library and select **Properties>State**. The State dialog box is displayed.



State of TankLib104 1.0-0

● Open

○ Closed

○ Released

Figure 41. State dialog box

2. Select the desired state and click **OK**. The library state is changed.

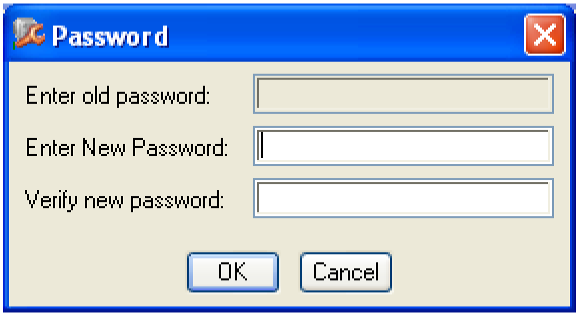
The library state can only change:

- From Open to Closed or Released.
- From Closed to Open or Released.

Library Password Protection

To password protect the libraries:

1. Right-click the library and select **Properties > Protection**. The Protection Properties dialog opens.
2. Click **Set Password**. The Password dialog opens, see Figure 42.



Password

Enter old password:

Enter New Password:

Verify new password:

Figure 42. Password dialog box

3. Enter the new password and confirm it in the Verify new password field.

   If the library is already password protected, you have to enter the old password before entering a new one. A password may consist of both letters and digits. It must be at least 6 characters long.

4. Click **OK**. The library can now not be changed without entering the password.

Add Types to Libraries Used in Applications

Types can only be added if the library state is Open.

Follow the steps below to add the following functions in a library:

5. To the library (see Figure 43), add the following:

   a. To connect another library to library, right-click the Connected Libraries folder and select **Connect Library**.

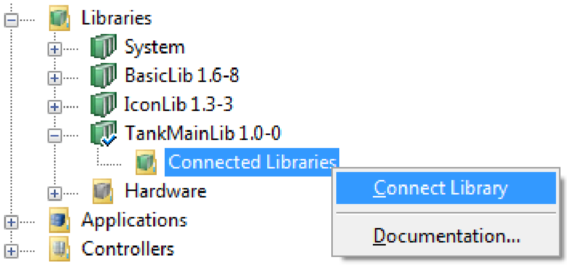


Figure 43. Connecting a Library

   b. To add project constants to library, right-click the library folder and select **Project Constants**.

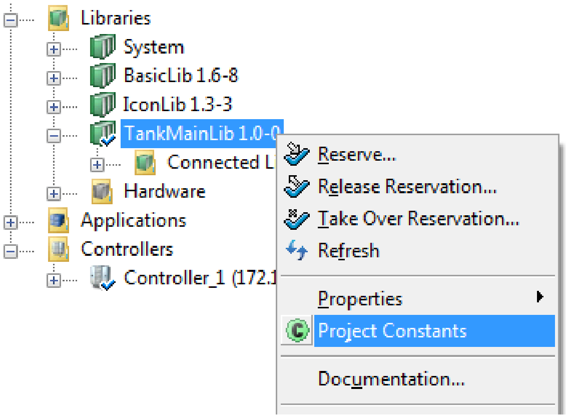


Figure 44. Adding Project Constants

   c. To add a type to the library, right-click the folder corresponding to the type you want to add and select the command for creating a new type.

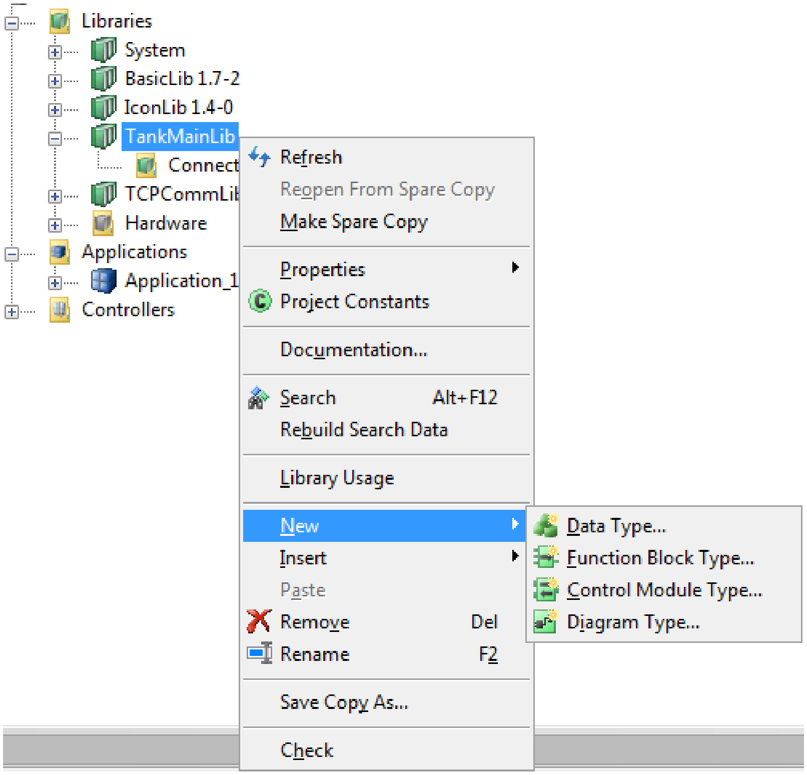


Figure 45. Adding a type

Add Customized Hardware Types to Library

For more information on working with types and project constants, see Application Types and Instances on page 30.

Customized hardware types can only be added to the library if the library state is Open. To add a customized hardware type to a library:
In Project Explorer, expand Libraries > Hardware.
Figure 46. Hardware with its libraries.

6. Right-click Hardware types folder under your chosen library, and select **Insert/Replace Hardware Type(s)**.

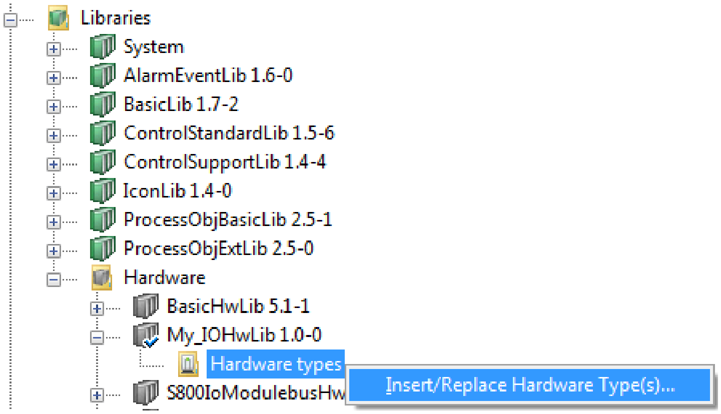


Figure 47. Inserting hardware types in library

7. Browse and select the device capability description file (for example a *.gsd file) you want to add as hardware and click **Open**. (See also Supported Device Capability Description Files on page 120).

8. The Device Import Wizard starts. Follow the instructions in the wizard.

In exceptional cases, it is possible to insert individual external customized hardware types to a user-defined library, for example, a hardware type of a *.gsd file that have been converted and used in an earlier version of Control Builder.

In this case, right-click the Hardware types folder under your chosen library and select **Insert/Replace Hardware Type(s)** and browse to the hardware type (*.hwd file) to be inserted. With **Insert/Replace Hardware Type(s)** it is also possible to replace same hardware type.

If a hardware definition file (*.hwd) is re-imported with changed parameters, Control Builder must be restarted so that the changes take effect.

If changes are made to existing *.hwd files, a new GUID is created for them to coexist after the re-import.

Device Import Wizard

You use this wizard to import a device capability description file. The wizard will convert this file to a hardware type and insert the type into a user-defined library. The appearance of some wizard dialog boxes will be different depending on the file type to import.

Always complete the wizard, even if you are not finished. Then, you can re-import the file and continue where you left off.

When a wizard dialog box is displayed, relevant information is read from the device capability description file. If it is large this may take a while, and a progress bar will be shown.

- You can import a new device capability description file, as described above (Add Customized Hardware Types to Library on page 118).
- You can change conversion settings for a previous import, as described in Wizard on page 123.
- When you receive an updated device capability description file, you may want to replace the previous import. Import the new file the same way as the old one, as described above.

For more information on the Device Import Wizard, refer to the online help.

Supported Device Capability Description Files

You can only import supported device capability description files. The following files are supported:

- PROFIBUS GSD files
- PROFINET IO GSD files
- Ethernet/IP and DeviceNet EDS files

For PROFIBUS GSD-files, *.gs? is the standard file extension. However, a file can also have a different extension that specifies its language, for example, *.gse (English) or *.gsg (German).

For PROFINET IO GSD files, *.xml is the standard file extension. PNIO uses GSDML, an XML based markup language to describe the characteristics of the PNIO devices.

For Ethernet/IP and DeviceNet, *.eds is the standard file extension. The wizard will convert the EDS file to a hardware definition file (HWD File) and insert it as a hardware type into the user-defined library.

You can only import PROFIBUS GSD-files with hardware types for CI854, and not for CI851. (However, when you upgrade a previous system offering, any included hardware types for CI851 will be upgraded as well.)

For more information on using Device Import Wizard for importing gsd, xml and eds files into the Control Builder, refer to:

- *AC 800M, PROFIBUS DP, Configuration (3BDS009030*).*
- *AC 800M, ProfiNet I/O, Configuration (3BDS021515*).*
- *AC 800M, EtherNet/IP DeviceNet, Configuration (9ARD000014*)*

Additional Files for Libraries with Hardware

There are a number of files associated with libraries for hardware and hardware types. For standard system libraries, it is not possible to perform any operation on these type of files. For a user-defined library there are some files that can be managed.

The file types, described below, are associated with the hardware definition and cannot be changed or replaced.

File Types Associated with Hardware Types

To display the Additional Files dialog box for a hardware type:

1. In Project Explorer, expand the library with the hardware type under Libraries > Hardware.
2. Under Hardware types for the library, right-click the hardware type and select **Files**.

The only file type (in a user-defined library) that the user can perform any operations on is the Help File. See Help File on page 123.

The file types, listed in Table 12, are associated with the hardware type and cannot be modified by the user.

Table 12. File Types Associated with Hardware Types

File Type	Description
Firmware File	Firmware file for CPU or communication interface unit.
Update File	Update file for firmware; a download support file.
Firmware Idx File	Idx file for firmware, used when analyzing a crash dump.
Protocol Handler Control Builder File	Protocol handler used by Control Builder.
Protocol Handler Controller File	Protocol handler used by controller.
Protocol Handler Idx File	Idx file for controller protocol handler, used when analyzing a crash dump.

File Types Associated with Libraries

It is only possible to manage Additional files for a user-defined library.

To display the Additional Files dialog for a library with hardware types:

1. In Project Explorer, browse Libraries > Hardware.
2. Right-click the library and select **Properties > Files**.

The file types, listed in Table 13, are associated with the library.

Table 13. File Types Associated with Libraries

File Type	Description
Help File	A help file (of *.chm or *.hlp type) can be added, replaced, deleted or extracted, See Help File on page 123
Import File	Import file is a device capability description file (for example a *.gsd file) that has been added with the Device Import Wizard. This type of file can be deleted (Delete button), or extracted (Extract button) to a file on disk. By pressing the Wizard button it is also possible to change the previous done settings. See Wizard .

Wizard

Settings for a previously added device capability description file can be changed.

1. In Additional Files for a library, select the row with the device capability description file (Import File) and press the **Wizard** button.
2. In the displayed Device Import Wizard, define the new conversion settings.

Help File

A help file (of *.chm type) can be added, replaced, deleted or extracted for a customized hardware type, as well as for a user-defined library.

Adding a help file to a customized hardware type or a user-defined library provides access to the associated help file when you press F1on the user-defined library or on the customized hardware type, in Project Explorer. For further information about requirements on customized online help, see the *Compact 800 Engineering Compact Control Builder AC 800M Binary and Analog Handling (3BSE041488*)* manual.

To add a help file to a user-defined library or to a customized hardware type:

1. In Additional Files dialog box, select the **Help File** row and press the **Add** button.

Browse to the help file (of *.chm type) and click **Open**.

Replace and Delete

A help file that has been added can be replaced and deleted by selecting the row with the help file and pressing **Replace** and **Delete** button respectively. It is also possible to delete a device capability file (Import File) for a user-defined library.

Extract and Save a Copy of a File

A help file can be extracted and saved on disk by selecting the row with the help file and press the **Extract** button (to the right of the grid). Browse to a place on disk and save a copy of the file by pressing **Save** button.

In some exceptional cases there is a need to extract an individual customized hardware type to a hardware definition file (*.hwd file). In this case, press the **Extract** button under *Hwd File*.

Properties on Hardware Types

In Additional Files for a customized hardware type, it is possible to set a version information text of maximum 18 character to the help file, by pressing the **Properties** button.

Delete Hardware Types

A hardware type in a library can be removed.

It is not possible to remove a hardware type from a library, if it is used in any hardware configuration.

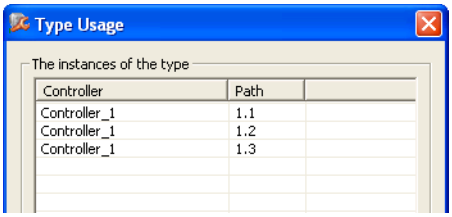
1. In Project Explorer, expand the library with the hardware type under Libraries > Hardware.
2. Under Hardware types for the library, right-click the hardware type and select **Remove**.

Type Usage for Hardware Types

It is possible to display a list of which controller(s) that use(s) the hardware type together with hardware tree position numbers.

1. In Project Explorer, expand the library with the hardware type under Libraries > Hardware.

2. Under Hardware types for the library, right-click the hardware type and select **Type Usage**.



The instances of the type

Controller	Path	
Controller_1	1.1	
Controller_1	1.2	
Controller_1	1.3	

Figure 48. Type Usage for a selected hardware type.

Hide and Protect Control Module Types, Function Block Types, Diagram Types, and Data Types

When you create libraries with self-defined control module types, function block types, diagram types, and data types, Control Builder provides you with two protection features (attributes). These two attributes are called *Hidden* and *Protected***,** and can be set from Project Explorer.

Hidden

Setting the Hidden attribute will completely hide your code from other users. To hide the code makes it easier to improve your type as often as you like. This is a common situation when developing types that will be re-used over and over again in different library solutions.

Protected

Setting your type to Protected will protect the internal type structure from being seen. This means that only the type itself will be visible, and thus your type definition will be protected from external exposure, as well as any attempt to duplicate it. This is extra valuable when you create a type solution for re-use engineering.

When a protected type is opened in an editor, only the parameter declaration is visible (read-only). Other declarations like variables and function blocks are not visible. Only code block tab is shown as a blank page, that is, the IEC 61131-3 logic is protected. The complete type structure will still be protected from external exposure.

The Hidden and Protected attribute can also be used for structured data types.

Override

After you have protected your types, you can always override the hidden and protected attribute temporarily, while you work on improvements. The override protection property can be set in Project Explorer.

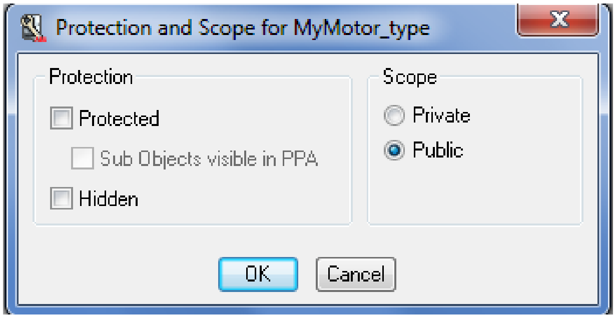
For self-made libraries with password protection, you must enter the password before you make an override, see Library Password Protection on page 115

The protection cannot be overridden for Control Builder standard libraries. They cannot be updated or changed by the user.

Protect a Self-Defined Type

To protect a self-defined type:

1. In Project Explorer, right-click the type and select **Properties > Protection and Scope**. A Protection and Scope window opens.


Protection and Scope for MyMotor_type

Protection
□ Protected
□ Sub Objects visible in PPA
□ Hidden

Scope
○ Private
● Public

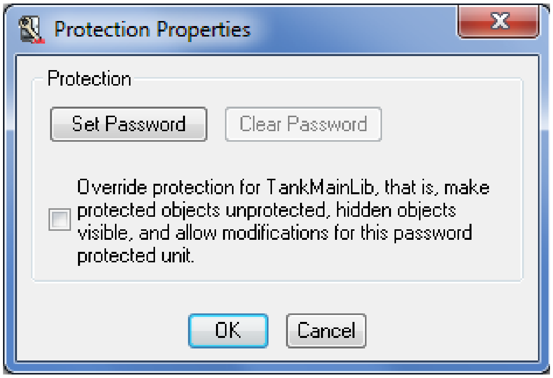
Figure 49. Protection and scope

2. Check the desired protection radio button(s) and click **OK**.

Override Protection Attributes

To override protection for a library or application:

1. In Project Explorer, right-click the library (or application) and select **Properties > Protection**. A Protection Properties window opens.



□ Override protection for TankMainLib, that is, make protected objects unprotected, hidden objects visible, and allow modifications for this password protected unit.

Figure 50. Protection properties

2. Check the Override check box (see figure above) and click **OK**. The Override feature will have impact in Project Explorer only.

Task Control

A *task* is defined as an execution control element that is capable of starting, on a periodic basis, the execution of a set of POUs (Programs, Function blocks, functions etc.).

The Control Builder setup three tasks (Fast, Normal and Slow) by default, provided that an AC 800M Control Project template has been selected. The tasks are connected to their respective diagrams (one task per diagram). The tasks serve as 'work schedulers' for the diagrams and contain settings for interval time and priority. However, setting interval time and priority is not enough; you must also tune your tasks.

To learn how to tune tasks, see *Compact 800 Engineering Compact Control Builder AC 800M Planning (3BSE044222*)* manual.

If a diagram does not have a task connected, it will run by the task connected to the corresponding Application.

You may create and connect several tasks to a controller, but experience show that more than five tasks in each controller makes it difficult to overview.

The Control Builder provides a Task Analysis tool that predicts the execution of an application by the controller before loading it onto the controller. See Task Analysis on page 150 for more information.

Task Connections

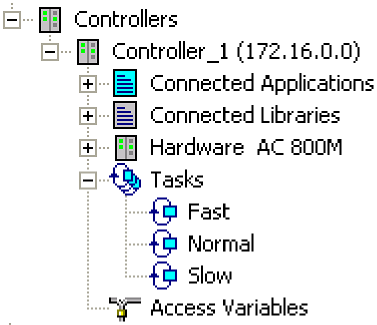
A task can be connected to a program, a function block, a control module or a single control module, a diagram, and several tasks may execute in the same controller. An application can also be connected to a task, and all POUs in an application execute in this task, unless otherwise specified. A task can only execute POUs in one application. Hence, POUs from different applications can not be connected to the same task.

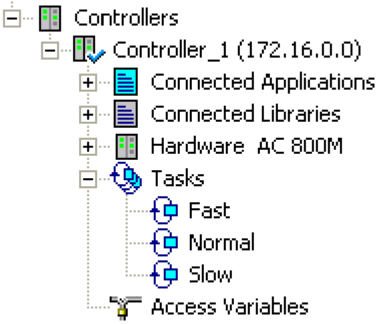
Do not re-connect tasks to applications unless it is necessary, as this might disrupt the task execution during reconfiguration. Else change the parameters of the connected task (to fit the needs).

Create a New Task

To create and configure a new task:

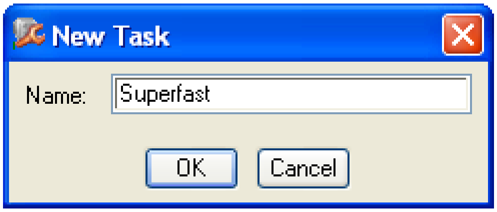
1. Expand the Hardware tree, until you find **Tasks**.





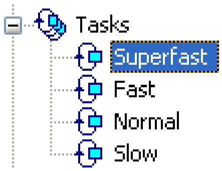
2. Right-click **Tasks** and select **New Task**. A ‘New Task’ window opens.

3. Name the task.



Name: Superfast

4. Click **OK**.

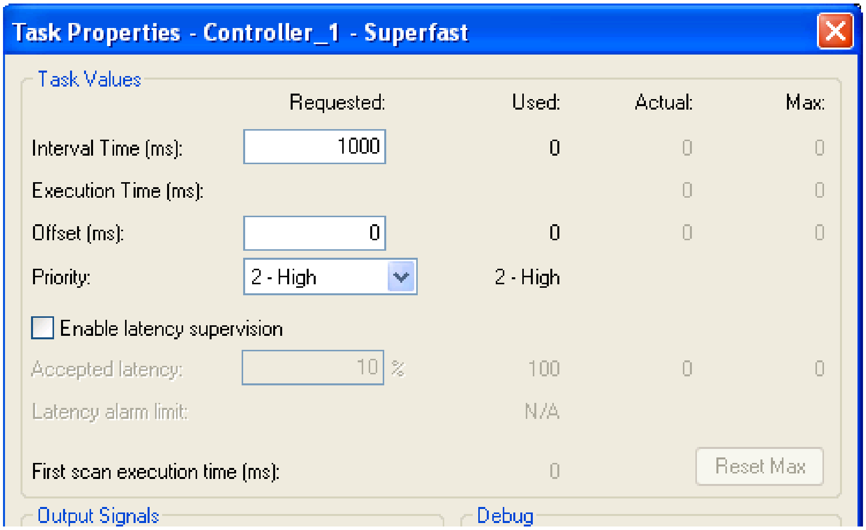


- Tasks
  - Superfast
  - Fast
  - Normal
  - Slow

Figure 51. A new task has been created.

After the task has been created, it is time to configure the task with new properties.

5. Right-click the new task (Superfast) and select **Properties**. A ‘Task Properties’ window opens.



Task Properties - Controller_1 - Superfast

Task Values

	Requested:	Used:	Actual:	Max:
Interval Time (ms):	1000	0	0	0
Execution Time (ms):			0	0
Offset (ms):	0	0	0	0
Priority:	2 - High	2 - High		

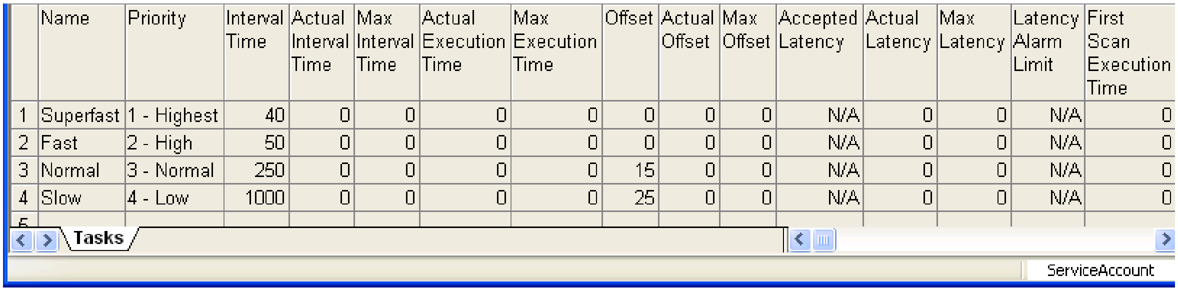
□ Enable latency supervision

Accepted latency:	10 %	100	0	0
Latency alarm limit:		N/A		
First scan execution time (ms):		0		

Figure 52. A Task Properties window for configuring a task.

6. Change the interval time to 40 ms and Priority to 1-Highest. Click **Apply** followed by **Close**.

7. Right-click Tasks and select **Editor** to view the new task. A ‘Task Overview’ window opens.



	Name	Priority	Interval Time	Actual Interval Time	Max Interval Time	Actual Execution Time	Max Execution Time	Offset	Actual Offset	Max Offset	Accepted Latency	Actual Latency	Max Latency	Latency Alarm Limit	First Scan Execution Time
1	Superfast	1 - Highest	40	0	0	0	0	0	0	0	N/A	0	0	N/A	0
2	Fast	2 - High	50	0	0	0	0	0	0	0	N/A	0	0	N/A	0
3	Normal	3 - Normal	250	0	0	0	0	15	0	0	N/A	0	0	N/A	0
4	Slow	4 - Low	1000	0	0	0	0	25	0	0	N/A	0	0	N/A	0
5															

The Task Overview window lists all the tasks with each property settings. To change the settings for a certain task:

8. Select a task in the Task Overview window and open **Tools > Task Properties**.

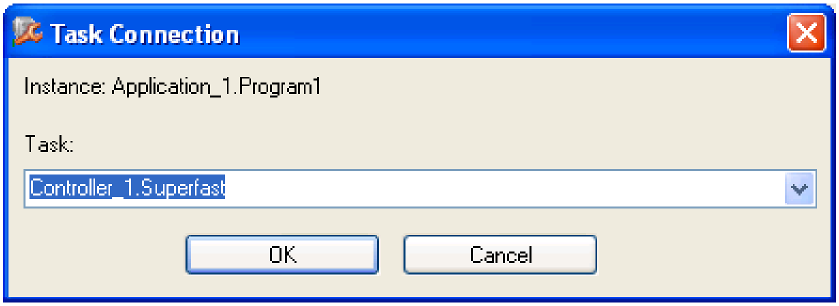
Right-click a task directly in the hardware tree and select **Properties** to open the Task Properties window directly.

Select **Tools > Reset Max**, to reset all tasks that appear in the editor.

Connect a Task to a Program

To connect the task SuperFast to Program1:

1. Right-click **Program1** and select **Properties > Task Connection**. A ‘Task Connection’ dialog box opens.

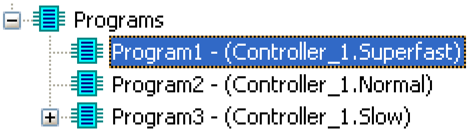


Instance: Application_1.Program1

Task:

Controller_1.Superfast

2. Select a task from the drop-down menu (here SuperFast) and click **OK**.



Programs
Program1 - (Controller_1.Superfast)
Program2 - (Controller_1.Normal)
Program3 - (Controller_1.Slow)

Figure 53. Program1 has changed task to Superfast.

Function Blocks with Different Task Connections

You can connect function blocks inside a program to a task different from the one connected to the program, (right-click on the function block and select 'Task Connection').

However, variables inside the function block that pass values to and from the function block are controlled by the program task. The code in the function block will run according to its task, but the parameters will be updated according to the program task. This means, in practice, that the function block in a program can only run at a slower, or a least at the same, speed as the program. However, if you use external variables or connect I/O directly to the function block, there will be a direct reference, independent of the task cyclicity of the function block.

To set-up specific time intervals and task priority different from the task connected to the application whilst for example, designing libraries, can be done by declaring and using global variables, or by using parameters.

For more information, see Control the Execution of Individual Objects on page 92.

Task Execution

There are four important task parameters that can be set to optimize program execution:

- *Priority*, which sets the execution order for tasks, see sub section Priority below.
- *Interval time*, sets the task intervals during the program is executed, see sub section Interval Time on page 136.

- *Offset*, a parameter that helps you to avoid unexpected delays in execution when tasks are scheduled to execute at the same time. See sub section Offset on page 137.
- *Execution time*, for best real time behavior and communication performance, avoid extensive continuous execution. See Execution Time on page 142 and also Communication Considerations on page 140.

All POUs connected to a task execute with the same *priority*, *interval time, offset*, and *execution time*.

Task Priority

There are six levels of priority: *Time Critical, Highest, High, Normal, Low*, and *Lowest*, numbered from 0 to 5. The tasks are executed according to their priority, where the time-critical task has the highest priority. A task with higher priority may interrupt any task with lower priority, but a task cannot interrupt another task with the same priority. There can only be one time-critical task. Such a task may interrupt the execution at any point, while other tasks may only interrupt execution at defined points.

An ordinary (non-time-critical) task can be interrupted:

- at the start of any code block,
- at backward jumps, for example for, while, repeat statements.

A time-critical task has special properties.

- The task is not driven by the same scheduler as the rest of the tasks. Instead, the task is driven from the system's real-time clock (hence the high precision).
- The tasks have high precision in execution time. The resolution is 1 ms.
- A change to/from time-critical priority in Online mode is not possible.
- A change to/from time-critical priority in Offline mode requires re-compilation of the application.

Consider the following points, when using the time-critical priority.

- Only one time-critical task per controller is allowed.

- The execution time for a time-critical task (priority 0) must not exceed 100ms. This restraint prevents the task from blocking other functions, for example communication.
- All functions cannot be called from the program connected to the task. You cannot set time-critical priority if the code contains invalid instructions (this is checked during compilation). The time-critical task interrupts execution at any time, which means that execution might be interrupted mid-statement.
- If a power failure occurs while the time-critical task is running, the execution of the current code block is completed (assuming that it can be completed within 1 ms). For a warm start to be possible, no code block in the time-critical task may take more than 1 ms to execute.

Task priorities 1–5 can be set by using the firmware function *SetPriority*. This function is located in the System folder.

Interval Time

The interval time, during which the program is executed, is set in the Task Properties dialog box. Default values are 50 ms (Fast), 250 ms (Normal) and 1000 ms (Slow). You can change these values at any time. For a time-critical task, the interval time can be as short as 1 ms. The interval time of tasks of priority 1–5 cannot be less than 10 ms. The resolution is 1 ms.

If two tasks have the same priority, and they both wait for execution, the task with the shortest interval time will be executed first.

All task intervals must be multiples of each other. The shortest interval is the "time base".

Execution Example

Figure 54 shows two tasks executing in the same system. Task 1 and task 2 have interval times of 30 and 200 ms, and execution times of 10 and 50 ms, respectively.

When the tasks have been assigned the same priority, the execution start time of task 1 is very much delayed. It also drops one execution.

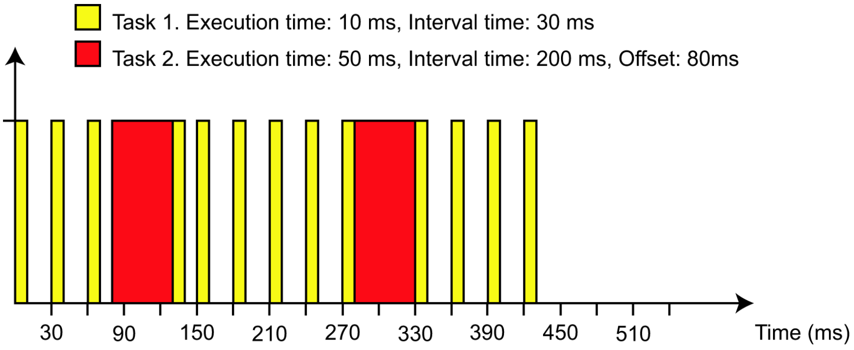


Figure 54. Execution of two tasks with the same priority.

In Figure 55, task 1 has higher priority than task 2, and interrupts the execution of task 2. Hence task 1 is not delayed much by task 2.

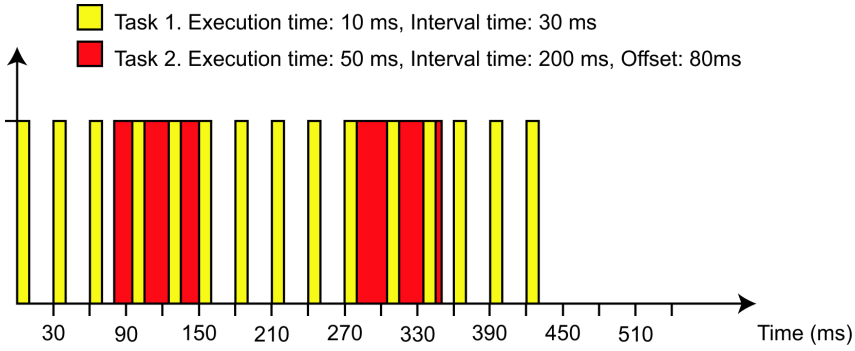


Figure 55. Execution of two tasks with different priorities.

Offset

The compiler will detect inappropriate offset settings.

The offset of each task must be equal or greater than the sum of the execution times of all higher-priority tasks.

If your tasks are scheduled to execute at the same time you will receive a warning during download. However, this compiler function is merely calculating theoretical periodic executions, which means that it will not warn you for task collision caused by, for example a too close offset time. Therefore, consider the compiler warning as a first preliminary check provided to you and not as a guarantee that will prevent task collisions.

Two tasks will be scheduled to start execution at the same time if the greatest common divisor of the tasks interval times divides the difference in the tasks offsets.

Turning off Task Collision warnings

You can turn off the task collision warning from the Project Explorer.

1. Right-click the Project item and select **Settings > Compilation Warnings** from the context menu. A Compilation warnings dialog box will open.
2. Click to clear **Task Collisions** check box and then **OK**.

When tasks are scheduled to execute at the same time, the task with the highest priority will be executed first. If tasks have the same priority the task with the shortest interval time will be executed first. Offset is a mechanism that can be used to avoid unexpected delays in execution when tasks are scheduled to execute at the same time.

Do not change task offset for a controller with a running application. This may result in that the task executes one more time than expected.

In Figure 56 and Figure 57, the execution of two tasks with the same priority with interval times of 50 ms and 100 ms is shown. When both tasks have a 0 ms offset (Figure 56), the execution start time of task 2 is delayed, and the actual interval time for task 2 is influenced by variations in the execution time of task 1.

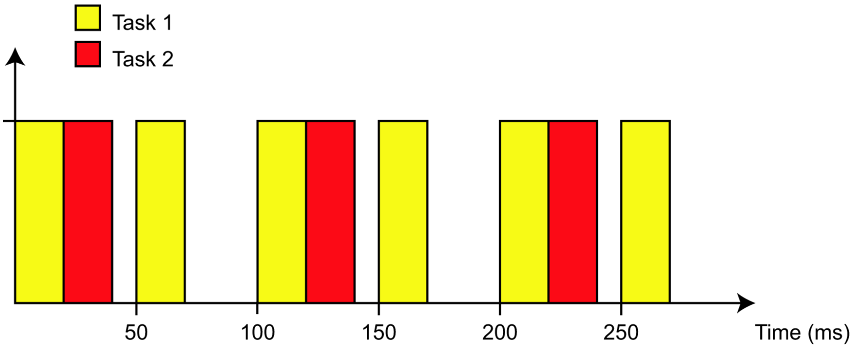


Figure 56. No offset. The two tasks have the same priority, but different interval times (50 and 100 ms).

If task 2 is assigned an offset, as in Figure 57, neither task is delayed, and the actual interval time for task 2 will not be affected by task 1.

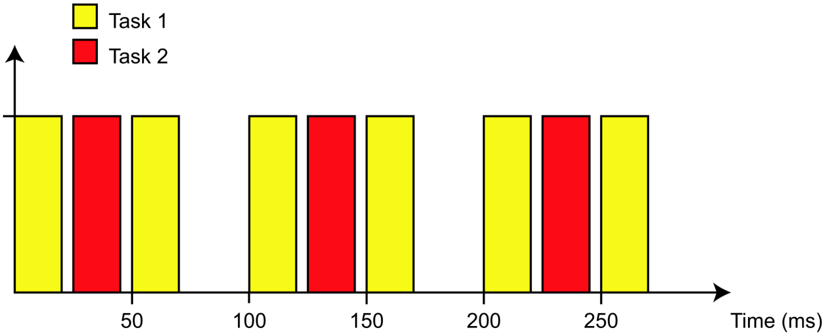


Figure 57. Offset is set on task 2. The two tasks have the same priority, but different interval times (50 and 100 ms) and are thus executed at the requested times.

An application starts to execute by scheduling all tasks in the application to execute at the same time. The task with highest priority is executed first, and if tasks have the same priority, the task with the shortest interval time will be executed first.

Execution Synchronization

When a task has finished execution of the first scan after application start at time *t*, the start of its next execution is synchronized to time 0 (the time the controller started to execute).

$t = n$ * (interval time) + d, $0 \leq d <$ interval time

d is the time from the start of the current interval time, to when the task finished execution in the current interval. The synchronization to time zero (0) implies that the start of the next execution will be at the first start point after the current time.

If offset = 0, the task will be scheduled to execute at time (n + 1) * (interval time). However, if the time to the start of the next execution, (interval time) - *d*, is less than 10 ms, the task will be scheduled to execute a time (n + 2) * (interval time).

If offset > 0, then if offset > *d*, the start of the next execution will be at a time *n* * (interval time) + offset. If offset < *d*, the start of the next execution will be at a time (n + 1) * (interval time) + offset. If the time to the start of the next execution is less than 10 ms, the interval time will be added to the start time of the next execution.

The same synchronization of execution time will be performed after a change in interval time or offset.

Time critical task is not synchronized to time zero (0).

Communication Considerations

POU execution has higher priority than other functions, such as communication. These functions are performed in the gaps between the execution of different tasks. If several tasks with long execution times are executed immediately, one after the other, the time gaps are few but long (see Figure 58).

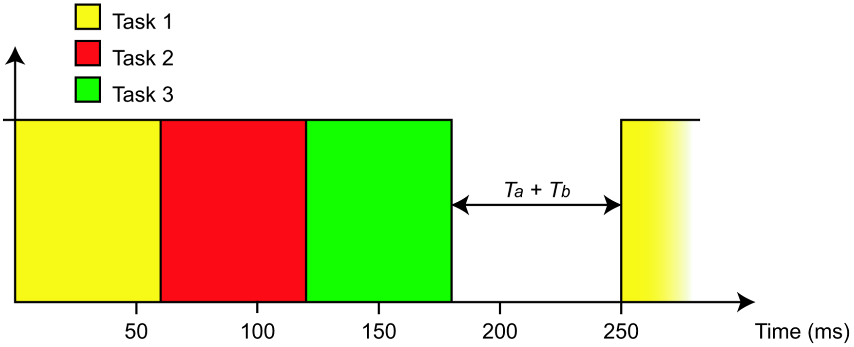


Figure 58. The result of having no offset for three tasks with long execution times. The gap (T_a+T_b) is the time available for the execution of other functions, for example communication.

The offset mechanism can be used to make the time gaps more frequent (see Figure 59).

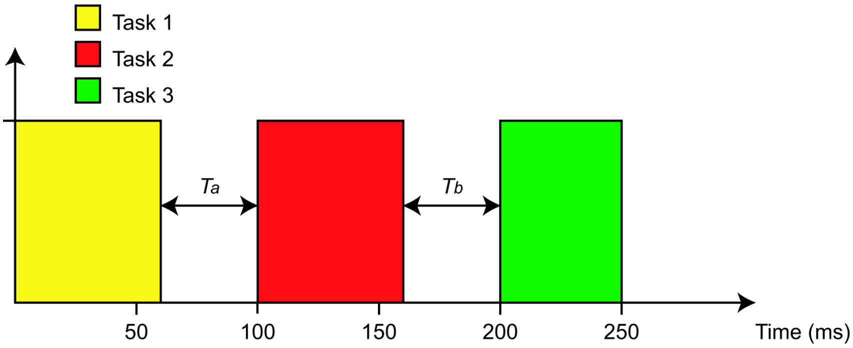


Figure 59. The result of assigning offset to tasks 2 and 3, is that the time available for the execution of other functions occurs more often (T_a).

The same processor handles communication and IEC 61131-3 code. This means that you have to consider how much code you include in each task, when you tune the tasks.

Assume that we have a task running code with an execution time of 500 ms and an interval time of 1000 ms. This means a cyclic load of 50% (load = execution time / interval time). But, this also means that no communication can be performed during the 500 ms execution (since communication has lower priority than the task).

Now, assume that we have divided the code into 4 tasks such that each one corresponds to 125 ms of the execution time. The interval time is still 1000 ms, hence the load is still 50%. But, if we set the offset for the 4 tasks to 0, 250, 500, and 750 ms, the result will be completely different. Now, code will be executed for 125 ms, after which there will be a pause when communication can be performed. Following this, code will be executed for another 125 ms followed by another pause when further communication can be performed. Hence, we still have the same cyclic load, but the possibility for communication has increased considerably.

To conclude, try to tune your tasks using offsets before you change the priority. Actually, the only time you have to change the priority, is when two tasks have so much code that their execution cannot be "contained" within the same time slot, that is, the total execution time exceeds the length of the time slot. It is then necessary to specify which of the two tasks is most important to the system.

More information about task tuning can be found in the *Compact 800 Engineering Compact Control Builder AC 800M Planning (3BSE044222*)*.

Execution Time

The maximum allowed execution time for time-critical tasks must not exceed 100ms. This is also recommended for the other tasks in the controller. The execution time for each individual task should be kept feasible to 100 - 200ms.

The maximum allowed execution time does not include the first scan execution time.

It is preferred to split the execution of a program or application into different tasks, if the execution time is high and good real time behavior is needed. See Communication Considerations on page 140.

Overrun and Latency

Overrun and Latency are two functions for supervising a task. Overrun checks if each task finishes before it is supposed to start the next time, and detects if the task runs for too long. Latency on the other hand, checks that a task starts on time (on each cyclic start), and detects if the task starts too late.

The Overrun function is configured per controller via the Controller Settings dialog box, while the Latency function is configured per task via the Task Properties dialog box. Both Overrun and the Latency function uses the Error Handler to report any errors.

Overrun Supervision

Overrun occurs when the execution of a task takes too long, that is, the task is still executing when the next execution of the task is scheduled to start.

By setting the maximum number of consecutive overruns allowed (missed scans), you can control when a fatal overrun error is considered to have occurred, and consequently configure a controller reaction.

These reaction settings are:

- Nothing,
- Stop Application,

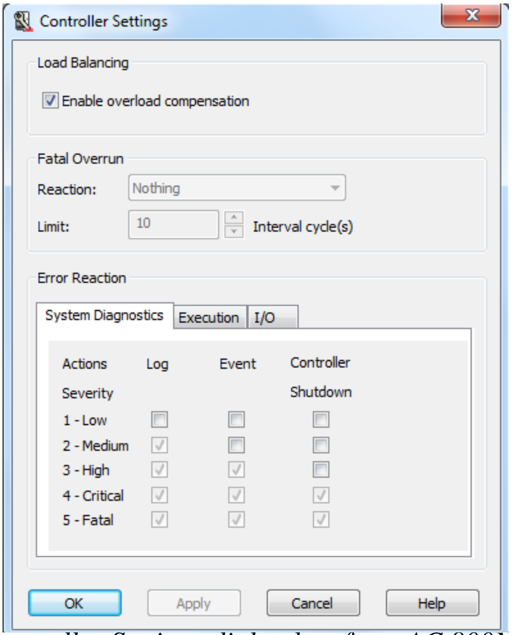
- Reset Controller.

In an AC 800M controller, load balancing and overrun supervision functions are mutually exclusive, whereas the Load Balancing function is default. Hence, the overrun supervision is turned off. For more information about load balancing and cyclic load, see Load Balancing on page 147.

Configuring Overrun Supervision

Overrun supervision is set for each controller in the Controller Settings dialog box. To select Overrun Supervision for a controller, follow these steps:

1. Expand the Hardware tree until the controller (for example, Controller_1).
2. Right-click the controller and select **Properties > Controller Settings** from the pop-up menu. A 'Controller Settings' dialog box opens.



Controller Settings

Load Balancing

☑ Enable overload compensation

Fatal Overrun

Reaction: Nothing

Limit: 10 Interval cycle(s)

Error Reaction

System Diagnostics | Execution | I/O

Actions Severity	Log	Event	Controller Shutdown
1 - Low	☐	☐	☐
2 - Medium	☑	☐	☐
3 - High	☑	☑	☐
4 - Critical	☑	☑	☑
5 - Fatal	☑	☑	☑

Figure 60. Controller Settings dialog box for a AC 800M controller.

3. Uncheck Load Balancing, (**Enable overload compensation** check box).

4. Select a reaction for Fatal Overrun from the **Reaction** drop-down menu, (*Reset Controller* or *Stop Application* will activate the Limit field).
5. Enter the number of consecutive overruns allowed in the **Limit** field, (number of consecutive overruns before a fatal overrun is considered to have occurred).
6. Use the tabs under Error Reaction to set-up actions for different error types and severity. (For information on Error Reaction settings, see Controller Settings in Controllers on page 320).
7. Click **OK**.

If overrun errors occur, re-program the faulty task to decrease load.

Latency Supervision

Latency occurs when the execution of a task is delayed, that is, the task starts to execute later than scheduled. The latency function will supervise your tasks (start on time on each cyclic load), and detect if a task starts sooner or later than scheduled.

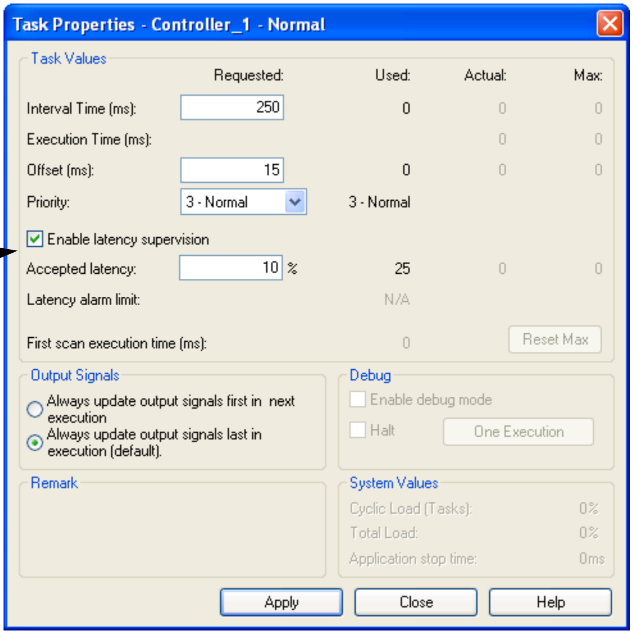
Latency is activated in the Task Properties dialog box, where you set the acceptable latency in percent (accepted latency in percentage of the interval time). The lowest accepted value for Latency Time is always 10 ms.

Configuring Latency Supervision

Latency supervision is set for each task in the Task Properties dialog box. To select Latency Supervision for a task, follow these steps:

1. Expand the Hardware tree, until you find **Tasks**.

2. Right-click a task and select **Properties** from the pop-up menu. A ‘Task Properties’ dialog box opens.



Enable Latency supervision check box

Task Properties - Controller_1 - Normal

Task Values

	Requested:	Used:	Actual:	Max:
Interval Time (ms):	250	0	0	0
Execution Time (ms):			0	0
Offset (ms):	15	0	0	0
Priority:	3 - Normal	3 - Normal		

☑ Enable latency supervision

	Requested:	Used:	Actual:	Max:
Accepted latency:	10 %	25	0	0
Latency alarm limit:		N/A		
First scan execution time (ms):		0		

Output Signals

○ Always update output signals first in next execution

● Always update output signals last in execution (default).

Debug

□ Enable debug mode

□ Halt

Remark

System Values

Cyclic Load (Tasks): 0%

Total Load: 0%

Application stop time: 0ms

3. Select Latency, (check **Enable latency supervision** check box).

4. Enter latency percentage into the **Accepted latency** entry field. The actual used latency time is shown to the right of the entry field (here 25 ms). The lowest accepted latency time is 10 ms.

5. Click **Apply**. Note how the actual latency time changes if the accepted latency percentage exceeds 10 %.

6. Click **OK**.

If latency error occurs, tune the tasks. Information about task tuning can be found in the *Compact 800 Engineering Compact Control Builder AC 800M Planning (3BSE044222*)*.

Latency Alarm Limit

A latency warning is issued if latency is above 70% of accepted latency. A system alarm, actual latency in ms is generated, and added to the system log. A yellow warning ⚠ is written to the Actual column of Latency alarm limit and “Latency high alarm limit exceeded” is written in the Remark field of the task properties dialog box.

Latency is measured on a periodic basic, the time from the start of one execution to the start of next execution is measured. The latency is then calculated as the difference between this value and the interval time. Latency can then be both positive and negative. The maximum latency time is the absolute value of actual latency.

If requested offset is 0 it is possible that actual offset is large, compared to actual latency.

Example

Task A: Interval Time=150 ms, Offset=0 ms, Priority=4 - Low and Execution Time=1 ms.

Task B: Interval Time=150 ms, Offset=0, Priority=3 - Normal and Execution Time=17 ms.

In this case the actual offset of Task A is about 18 ms and actual latency vary from -1 to +1 ms.

The execution of task A is delayed about 18 ms for each interval, which results in an actual offset of 18 ms. This delay is repeated for each period which result in a small actual latency, -1 to +1 ms.

If the interval time of Task A is changed to 50 ms the actual latency of Task A will assume the values -18 ms, 0 ms, +18ms. Actual offset will assume the values 0 ms and 18 ms.

Task Abortion

If a task is aborted, the corresponding application will be stopped. The following criteria apply to a task abortion.

Time-critical Tasks

Time-critical tasks (priority 0) are aborted when the execution time exceeds 300 ms.

Non Time-critical Tasks

Non-time-critical tasks (priority 1-5) are aborted when:

- The execution time exceeds 10 seconds.
- The execution time exceeds (100 * IntervalTime).

This means that if IntervalTime is set to 100 ms or higher (100 * 100 ms = 10 seconds), tasks will be aborted if they have not been executed within 10 seconds.

If IntervalTime has been set to <100 ms, tasks will be aborted if they are not executed within (100 * IntervalTime).

Load Balancing

The cyclic load is the percentage of controller CPU power used for program execution of application code. If the cyclic load exceeds 70% in the controller, so-called *load balancing* is initiated automatically. The interval time for all tasks, except the time-critical task, is then generally increased, to limit the cyclic load to 70%.

If the cyclic load then falls below 70% again, the interval time will normally be decreased in all tasks, except for the time-critical task. However, the interval time never falls below the original defined interval time.

Whenever the interval time is changed due to load balancing, a *SystemSimpleEvent*, expressed in percent (%) of the actual interval time, is generated, and added to the system log.

Load balancing for the time-critical task is handled as follows (this differs from non-time-critical tasks). The interval time for the time-critical task is increased, whenever its execution time exceeds 50% of its interval time.

For example, if a time-critical task has an interval time of 100 ms, and the execution time becomes 54 ms in an interval, then the new interval time becomes 108 ms. However, the interval time must be reset manually, after it has been increased. The interval time of the time-critical task is never decreased automatically, as for the other tasks.

Change the *Requested Interval Time* to its original value, or another suitable value, in the Task Properties dialog box(in Online mode). Press **Apply** or **OK** to bring the reset into effect.

Whenever the interval time is increased for the time-critical task, due to load balancing, a *SystemSimpleEvent*, expressed as the actual interval time in ms, is generated and added to the system log.

Non-Cyclic Execution in Debug Mode

A task can be set up for non-cyclic execution. Use non-cyclic execution to simplify the debugging of a program.

Debug Mode

Debug mode allows you to debug an application by halting the application running in the controller, and executing the code one execution at the time.

Debug mode is enabled from the Task Properties dialog box(right-click the task in Project Explorer, and select **Properties**).

When you have selected *Enable debug mode*, you can halt the cyclic execution of a task by clicking **Halt**. When the task is halted, you can execute the task once by clicking **One Execution**. (This is referred to as “non-cyclic execution”.)

Other tasks will not be affected if one task is set up for Debug mode, they will run in normal cyclic execution mode.

To return to normal cyclic execution of the task, click **Run**.

A task in Debug mode is indicated in Project Explorer with a warning icon (a yellow circle with a black exclamation point).

Functions based on the real-time clock (PID controllers, timers, etc.) cannot be properly debugged in Debug mode.

Timer functions will take into account the actual time elapsed since started, regardless if, for example, the task is halted in Debug mode.

Task Analysis

The Control Builder provides a Task Analysis tool to predict the execution of tasks in controllers before downloading the application to a controller.

The Task Analysis tool provides the following functions before the download of the application:

- Analyzes the task scheduling in the application.
- Presents a graphical representation of how the tasks will execute with the application.
- Detects possible overload situations before the download of the application. The tool detects problems such as task latency, task overrun and overload of task execution.
- Allows remedial actions by providing the option to change the execution time of the tasks and view the updated analysis.

The update of the task execution time using the Task Analysis tool updates the task for analysis only. The actual execution time of the task need to be changed by updating the Task Values in the Task Properties dialog box in Control Builder.

The Task Analysis tool can be used before normal download. For initial download, the execution time of the tasks is assumed to be 1ms for the analysis.

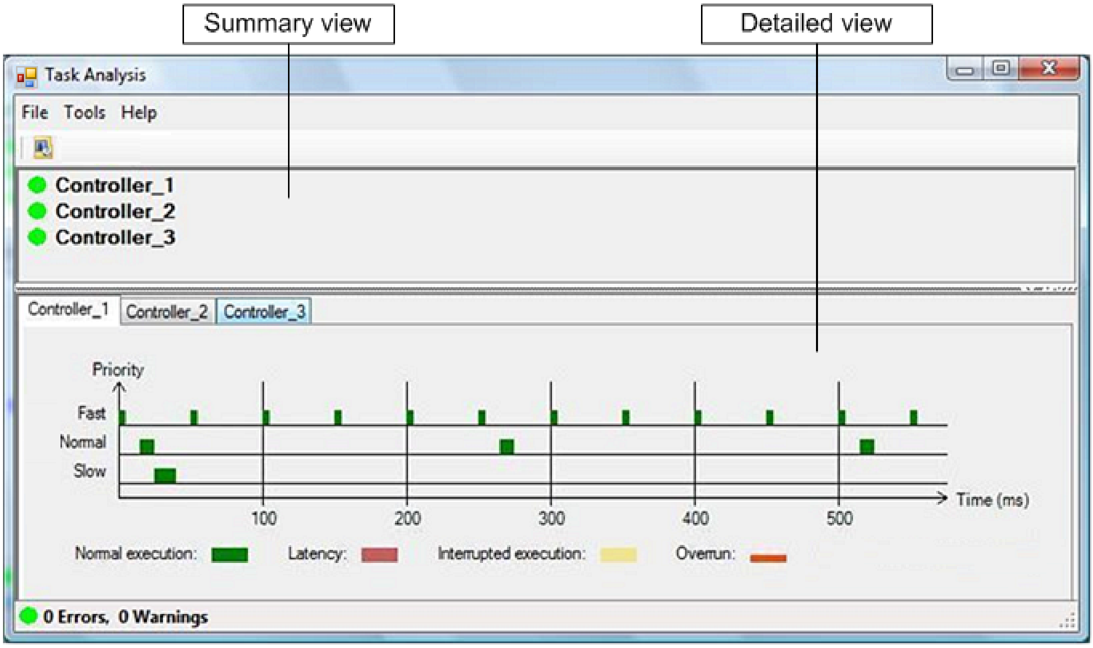
If the task configuration in the Control Builder project is changed before a normal download, the Task Analysis dialog box automatically appears during the normal download.

To open the Task Analysis dialog box in Control Builder in Offline mode or Online mode, go to **Tools > Task Analysis**.

To enable/disable the Task Analysis function, go to **Tools > Setup > Station > Application Download**, and edit the value in the **EnableTaskAnalysisTool** text box to *true* or *false*. The default is *true*.

Exploring the Interface

The Task Analysis dialog box displays a summary view, a detailed view, and the status of the summary as shown in Figure 61.



● 0 Errors, 0 Warnings

Figure 61. Task analysis tool opened from Tools > Task Analysis

Summary view

This view lists the controllers to which the applications are downloaded. A circular icon (for example, ●) appears beside each controller indicating the various states.

The indications are:

- Red icon: Error
- Yellow icon: Warning
- Green icon: Ok

If the task execution contains errors or warnings, the description of the error or warning is also displayed.

Detailed view

This view displays each controller (listed in Summary view) in a separate tab, as shown in Figure 61.

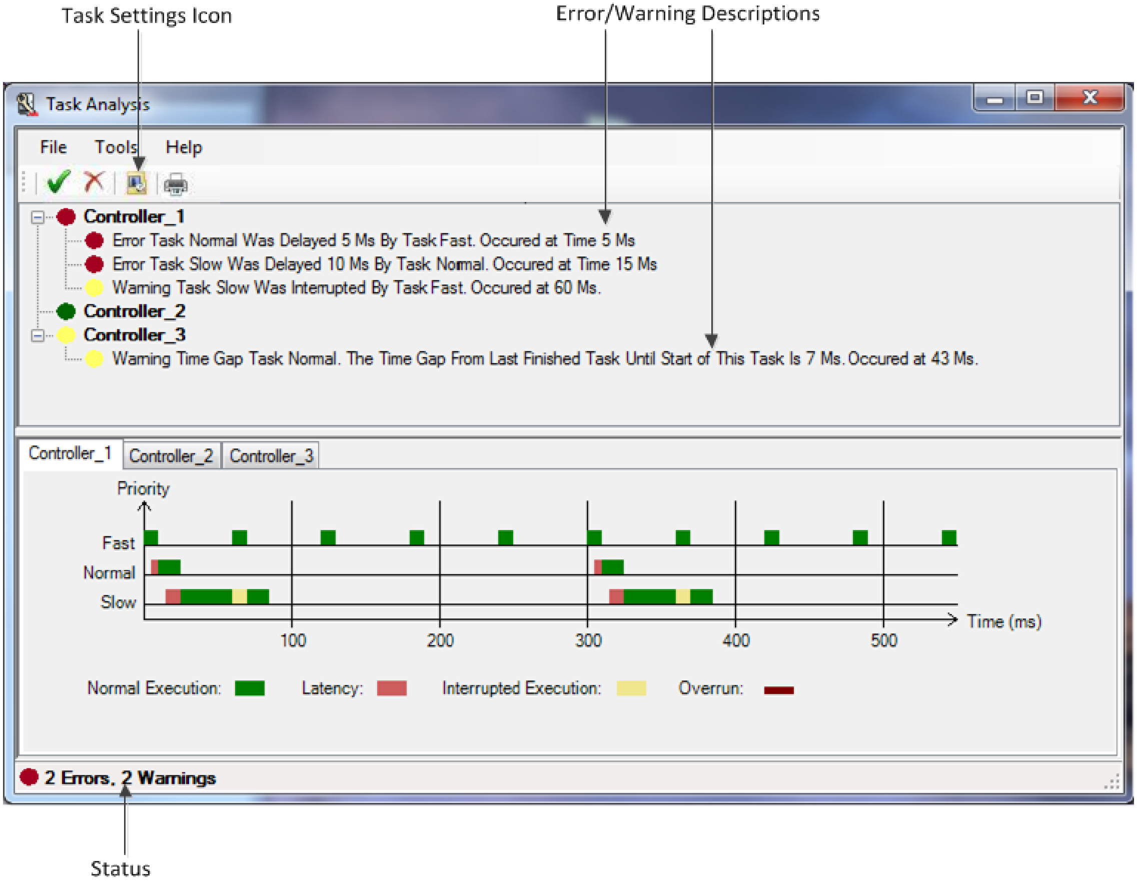
Click each tab to open the graph showing the task execution of that controller. The tasks are plotted on the graph with the Priority on the Y-axis and the Time (task execution time) on the X-axis. Moving the cursor over each task name opens a tooltip displaying its execution time, interval time, and offset.

Status

This is found at the bottom of the tool interface as shown in Figure 61. It displays the total number of errors and warnings, and the icon (in red, yellow or green). This helps to decide if it is safe to download the new application.

The significance of the indications are described below:

- Red — the new application **cannot** be downloaded as there is a risk of overloading the controller.
- Yellow — the download of the new application **may** cause overloading of controller. The user must, based on analysis, decide if it is feasible to go ahead with the new application download.
- Green — the new application is **safe** to be downloaded to the controller.



- ● Controller_1
  - ● Error Task Normal Was Delayed 5 Ms By Task Fast. Occured at Time 5 Ms
  - ● Error Task Slow Was Delayed 10 Ms By Task Normal. Occured at Time 15 Ms
  - ● Warning Task Slow Was Interrupted By Task Fast. Occured at 60 Ms.
- ● Controller_2
- ● Controller_3
  - ● Warning Time Gap Task Normal. The Time Gap From Last Finished Task Until Start of This Task Is 7 Ms. Occured at 43 Ms.

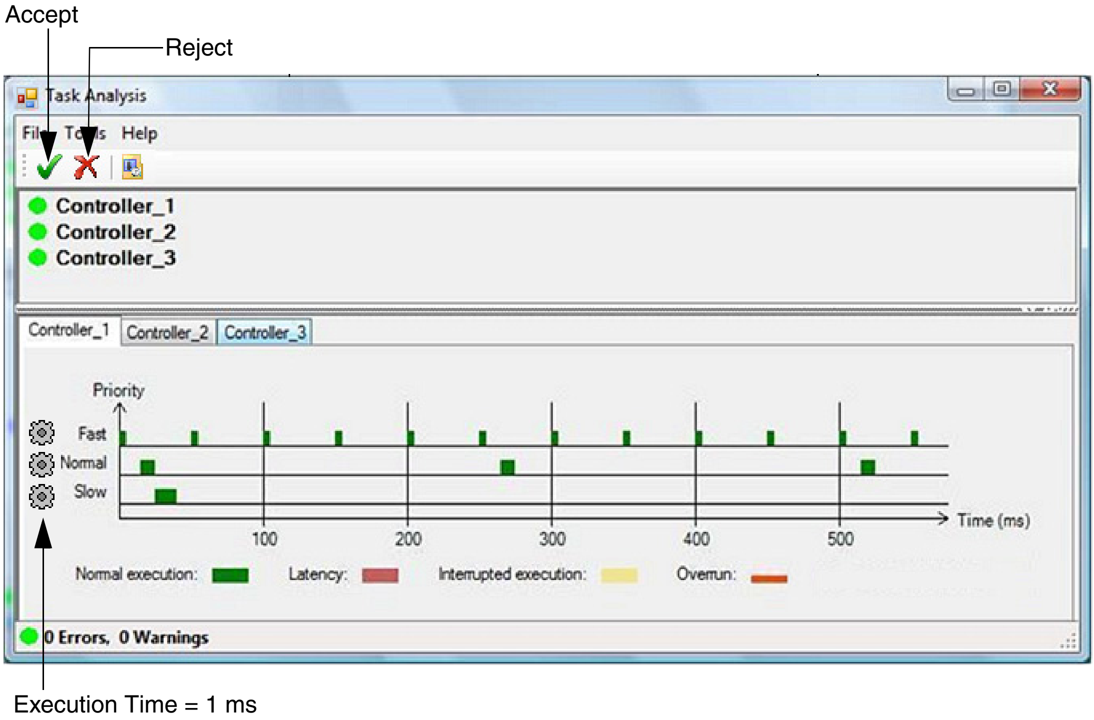
● 2 Errors, 2 Warnings

Figure 62. Task Analysis tool with error and warning indications

Task Analysis During Download

If the task configuration in the Control Builder project is changed before the download, the Task Analysis dialog box automatically appears during normal download, with the additional options to accept or cancel the download (✓ and ✗ icons). See Figure 63.

If the Task Analysis dialog box shows errors, the ✓ icon is not activated.


Accept

Reject

Execution Time = 1 ms

● 0 Errors, 0 Warnings

Figure 63. Task Analysis with additional options to accept or cancel the download

The execution time is fetched from the controller.

If a task is not running in the controller when the execution time is requested, the tool uses 1ms as the execution time, and the ⚙ icon appears beside the task name. See Figure 63. The ⚙ icon also appears if the task execution time is modified for analysis.

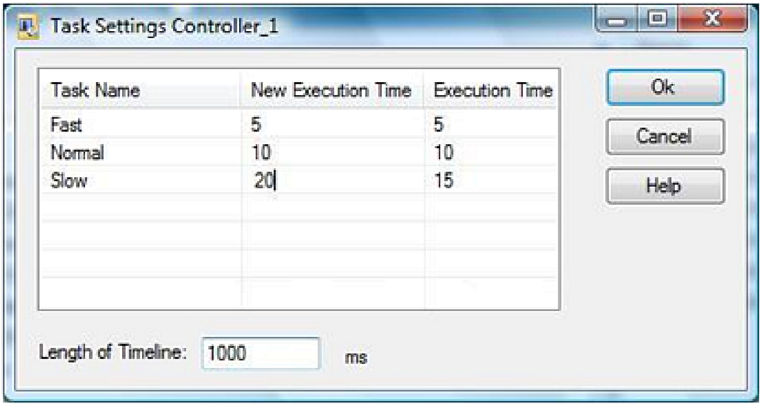
Modifying Task Execution Time

The Execution Time of each task can be modified for analysis.

To modify the execution time of a task for analysis:

1. On the detailed view in Task Analysis dialog box, open the tab screen of the controller for which the task need to be changed.
2. Click the icon, or from the toolbar, select **Tools > Settings**.

   The **Task Settings** *ControllerName* dialog box appears as shown in Figure 64.



Task Settings Controller_1

Task Name	New Execution Time	Execution Time
Fast	5	5
Normal	10	10
Slow	20	15

Length of Timeline: 1000 ms

Figure 64. Task settings

3. Modify the execution times under **New Execution Time** column corresponding to the task name, and click **OK**.

   The graph is updated as per the new execution time, and the icon appears beside the task name of the modified task.

Error and Warning Categories

The errors and warnings that are displayed by the Task Analysis tool are generated based on the following categories of analysis:

- Accepted latency
- Task latency
- Task overrun

- Interrupted execution
- Cyclic load overload
- Total load overload
- First scan execution limit

Table 14 describes these categories and the corresponding reasons for errors and warnings.
In the Task Analysis dialog box, these errors and warnings are displayed with relevant messages that describe the problem.

Table 14. Categories of errors and warnings in Task Analysis tool

Category	Reason for Warning	Reason for Error
Accepted latency	An *Accepted Latency* value that is set below 10% (default value) of the Interval Time.	-
Task latency	The latency is detected and it is not within the *Accepted Latency*, but the latency supervision is disabled.	The latency is detected and it is not within the *Accepted Latency*, and the latency supervision is enabled.
Task Gap	The time gap is too small (less than 20% of the execution time of the task last executed) or <= 5ms.	The time gap is too small (less than 10% of the execution time of the task last executed).
Task overrun	-	The overrun is detected, that is, the task has not finished executing one scan before the next cycle is supposed to start.
Interrupted execution	The task is interrupted by a higher prioritized task, and the task scan is delayed.	-
Cyclic load overload	The task uses more than 50% of the total cyclic load in the controller.	The task uses more than 70% of the total cyclic load in the controller.

Table 14. Categories of errors and warnings in Task Analysis tool

Category	Reason for Warning	Reason for Error
Total load overload	The total load in the controller is above 70%.	The total load in the controller is above 98%. **Note:** This check is relevant for download using Load Evaluate Go as well as for the download with modified execution times.
First scan execution limit	The load dependent first scan execution time (LFST) is 90% of the maximum Interval Time+Accepted Latency. **Tip:** The duration of the first scan execution time depends on the cyclic load of the remaining tasks. If the remaining tasks use L% CPU load, the LFST = (FST*100)/(100-L).	The load dependent first scan execution time (LFST) is more than the maximum Interval Time+Accepted Latency.

Search and Navigation

The Search and Navigation function makes it possible for the user to search for symbols (see Symbol and Definition on page 161) in a project, by using advanced queries, for example, to find out where a certain variable is used in an application.

If a global variable and a data type in the application have the same name the search data base will become faulty. This may results in that a symbol cannot be found.

All symbols matching the search criteria are shown, together with definitions where the symbols are declared. If a symbol is selected, all references where the selected symbol is used in the project are also shown. By double-clicking on a definition, it is possible to navigate to the editor where the symbol is declared. A double-click on a reference shows the editor where the symbol is used.

A report that contains the last search result shown in the Search and Navigation dialog box can also be generated (see Reports on page 172).

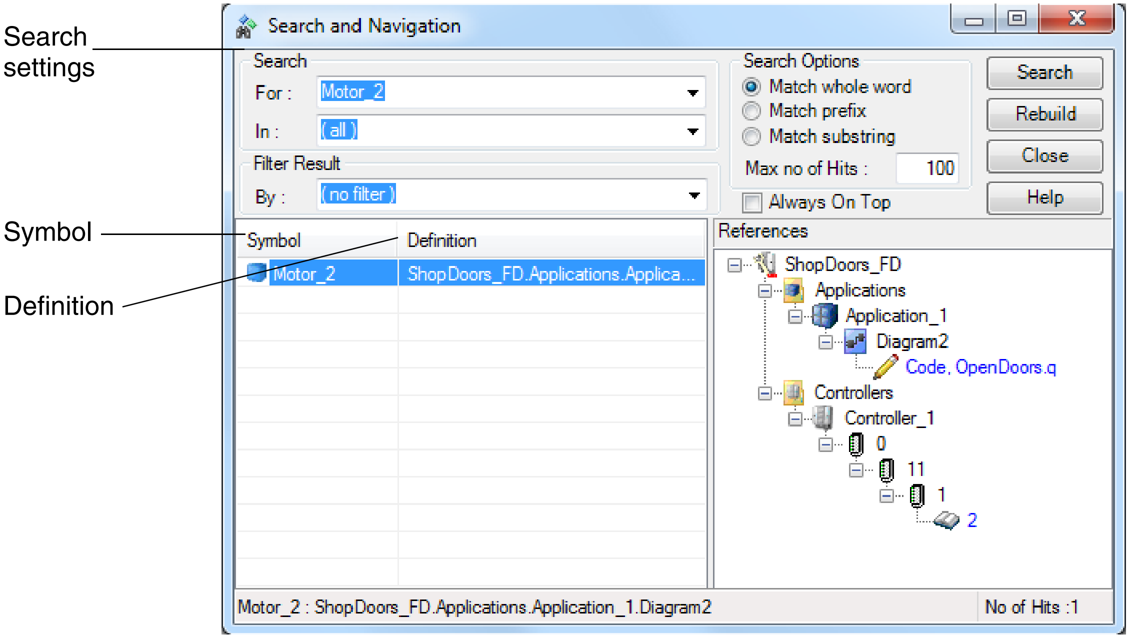
The Search and Navigation function is available in offline, online and test mode. For information on search and navigation in online mode, see Search and Navigation in Online and Test Mode on page 310.

Search and Navigation Dialog

The Search and Navigation dialog box mainly consists of Search settings, Symbol, Definition and References. All Search settings are remembered and will be applied next time the dialog box is used (until Control Builder is shut down).

The Search and Navigation dialog box can be accessed from Project Explorer, context menus and editors:

- In the Project Explorer, select **Edit > Search**.
- Right-click a Project Explorer object (not Tasks) and select **Search** or **Alt+F12**.
- Select **Edit > Search** or right-click and select **Search** (or **Alt+F12)** in a POU editor, a connection editor, a hardware editor or an access variable editor. These editors also have a search tool bar button that has the same function.



Search

For : Motor_2

In : (all)

Filter Result

By : (no filter)

Search Options

● Match whole word

○ Match prefix

○ Match substring

Max no of Hits : 100

□ Always On Top

Symbol	Definition
Motor_2	ShopDoors_FD.Applications.Applica...

References

- ShopDoors_FD
  - Applications
    - Application_1
      - Diagram2
        - Code, OpenDoors.q
  - Controllers
    - Controller_1
      - 0
        - 11
          - 1
            - 2

Motor_2 : ShopDoors_FD.Applications.Application_1.Diagram2 No of Hits :1

Figure 65. The Search and Navigation dialog box

Search Settings

The Search part of the dialog box consists of the Search For: drop-down list, the Search In: drop-down list, the Search Options radio buttons, the Max no of Hits edit field and the **Search** button. Filter Result belongs to References (see Filter Result on page 168) and the **Rebuild** button rebuild the Search data base (see Search Data on page 172).

Search For:

In the Search For text field you enter the symbols to search for (see Symbol and Definition on page 161). Search Options can be selected for the symbol text entered in the Search For: text field. An empty text or an asterisk (*) character in the Search For: text field search for all symbols. All symbols are case-insensitive, that is, a search for the texts “my”, “My”, “mY” and “MY” gives the same search results.

Search Options

The default setting of Search Options is Match whole word. The Match substring option searches for all symbols containing the entered text as a substring and the Match prefix option searches for all symbols containing the entered text in the beginning of the symbol names.

Max no of Hits:

The entered value in the Max no of Hits: field maximizes the number of symbols that can be found at a search. The default value is 100.

Search In:

The selection in the Search In: drop-down list specifies where, in the project, you want to search for the entered text symbol. An empty text field gives a search through the whole project. Applications, Controllers or Libraries are selected if a search after the Symbol is performed in all applications, all controllers or all libraries respectively.

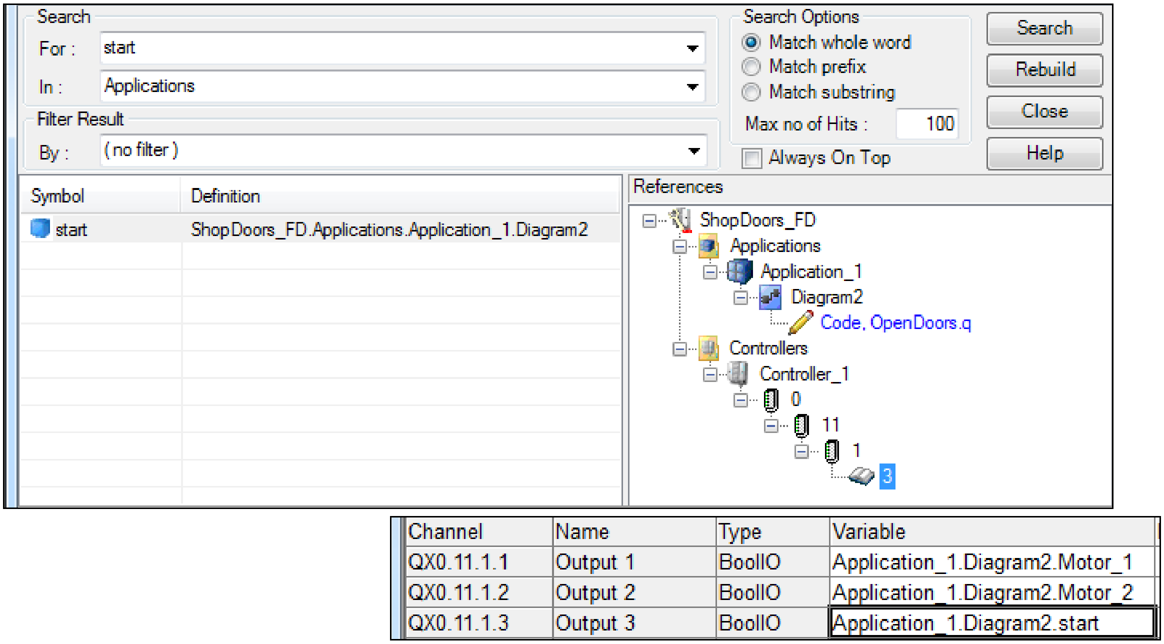
The text in the Search and Navigation Dialog on page 159, *Applications.Application_1.Diagram2* performs a search in Diagram2 of Application_1.

In Controllers it is only possible to search for access variables and I/O channels as symbols, since the search symbol has to be defined (declared) under Controllers, in Project Explorer, to match the search criteria.

Select Search “In: Applications” (not Controllers) if you want to know in which I/O unit a certain variable is connected.

Example

In the example below, see Figure 66, a search for the variable “start” is performed to find out which I/O channel it is connected to. “start” is connected to channel 3 in hardware on position 0.11.1. By double-clicking on I/O channel (3), in References pane, you navigate to the I/O unit editor there “start” is connected.



Search

For : start

In : Applications

Filter Result

By : (no filter)

Search Options

● Match whole word

○ Match prefix

○ Match substring

Max no of Hits : 100

□ Always On Top

Symbol	Definition
start	ShopDoors_FD.Applications.Application_1.Diagram2

References

```
ShopDoors_FD
  Applications
    Application_1
      Diagram2
        Code, OpenDoors.q
  Controllers
    Controller_1
      0
        11
          1
            3
```

Channel	Name	Type	Variable
QX0.11.1.1	Output 1	BoolIO	Application_1.Diagram2.Motor_1
QX0.11.1.2	Output 2	BoolIO	Application_1.Diagram2.Motor_2
QX0.11.1.3	Output 3	BoolIO	Application_1.Diagram2.start

Figure 66. (Part of Search and Navigation dialog box at top) A search for "start" variable in "Applications" to find out which I/O channel "start" is connected to. (Part of Hardware Editor at bottom).

Search Button

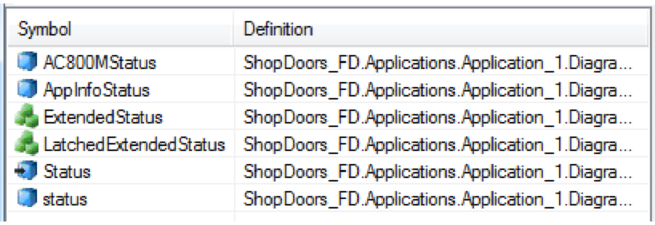
A click on the **Search** button performs the search according to the settings. The search result will be shown.

Always on Top

If Always on Top is checked, the Search and Navigation dialog box is placed in front of all other Windows dialog boxes.

Symbol and Definition

The Symbol objects or the Definitions can be sorted in ascending or descending order, by clicking on the corresponding title. A new click will toggle the sorting order. The selected sorting order is remembered and will be used next time.



Symbol	Definition
AC800MStatus	ShopDoors_FD.Applications.Application_1.Diagra...
AppInfoStatus	ShopDoors_FD.Applications.Application_1.Diagra...
ExtendedStatus	ShopDoors_FD.Applications.Application_1.Diagra...
LatchedExtendedStatus	ShopDoors_FD.Applications.Application_1.Diagra...
Status	ShopDoors_FD.Applications.Application_1.Diagra...
status	ShopDoors_FD.Applications.Application_1.Diagra...

Figure 67. The Symbol and Definition part of the Search and Navigation dialog.

Symbol

A symbol is an object, which can be search for in a project, by using the Search and Navigation dialog box.

Examples of symbols are:

- hardware channels, access variables, project constants, variables, global variables, external variables, communication variables, parameters, extensible parameters, diagrams, programs, function blocks, function block types, control modules, control module types, single control modules, data types, functions, Sequential Function Chart steps, Sequential Function Chart transitions, Sequential Function Chart sequences, applications, controllers and libraries.

Examples of objects that are **not** symbols:

- hardware types, tasks, task connections, comments, descriptions and language statements in the code, labels in Instruction List code, code block names, connected libraries.

A symbol can be selected by clicking on it, clicking on the definition of the symbol or by using the arrow up/down keys on the keyboard.

Definition

The definition of a symbol is where the symbol is declared. The definition of a variable is where in the project the variable is declared, for example in a program.

It is possible to navigate to the definition by double-click on it or by using the context menu. The enter key on the keyboard can also be used. The editor where the symbol is declared is shown with the symbol highlighted.

Definition Context Menu

Right-click a Definition to get the context menu selections.

- **Go To Definition in Editor** navigates to the editor where the symbol is declared.
- **Go To Definition in Project Explorer** navigates to the location of the symbol in Project Explorer.
- **Report**... See Reports on page 172.

References

The References of a symbol is where in the project the symbol is used.

For example, a variable can be used/accessed by several code lines in several code blocks, and as an actual parameter to a function call or function block call, or as a parameter to a control module/single control module. The variable can also be used (connected to) an I/O channel or an access variable.

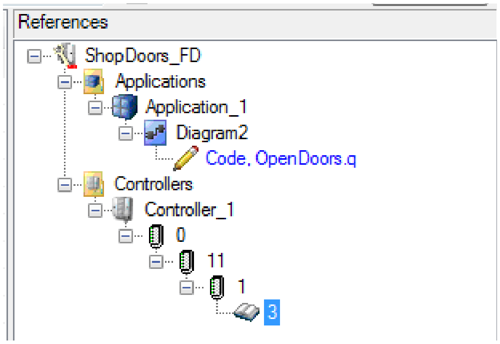


Figure 68. The References part of the Search and Navigation dialog

In the example in Figure 68, the *start* symbol is used at two locations:

- function block OpenDoors, in Code code block of Diagram2.
- in channel 3 of unit 1 at position 0 in Controller_1.

It is possible to navigate to a reference by double-clicking it, or by using the context menu. The enter key of the keyboard can also be used. The present editor is shown with the symbol highlighted.

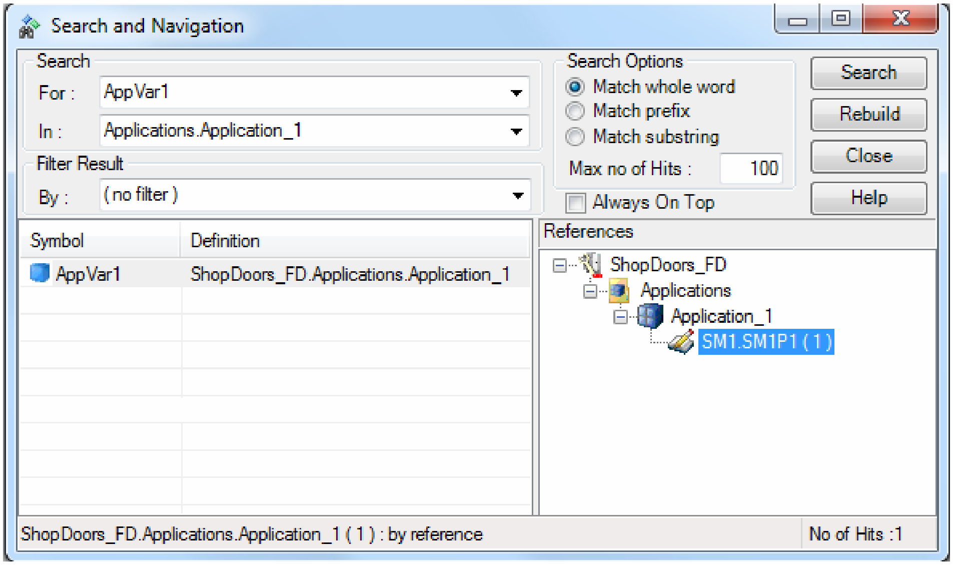
In the References pane, the project name always appears as the root. Communication Variables are the only symbols that have references in different projects.

If the communication variable that is being searched is present in another project, the References pane displays this variable as part of another project only if the other project also has been downloaded from the same workstation as the current project.

References Context Menu

Right-click on a Reference to get the context menu selections.

- **Go To Reference in Editor** navigates to the editor of the selected reference.
- **Go To Reference in Project Explorer** navigates to the referenced object in the Project Explorer.
- The **Search** menu selection gives the user a possibility to initiate new searches from the references pane. This is useful when a variable/parameter is connected to a parameter of a control module, single control module, function block or diagram type.



Search and Navigation

Search

For : AppVar1

In : Applications.Application_1

Filter Result

By : (no filter)

Search Options

● Match whole word

○ Match prefix

○ Match substring

Max no of Hits : 100

□ Always On Top

Symbol	Definition
AppVar1	ShopDoors_FD.Applications.Application_1

References

- ShopDoors_FD
  - Applications
    - Application_1
      - SM1.SM1P1 (1)

ShopDoors_FD.Applications.Application_1 (1) : by reference

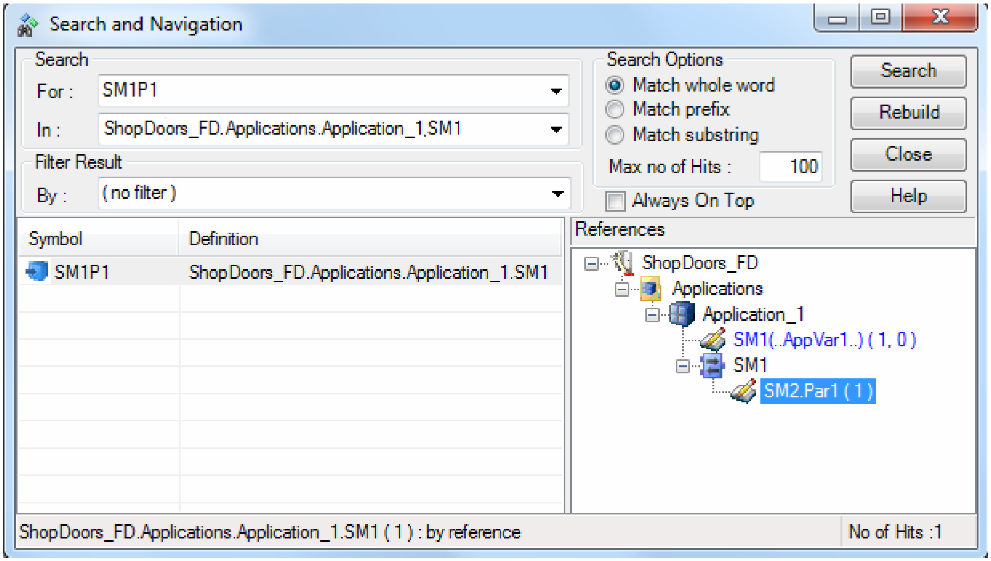
No of Hits :1

Figure 69. A search for Variable "AppVar1" in Applications.

In the example in Figure 69, *Appvar1* is connected to a parameter *SM1P1* of a Single Control Module named *SM1*.

1. In References, select *SM1.SM1P1(1)*.
2. Right-click and select Search.
   The Search For: and Search In: text fields will be automatically updated according to Figure 70. A new search is performed.

The Execute Search Instantly check box (see Execute Search Instantly on page 169) has to be checked. If it is not checked, the user must click the **Search** button.



Search and Navigation

Search

For : SM1P1

In : ShopDoors_FD.Applications.Application_1.SM1

Filter Result

By : (no filter)

Search Options

● Match whole word

○ Match prefix

○ Match substring

Max no of Hits : 100

□ Always On Top

Symbol	Definition
SM1P1	ShopDoors_FD.Applications.Application_1.SM1

References

```
ShopDoors_FD
  Applications
    Application_1
      SM1(..AppVar1..) ( 1, 0 )
      SM1
        SM2.Par1 ( 1 )
```

ShopDoors_FD.Applications.Application_1.SM1 (1) : by reference

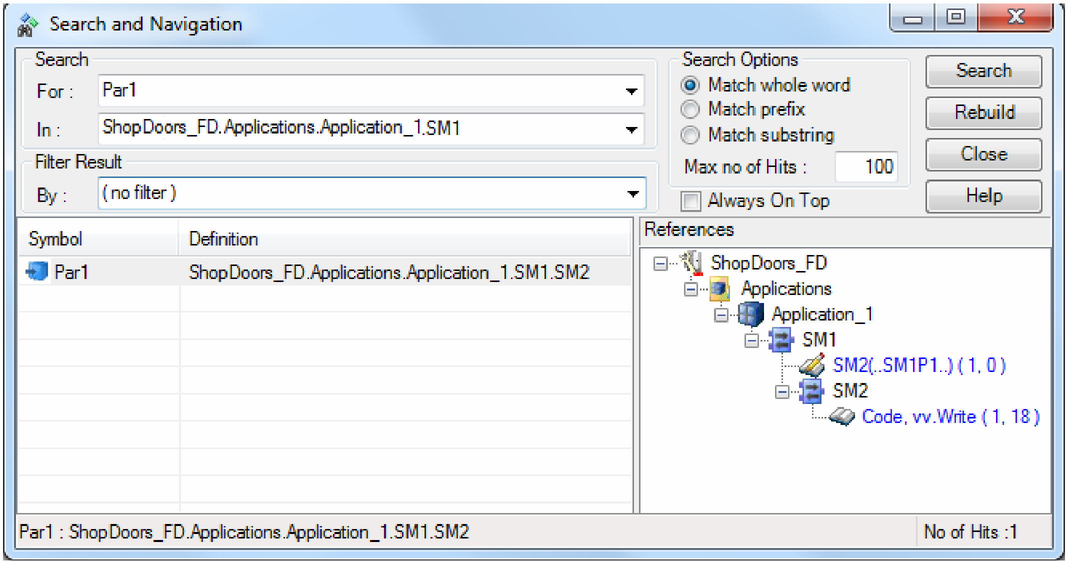
No of Hits :1

Figure 70. A search for SM1P1 in SM1.

A new search can be done to follow parameter *Par1* in single control module *SM2*.

3. In References, select *SM2.Par1(1)*.

4. Right-click and select **Search**.



Search and Navigation

Search
For : Par1
In : ShopDoors_FD.Applications.Application_1.SM1

Filter Result
By : (no filter)

Search Options
● Match whole word
○ Match prefix
○ Match substring
Max no of Hits : 100
□ Always On Top

Symbol	Definition
Par1	ShopDoors_FD.Applications.Application_1.SM1.SM2

References
- ShopDoors_FD
  - Applications
    - Application_1
      - SM1
        - SM2(..SM1P1..) (1, 0)
        - SM2
          - Code, vv.Write (1, 18)

Par1 : ShopDoors_FD.Applications.Application_1.SM1.SM2 No of Hits :1

Figure 71. A search for parameter Par1 in SM1.

This example shows an easy way for the user to follow a parameter through a control module hierarchy. The users only have to use the **Search** context menu to follow the parameter downwards the control module hierarchy. It is also possible to follow a parameter upwards a module/function block hierarchy.

Icons in References

The references are marked in blue and preceded by an icon.The icon can be any of the following:

Icon	Description
✏	The symbol is written.
📖	The symbol is read.
( )	The symbol is a function block/function block call.
✏📖	The symbol is accessed by reference.
∘A	The symbol is a reference to a graphical connection.

Filter Result

The Filter Result option makes it possible to show references with write access only, or to show references with read access only.

The possible selections are read, write, I/O Channel Out and I/O Channel In. I/O Channel Out shows references to output channels only, and Channel In shows references to input channels only.

Navigation to Editors

It is possible to navigate to the following editors and dialogs:

- The POU editor
- The Connection editor (offline only)
- The Control Module Diagram editor
- The Hardware configuration editor
- The Access Variables editor
- The Project Constant dialog (offline only)

It is also possible to navigate to another project, if it is also displayed in the References pane while searching communication variables.

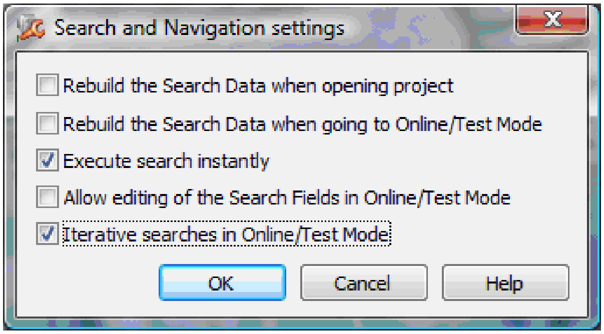
When navigating to an editor or a dialog box, the window already can be active, but minimized, as well as hidden behind other windows.

It is possible to navigate from a control module parameter or a single control module parameter connection in the References to a Connection editor. However, if the parameter connection is a graphical connection, Control Builder navigates to the Control Module Diagram editor.

Search and Navigation Settings

The Search and Navigation settings dialog box has settings for executing the search and editing of the search fields.

Select **Tools > Setup > Station > Search and Navigation Settings** to view the Search and Navigation settings dialog box.



Search and Navigation settings

☐ Rebuild the Search Data when opening project

☐ Rebuild the Search Data when going to Online/Test Mode

☑ Execute search instantly

☐ Allow editing of the Search Fields in Online/Test Mode

☑ Iterative searches in Online/Test Mode

Figure 72. The Search and Navigation settings dialog with default settings

Rebuild the Search Data when Opening Project

When this option is checked, Control Builder will rebuild search data when a new project is loaded in the Control Builder. This check box is, by default, unchecked.

Rebuild the Search Data when Going to Online/Test Mode

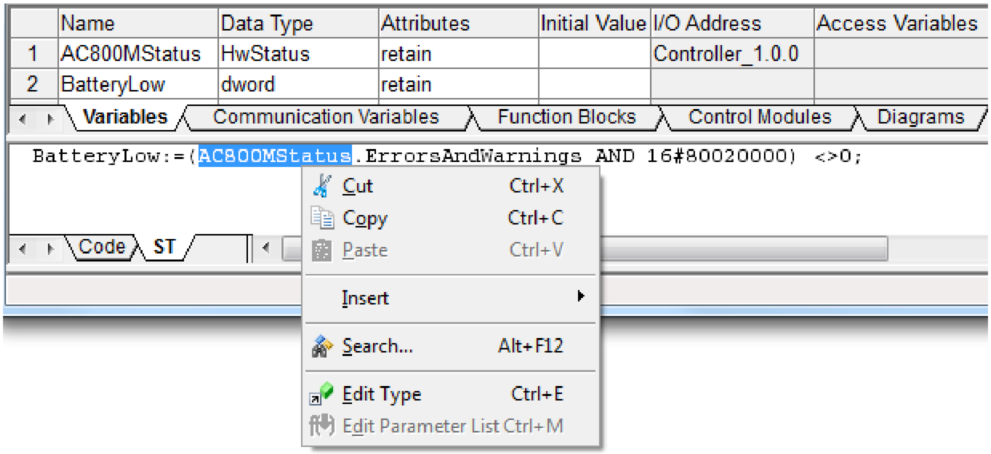
When this option is checked, search data is rebuilt when Control Builder is entering online mode or test mode. This setting ensures that the search data is consistent in online and test mode compared to offline mode. This check box is, by default, unchecked.

It is recommended to normally have this check box unchecked

Execute Search Instantly

When this option is checked, the Search and Navigation dialog box will instantly perform a search when the dialog is accessed with the **Search** command, from a menu or tool bar button, that is, the user do not have to press the **Search** button in the dialog. The search is only performed if it is obvious what symbol to search for, that is, both the Search For: and Search In: boxes in the Search and Navigation dialog have to be filled in automatically. This check box is, by default, checked.

Example:

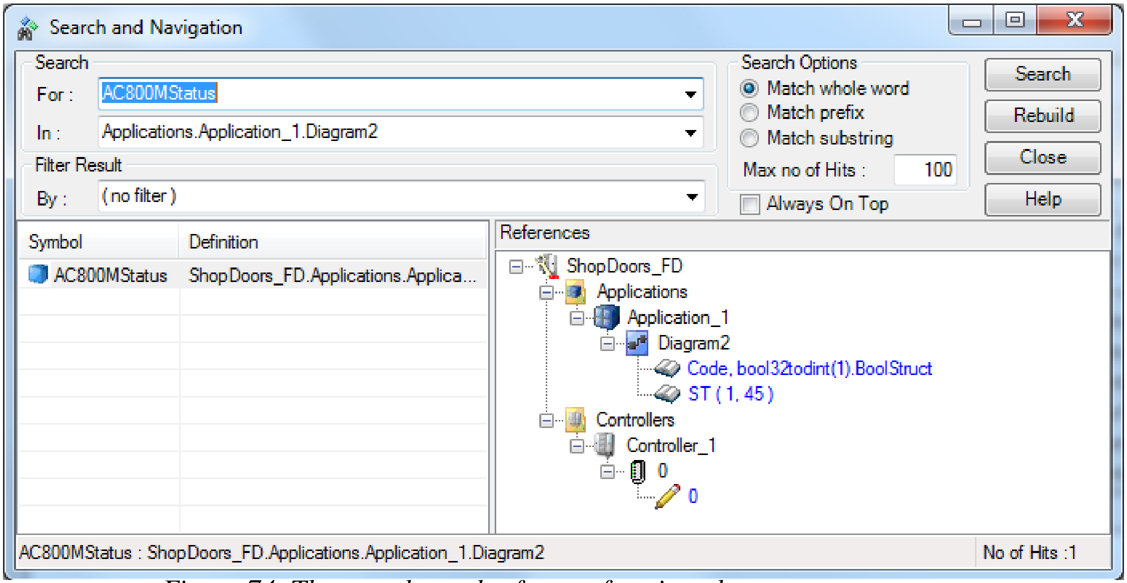


	Name	Data Type	Attributes	Initial Value	I/O Address	Access Variables
1	AC800MStatus	HwStatus	retain		Controller_1.0.0	
2	BatteryLow	dword	retain			

```
BatteryLow:=(AC800MStatus.ErrorsAndWarnings AND 16#80020000) <>0;
```

Figure 73. Selection of the AC800MStatus and the Search option

1. In the code block, double click the *AC800MStatus* variable to select it.
2. Right click and select **Search**, or go to the toolbar and select **Edit > Search** (or **Alt-F12**).



Search and Navigation

Search
For : AC800MStatus
In : Applications.Application_1.Diagram2

Filter Result
By : (no filter)

Search Options
● Match whole word
○ Match prefix
○ Match substring
Max no of Hits : 100
□ Always On Top

Symbol	Definition
AC800MStatus	ShopDoors_FD.Applications.Applica...

References
- ShopDoors_FD
  - Applications
    - Application_1
      - Diagram2
        - Code, bool32todint(1).BoolStruct
        - ST (1, 45)
  - Controllers
    - Controller_1
      - 0
        - 0

AC800MStatus : ShopDoors_FD.Applications.Application_1.Diagram2 No of Hits :1

Figure 74. The search result after performing above steps.

Allow editing of the Search Fields in Online/Test Mode

When this option is checked, it enables free editing in the Search field. It is introduced since the strings in the search fields are very sensitive in this mode. A single misplaced character ruins the search and the "search in" field is also case sensitive. This check box is, by default, unchecked.

Iterative searches in Online/Test Mode

When this option is checked, the searches made in Online/Test mode are iterative, and the search hits are presented in one pane. For details, see Search and Navigation in Online and Test Mode on page 310.
This checkbox is, by default, checked.

Search Data

The Search data base contains search data, that is, information about all symbols, information about the definition of each symbol and information about all references of each symbol.

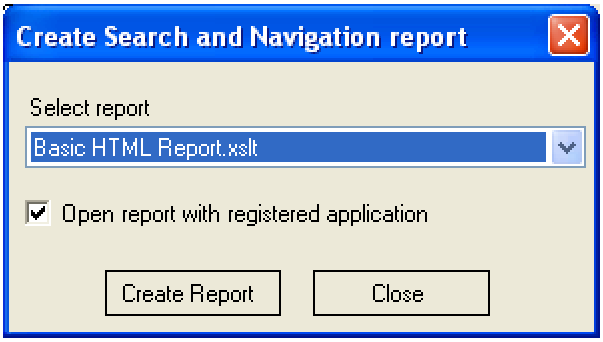
It is possible to perform a manual rebuild of the Search data base. The Search data base can be rebuilt in the following ways:

- selecting **Rebuild Search Data** from the context menus of application, controller and library.
- selecting **Tools > Rebuild all Search Data**
- clicking the **Rebuild** button in the Search and Navigation dialog

Reports

The search result can be transformed into a report by using *Basic HTML Report.xslt*, that is by default installed together with Control Builder. The report contains the last search result shown in the Search and Navigation dialog. All symbols, definitions and references are included in the report. The symbols in the report are shown in the same order as in the Search and Navigation dialog.

1. Right-click on a Definition and select **Report....**



Create Search and Navigation report

Select report

Basic HTML Report.xslt

☑ Open report with registered application

Figure 75. The Create Search and Navigation report dialog.

2. Click **Create Report** button.
   If the Open report with registered application is checked, the report will be opened in a registered application. The Basic HTMLReport produces reports in HTML format, that is, the report is opened in the registered Web browser.

3. Specify a directory to save the report in and enter a suitable file name.
4. Click **Save** button to store the report file on disk.

It is possible to export the report to Microsoft Excel by using Export to Microsoft Excel in the Internet Explorer context menu.

Analog Input and Output Signal Handling

Signals start and end in I/O units with I/O channels of the RealIO data type. Between input and output I/O units, signals are handled in I/O function blocks of the RealIO data type, or directly in various function blocks, or in control modules of the ControlConnection data type.

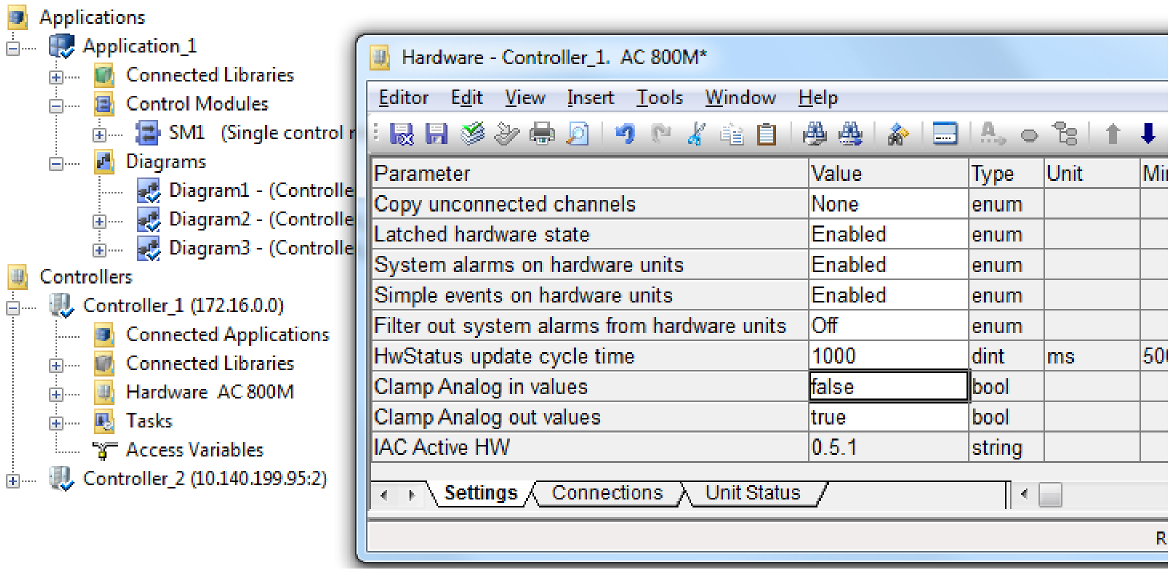
Over and under range measurement

Signal objects of real type are equipped with an option to increase the signal range with a fixed pre-selected factor of +-15% of the specified range. You can select individual Signal Objects connected to variables of data type RealIO on the controller and set the input parameter EnableOverUnderRange to true. The Signal Object enabled with over and under range feature, displays the output parameter OverUnderRangeEnabled as true to inform the surrounding code about the extended range.

The default value on EnableOverUnderRange depends on a global project constant from BasicLib. The default value for this project constant is false and Over and Under range feature is disabled.

Input objects connected to I/O

To enable signal range extensions on input signals, in Project Explorer, click connected **controller > Hardware AC 800M >Editor > Settings**. Set the Clamp Analog in values as false. See Figure 76.

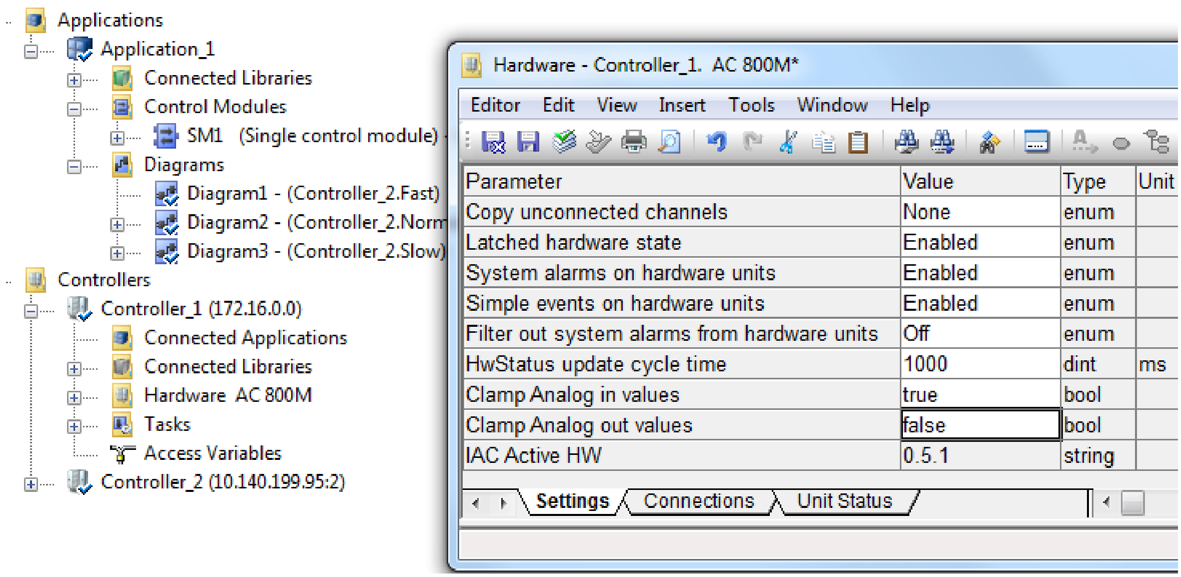


Parameter	Value	Type	Unit	Mi
Copy unconnected channels	None	enum		
Latched hardware state	Enabled	enum		
System alarms on hardware units	Enabled	enum		
Simple events on hardware units	Enabled	enum		
Filter out system alarms from hardware units	Off	enum		
HwStatus update cycle time	1000	dint	ms	50
Clamp Analog in values	false	bool		
Clamp Analog out values	true	bool		
IAC Active HW	0.5.1	string		

Figure 76. Enabling over and under range for input objects.

Output objects connected to I/O

To enable signal range extensions on output signals, in Project Explorer, click connected **controller > Hardware AC 800M >Editor > Settings**. Set the Clamp Analog out values as false. See Figure 77.



Parameter	Value	Type	Unit
Copy unconnected channels	None	enum	
Latched hardware state	Enabled	enum	
System alarms on hardware units	Enabled	enum	
Simple events on hardware units	Enabled	enum	
Filter out system alarms from hardware units	Off	enum	
HwStatus update cycle time	1000	dint	ms
Clamp Analog in values	true	bool	
Clamp Analog out values	false	bool	
IAC Active HW	0.5.1	string	

Figure 77. Enabling over and under range for output objects

Backup Media

The AC 800M controllers contain a card slot located at the front of the controller. This card slot allows the restore of the saved configuration data and firmware data from the backup media.

The supported backup media for AC 800M controllers are:

- Compact Flash card (supported in all AC 800M controllers except PM891)
- Secure Digital card (supported only in PM891)

The backup media cards are useful to save data in case of unpredictable power supply and for transferring new or updated applications to other controllers.

For more information about the AC 800M controller, see the subsection ‘Product Overview’ in the *AC 800M Controller Hardware*.

The card will be activated and read after a long controller reset (or power failure) and your application(s) can be loaded into the new controller host without performing a monitored application download from a Control Builder station.

The backup media does not support distributed applications; hence you cannot use the memory card in a controller that run distributed applications.

An AC 800M configured as time master (CNCP order number 1) does not transmit any clock synchronization messages if it starts from a backup media image, and the time quality in the AC 800M is bad due to a discharged battery. The time in the AC 800M has to be manually set using the function block SetDT in order to have the clock synchronization in place.

Compact Flash

Compact Flash (CF) is a portable memory card that can be easily inserted to the card slot located at the front of AC 800M controllers (except PM891).

Specifications for Compact Flash Card

The following are the specifications for the CF card used in AC 800M controllers (PM8xx, except PM891):

- Formatted according to FAT16 or FAT32.
- Minimum read speed – 8MB/second.
- Minimum write speed – 6MB/second.
- Same (or better) ambient temperature operative range compared to the PM8xx that uses the card.

Recommended Compact Flash Cards

Only industrial type Compact Flash cards must be used with the AC 800M controller.

The recommended industrial type CF cards are:

- SanDisk Industrial Grade
- SiliconSystems SiliconDrive

Secure Digital

Secure Digital (SD) is a portable memory card that can be easily inserted to the card slot located at the front of the PM891 controller.

Specifications for Secure Digital Card

The specifications for the SD/SDHC card used in AC 800M controller (PM891):

- Formatted according to FAT32.
- Minimum read speed – 8MB/second.
- Minimum write speed – 6MB/second.
- Same (or better) ambient temperature operative range compared to the PM891 that uses the card.

SD/SDHC card formatted according to exFAT is not supported.

Adding CF Card or SD Card to Hardware

Ensure that BasicHwLib is inserted under Hardware and that it is connected to the controller.

From the Project Explorer:

1. Expand the **Controllers** item until you reach the **CF Reader** (or **SD Reader**) item (see Figure 78).
2. Right-click the **CF Reader** (or **SD Reader**) and select **Insert Unit** from the context menu. A dialog opens.
3. Select **CF Card** (or **SD Card**) in the dialog, and click **Insert**.
4. Click **Close**.

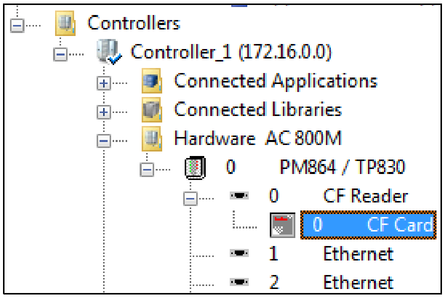


Figure 78. The Controllers item expanded and the CF Card connected to the CF Reader item.

Saving Cold Retain Values on Files

The cold retain values used by the backup media can either be saved cyclically via the settings in the hardware editor, or from the code via the function block (SaveColdRetain).

Either way, these values are only saved on files located on the backup media. Thus, not be confused with the cold retain values saved by Control Builder or OPC Server during a download.

Read more about the SaveColdretain function block type in Control Builder online help.

An OPC Server will not be able to give any data if the AC 800M starts to execute a different version found at the backup media after the power is resumed. All OPC quality in this case will be BAD, because the OPC Server has no way of finding the correct description files. But, if the backup media has the last created version, then the AC 800M continues to execute the last version, and the OPC server can generate data.

Also note that cold retain values will not be saved on the backup media in case there is an application version mismatch.

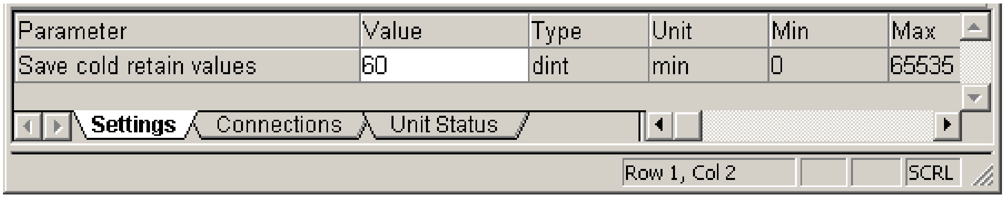
Setting Up Cyclic Save of Cold Retain Values

As mentioned earlier, saving cold retain values cyclic are one of two methods for a single CPU configuration. The other method is saving cold retain values based on process events, accomplished by calling the function block (SaveColdRetain) from the code. You should typically decide one of these two methods. However, if you run with a redundant CPU configuration, then you must read Cold Retain Values for Redundant CPU Configuration on page 180.

This subsection will describe how to save cold retain values cyclic. Provided that you have added the CF Card (or SD Card) to your Hardware tree, do the following:

1. Double-click the **CF Card** (or **SD Card**) and select **Settings** tab in the hardware editor.

2. Set the cyclic interval time for saving cold retain values to file. The default value is (60 min.). See Figure 79.



Parameter	Value	Type	Unit	Min	Max
Save cold retain values	60	dint	min	0	65535

Figure 79. Settings for Save cold retain values (default 60 min.).

To prevent CF card or SD card from saving additional cold retain values, you must set the parameter Value to zero (0). Otherwise it will keep saving new values to file. Setting the value to 0 would normally be the case before shipping the backup media to a host control system.

3. Close the hardware editor.

Cold Retain Values for Redundant CPU Configuration

If you have a redundant CPU configuration; you cannot save cold retain values cyclic or by the function block.

However, you can always save cold retain values via the Tool menu in Control Builder so that your cold retain values will be part of the application, thus be loaded to the backup media.

To save cold retain values for a redundant CPU configuration in Control Builder, first make sure your project is Online:

1. In the Project Explorer menu bar select **Tools > Save “ColdRetain” Values**. A ‘Save “ColdRetain” Values’ dialog will open.
2. Click **Save**. The cold retain values are saved with your application and you are now ready to download to the CF card or SD card. These values will be included when you download the next time to the CF or SD card.

If an AC 800M contains redundant communication interfaces on the CEX-bus, then perform a download to the controller before creating the Compact Flash image. Make sure that the project is not closed while creating the image and before it goes offline, else the image is not completed.

Downloading the Application to Removable Media

Before you can download your application to the backup media, you must connect an external Compact Flash Writer or Secure Digital Writer to your Control Builder PC. The writer is normally connected to the PCs USB port.

It is not possible to download to removable media if the Difference Report is enabled for the project. To check the Difference Report setting, right click the project name, and select **Settings** > **Difference Report**.

From the Project Explorer, make sure your project is in offline mode and that the Difference Report is not enabled. Then, do the following:

1. Insert a Compact Flash card or a Secure Digital card in the Writer slot.
2. Right-click controller and select **Download to Removable Media** from the context-menu. A **Backup Media** dialog window will open.
3. Select Writer and click **OK**. The Control Builder will write the application to the backup media.

In case the Control Builder source code files is to be placed on the CF/SD card, it is recommended to zip these files into one single file before placing it on the card.

For a redundant CPU configuration, you need to write the same application twice (two CF/SD cards, one in each CPU). Copy (in Windows Explorer) the downloaded application (two folders) from the CF/SD card and paste them temporarily on your local disk. Insert the next memory card into the Writer and drag your two folders from the hard disk and drop them on the new CF memory card.

Configuration Load

Configuration Load means to load a controller configuration, all applications and their corresponding cold retain values from the backup media. After a configuration load, the application can read all the critical process (cold retain) values that was stored on the backup media (CF card or SD card).

If or when a control system is shuts down due to power failure, and no battery backup in the controller is available, the backup media can re-boot the control system with the latest and the most efficient cold retain values.

In case of a redundant processor unit configuration, it is recommended to insert a CF card or SD card in both CPUs.

Application Version Check

If the application version in the controller is not identical with the version in the backup media or vice verse; a warning message will alert and no more cold retain values can be saved.

Upgrading Controller Firmware using Backup Media

When a controller is started, or when a long reset is done, the execution starts in the Boot Loader. While starting, the controller checks for any inserted CF card or SD card. If a card is present, then the controller checks for valid firmware in it. If valid firmware is found, it will be used for upgrading the current firmware.

Upgrading a controller's firmware using a removable backup media, involves the following steps:

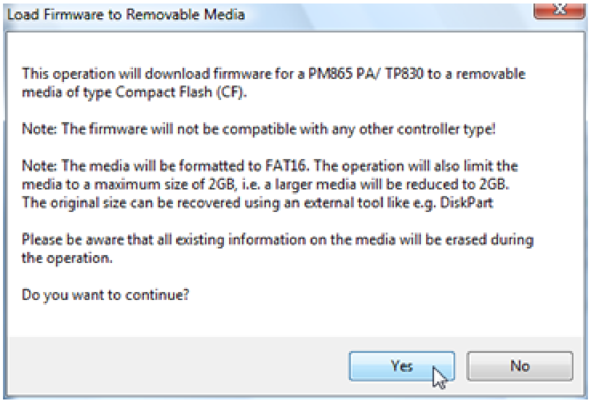
1. Loading a copy of the firmware (that is, a firmware image) onto the backup media using Control Builder (refer Loading the Firmware Image to Removable Media on page 182).
2. Upgrading the controller firmware using the image on the backup media (refer Upgrading Controller Firmware from a CF/SD card on page 186).

Loading the Firmware Image to Removable Media

Follow the steps given below for loading a firmware image from the Control Builder to a removable backup media:

1. Mount the backup media card (SD or CF card) on the card reader-writer of the Control Builder PC. Make sure that no other program uses or accesses the card.
2. Right-click on the controller object of the same type as the contoller to be upgraded.
3. From the context-menu, select **Load Firmware to Removable Media**. The Load Firmware to Removable Media window appears.

4. The Load Firmware to Removable Media window displays details of the card being used and the action that will be taken. The displayed details differ depending on whether the media card is SD or CF. Click **Yes** to proceed or **No** to cancel the operation.



Load Firmware to Removable Media

This operation will download firmware for a PM865 PA/ TP830 to a removable media of type Compact Flash (CF).

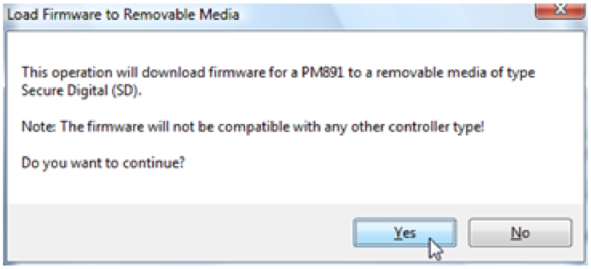
Note: The firmware will not be compatible with any other controller type!

Note: The media will be formatted to FAT16. The operation will also limit the media to a maximum size of 2GB, i.e. a larger media will be reduced to 2GB. The original size can be recovered using an external tool like e.g. DiskPart

Please be aware that all existing information on the media will be erased during the operation.

Do you want to continue?

Figure 80. Card details for PM865 PA/TP830



Load Firmware to Removable Media

This operation will download firmware for a PM891 to a removable media of type Secure Digital (SD).

Note: The firmware will not be compatible with any other controller type!

Do you want to continue?

Figure 81. Card details for PM891

5. On clicking **Yes**, a list of identified removable media appears. If the card is not present in the list of removable media, then try the following:
   - Unmount and then remount the media again.

- Make sure that the card is formatted in a file system. If not, use the Windows format tool or Diskpart to format it in FAT or FAT32 file system.

6. Click the required removable media to select it, and then click **Yes** to proceed. Either of the following cases will happen:
   - If the media used is CF, the Diskpart tool then formats the CF card to FAT 16 with a maximum size of 2 GB (even if the size of the card is greater). The progress of the Diskpart tool will be displayed in a command prompt window. Upon completion the window closes automatically and the firmware image is copied to the card
   - If the media is an SD card, then no formatting is required at this point. The firmware image is copied to the card.

If the above operations are a success, then:

- There will be four files on the card (see Figure 82 for CF card and Figure 83 for SD card). If the media card is CF, then it has been formatted as FAT.
- The file *content.txt* has been rewritten and the first row describes the selected controller. Other rows remain either untouched or partly rewritten.

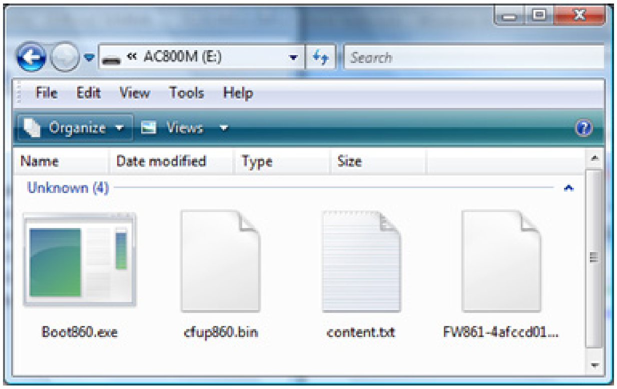


Figure 82. Firmware image files on CF card

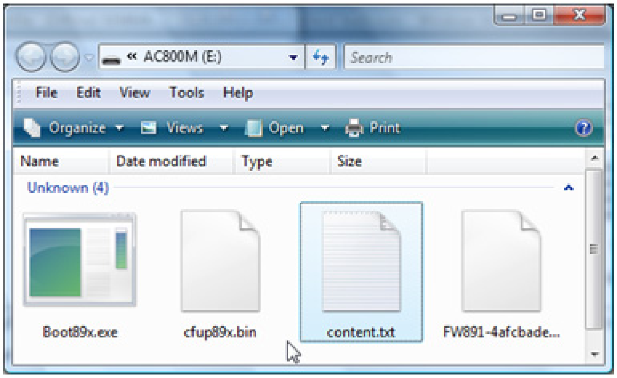
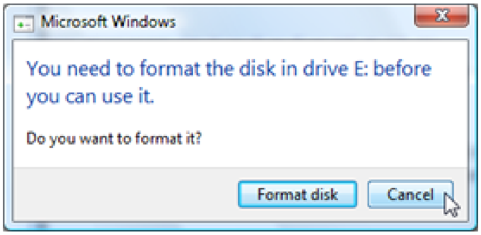


Figure 83. Firmware image files on SD card

If the operation is a failure, a message is displayed conveying the same. Further information about the failure can be found in the Control Builder session log.

While Diskpart is formatting the CF card, it is possible that Windows may discover the card as an unformatted disk. In such a case, the following dialogue will be dislayed. Here, select **Cancel**. If not, there will be two program instances trying to format the card at the same time.


Microsoft Windows

You need to format the disk in drive E: before you can use it.

Do you want to format it?

Figure 84. Windows dialog for formatting unformatted disks

Upgrading Controller Firmware from a CF/SD card

1. Insert the CF card or SD card in the card reader slot of the CPU and Power-On.
2. Perform a Controller Reset, by pressing and holding the INIT button till the green Run LED starts flashing.
3. Release the INIT button to start the loading firmware. The process to load the Firmware starts, and the Run and the Battery LEDs indicate the progress.

At the end of the operation, the hardware reset starts the newly programmed system.

Restoring Formatted CF Cards to Original Size

In some cases the CF card used for copying the firmware from Control Builder, may have a size of more than 2GB. During copying of the firmware, Diskpart will format this card to FAT 16, and the size will be limited to 2GB. In such a case, to restore the card to its full original size, follow the steps given below:

1. Start the Diskpart tool by selecting **Start** > **All Programs** > **Accessories** > **Run** and then type **diskpart.exe**. The Diskpart tool opens in the command prompt. You can then procced with the commands written in bold in the following steps.
2. List all volumes to identify the actual media by using the **list volume** command.
3. Select the volume by its number or drive letter *n* by using the command **select volume** *n*.
4. Clean the selected volume using the command **clean.**
5. Create a partition using **create partition primary** command.
6. List all partitions to identify the partition by using **list partition** command.
7. Select the partition by its number *n* by using the command **select partition** *n*.
8. Activate the partition using the **active** command.
9. Proceed to format the card with default settings using the **format** command.
10. When the format is complete, **exit**.

You may try the above steps in also cases where the card is shown as unformatted and/or unreadable.

Compiler Switches

Compiler Switches are used to control the behavior of the compiler by setting additionally language restrictions.

Global restrictions are valid for all code. Restrictions can be set to generate errors or warnings at compilation. At compilation, errors and warnings are generated according to these settings and global restrictions. These restrictions can be used to stop the use of complex constructions in code, which might cause instabilities or errors.

Global restrictions are combined as follows:

- A global error always generate an error
- A global warning generate a warning for applications.

It is possible to exclude a library from checking with user-defined compiler switches. Only warnings can be excluded for a library, not errors.

If a library is excluded from a certain restriction, this restriction will not be checked for any type belonging to that library.

If restrictions are changed, a re-compilation is required before the next download.

Restrictions are checked both at compilation and when checking the code.

Settings

Right-click the control project (root object) and select
Settings > Compiler Switches to open the Compiler Switches dialog.

The possible settings of compiler switches are described in Table 15.

Table 15. Compiler Switches

Switch	Description	Global
Simultaneous Execution in SFC[1]	Simultaneous sequences in SFC	A
Loops In ST	Loops in Structured Text (FOR, WHILE, REPEAT and EXIT)	A
Nested IF or CASE	Nested IF and CASE statements in Structured Text	A
Implicit Cast	Automatic conversion of data types (e.g. integer to real)	A
Instruction List language	Instruction List	A
Ladder Diagram language	Ladder Diagram	A
Loops in Control Modules	Code sorting loops	E
SFC Language	Sequential Function Chart Language	A
Force I/O from code	The compiler switch for forcing I/O signals from code. It restricts changes of the Forced component in variables of one of the data types BoolIO, RealIO, DintIO and DwordIO and results in either warning or error when the switch is activated. Example: MyBoolIOVar.Forced := true; Not allowed since this assignment directly affects the “Forced” component.	A

Table 15. Compiler Switches (Continued)

Switch	Description	Global
Multiple calls to the same Function Block	This switch defines if the compiler should check if a POU Type contains more than one call to a specific Function Block instance	W
None or multiple calls to ExecuteControlModules	The ExecuteControlModules function is called once in every scan from a Function Block Type that contains ControlModule instances. This switch decides if the compiler checks that the call is made correctly.	W
No forward flow between blocks in FD	Verification of forward flow in Function Diagram	W

(1) This switch does not affect the “sequence selection” functionality of SFC.

Notes to Table 15
“**A**”: - **Allowed**, Gives no error or warning
“**W**”: - Gives a compiler **Warning** if the rule is violated, acknowledge required before download is allowed.
“**E**”: - Gives an compiler **Error** if the rule is violated, download is blocked.
The default settings are marked with boldface letters in the table.
“**E & M**” - **Error and mandatory**, same as "Error" but can not be changed by the user.

See Control Builder online help for more specific information how to configure compiler switches.

Reports

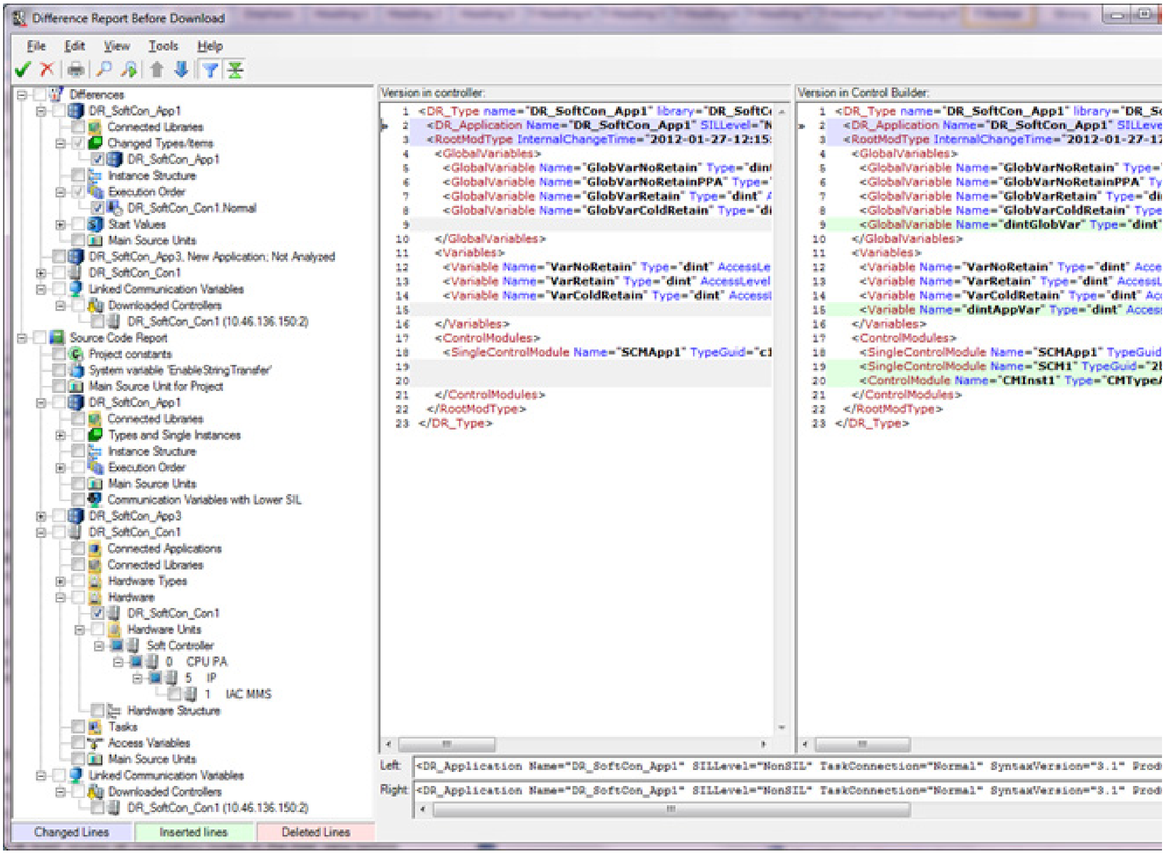
Difference Report

If the Difference Report function is enabled, the Difference Report Before Download dialog displays (in the same dialog):

- Differences
- Source Code Report
- Compilation Messages

Based on the information presented in the reports, you can either accept or reject the changes, to continue with the download or cancel the download.

To enable/disable the function, right-click the control project folder (root object) and select **Settings > Difference Report**. Difference report shows the difference between data downloaded to the controller and the data present in Control Builder, see Figure 85. The tree view to the left shows the parts of the application that have changed. By clicking an item in the tree, you can display the present controller code to the left, and the new code to the right. Differences are also indicated by colors (the color coding is explained on the status bar at the bottom of the report window).



```
⊟ □ Differences
  ⊟ □ DR_SoftCon_App1
      □ Connected Libraries
    ⊟ ☑ Changed Types/items
        ☑ DR_SoftCon_App1
      □ Instance Structure
    ⊟ ☑ Execution Order
        ☑ DR_SoftCon_Con1.Normal
    ⊞ □ Start Values
      □ Main Source Units
    □ DR_SoftCon_App3, New Application; Not Analyzed
  ⊞ □ DR_SoftCon_Con1
  ⊟ □ Linked Communication Variables
    ⊟ □ Downloaded Controllers
        □ DR_SoftCon_Con1 (10.46.136.150:2)
⊟ □ Source Code Report
    □ Project constants
    □ System variable 'EnableStringTransfer'
    □ Main Source Unit for Project
  ⊟ □ DR_SoftCon_App1
      □ Connected Libraries
    ⊞ □ Types and Single Instances
      □ Instance Structure
    ⊞ □ Execution Order
      □ Main Source Units
      □ Communication Variables with Lower SIL
  ⊞ □ DR_SoftCon_App3
  ⊟ □ DR_SoftCon_Con1
      □ Connected Applications
      □ Connected Libraries
    ⊞ □ Hardware Types
    ⊟ □ Hardware
        ☑ DR_SoftCon_Con1
      ⊟ □ Hardware Units
        ⊟ Soft Controller
          ⊟ 0  CPU PA
            ⊟ 5  IP
                □ 1  IAC MMS
        □ Hardware Structure
      □ Tasks
      □ Access Variables
      □ Main Source Units
  ⊟ □ Linked Communication Variables
    ⊟ □ Downloaded Controllers
        □ DR_SoftCon_Con1 (10.46.136.150:2)
```

Version in controller:

```
<DR_Type name="DR_SoftCon_App1" library="DR_SoftC
  <DR_Application Name="DR_SoftCon_App1" SILLevel="N
  <RootModType InternalChangeTime="2012-01-27-12:15
    <GlobalVariables>
      <GlobalVariable Name="GlobVarNoRetain" Type="dint
      <GlobalVariable Name="GlobVarNoRetainPPA" Type="
      <GlobalVariable Name="GlobVarRetain" Type="dint" A
      <GlobalVariable Name="GlobVarColdRetain" Type="di

    </GlobalVariables>
    <Variables>
      <Variable Name="VarNoRetain" Type="dint" AccessLe
      <Variable Name="VarRetain" Type="dint" AccessLevel
      <Variable Name="VarColdRetain" Type="dint" Accessl

    </Variables>
    <ControlModules>
      <SingleControlModule Name="SCMApp1" TypeGuid="c1


    </ControlModules>
  </RootModType>
</DR_Type>
```

Version in Control Builder:

```
<DR_Type name="DR_SoftCon_App1" library="DR_So
  <DR_Application Name="DR_SoftCon_App1" SILLeve
  <RootModType InternalChangeTime="2012-01-27-12
    <GlobalVariables>
      <GlobalVariable Name="GlobVarNoRetain" Type="
      <GlobalVariable Name="GlobVarNoRetainPPA" Ty
      <GlobalVariable Name="GlobVarRetain" Type="di
      <GlobalVariable Name="GlobVarColdRetain" Type
      <GlobalVariable Name="dintGlobVar" Type="dint"
    </GlobalVariables>
    <Variables>
      <Variable Name="VarNoRetain" Type="dint" Acce
      <Variable Name="VarRetain" Type="dint" AccessL
      <Variable Name="VarColdRetain" Type="dint" Acc
      <Variable Name="dintAppVar" Type="dint" Access
    </Variables>
    <ControlModules>
      <SingleControlModule Name="SCMApp1" TypeGuid
      <SingleControlModule Name="SCM1" TypeGuid="2
      <ControlModule Name="CMInst1" Type="CMTypeA
    </ControlModules>
  </RootModType>
</DR_Type>
```

```
Left:  <DR_Application Name="DR_SoftCon_App1" SILLevel="NonSIL" TaskConnection="Normal" SyntaxVersion="3.1" Prod
Right: <DR_Application Name="DR_SoftCon_App1" SILLevel="NonSIL" TaskConnection="Normal" SyntaxVersion="3.1" Prod
```

Figure 85. Difference Report Before Download

The Difference Report presents the differences found, under the *Differences* item in the tree view.

Table 16. Categories under 'Differences' item

Category	Displays Differences for...
ApplicationName	• Project Constants • Connected Libraries • Changed Types/Items • Instance Structure • Execution Order • Start Values • Main Source Units
ControllerName	• Connected Applications • Connected Libraries • Hardware Types • Hardware • Tasks • Access Variables • Main Source Units • Foundation Fieldbus – If an external configuration tool like Fieldbus Builder FF is used, the changed settings are displayed

Table 16. Categories under 'Differences' item (Continued)

Category	Displays Differences for...
Linked Communication Variables	• Downloaded Controllers – Communication variables in downloaded controllers • Resolved Controllers – Controllers where communication variables will be resolved as a result of the download
System variable *VariableName*	Changed System Variable

To reduce the compilation time during download of a project to a controller, it is possible to exclude the start values from the difference report. The start value analysis is enabled/disabled via **Project > Settings > Difference Report**.

History of Difference Report

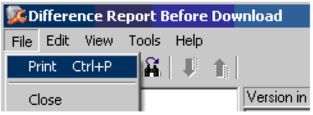
The accepted Difference Reports could be accessed again after a download is conducted. Select **View Accepted Difference Reports** from **Tools** menu to view the list of reports with date and time of download.

Printing Difference Report as a PDF File

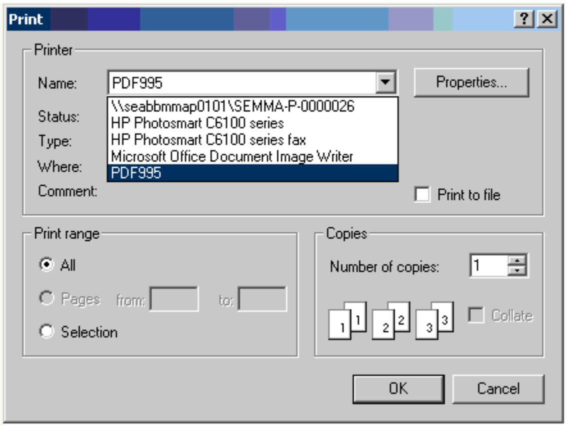
It is possible to print to a PDF-file instead of a printer if a PDF printer driver (Adobe PDF or PDF995 or others) and the corresponding converter is installed.

To print the Difference Report as PDF File:

1. Select **File > Print** in the Difference Report.



2. Select **PDF995/Adobe PDF** in the Print Dialog. Click **OK**.



Print

Printer

Name: PDF995

\\seabbmmap0101\SEMMA-P-0000026
HP Photosmart C6100 series
HP Photosmart C6100 series fax
Microsoft Office Document Image Writer
PDF995

Status:
Type:
Where:
Comment:

□ Print to file

Print range

● All
○ Pages from: to:
○ Selection

Copies

Number of copies: 1

□ Collate

3. A Save As dialog displays. Enter the file name/folder and click **Save.**

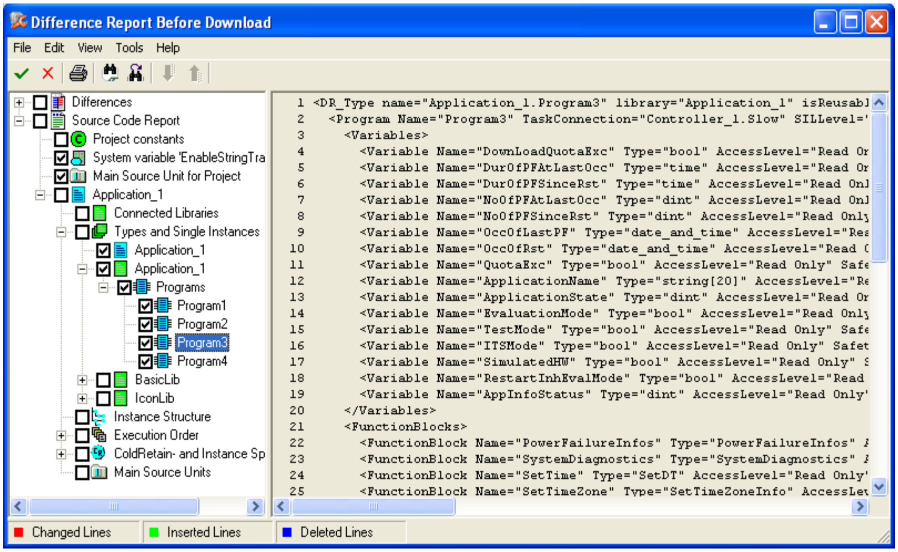
4. The PDF Viewer application is launched to display the difference report in PDF format.

Source Code Report

The source code report shows the complete source code for the current project in the Control Builder, and enables a review of the source code that is independent of editors and user interfaces of the Control Builder.

You perform the review by comparing the code presented in the report with the code in the editors of the Control Builder, checking that the source codes correspond with each other. If you find discrepancies, for example in the controller configuration, you can try to compile and download again.

The main difference compared with the difference report is that the source code report shows all source code from the different parts.



```
<DR_Type name="Application_1.Program3" library="Application_1" isReusabl
  <Program Name="Program3" TaskConnection="Controller_1.Slow" SILLevel='
    <Variables>
      <Variable Name="DownLoadQuotaExc" Type="bool" AccessLevel="Read Or
      <Variable Name="DurOfPFAtLastOcc" Type="time" AccessLevel="Read Or
      <Variable Name="DurOfPFSinceRst" Type="time" AccessLevel="Read Onl
      <Variable Name="NoOfPFAtLastOcc" Type="dint" AccessLevel="Read Onl
      <Variable Name="NoOfPFSinceRst" Type="dint" AccessLevel="Read Only
      <Variable Name="OccOfLastPF" Type="date_and_time" AccessLevel="Rea
      <Variable Name="OccOfRst" Type="date_and_time" AccessLevel="Read C
      <Variable Name="QuotaExc" Type="bool" AccessLevel="Read Only" Safe
      <Variable Name="ApplicationName" Type="string[20]" AccessLevel="Re
      <Variable Name="ApplicationState" Type="dint" AccessLevel="Read Or
      <Variable Name="EvaluationMode" Type="bool" AccessLevel="Read Only
      <Variable Name="TestMode" Type="bool" AccessLevel="Read Only" Safe
      <Variable Name="ITSMode" Type="bool" AccessLevel="Read Only" Safet
      <Variable Name="SimulatedHW" Type="bool" AccessLevel="Read Only" S
      <Variable Name="RestartInhEvalMode" Type="bool" AccessLevel="Read
      <Variable Name="AppInfoStatus" Type="dint" AccessLevel="Read Only'
    </Variables>
    <FunctionBlocks>
      <FunctionBlock Name="PowerFailureInfos" Type="PowerFailureInfos" A
      <FunctionBlock Name="SystemDiagnostics" Type="SystemDiagnostics" A
      <FunctionBlock Name="SetTime" Type="SetDT" AccessLevel="Read Only'
      <FunctionBlock Name="SetTimeZone" Type="SetTimeZoneInfo" AccessLev
```

Figure 86. Source code report before download

The left part of the dialog displays a tree containing the different parts of the report (see table below). To view the source code for a specific item, navigate the tree until you find the item, and then double-click the item (or right-click the item and select **Show Source Code**).

Table 17. Categories under 'Source Code Report' item

Category	**Displays Source Code for...**
Project Constants	Project Constants
System Variable *VariableName*	System Variable

Table 17. Categories under 'Source Code Report' item (Continued)

Category	**Displays Source Code for...**
Main Source Units for Project	Main source units for project
ApplicationName	• Connected Libraries • Types and Single Instances • Instance Structure • Execution Order • ColdRetain and Instance Specific Values • Main Source Units
ControllerName	• Connected Applications • Connected Libraries • Hardware Types • Hardware • Tasks • Access Variables • Main Source Units
Linked Communication Variables	• Downloaded Controllers • System Controllers

Information about execution order and linked communication variables will be part of the report, provided that a compilation has been performed.

Source code for protected types will not be displayed in the report. In the report, a protected type is indicated by a padlock icon 🔒. If the protected type is part of a library, it is possible to override the protection by entering the password.

To print the source code for the whole project, select **File > Print**. To print the source code for selected parts of the project, navigate the tree to the item you want to print, right-click the item and select **Print Source Code**. Alternatively, you can select **File > Print**, and select print range **Selection** in the Print dialog.

ℹ The source code report has a filter function to increase the readability of the source code for Function Block Diagrams and Control Modules. This filter is by default turned on (select **Tools > Filter**).

ℹ You can generate a source code report without compilation or download. See Source Code Report Generated for Project in Control Builder on page 198.

You can also generate a source code report for the project in the controller. See Source Code Report Generated for Project in Controller on page 198.

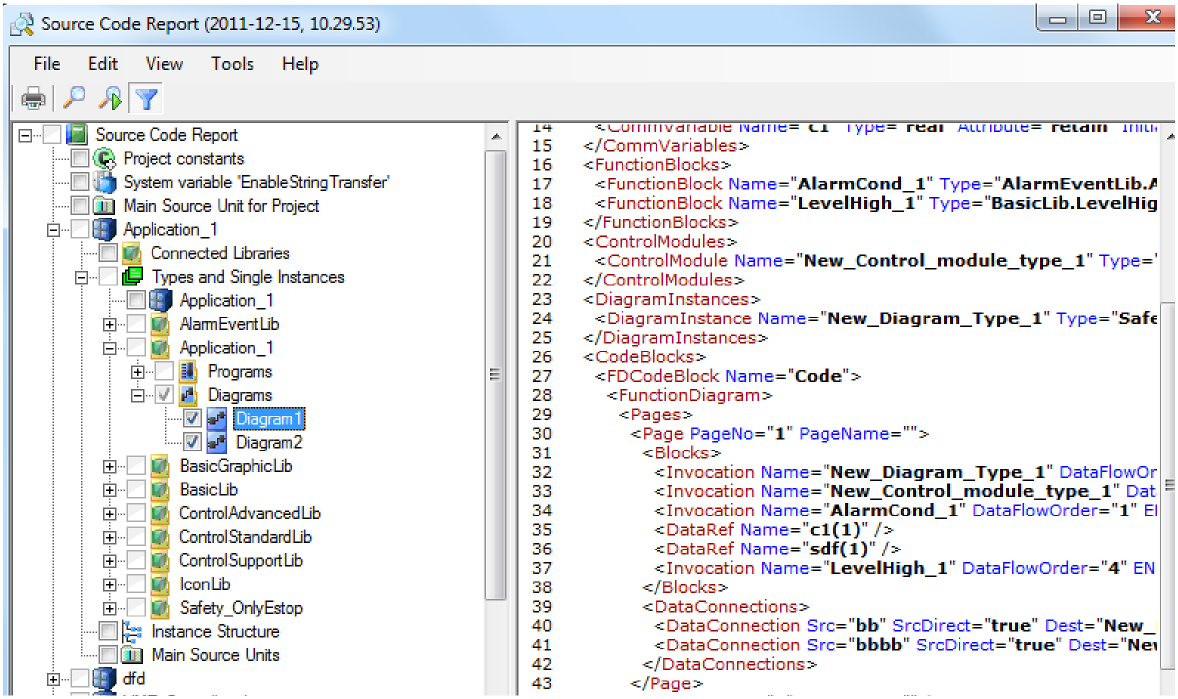
Reports Generated at Download

Difference Report and Source Code Report Generated at Download

For a description of the difference report and source code report generated when you perform a download of a project from the Control Builder to the controller, see Difference Report on page 190 and Source Code Report on page 194.

Source Code Report Generated for Project in Control Builder

To generate a source code report for the project in the Control Builder, without performing any compilation or download, select **Tools > Source Code Report**.



```
  <CommVariable Name="c1" Type="real" Attribute="retain" Initi
 </CommVariables>
 <FunctionBlocks>
  <FunctionBlock Name="AlarmCond_1" Type="AlarmEventLib.A
  <FunctionBlock Name="LevelHigh_1" Type="BasicLib.LevelHig
 </FunctionBlocks>
 <ControlModules>
  <ControlModule Name="New_Control_module_type_1" Type='
 </ControlModules>
 <DiagramInstances>
  <DiagramInstance Name="New_Diagram_Type_1" Type="Safe
 </DiagramInstances>
 <CodeBlocks>
  <FDCodeBlock Name="Code">
   <FunctionDiagram>
    <Pages>
     <Page PageNo="1" PageName="">
      <Blocks>
       <Invocation Name="New_Diagram_Type_1" DataFlowOr
       <Invocation Name="New_Control_module_type_1" Dat
       <Invocation Name="AlarmCond_1" DataFlowOrder="1" El
       <DataRef Name="c1(1)" />
       <DataRef Name="sdf(1)" />
       <Invocation Name="LevelHigh_1" DataFlowOrder="4" EN
      </Blocks>
      <DataConnections>
       <DataConnection Src="bb" SrcDirect="true" Dest="New_
       <DataConnection Src="bbbb" SrcDirect="true" Dest="New
      </DataConnections>
     </Page>
```

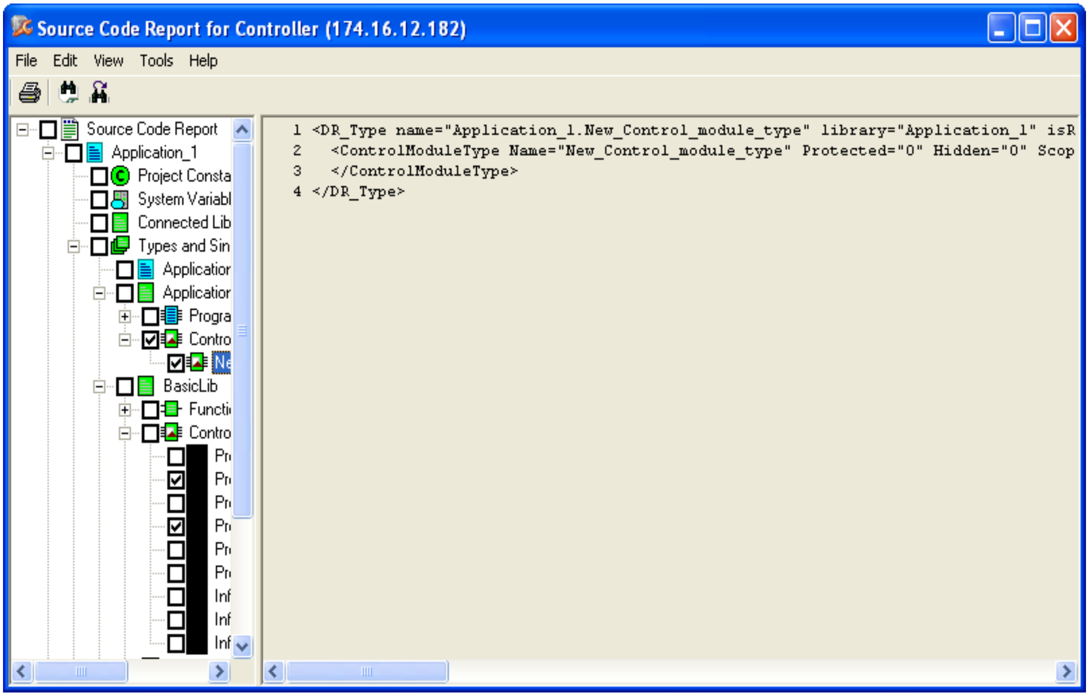
Figure 87. Source code report generated without prior compilation

Source Code Report Generated for Project in Controller

A source code report for the project running in the controller can be generated provided that:

- A successful download to the controller, with difference report enabled, has been performed.
- The project in the Project Explorer is the same as the project in the controller.

To generate a source code report for the project in the controller, right-click the controller in the Project Explorer and select **Remote System**, and then click **Show Downloaded Items**. In the Downloaded Items dialog, click **Source Code Report**.



```
<DR_Type name="Application_1.New_Control_module_type" library="Application_1" isR
  <ControlModuleType Name="New_Control_module_type" Protected="0" Hidden="0" Scop
  </ControlModuleType>
</DR_Type>
```

Figure 88. Source code report generated for project in controller.

Portability Verification

This menu is located under the menu option **Tools > Verify Portability** in the Project Explorer. This functionality verifies that the source code doesn't contain any characters with an ASCII value above 127. If a project, containing characters with ASCII values above 127, is moved between computers with different local system settings it may result in errors when the Control Builder project is loaded.

Performance Management

The compiler statistics is a separate tool accessible from the tools menu in the Control Builder as shown in Figure 89. When it is started, the currently opened project in the Control Builder is compiled, and the collected information is saved in XML format in the 'Results' subfolder of the working folder, which is presented in a separate dialog, see Figure 90. Only information about compilable applications can be gathered by the tool. If a project contains applications with errors, only statistics of the correct applications is presented. In this case the statistics presented is taken from a part of the project. One file is generated per application and it replaces old ones if it previously exists for that application. The tool can also be started from a Control Builder with no project loaded. In that case only information gathered from previously generated files is displayed.

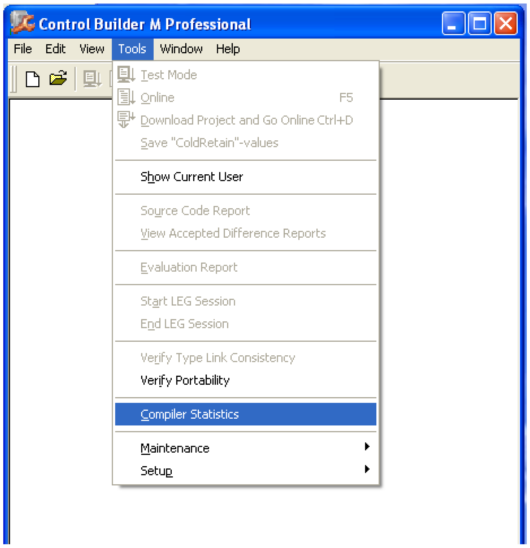
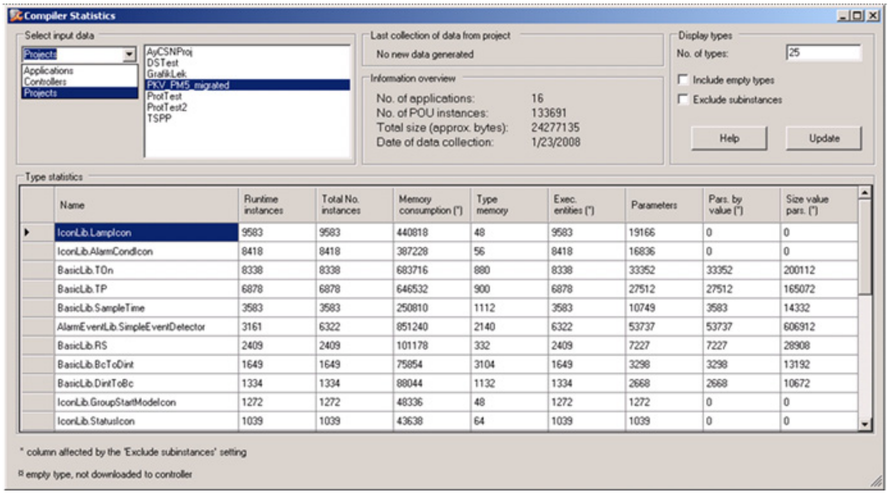


Figure 89. Compiler Statistics Tool



Last collection of data from project

No new data generated

Information overview

No. of applications: 16
No. of POU instances: 133691
Total size (approx. bytes): 24277135
Date of data collection: 1/23/2008

Display types

No. of types: 25

□ Include empty types

□ Exclude subinstances

Type statistics

Name	Runtime instances	Total No. instances	Memory consumption (*)	Type memory	Exec. entities (*)	Parameters	Pars. by value (*)	Size value pars. (*)
IconLib.LampIcon	9583	9583	440818	48	9583	19166	0	0
IconLib.AlarmCondIcon	8418	8418	387228	56	8418	16836	0	0
BasicLib.TOn	8338	8338	683716	880	8338	33352	33352	200112
BasicLib.TP	6878	6878	646532	900	6878	27512	27512	165072
BasicLib.SampleTime	3583	3583	250810	1112	3583	10749	3583	14332
AlarmEventLib.SimpleEventDetector	3161	6322	851240	2140	6322	53737	53737	606912
BasicLib.RS	2409	2409	101178	332	2409	7227	7227	28908
BasicLib.BcToDint	1649	1649	75854	3104	1649	3298	3298	13192
BasicLib.DintToBc	1334	1334	88044	1132	1334	2668	2668	10672
IconLib.GroupStartModelIcon	1272	1272	48336	48	1272	1272	0	0
IconLib.StatusIcon	1039	1039	43638	64	1039	1039	0	0

* column affected by the 'Exclude subinstances' setting

¤ empty type, not downloaded to controller

Figure 90. Compiler Statistics dialog

The tool presents the following information:

- The number of runtime instances of a type.
- The number of sub-instances of a type and total number of instances caused by the type.
- The memory cost of one instance of the type, both including sub-instances and without sub-instances.
- The total memory cost for all instances of the type. Both including sub-instances and without sub-instances.
- The number of code blocks of the type.
- The number of execution entities (Code calls) for all instances of the type, both including sub-instances and without sub-instances.
- The number of parameters passed by value of a type and the number of bytes passed by value.
- As above for all instances of the type, both including sub-instances and without sub-instances.

Project Documentation

Project Documentation function generates documentation of libraries and applications (in offline mode) for all the items in a selected project explorer folder. This function can be used to make a reference book for a library, an application, a controller, or a single object in a folder.

The project documentation function provides you with filter options while documenting your control project. The filter helps you specify parts of the control project and keeping the document size to a minimum. All documentation is produced as Microsoft Word documents as default, hence Microsoft Office must be installed.

All project documentation will be connected to a standard template. But you can create templates of your own for the documentation.

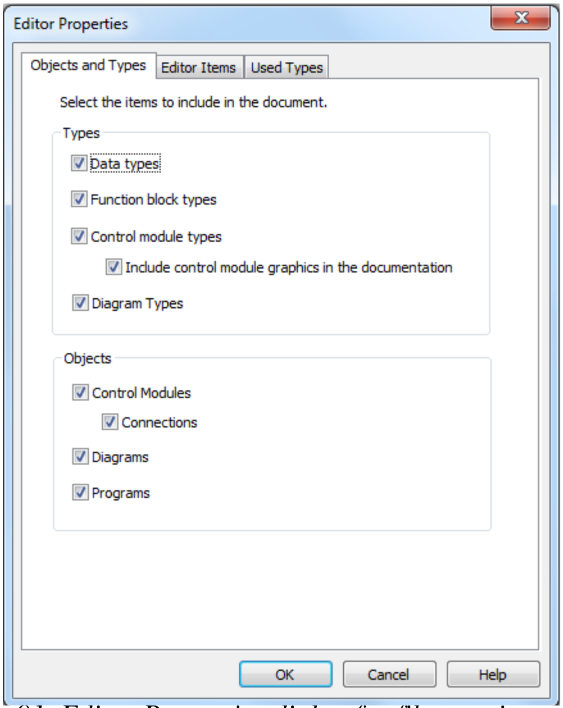
A complete overview of a library, an application, a controller, or an object in these folders can be exported to a file for printout from Project Explorer. However, it is not possible to select a folder at the root level, for example the Libraries object folder. As an example, it is possible to filter out all ColdRetain variables and Parameters in an application.

If the project documentation function is used in Online mode, the cold retain values can also be obtained.

Printing Project Documentation

To print documentation, in Project Explorer:

1. Right-click any object in the tree view and select **Documentation**. The Documentation dialog box opens.
2. Click **More** to filter information. The Editor Properties dialog box opens.



Select the items to include in the document.

Types

☑ Data types

☑ Function block types

☑ Control module types

☑ Include control module graphics in the documentation

☑ Diagram Types

Objects

☑ Control Modules

☑ Connections

☑ Diagrams

☑ Programs

Figure 91. Editor Properties dialog for filter options.

The Editor Properties dialog box contains three main areas, which are represented by tabs in the dialog, see Figure 91.

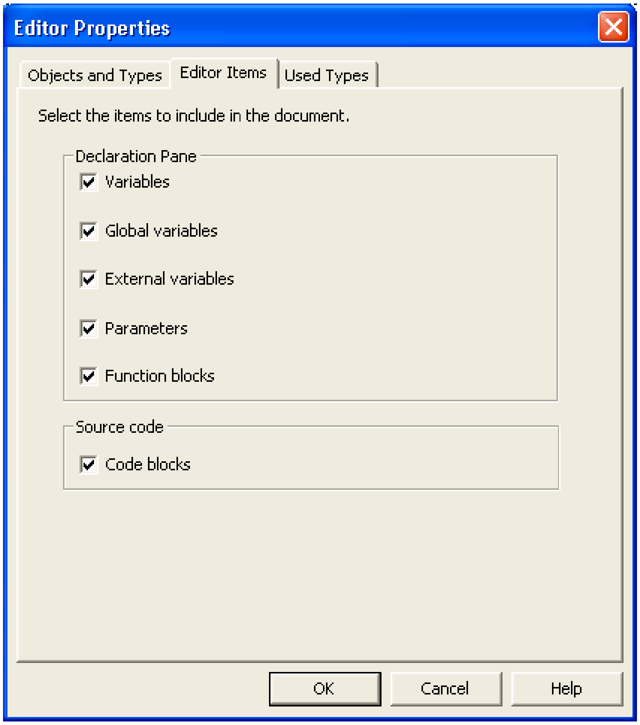
- Objects and Types,

- Editor Items,
- Used Types.

Objects and Types

This is the start level for filtering the contents of your application or library. As you can see, all options have been selected by default. You adjust the filter setting by exclude an option.

Editor Items



Select the items to include in the document.

Declaration Pane

- ☑ Variables
- ☑ Global variables
- ☑ External variables
- ☑ Parameters
- ☑ Function blocks

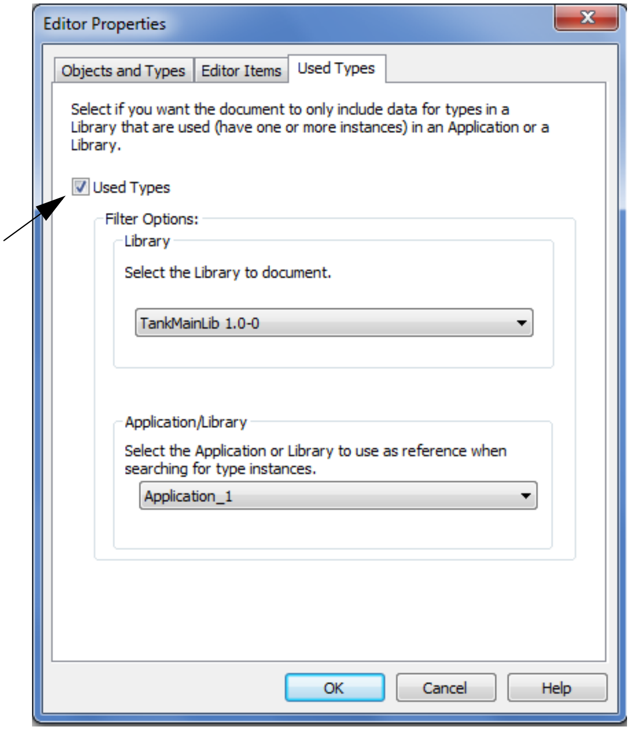
Source code

- ☑ Code blocks

Figure 92. Editor Items tab for selecting items inside filtered types and objects.

After adjusting the filter settings for types and objects, another filtering can be done per item. You can now specify which items to include/exclude for the previous selected types and objects. The items are grouped under Declaration Pane and Source code.

Used Types



Select if you want the document to only include data for types in a Library that are used (have one or more instances) in an Application or a Library.

☑ Used Types

Filter Options:

Library

Select the Library to document.

TankMainLib 1.0-0

Application/Library

Select the Application or Library to use as reference when searching for type instances.

Application_1

Used Types must be checked.

Figure 93. Used Types dialog for printing used types only.

This filtering option selects types in a library that has an object (instance) in an application or inside another library. The resulting documentation from this dialog will only include the information for those types that have been matched as a reference in the selected application or library (see the drop-down menus in Figure 93).

In order to select a library or an application/library reference from the drop-down menus, you must first check the Used Types check box.

Section 2 Alarm and Event Handling

Introduction

An important part of an automation system is to be able to supervise and interact with the system. For this to be possible, information about the status of the supervised processes must be made available to the operator. Both the operator and the controllers need to be able to interact with the process.

This requires that information is transferred to and from the operator interface, in the form of commands, alarms, and events.

Alarms and events are generated in three ways:

- by using objects based on library types containing alarm and event functions,
- by using objects especially made for alarm and event handling (based on the types in the Alarm and Event library),
- by hardware units throughout the system (system alarms).

This section describes how to add alarm and event handling when there are no built-in functions for this. For information on how to configure alarm and event handling using objects that already contain alarm and event handling functions, refer to the *Compact 800 Engineering Compact Control Builder AC 800M Binary and Analog Handling (3BSE041488*)* manual, and to online help for the object in question.

> This chapter describes the alarm handling functions in the Alarm and Event library. Signal objects, process objects, and a number of control objects have built-in alarm functionality that is similar to the functions described in this section. For a description of built-in alarm functions, see the references above.

Alarms and Events

Alarms and events inform the operator of the status of processes and systems. An alarm represents a named state, also called an alarm condition (this is an OPC standard term). Events give information about changes that is needed to analyze various error situations. The OPC standard defines three kinds of events:

- Condition-related events, which are created when an alarm state changes.
- Simple events, which are created at occurrences like when a motor starts.
- Tracking-related events, which are created at occurrences like an operator action.

Alarms are usually presented to the operator in alarm lists, while events are presented in event lists. Alarms and events can also be handled by various parts of the system without the involvement of an operator, so that, for example, a process is stopped when a certain alarm goes on. Alarms and events are collected from controllers and other parts of the system, and transferred to subscribing OPC clients (operator interfaces) using an OPC server, see Alarm and Event Communication on page 237.

Alarms and events are often logged, for use in trouble-shooting and when tracing the origins of an error, see Section 5, Maintenance and Trouble-Shooting.

There are two main types of alarms and events:

- Process alarms and events are generated by changes in the alarm condition of a monitored process signal, see Process Alarm and Event Generation on page 209.
- System alarms and events are generated by a change in the status of the system itself, for example by a hardware failure or by the application via function block (SystemAlarmCond). See Detection of Simple Events on page 218 and System Alarm and Event Generation on page 230.

Alarm and event handling also requires clock synchronization, in order for time stamps to be reliable when trying to analyze a sequence of events. See Time Stamps on page 234 and Sequence of Events (SOE) on page 222.

All alarms and events follow the OPC Alarm and Event specification.

Alarm and Event Library

The Alarm and Event library contains function blocks and control modules for:

- Creating alarms and events when a monitored signal of type bool changes,
- Creating simple events with user-defined data, for use in, for example, batch applications,
- Printing alarms and events.

Additional Information

For examples of how to use components from the Alarm and Event library, see Condition State Example on page 243. For details on how to use alarm and event functions, see Alarm and Event Functions on page 251. This sub-section also describes how to set up printers and print queues.

For a complete list of all objects in the Alarm and Event library, see the manual *Compact 800 Engineering Compact Control Builder AC 800M Binary and Analog Handling (3BSE041488*)*.

Process Alarm and Event Generation

Process alarms and events can be generated using a number of objects based on types in the Alarm and Event library.

- The function block types AlarmCond and AlarmCondBasic, as well as the control module types AlarmCondM and AlarmCondBasicM, can be used to generate alarms and events each time there is a change in a monitored signal (of type bool). See Process Alarms and Events on page 210.

The function block type AlarmCondBasic and the control module type AlarmCondBasicM are versions of AlarmCond and AlarmCondM, which consume less memory. These types do not allow inverting the monitored signal and they support internal time stamps only.

- The function block type SimpleEventDetector can be used to generate a simple event whenever a monitored signal of type bool changes. See Detection of Simple Events on page 218.
- The function block type DataToSimpleEvent can be used to create a simple event and add user-defined data to it. Detection of Simple Events on page 218.

There are also system generated alarms and events, see System Alarm and Event Generation on page 230.

Process Alarms and Events

Alarm condition-driven alarms and events are created when the monitored signal changes, that is, when an alarm condition is fulfilled. This monitored signal must be of type bool and is typically taken from another function block or module in the system, or from an external device. The alarm condition function blocks and control modules are state machines, which change from one state to another following a set of configurable rules, whenever the monitored signal changes. This is defined as a change in the *alarm condition*. Each time an alarm condition changes, an event is created as well.

All alarm condition objects can be used in time-critical tasks.

AlarmCond and AlarmCondM

The two basic types for creating alarm conditions are the function block type AlarmCond and the control module type AlarmCondM. The principle behind the two is the same. Through parameters, it is possible to connect to the monitored signal, add information to the alarm, provide other objects with status information, and to control the behavior of the alarm condition. In Figure 94, the function block type AlarmCond is used to illustrate the function of the different parameters.

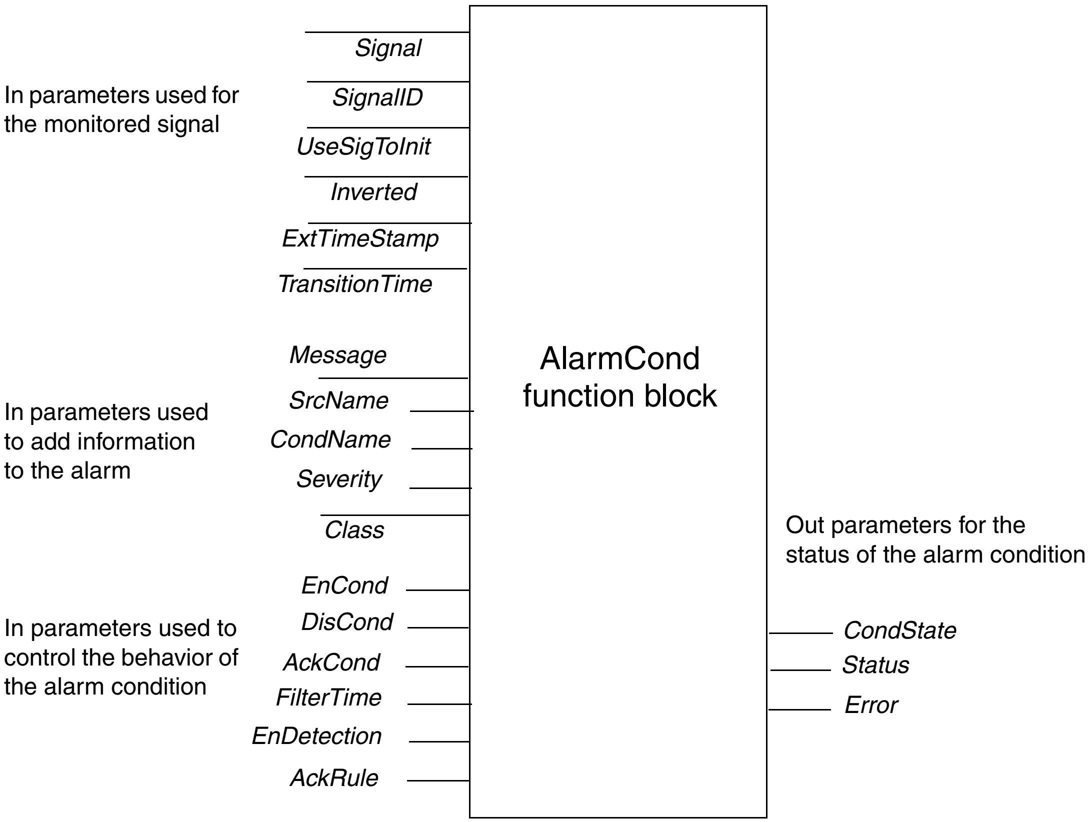

Signal
SignalID
UseSigToInit
Inverted
ExtTimeStamp
TransitionTime
In parameters used for the monitored signal
Message
SrcName
CondName
Severity
Class
In parameters used to add information to the alarm
AlarmCond function block
EnCond
DisCond
AckCond
FilterTime
EnDetection
AckRule
In parameters used to control the behavior of the alarm condition
Out parameters for the status of the alarm condition
CondState
Status
Error

Figure 94. The function block AlarmCond.

If you change the value of an *Edit* parameter, this change will not take effect until after a warm or cold download.

The following alarm condition parameters are *Edit* parameters:

- *ExtTimeStamp,*
- *SignalID,*
- *UseSigToInit,*
- *SrcName,*
- *CondName,*
- *Inverted,*
- *AckRule.*

The Description field in the parameter editor starts with EDIT if the parameter is an *Edit* parameter.

The control module type AlarmCondM has similar functions and uses the same parameters as the AlarmCond function block type.

For more information on parameters and their possible values, also see online help and the Description column in the parameter editor.

Alarm Condition Types with Reduced Functionality

In applications where it is necessary to minimize memory consumption, the function block type AlarmCondBasic and the control module type AlarmCondBasicM offer an alternative to AlarmCond and AlarmCondM.

Basically, they are the same as their counterparts AlarmCond and AlarmCondM, with the following differences:

- They consume less memory.
- They always use acknowledgement rule number 1 (*AckRule*=1).
- It is not possible to invert the in signal, that is, the *Inverted* parameter cannot be used.
- External time stamps cannot be used, that is, the parameters *ExtTimeStamp* and *SignalID* are not used.
- Remote time stamps cannot be used, since the parameter *TransitionTime* cannot be used.

Select Signal to Monitor

The monitored signal can be internal (that is, reside in the controller), or external (that is, reside outside the controller).

Which type of signal that is monitored is indicated by the parameter *ExtTimeStamp*. If this parameter is True, the external signal indicated by the hardware address in the parameter *SignalID* is monitored. If *ExtTimeStamp* is false, the parameter *Signal* is used to connect to the monitored signal.

The parameter *Inverted* can be used to invert the in signal (True=invert signal).

UseSigToInit is used to indicate from where the initial value of the signal should be taken (the state machine needs a start value). This parameter is only relevant when the monitored signal is external. When *UseSigToInit* is True, *Signal* is used to get an initial value.

Control the Behavior of the Alarm Condition

The following parameters can be used to control the behavior of an alarm condition:

- *AckRule* determines which acknowledgement rule is used. The acknowledgement rule decides the behavior of the alarm condition when an alarm has been created. This parameter is an EDIT parameter (that is, it is used for configuration purposes only, and cannot be changed without a restart) and it cannot be changed from the code.
- *FilterTime* determines how long the signal must deviate before a change is considered to have taken place. The filter time should be set so that glitches do not cause an alarm.
- *TransitionTime* determines the time of the event occurrence when the Signal change. If the value is equal the default value (the time) will be read inside this FB instead
- *EnDetection* enables detection when True. When this parameter becomes False, the alarm condition goes to an inactive state and the signal is no longer monitored. By setting this parameter to False, you will stop detection of new alarms and leave existing alarms unacknowledged.
- *AckCond* is used to acknowledge an alarm (True = acknowledge). It is normally used to acknowledge alarms from simple devices such as push buttons.

- *DisCond* disables the alarm condition when True.
- *EnCond* enables the alarm condition when True.

How the condition state changes when an alarm is acknowledged depends on the value of the acknowledgement rule (*AckRule)* parameter. This parameter is available in the AlarmCond and AlarmCondBasic function blocks, and in the AlarmCondM and AlarmCondBasicM control modules.

The *AckRule* parameter is normally set to 1 (normal). It cannot be changed online.

There are five acknowledgement rules:

- *AckRule* = 1, “normal handling”, alarms must be acknowledged and inactive before the “normal” state is resumed,
- *AckRule* = 2, alarms need no acknowledgement,
- *AckRule* = 3, alarms return to “normal” state on acknowledgement,
- *AckRule* = 4, not used (reserved for future use),
- *AckRule* = 5, alarms return to “normal” state when a sum system alarm is acknowledged and returns to its normal state.

For more information about the different acknowledgement rules, see Acknowledgement Rules – State Diagrams on page 252.

Alarm and Event Information

There are a number of parameters for adding information to alarms and events:

- *Message* can be used to add a textual description of the alarm condition, for example, “temperature low”.
- *SrcName* identifies the alarm source, for example, “Motor101”.
- *CondName* identifies the alarm condition, for example, “Level_High“.
- *Severity* indicates the degree of severity, where 1 is the least severe, and 1000 is the most severe level. This parameter is very useful when filtering alarms and events.
- *Class* can be used to classify the alarm (1-9999). This parameter is also useful when filtering events,

This information can be displayed in the operator interface and written to various logs. It can also be used to sort and filter alarms and events.

Since the source name and the condition name identify the alarm, the combination of the two must be unique within a controller. Any attempt to define an alarm condition that results in a non-unique combination of source name and condition name will result in an error (the *Error* parameter will become True). Also, a simple event is generated.

If an OPC server detects a non-unique alarm (that is, two controllers have the same combination of source name and condition name), a system simple event is generated.

There are two alternatives for indicating the source of an alarm or event:

- Leave the *SrcName* parameter empty. The *Name* parameter of the alarm owner (see Alarm Owner Concept on page 218) will be used as the source name.

For a program or application to have a source name, you need to create a variable called Name in the program or application. If the *SrcName* parameter is left empty and the alarm owner is a program or application, the value of the Name variable will be used as the source name.

- Set the *SrcName* parameter to whatever source name you want to use.

All alarms belonging to the same alarm owner must have the same source name.

The condition name is normally the name of the alarm condition function block or control module instance, for example Level_High, but could also be set via the *CondName* parameter.

Condition names are case sensitive, that is, Level_High is not the same as LEVEL_HIGH.

The same condition names should be used throughout the whole project, since it is important that the operator has a limited set of condition names to deal with. Using condition names in a consistent and structured manner also makes it easier to understand the process.

For detailed information about source name and condition name restrictions and syntax, see online help for the Alarm and Event library.

The class parameter (*Class*) can be used to classify all alarms.

The default class is 9950 for all system alarms and system events. All other numbers can be used as required. Possible values are 1-9999. The default value can be changed by changing the CPU setting *AE System AE class*.

Status Information

There are three parameters that can be used to retrieve status information for an alarm condition:

- *CondState* indicates the state of the alarm condition (0-6, see below).
- *Error* indicates an error in the alarm condition.
- *Status* gives the status code from the latest execution.

If a parameter is outside its defined range, the *Status* parameter will take a negative value or the value 703.

Alarm conditions are state machines, which change from one state to another following fixed rules. The most important reason for an alarm condition to change is a change in a monitored signal. The alarm condition (indicated by the parameter *CondState*) also changes if:

- an alarm is acknowledged,
- an alarm is disabled,
- an alarm is enabled,
- auto-disable occurs.

The condition state (*CondState)* parameter indicates the state of an alarm. An alarm can be in one of seven states:

Integer value	State
0	Alarm condition not defined
1	Disabled
2	Enabled, Inactive, Acked - **Idle**
3	Enabled, Inactive, Unacked
4	Enabled, Active, Acked
5	Enabled, Active, Unacked
6	Enabled, AutoDisabled, Unacked

The *CondState* parameter can be used to pass the state of an alarm to other parts of the software.

To see the state of all alarm conditions for a certain object in Project Explorer, right-click the object and select **Alarm Conditions** from the context menu.

Autodisable

AC 800M controllers have a CPU parameter called *AE Limit auto disabl*e. This setting controls the number of times an alarm can go on and off, without being acknowledged. When the limit is reached, the alarm condition is automatically disabled, and the state AutoDisabled is entered. The default setting is 3, and the maximum setting is 127. If *AE Limit auto disable* is set to 0, autodisabling is turned off and alarms can be activated an unlimited number of times.

An alarm that is in AutoDisabled state does not send any event (even though the alarm condition changes), until it is acknowledged. See Acknowledgement Rule 1 on page 252.

Alarm Owner Concept

The alarm owner concept is important, since it is the key to manipulating the source of an alarm. Not all objects in the Project Explorer tree hierarchy are alarm owners.

For an object (for example, a tank object) to be an alarm owner, it must fulfill two criterias:

1. It must have the attribute Alarm Owner set to True.
2. It has to be the last link in an unbroken chain of alarm owners, all the way from the program or application, down to this particular object. It must not be a sub object to an object with the attributes hidden or protected.

The attribute "Sub Objects visible in PPA" will not affect the Alarm ownership.

If an object is not an alarm owner, or the alarm owner chain is broken, the system looks further up in the hierarchy, until it finds an object on a higher level that is directly above the origin of the alarm or event, and fulfills the above criteria.

This is the point of the alarm owner concept. By not setting the Alarm Owner attribute for low-level objects, alarms and events can be connected to an object on a level higher than their true origin. If no alarm owner is found, the program or application itself becomes the alarm owner. The following objects are always alarm owners:

- Applications,
- Programs.

Detection of Simple Events

A simple event detector generates a simple event each time there is a change in the monitored signal. A simple event detector can be implemented by means of the function block type SimpleEventDetector.

SimpleEventDetector can be used with internal, external or remote time stamps. This function block type is connected to the monitored signal exactly the same way as the function block type AlarmCond, that is, using the parameters *Signal*, *SignalID* and *UseSigToInit*. See Select Signal to Monitor on page 213. It is also possible to set the filter time (via a *FilterTime* parameter).

For SimpleEventDetector, the following applies:
If *ExtTimeStamp* is True, *FilterTime* is not used.

The function block DataToSimpleEvent can be used to add data to a simple event. See Simple Events on page 233.

For more information on how to configure these function blocks, see alarm and event online help.

Built-in Alarm and Event Handling in Other Libraries

This section deals with alarm and event handling based on the Alarm and Event library. However, alarm and event functions are built in to a number of other types in the standard libraries that are delivered with Compact Control Builder.

This sub-section gives a short introduction to signal objects and to the built-in alarm and event functions of process objects and control loops. It also describes the inhibit and disable functions for these objects, since they are relevant to the interaction with the types in the Alarm and Event library.

Alarm and Event Handling Using Signal Objects

The Signal Library contains types that can be used to create representations of objects with an input or output signal, for example a temperature sensor. By using a signal object, you can go to manual mode and set the value of the signal, as well as supervise the signal and generate alarms when the signal deviates.

Never use types from the Signal Libraries to represent *all* I/O channels and if used, types from SignalBasicLib should be taken. This will consume a lot of memory and will result in poor performance. Use signal objects when there is a real need to control and monitor an I/O signal. Signal objects normally represent an object with a single signal.

For more information about the Signal Libraries, see online help and the manual *Compact 800 Engineering Compact Control Builder AC 800M Binary and Analog Handling (3BSE041488*)* manual.

Alarm and Event Handling in Control Loops and Process Objects

Alarm and event handling is built into a number of library types, such as control loops and process objects. These alarms and events are handled the same way as other process alarms and events.

Alarms and events can be generated directly by those objects, each time the alarm condition is fulfilled, or the object can generate a bool signal that can be connected to an alarm condition object.

For a description of how to configure built-in alarm handling for various library types, see online help for the type in question, and the *Compact 800 Engineering Compact Control Builder AC 800M Binary and Analog Handling (3BSE041488*)* manual.

Inhibit and Disable Alarms and Events

Sometimes there is a need for temporarily suspending alarm and event generation. This can be done for all objects with built-in alarm handling:

- Disable – the alarm condition is disabled, no alarms and events are generated, nothing is sent, and no control action is taken (that is, the system does not act upon the alarm condition).

Normally, the control action will be a boolean signal that causes a certain reaction, for example, a signal that stops a motor. However, a control action could also cause a more complex series of actions.

- Inhibit – the control action itself is inhibited (that is, the system does not act upon this alarm or event), while alarms and events are still presented to the operator in the operator interface.

Inhibit is only available in the types listed under Inhibit Parameters on page 220.

Alarms and events can be disabled from the interaction windows and from OPC AE, as well as from the application, via interaction parameters.

Inhibit Parameters

The inhibit function is present in the following standard library types.

- Signal library
  - SignalInReal
  - SignalReal
  - SignalInBool
  - SignalBool
  - SDLevelM
  - SignalBoolCalcInM

  - SignalInBoolM
  - SignalInRealM
  - SignalReadCalcInM
  - SignalSimpleInRealM
- Standard Control library
  - Level6CC
  - Level4CC
  - Level2CC
- Supervision Basic library
  - SDBool
  - SDInBool
  - SDInReal
  - SDLevel
  - SDOutBool
  - SDReal
  - SDValve
  - InfoAlarmSDInReal

In these types, control actions are inhibited by setting a parameter *InhXAct*, where *X* stands for the name of the condition, for example *InhGTHAct* (where GTH stands for Greater Than High).

There are also parameters for indicating if the alarm condition (event generation) has been inhibited or not.

Disable/Enable Parameters

The disable function is available in all types that contain built-in alarm handling. An alarm condition is disabled by setting the *EnableY* parameter to False, where Y stands for the name of the condition, for example *EnableGTH* (where GTH stands for Greater Than High).

There are also parameters for indicating if the alarm condition has been disabled or not.

There are additional parameters that affect the behavior of built-in alarm conditions, for example *AEConfigX*. For more information on parameters, see online help for the object in question (select and press F1).

External Time Stamps (S800 I/O)

A special form of external time stamp is created by external units with Sequence-of-Event (SOE) support, such as DI831. A low level event is then time-stamped by the I/O unit and sent to the controller to be dealt with. This triggers alarms or simple events in the controller. The change of status is time-stamped with the low level event time stamp.

Sequence of Events (SOE)

Some I/O modules add a low-level time stamp to an alarm or event when it detects a change in a signal. Instead of using the time stamp created by the controller when it detects a change in the monitored signal (that is, when the task is executed), the controller simply adds the time stamp created by the I/O module. In this way, the time stamp shows when the change actually occurred, instead of when it was detected by the controller.

For this to work, the I/O module will have to support Sequence of Events (SOE). SOE is currently supported on ModuleBus and PROFINET IO only. For information on enabling/disabling and configuring SOE, see online help for S800 I/O.

External Time Stamps (PROFINET IO)

Sequence of Events (SOE) for PROFINET IO

Time stamped events are passed by PROFINET IO and CI871 through the controller and are indicated in the AC 800M OPC Server. The timestamping is done by the PNIO device. The PROFINET IO SOE is supported by use of the ABB SOE profile.

The following are the definitions and functions of ABB SOE Profile:

1. Alarms from the PNIO device are converted into an External Event. These External Events transferred through the AC 800M OPC-Server are indicated in the EventList with their corresponding source address.
2. The external event can be picked up from the IEC-61131 Application by a Function block like alarm condition and converted to a process alarm.
3. The time synchronization of PNIO device is done externally and not by the CI871. It is the responsibility of the PNIO devices to get a time synchronization

managed (through access to the central time master in the system). The PNIO device defines the information to be time stamped.

4. The ABB SOE profile is handled as a process alarm on PROFINET IO with a vendor specific User Structure Identifier (USI).

5. Once the SOE alarm is acknowledged (to ensure that it is not lost). The PNIO device deletes the alarm only after receiving the acknowledgement from the controller. The controller sends the acknowledgement after storing the alarm in the non-volatile memory.

It is recommended to configure Function blocks as Alarm condition for process signals only where the process values can be used as initial value in case of restart behavior. Otherwise alarms can get frozen.

External Time Stamps (INSUM)

Creating an Application that Handles INSUM Alarms

All INSUM devices (MCU, Circuit Breaker) have supervision functions that can report alarms. The different device types supervise and report specific alarm types. The alarms are reported in specific Network Variables.

MCUs report the alarms in the Network Variable NVAlarmReport.

The user can decide if there should be a summary entry that tells that there are some alarms (one or more) in the device. It is possible to have a separate summary alarm for warnings and a separate alarm for trips.

This subsection discusses both methods, receiving INSUM alarms in the application program, and generating alarm to the alarm lists. The user can decide to use either methods or just one of them. For more information refer to *Compact 800 Engineering Compact Control Builder AC 800M Binary and Analog Handling (3BSE041488*)* manual.

Receiving INSUM Alarms in the Application

To receive alarms in the application program the INSUMReceive function block is used in the same way as when receiving other input network variables from an INSUM device, choose the correct NVindex and data type. The data type should in this case be NVAlarmReport (see also the MCUAlarmTrips/WarningsStructs regarding how to interpret the bits).

The time stamp set by the INSUM device in the alarm variable is presented in the two time fields of the NVAlarmReport. This time information is only correct if the clock in the INSUM device is synchronized. The system software does not fill in these fields if the time stamp received from the INSUM device is incorrect. (See below).

Generating Alarms for Alarm Lists

The controller system software generates alarms for the alarm and event lists in the system, based on the updates of the INSUM alarm information if the parameter *Generate Alarms* on the device is set to *Enabled* or *Enabled Trip/Warning* or *Enabled Detailed.*

If the time stamp received from the INSUM device is correct (a valid time) this time stamp is used for the generated alarm message. If it is not, the system software tags the generated alarm message with the current controller time.

If the parameter *Generate Alarms* is set to disabled, alarm information can anyway be sent to the alarm and event lists by the application. This can be done by creating an *AlarmCond* function block and to connect information received from an INSUM device to the parameter *Signal* and to set *External Time Stamp = FALSE*.

In this case, the alarm messages are time stamped in the controller. If this time accuracy is sufficient, this method is probably to be recommended because it is easier to configure. No System Clock is needed in the INSUM system. If you let the system software generate the alarms it can use the time stamp given by the INSUM devices. If the INSUM System Clock is used this is a much more accurate time stamp.

Summary Alarms, One Alarm Object Per Device

Generate Alarms = Enabled means that the system software internally (without needing INSUMReceive) creates a subscription of the alarm variable from the INSUM device. When this variable is updated from the INSUM system, the system software evaluates the content.

If a bit (one or more) which is classified as an alarm (e.g. not the bit "Started1") is set and no such bit previously was set, the system software generates one alarm message.

If an alarm update is received with the change that no alarm classified bits are set any more, the system software generates the *alarm-off* message.

Summary Alarms, One Alarm Object For Warnings and One for Trips

Generate Alarms = *Enabled Trip/Warning*. The difference compared to the handling for *Enabled* is that the system software generates one specific alarm message when a warning bit is set and another alarm message when a trip bits are set.

This means that there will be one alarm message for the first warning and one for the first trip. To use this setting two AlarmCond blocks should be created for each INSUM device, one for the warnings and one for the trips. If an alarm update is received with the change that no warning bits are set there will be an *alarm off* message for the warnings. The same applies for the trip bits.

Detailed Alarms

Generate Alarms = *Enabled Detailed*. The difference compared to the handling for *Enabled* (see Summary Alarms, One Alarm Object Per Device on page 225) is that for each alarm classified bit which is set (and previously was not set) the system software generates one separate alarm message. If an alarm update is received with the change that an alarm classified bit that previously was set now is reset, the system software generates the *alarm off* message for that bit.

Using *Enabled Detailed* means that one *AlarmCond* block should be created for each alarm type that the INSUM device sends. For a large INSUM configuration where more than just a few alarm types per device should be supervised this easily leads to a very large number of AlarmCond blocks.

Creating AlarmCond Blocks for Generated Alarms

The function block AlarmCond should be used to get descriptive messages in the event and alarm list and get an association with an alarm object. AlarmCond is associated with the alarm messages that the system generates by setting *ExternalTimeStamp=TRUE* and to identify the alarm object with the parameter *SignalId*.

Alarm Generation = Enabled

The SignalId should be a string that specifies the hardware position for the INSUM device. This is done with the syntax *C.G.D*, where:

- C is the position of the CI857,
- G is the position of the INSUM Gateway and,
- D is the position of the INSUM device. The position numbers are separated by a dot '.'.

Example:

- The syntax *2.1.204* means the alarm for device #204 connected via Gateway #1 on CI857 #2.

Alarm Generation = Enabled Trip/Warning

The SignalId should be a string that in addition to the hardware position for the INSUM device, also specifies a trip or a word.

This is done with the syntaxes *C.G.D-T or C.G.D-W*, where:

- C, G and D as above,
- T represents Trips and W represents Warnings.

Examples:

- The syntax *2.1.204-W* means a warning for device #204 connected via Gateway #1 on CI857 #2.
- The Syntax *2.1.204-T* means a trip in device #204 connected via Gateway #1 on CI857 #2.

Alarm Generation = Enabled Detailed

The SignalId should be a string that, in addition to the hardware position for the INSUM device, also specifies the alarm word and bit within the word. This is done with the syntax *C.G.D-X/B*, where:

- C, G, and D as above, and,
- X is the word within NVAlarmRep (preceded by a dash “-”),
- B is the bit within the word.

There are four words with warnings called W0-W3 and four words with trips called T0-T3. The bits are numbered from 0 to 15. The word and the bit is separated by a slash ‘/’.

Example:

The syntax *2.1.204-W1/3* means the alarm bit 3 in word W1 in device #204 connected via Gateway #1 on CI857 #2.

Choose Alarm Handling Method for INSUM Alarms

This section contains some suggestions about choosing and handling INSUM alarms. Whether to send alarms to alarm list or not:

- If Alarms should be possible to view, but are not necessary to see in the Alarm lists:
  - *Set Generate Alarms = Disabled*.
  - Do not create any AlarmCond blocks.
- If the INSUM Alarms should be sent to the alarm list:
  - Use AlarmCond function blocks. See INSUM Alarms in Alarm Lists below.

INSUM Alarms in Alarm Lists

Time stamping:

- If local (in the INSUM devices) time stamping should be used:
  - Use a system clock in the INSUM system.
  - Set *Generate Alarms = Enabled, Enabled Trip/Warning, Enabled Detailed*
  - Use an AlarmCond block with *External Time Stamp = TRUE*.
- If it is sufficient with time stamping in the application in the controller:
  - Set *Generate Alarms = Disabled*
  - Use an AlarmCond block with *External Time Stamp = FALSE*.
  - Connect it to the variable with the INSUM device information to be supervised. The accuracy of this time stamping cannot be better than the cycle time of the application where the AlarmCond is executed.

Separation of alarms in the alarm list:

- If the timing between different alarms within a device must be possible to see in the alarm list than it is required to:
  - Set *Generate Alarms = Enabled Detailed*.
  - Use one AlarmCond per alarm type.

- If it is sufficient to be able to identify the device than it is possible to:
  - Set *Generate Alarms* = *Enabled*.
  - Use one AlarmCond per INSUM device.
- If it is sufficient to be able to identify the first warning and the first trip in a device than it is possible to:
  - Set *Generate Alarms* = *Enabled Trip/Warning*
  - Use two AlarmCond blocks per INSUM device.

Number of devices:

- If there are a lot of devices needing external time stamping than required for:
  - Use two (or one) AlarmCond per INSUM device.
  - Set *Generate Alarms* = *Enabled Trip/Warning* (or *Enabled*)
- If there are a few devices that need external time stamping than it is possible to:
  - Use one AlarmCond per alarm type.
  - Set *Generate Alarms* = *Enabled Detailed*

System Alarm and Event Generation

System alarms and system simple events that are generated in a controller are distributed to OPC alarm and event clients and locally connected printers, according to the current system configuration.

All system alarms available in a controller can be located by printing all alarms (use the PrintAlarms function block type and set the parameters to show the alarms you want to see). They can also be displayed by and interacted with applications, by means of the function block AttachSystemAlarm (this function block type retrieves the alarm condition state and some other information for an alarm condition). When units that are visible in Project Explorer (hardware units or program tasks) generate system alarms or system simple events, a warning icon is displayed on the corresponding unit.

System alarms and system simple events are used to draw attention to deviations from normal system behavior. All system alarms and system simple events can be sent to the OPC Alarm and Event Clients and even printed to the system log file, depending on the current system configuration.

Controller Generated System Alarms and System Simple Events

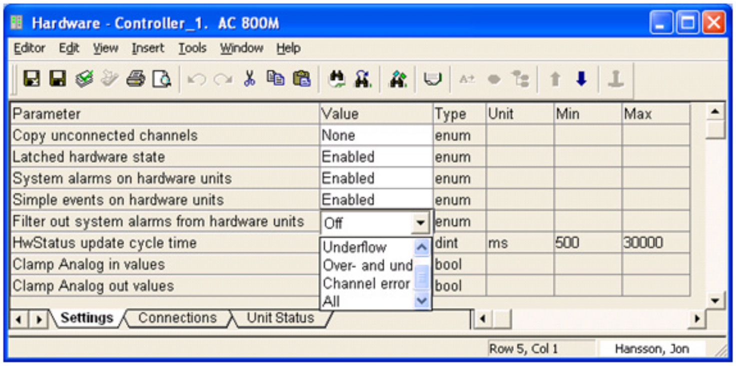
Controller generated system alarms and system simple events are defined within the controller. A list of all defined system alarms and system simple events within an AC 800M controller can be found in Appendix B, System Alarms and Events.

Filter out system alarms from hardware units

The function is used to reduce the number of alarms generated from hardware units, as important alarms tend to disappear in a crowd of alarms.

A example is when commissioning the system or a new part of an existing system, there might be transmitters that are connected and disconnected and the system generates a lot of underflow, overflow and channel error alarms.

The function is configured on the hardware object on the controller. Select **Controller > Hardware AC 800M >Editor > Settings**, then select **Filter out system alarms** from hardware units as shown in the Figure 95.



Parameter	Value	Type	Unit	Min	Max
Copy unconnected channels	None	enum			
Latched hardware state	Enabled	enum			
System alarms on hardware units	Enabled	enum			
Simple events on hardware units	Enabled	enum			
Filter out system alarms from hardware units	Off	enum			
HwStatus update cycle time		dint	ms	500	30000
Clamp Analog in values		bool			
Clamp Analog out values		bool			

Figure 95. Filter out system alarms

The parameter has five possible values:

Off: The filter function is shut off. The hardware status generates system alarms and systems events for all status changes. This is the default setting.

Underflow: Underflow status changes will not generate any alarms.

Over- and underflow: Neither underflow nor overflow status changes generate alarms.

Channel error: Channel error and IO warning will not generate system alarms or events.

All: Alarms and events from all the status changes above are suppressed.

Even if the setting is set to filter out alarms, the errors and warnings will still be visible in the hardware tree and the Unit Status tab in the hardware online editors. The change to the filter is performed in offline mode and downloaded to the controller to activate the change.

If the function is used during commissioning to decrease the number of alarms, it might be crucial to shut off the filter before entering normal operation.

User Generated System Alarms

User generated system alarms can be defined in your applications via the function block *SystemAlarmCond*.

Handling Alarms and Events

When implementing alarm and event handling, it is very important to create a good system for:

- classifying alarms and events,
- setting the severity of different types of alarms,
- indicating the source of an alarm or event,
- naming alarm conditions.

The most obvious reason for this is that you will be able to create an operator environment in which the operator will quickly be alerted to various things that require attention. The operator will also be able to quickly obtain additional information and decide on the best course of action.

However, alarms and events are also logged, in order to be used for trouble-shooting, and when analyzing things in order to improve performance of the plant.

This subsection describes:

- How to send data in XML format, see Simple Events on page 233. This is useful when creating batch records.
- How to handle system alarms and events, see System Alarms and Events on page 233.
- Internal, remote, and external time stamps (Sequence of Events, SOE), including time synchronization, see Time Stamps on page 234.

Simple Events

The DataToSimpleEvent function block is used to send data in XML format, for example, to record data for batch processes.

For more information on how to use this function block, see online help. For examples on how to use the DataToSimpleEvent function block, see Condition State Example on page 243.

System Alarms and Events

The handling of system alarms and events is to a certain degree configurable. The function block *AttachSystemAlarm* can be used to retrieve information on system alarms and events, such as state, and whether the alarm has been disabled or acknowledged.

The function block *SystemAlarmCond* can be used to retrieve system alarms and events via the application.

Time Stamps

When an alarm or event is created, a time stamp can be added to it, showing the exact time when the event occurred. There are three types of time stamp:

- Internal Time Stamps, that are created by the controller.
- Remote Time Stamps that are read from external communication partners via the parameter *TransitionTime*.
- External Time Stamps that are created by an I/O unit and transferred together with the event.

The *TransitionTime* parameter (of type date_and_time) can be used to read a remote time from a remote partner, via other protocols than MMS. The parameter is read each time a change is detected in the monitored signal. If it is left unconnected, it will have no effect.

When adding remote time stamps, it is possible to add any time. However, settings in the operator interface might filter out alarms and events with times that are outside the “normal” range (in the future or far back).

Internal time stamps simply show when the execution cycle in which the alarm was created started. External and remote time stamps show the actual time at which the alarm condition occurred in the external device or partner. All time stamps have a resolution of 1 ms; however, it is the interval time of the task where the alarm function block or module runs that determines the accuracy of the internal time stamps. All alarm function blocks and modules in the same task are given the same time stamp, if activated concurrently.

This is the point of using external and remote time stamps. Internal time stamps can never be more accurate than the execution time of the task allows for. With external or remote time stamps, the accuracy of the time-stamping mechanism in the external or remote device (for example, an S800 I/O unit) sets the limit, something which could seriously improve the accuracy of the time given in entries with external or remote time stamps.

If external time stamps are to be used, the external time stamp parameter (*ExtTimeStamp*) has to be set to True. When using external time stamps, there is also a *SignalId* parameter that is used to indicate the source of the external alarm or event.

External time stamps can only be created by external units with Sequence-of-Event (SOE) support.

All time stamps use UTC (Coordinated Universal Time).

Clock Synchronization

For time stamps to be useful, the whole system must use the same time, that is, the time must be synchronized. See also the *Compact 800 Engineering Compact Control Builder AC 800M Getting Started (3BSE041584*)*.

Depending on the type of controller, clock synchronization is possible by four different protocols: CNCP, SNTP, MB 300 TS, and MMS Time Service. Clock synchronization is set up in the controller hardware editor.

It is important to understand the difference between accuracy and resolution when calculating how much a time stamp may deviate from the true system time:

- *Resolution* is the number of decimals that are used to write the time. If the time is given as, for example, `2004-02-19 19:43:22:633`, the resolution might be 1 ms (but could also be, for example, 0.5 ms).
- *Accuracy* is a measure of how accurate a time stamp is, that is, how much it may deviate from the true system time. If the accuracy is 1 ms, then `2004-02-19 19:43:22:633` actually means any time between `2004-02-19 19:43:22:632` and `2004-02-19 19:43:22:634`.

For a more detailed, conceptual description of time synchronization, see the *AC 800M Communication Protocols (3BSE035982*)*

It is also important to understand that the accuracy deteriorates if a time stamp is created in a unit that is supplied with the time from a controller, via ModuleBus.

The possible difference between the time stamps of two events that occurred at exactly the same time, but in two different units in two different controllers, is the sum of the accuracy of time synchronization in the network and two times the accuracy of the ModuleBus time synchronization.

This means that the difference between external time stamps can be far greater than the accuracy of time synchronization between controllers.

The highest accuracy is achieved by using the CNCP protocol, with an AC 800M controller as master.

Alarm and Event Communication

Alarm and event information is communicated throughout the control network via OPC servers, that is, a number of OPC Server for AC 800M. When the state of an alarm condition changes, an event notification is sent to all subscribing OPC servers, which then forward these notifications to their clients. Changes in alarms in the OPC server are also forwarded to its clients. .

For detailed information on how to configure OPC Server for AC 800M, refer to the *AC 800M OPC Server (3BSE035983*)* manual.

Subscriptions

An OPC server subscribes to event notifications from a control system. Each controller compiles an internal list of all servers interested in various events. Condition-related events are generated when alarm conditions change their state. Simple events can be generated, for example, by the start of a motor. When an event occurs, the control system sends event notifications to all servers on the subscription list.

Configuration of OPC AE Communication – Overview

The whole system for transferring alarms and events, that is, controllers, OPC servers, and OPC clients, must be configured so that there are no disturbances in the alarm and event traffic.

There are several basic rules regarding system configuration:

- A control system can send data or event notifications to one or two subscribing OPC servers.
- A maximum of seven OPC clients can subscribe to data or event notifications from the same OPC server.
- A maximum of four Ethernet links (two redundant) are supported via Ethernet cards.
- A maximum of four Point-to-Point Protocols (PPP) are supported via serial cards.

The OPC server must be configured to recognize the control systems it is to communicate with. The OPC client must be configured to recognize the OPC server(s) it is to communicate with. See Figure 96.

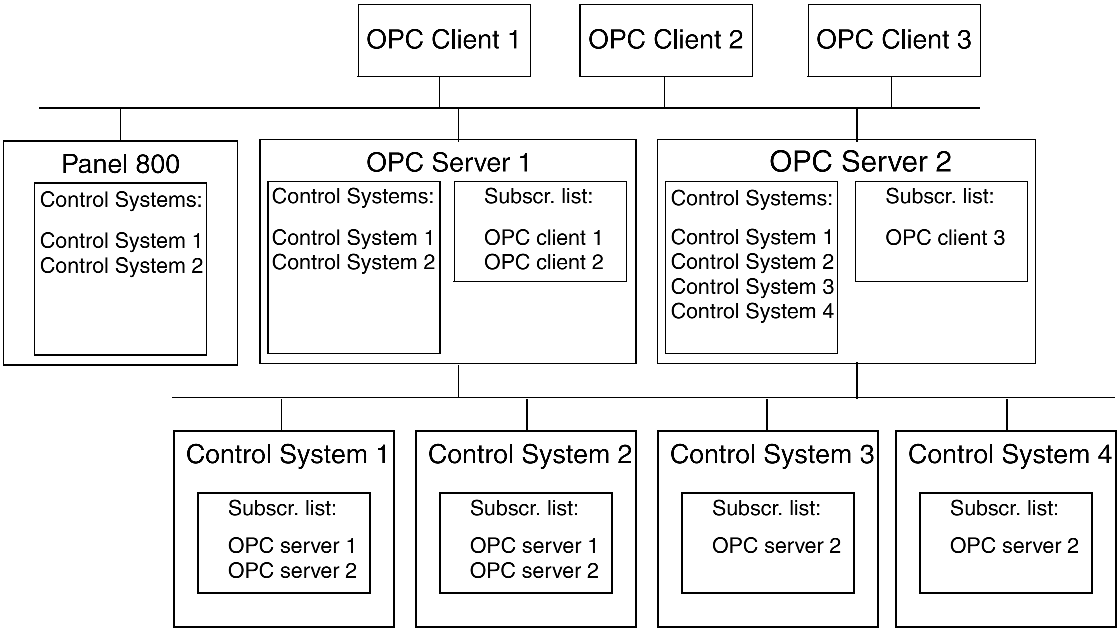


Figure 96. Example of a control network configuration.

Information about how to configure individual OPC servers is found in the *AC 800M OPC Server (3BSE035983*)* manual, and in the online help, which can be opened from the OPC server panel.

Buffer Configuration

Alarm and event handling requires a number of buffers. The memory for these buffers must be allocated in the controllers. These settings have to be made in the Settings tab for each controller CPU.

Table 18 describes the parameters in the Settings tab that need to be configured for the buffer. See also System Diagnostics on page 251.

These settings affect the Available memory. For more information regarding Available memory, refer to the *Compact 800 Engineering Compact Control Builder AC 800M Product Guide (3BSE041586*)* manual.

For controller types with limited memory, the settings for the buffer configuration should be carefully chosen or else the memory becomes full.

Table 18. Memory planning for buffer configuration

Parameter	Comment
AE Local printer event queue size	Each position allocates approximately 300 bytes of memory. The total memory need for local printers is: 300 * AE Local printer event queue size * AE Max number of local printer event queues
AE Max number of local printer event queues	The maximum number of event queues in the controller
AE Event subscription queue size	Each position allocates approximately 300 bytes of memory. Total memory need for subscribing OPC Servers are: 300 * AE Event subscription queue size * AE Max number of event subscriptions
AE Max number of event subscriptions	Number of subscribing OPC Servers

Table 18. Memory planning for buffer configuration (Continued)

Parameter	Comment
AE Buffer size of low level event	Each position allocates 72 bytes of memory. Total memory need for Sequence of Events are: 72 * AE Buffer size of low level event Set this setting to 2 if Sequence of Events is not used
AE Max no of Name Value items	The maximum number of XML tagged events
AE Max percent of log strings	The percentage of Name Value items that are strings. Used to allocate memory for Name Value item strings.

Local Printers

A local printer can be connected to the serial port of a controller, and print out event lists and/or alarm lists as needed.

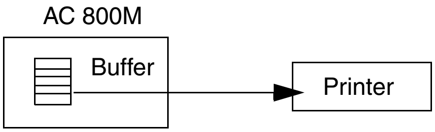


Figure 97. Example of a controller and local printer configuration.

There can be only one local alarm/event printer connected to each controller. Additional printers are invalid. There is limited data flow support for alarm/event printers connected to controllers. Alarms and events that occur when the printer is offline may not be printed when the printer goes online again. This applies to all printers with direct connection to a controller.

Print Format

The print format for alarm conditions and events is governed by a special format syntax.

The system supports the 8-bit ASCII character set (according to Windows). This means that the serial and parallel printers must support the 8-bit character set.

The abbreviations used in these format strings are given in Table 19. The character length of each field is given within parentheses..

Table 19. Abbreviations in format strings

Abbreviation	Explanation of the identification parameters
Ti	Time stamp (MM-DD-HH:MI:SS)
Sr	Source name (maximum 30)
Co	Condition name (maximum 15)
Me	Message (maximum 70)
Cs	Condition state text (maximum 20)
Tt	Transition type text (maximum 20)
S	Severity (4)
C	Class(4)

The fields may be in any order.

Ti, Sr, Co, Me, Cs, and Tt have user-defined dynamic lengths. If the length of a string is defined as longer than a presentation function that is already set, the presentation is reduced accordingly

The text for the condition state originates from project constants such as cAlarmCondStatetext.On1, cAlarmCondStatetext.Off1, and so on.

A maximum of 132 characters can be printed for each alarm/event.

Globally Defined Print Formats

Global print formats are defined in the project constants, which are categorized based on alarm and event conditions or transitions:

- For Alarm Conditions
  - cPrintAlarmPres.AlarmCondFormat
  - cPrintAlarmPres.TimeFormat

    - cPrintAlarmPres.FooterFormat
- For Events
    - cPrintEventPres.CondEventFormat
    - cPrintEventPres.SmpEventFormat
    - cPrintEventPres.TimeFormat
- For Alarm Condition State Texts
    - cAlarmCondStateText.Undefined
    - cAlarmCondStateText.On1
    - cAlarmCondStateText.Off1
    - cAlarmCondStateText.Acked
    - cAlarmCondStateText.Disabled
    - cAlarmCondStateText.Idle
    - cAlarmCondStateText.Autodisabled
- For Event Transition Texts
    - cEventTransitionText.Undefined
    - cEventTransitionText.On1
    - cEventTransitionText.Off1
    - cEventTransitionText.Ack
    - cEventTransitionText.Disable
    - cEventTransitionText.Enable
    - cEventTransitionText.Autodisable

Sending an Alarm to the Application

Instead of sending your alarms to a local printer you can choose to only redirect the alarm to the application. The function block PrintEvents contain two parameters; the first parameter EventItem catch the values (Source Name, Condition name, Time stamp, Severity etc.) and the second parameter EventItemText format these values as if they was send to a printer and bring it to the application as well. Hence, these values can then be sent and processed by your local code.

However, sending an alarm only to the application requires that you do not connect the Channel parameter (leaving the Parameter field empty).

By sending an alarm to the application you can then redirect this information to your cell phone. Every time an incoming alarm has a severity higher than 700, you should be notified with a SMS.

Condition State Example

The following example shows how to use the condition state parameter (*CondState*) to control a pump.

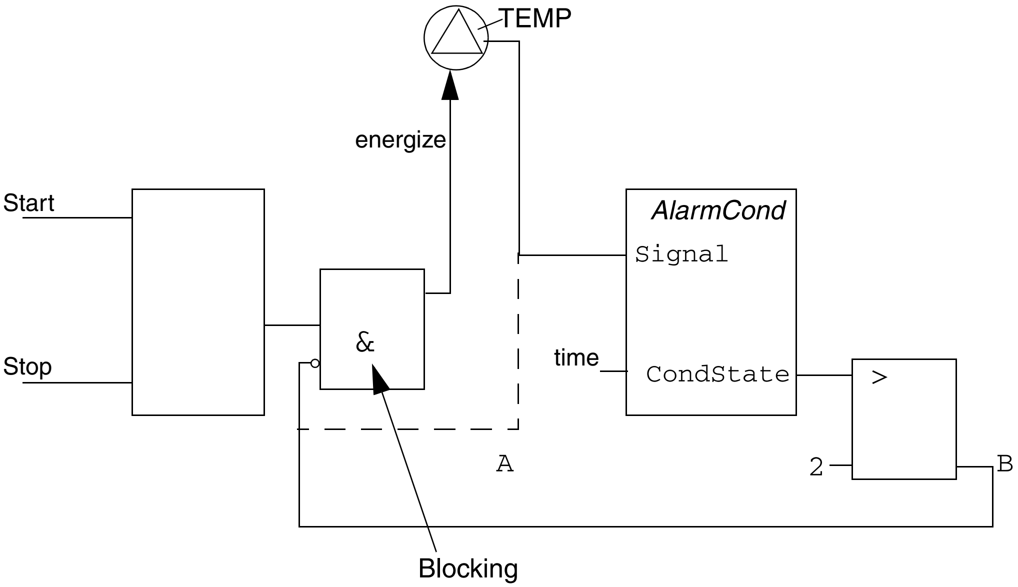


Figure 98. Manipulating the condition state using I/O.

Figure 98 shows two alternative ways of stopping a pump when the temperature is too high. The TEMP signal goes high when the temperature is too high.

In alternative A, the TEMP signal is simply used to stop the pump (using the blocking function, note that the TEMP input is inverted). There is no way to disable this alarm. The pump is blocked as long as TEMP is high.

Alternative B uses an AlarmCond function block, which makes it possible to wait for an action from the operator, before unblocking the pump. The blocking signal to the pump does not go high until *CondState* > 2, that is, the alarm is enabled and not idle (for a list of possible states, see Status Information on page 216). Once it has gone high, it does not go low until Condstate => 1, that is, the alarm is disabled or has returned to its idle state (this means that the alarm must be acknowledged by the operator and TEMP must go low before the pump is unblocked, as long as acknowledgement rule 1 is used).

Alternative B also makes it possible to disable the blocking function by simply disabling the alarm condition.

This example has been simplified to illustrate a principle. In reality, it would not be desirable to have a motor start when an alarm is acknowledged. Instead, the operator would acknowledge the alarm, and then start the motor with a separate command.

Inhibit Example

The below example shows how to implement the inhibit function for a motor M103 (see Figure 99):

- An oil pressure sensor, P103, is used to stop the motor M103 if the oil pressure is too low.
- A SignalInReal object is used to supervise the sensor and a MotorUni is used to control the motor.
- The *LTLLAct* output from SignalInReal is connected to the *PriorityCmd01* in MotorUni. This means that the motor will be forced to stop when the oil pressure is below the LL level. *LTLLStat* may be connected to a warning lamp in a panel.

During start up of the equipment it is known that the oil pressure will be below the limit, but it must be possible to start the motor. Therefore, the application logic will set the *EnableLL* parameter in SignalInReal to False during start-up. This means that *LTLLAct* will not be set, that is, the motor will not be stopped and no alarm is sent to the alarm list as long as the motor is starting up. *LTLLStat* will not be set and the lamp will not be lit.

Suppose the operator, maybe for testing, wants to run the equipment at an oil pressure below the LL level. He could then inhibit SignalInReal from the faceplate. The motor will still run during the test, but an alarm will be sent to the alarm list. *LTLLStat* will be set and the lamp will be lit.

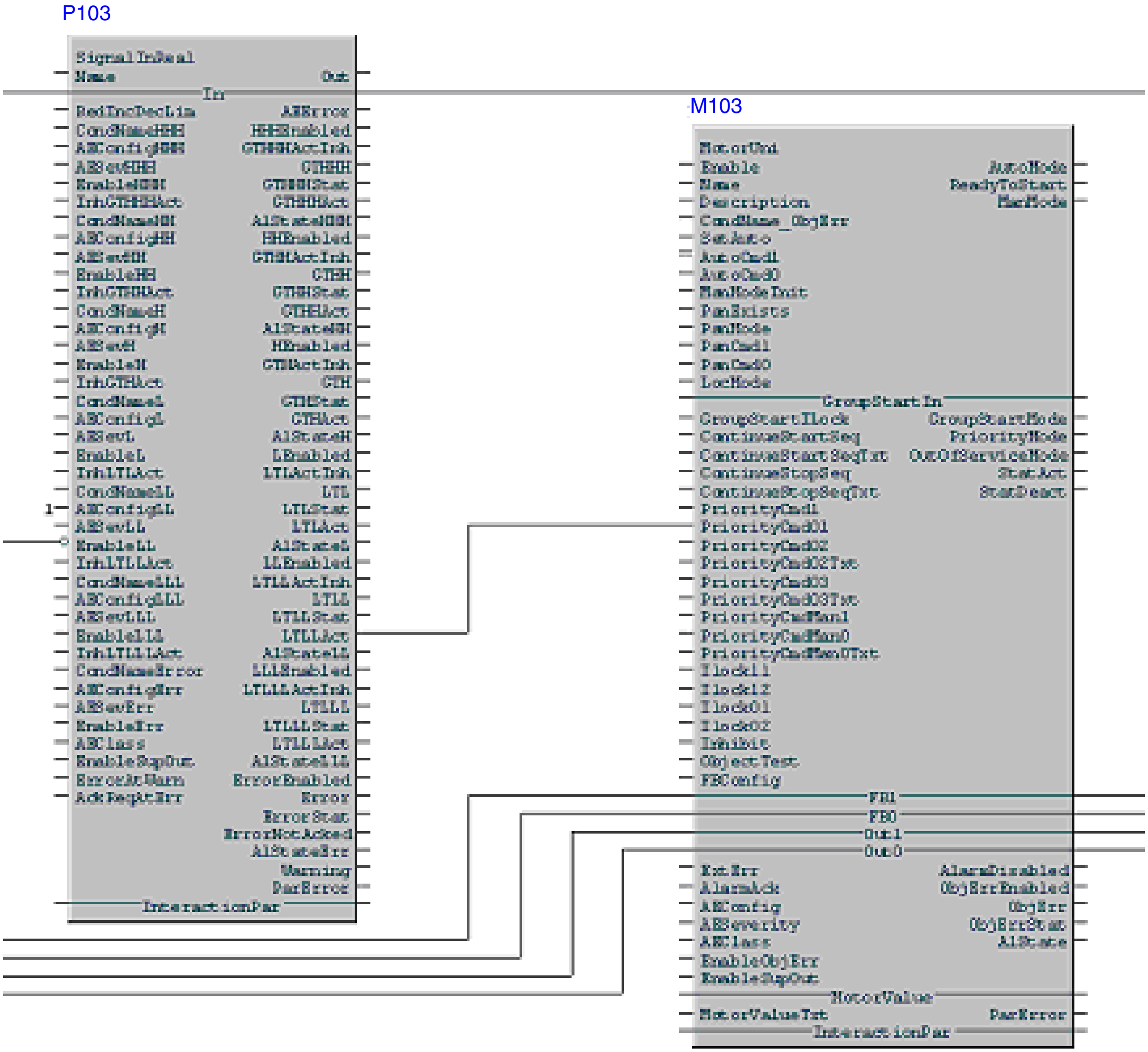


Figure 99. Example of how to implement inhibition of an alarm.

Simple Event Examples

The below examples show how to use the DataToSimpleEvent function block to send simple event data, for example for a batch process, where data records should be generated for the process at a number of points. There are three examples:

- Simple Data on page 247,
- Structured Data – Example 1 on page 249,
- Structured Data – Example 2 on page 249.

Simple Data

Presume that an engineer wants to record three parameters in the process: a temperature, a pressure and a stirring rate. Consequently, the engineer names them:

varTEMP = “TEMP”

varPRESS = “PRESS”

varSTRAT = “STRAT”

These are the names the user wants to see on the screen when the recording is done, but these names are not the same as the variable names. Instead, the names are coupled to the extensible parameters in the *Name* field:

Name[1] = varTEMP

Name[2] = varPRESS

Name[3] = varSTRAT

During execution TEMP=300.2, PRESS=23.1, and STRAT=10. Temp and press are real values (real) and STRAT is an integer, which causes no problem since *Values* is of AnyType.

NestingLevel “1” is chosen and this is how it could look in Control Builder:

```
varTEMP = “TEMP”
tempValue := 300.2;
pressValue := 23.1;
My Log(SrcName := SrcName,
      Message := Message,
      Class := Class,
      EventCode := thisNbrEvent
      RecipePath := myLongPath,
      Status => Status,
      Name[1] := varTEMP,
      Value[1] := tempValue,
      NestingLevel[1] := 1,
      Name[2] := varPRESS,
      Value[2] := pressValue,
      NestingLevel[2] := 1,
      Name[3] := varSTRAT,
      Value[3] := stratValue,
      NestingLevel[3] := 1 );
```

In OPC Server for AC 800M, this will be encoded into an XML string.

```
<DATA_EV_LOG>
      <TEMP Value=”300.2” type=”real”/>
      <PRESS Value=”23.1” type=”real”/>
      <STRAT Value=”10” type=”int”/>
</DATA_EV_LOG>
```

Structured Data – Example 1

An engineer wants to record data that belong together, that is, he or she wants to create a structure named PHYS_DATA containing physical properties of an object, in this case a tank.

The structure (PHYS_DATA) has no value in itself and the *NestingLevel*=1 when PHYS_DATA is coupled to the first extensible parameter.

The next step is to give PHYS_DATA properties, and three components are created in the following three extensible parameters:

height=4.1

length=3.0

depth=1.0

Since the parameters above are physical properties of PHYS_DATA, they are assigned with *NestingLevel*=2. They are all floats.

In this case, the XML data in OPC Server for AC 800M will look like:

```
<DATA_EV_LOG>
       <PHYS_DATA Value=”” type=””>
        <height Value=”4.1” type=”real”/>
        <depth Value=”3.0” type=”real”/>
        <length Value=”1.0” type=”real”/>
       </PHYS_DATA>
</DATA_EV_LOG>
```

Structured Data – Example 2

In this example, the engineer is in the same situation as in the previous example, but now he or she also wants to record the recipe parameters in one of the batch objects. The same procedure as in **Example 1** is performed but a new parameter “RecipePar” is added and *NestingLevel*=-1 is set. With *NestingLevel*=-1 it is indicated that the recipe parameters to be fetched are placed on *NestingLevel*=1, since the height, depth, and length values in the previous example were to be placed on *NestingLevel*=2.

The recipe parameters are fetched in the controller and are:

heat=3.4

temp=349.4

heating=true

From a *Control Builder* view, this would look like:

```
structName := “PHYS_DATA”;
varHeight := “height”;
heightValue := 4.1;

varRecipe := “RecipePar”

LogThis(SrcName := SrcName,
        Message := Message,
        Severity := Severity,
        Class := Class,
        EventCode := thisNbrEvent,
        RecipePath := myLongPath,
        Status => Status,
        Name[1] := structName,
        Value[1] := EmptyValue,
        NestingLevel[1] := 1,
        Name[2] := varHeight,
        Value[2] := heightValue,
        NestingLevel[2] := 2,
        Name[3] := varDepth,
        Value[3] := depthValue,
        NestingLevel[3] := 2,
        Name[4] := varLength,
        Value[4] := lengthValue,
        NestingLevel[4] := 2,
        Name[5] := varRecipe,
        Value[5] := EmptyValue,
        NestingLevel[5] := -1 );
```

The XML data will look as below. The last three parameters are fetched from a Batch Object.

```
<DATA_EV_LOG>
       <PHYS_DATA Value=”” type=””>
        <height Value=”4.1” type=”real”/>
        <depth Value=”3.0” type=”real”/>
        <length Value=”1.0” type=”real”/>
       </PHYS_DATA>
       <RecipePar Value=”” type””/>
       <heat Value=”3.4” type=”real”/>
       <temp Value=”349.4” type=”real”/>
       <heating Value=”true” type=”bool”/>
</DATA_EV_LOG>
```

Alarm and Event Functions

There are a number of functions that can be used to analyze and supervise alarm and event handling:

- The function block SystemDiagnostics contains a part that displays alarm and event related information. See System Diagnostics on page 251.
- For those who need detailed information about the alarm and event state machine, there is a collection of state diagrams. See Acknowledgement Rules – State Diagrams on page 252.

System Diagnostics

When in online mode, it is possible to view information regarding memory via the interaction window of the function block SystemDiagnostics (located in the Basic library).

The advanced mode of the interaction window displays system memory information.

There is also an **Alarm and Event** button which, if clicked, displays information regarding:

- Used amount of buffer size,
- The number of:
  a. alarms in the controller,
  b. different condition names in the controller,
  c. local printer queues,
  d. subscribing OPC Servers.
- The IP-addresses of the subscribing OPC Servers.

Acknowledgement Rules – State Diagrams

The control system handles four different condition state diagrams according to five different acknowledgement rules.

Acknowledgement Rule 1

Rule number 1 uses three different state diagrams.

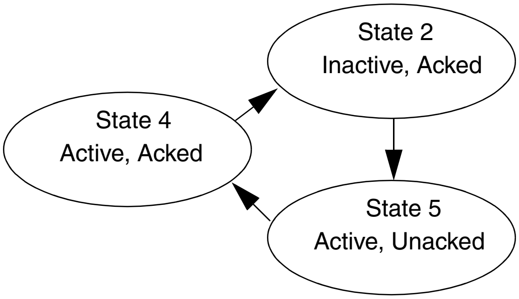


Figure 100. State diagram for enabled alarm conditions with AckRule 1, part 1.

In Figure 100 above, the alarm is in its normal state when it becomes active. It is then acknowledged, and on becoming inactive it returns to its normal state.

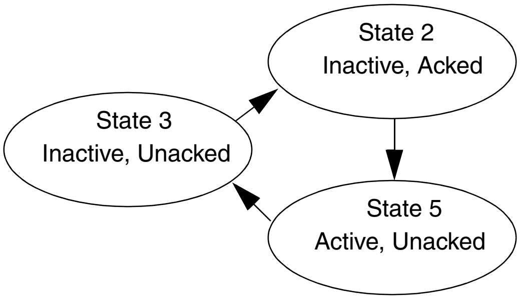


Figure 101. State diagram for enabled alarm conditions with AckRule 1, part 2.

In Figure 101 above, the alarm is in its normal state when the alarm becomes active. It then becomes inactive, and on being acknowledged returns to its normal state.

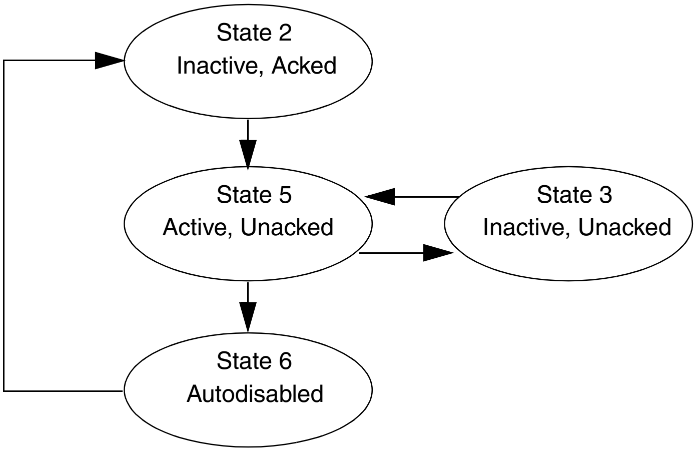


Figure 102. State diagram for enabled alarm conditions with AckRule 1, part 3.

The third instance occurs when an alarm switches between active and inactive without being acknowledged. In Figure 102, the alarm starts in its normal state and becomes active. It then switches twice between active and inactive without being acknowledged. When the alarm becomes inactive a third time it is automatically placed in the Auto-disabled state. Whether the alarm is active or inactive in this state is of no significance. When acknowledged the alarm returns to its normal state.

The default setting for auto-disable is three times. This can be changed through the CPU setting *AE Limit Auto Disable*. If it is set to 0, there will be no auto-disable function. There is also a system variable called AlarmAutoDisableLimit which affects all process alarms with acknowledgement rule number 1 (*AckRule*=1).

Acknowledgement Rule 2

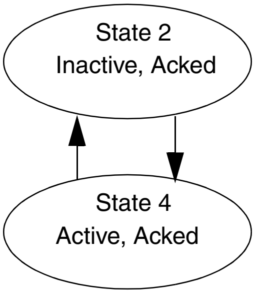


Figure 103. State diagram for enabled alarm conditions with AckRule 2.

Alarm conditions with AckRule 2 does not require acknowledgement and therefore follow a different state diagram. When the alarm becomes active it switches to an active and acknowledged state. On becoming inactive it returns to its normal state.

Acknowledgement Rule 3

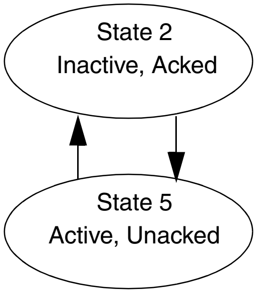


Figure 104. State diagram for enabled alarm conditions with AckRule 3.

Regardless of the signal being monitored, alarm conditions with AckRule 3 changes immediately to is normal state on acknowledgement. The alarm is no longer active and disappears from the alarm list provided by an OPC client.

Acknowledgement Rule 4

Presently, Acknowledgement Rule 4 (AckRule 4) is reserved for future use.

Acknowledgement Rule 5

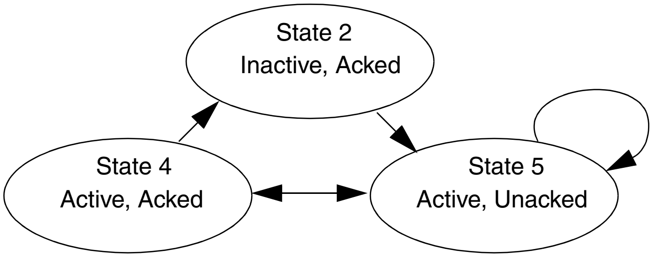


Figure 105. State diagram for enabled alarm conditions with AckRule 5, part 1.

AckRule 5 is used for so called sum system alarms. System alarms associated with hardware units are typical examples of sum system alarms. They are used to indicate several different errors that occur at the same time.

There are two procedures for sum system alarms, that is, for AckRule 5. The first of these is described in Figure 105 above. The sum system alarm is in its normal state when it becomes active. Sum system alarms are used as a collection of errors and Acknowledgement means that all errors are acknowledged. On becoming inactive it returns to its normal state.

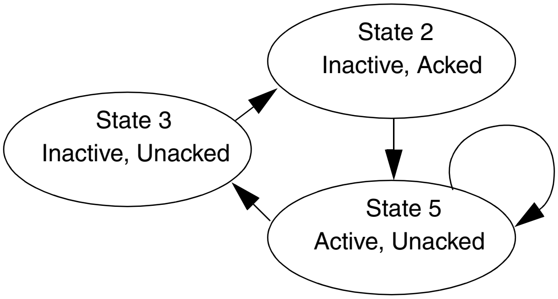


Figure 106. State diagram for enabled alarm conditions with AckRule 5, part 2.

The second instance is shown in Figure 106 above. The sum system alarm is in its normal state when it becomes active. It then becomes inactive, and on being acknowledged returns to its normal state.

Any alarm can be disabled from any state, and when re-enabled placed in the Inactive and Acked state. If the alarm state engine receives an incorrect Enable, Disable or Acknowledgement request, the request is ignored.

Section 3 Communication

Introduction

This section describes how to configure communication throughout your control network. How to design your control network, and which protocol(s) to choose for this is described in the *AC 800M Communication Protocols (3BSE035982*)*.

This section is split into the following parts:

- Communication Libraries on page 258 gives a brief overview of the Communication standard libraries.
- Supported Protocols on page 271 gives a brief overview of the protocols supported by control builder.
- Control Network on page 272 describes Control Network, which is used to communicate between controllers, engineering stations, and external devices.
- Variable Communication on page 274 describes variable communication briefly, and contains references to more detailed information.
- Reading/Sending Data on page 278 describes reading and sending data.
- Fieldbus Communication on page 284 describes the supported fieldbus protocols briefly.

Communication Libraries

The Communication libraries contains a number of libraries, one for each protocol, with function block types for reading and writing variables from one system to another. Typical communication function block types are named using the protocol name and function, for example, COMLIRead or INSUMConnect.

All supported protocols are described in the *AC 800M Communication Protocols (3BSE035982*)*, which also contains general information about how to set up communication in a control network. For detailed information on how to connect and configure function block types and control module types, see the corresponding online help (select the type and press F1).

COMLI Communication Library

The COMLI Communication library (COMLICommLib) contains function block types and data types for COMLI communication.

COMLI function block types follow the IEC 1131 standard, but some divergences occur. COMLI can be used for point-to-point or multidrop communication. Communication takes place serially and asynchronously, based on the master/slave principle, and in half duplex. Only address-oriented COMLI is supported on serial channels.

INSUM Communication Library

The INSUM Communication library (INSUMCommLib) contains function block types and data types for INSUM (Integrated System for User-optimized Motor control) communication.

INSUM is a system for protection and control of motors and switchgear. AC 800M controllers communicate with the INSUM system via TCP/IP, using the communication interface CI857.

Usage and Status Information for INSUMConnect Function Block

To establish connection using INSUMConnect, set the value of the **En_C** parameter to ‘true’, and specify the remote system with the CIPos and GWPos parameters. A reference to the connection is inserted into the **Id** parameter so that this parameter can be used by other function blocks communicating via the same connection (for example, INSUMReceive and INSUMWrite function blocks).

The execution status of INSUMConnect is presented via the following parameters:

- Valid

  A "bool" parameter that indicates if the connection is working (true) or not (false)

- Error

  A "bool" parameter that is true during one execution cycle, after the detection of an error.

- Status

  A "dint" parameter that gives a value about the execution status of the function block. A negative value means an error.

- MsgStatus

  A "INSUMGWMsgStatus" structure that contains status information about the connection. This information is received from the gateway.

- GWStatus

  A "INSUMGWStatus" structure that contains status information about the gateway. This information is collected by other means that just handles the connection (for example, the supervision of the CI857 module).

Usage and Status Information for INSUMReceive Function Block

To activate cyclic reading of data through INSUMReceive, set the value of **EN_R** parameter to ‘true’, and connect the **Id** parameter of INSUMReceive to the **Id** parameter of an INSUMConnect function block.

The execution status of INSUMReceive is presented via the following parameters, apart from the common paramters like Valid, Error, and Status (which are described for INSUMConnect):

- Ndr

  A "bool" parameter that is set to ‘True’ during one execution cycle, after the new data is received through the **Rd** parameter or any of the status parameters.

- MsgStatus

  An "INSUMDeviceMsgStatus" structure that contains status information about the Network Variable subscription created by this INSUMReceive block. This information is received from the gateway.

- DeviceStatus

  A "dint" value that contains status information about the INSUM device from which the INSUMReceive block receives data. This information is received from the Field Device List in the gateway.

Usage and Status Information for INSUMWrite Function Block

To run the write operation through INSUMWrite, set the value of the **Req** parameter to ‘true’, and connect the **Id** parameter of INSUMWrite to the **Id** parameter of an INSUMConnect function block.

The execution status of INSUMReceive is presented via the GWMsgStatus parameter, apart from the common paramters like Error and Status (which are described for INSUMConnect). The GWMsgStatus is a "dint" field that contains status information about how the write operation is executed. This information is received from the gateway.

The INSUM system consists of devices that are connected via a LonWorks network. There are different device types for different types of equipment that can be controlled and supervised. The device type used for motor control is called a Motor Control Unit (MCU). The MCU is located in the motor starter module.

Network Variables in Motor Control Units (MCU)

The table shows Network Variables that are defined in the INSUM Motor Control Unit.

Function/Object in MCU	NV name in MCU	Dir.	Description
Current Measurement	nvoCurrRep	In	Current information: A, % and Earth current
TOL (Thermal overload)	nvoCalcProcVal	In	Thermal capacity: % to Thermal Overload
	nvoTimeToTrip	In	Estimate of time until the motor will trip due to thermal overload based on the current load.
Motor Control	nvoTimeToReset	In	Remaining time until it is possible to reset the MCU after a thermal overload trip.
	nviDesState	Out	Commands: Start, Stop etc
	nvoCumRunT	In	Cumulated run hours
	nvoMotorStateExt	In	Motor status: Running, Stopped, Alarm etc
Contactor 1	nvoOpCount1	In	Number of switch cycles for contactor 1.
Contactor 2	nvoOpCount2	In	Number of switch cycles for contactor 2.
Contactor 3	nvoOpCount3	In	Number of switch cycles for contactor 3.
Control Access	nviCAPass	Out	Control access commands: Local/Remote control of the device
	nvoActualCA1	In	Feedback of Control access commands
Node	nvoAlarmReport	In	Alarmreport with Warning- and Trip information
Voltage Measurement	nvoVoltRep	In	Phase voltages and frequency

Function/Object in MCU	NV name in MCU	Dir.	Description
Power Measurement	nvoPowRep	In	Motor power: Active power, reactive power and power factor
General Purpose I/O	nviGpOut1	Out	General Purpose Output 1
	nvoGpOut1Fb	In	Feedback of General Purpose Output 1
	nviGpOut2	Out	General Purpose Output 2
	nvoGpOut2Fb	In	Feedback of General Purpose Output 2
	nvoGpIn1	In	General Purpose Input 1
	nvoGpIn2	In	General Purpose Input 2

Network Variables in Circuit Breakers

The table shows Network Variables that are defined in the INSUM Circuit Breakers.

Function/Object in Circuit Breaker	NV name in Circuit Breaker	Dir.	Description
Node	nvoNodeAlarmRep	In	Alarm report with Warning- and Trip information
	nviNodeCommand	Out	Commands: Open, Close etc
	nvoNodeStatusRep	In	Circuit Breaker Status: Closed, Open, Alarm etc
RMS Current	nvoAmpsCurrRep	In	Current information: A, % and Earth current
Control Access	nviCAPass	Out	Control access commands: Local/Remote control of the device
	nvoCAOwner	In	Feedback of Control access commands

MB300 Communication Library

The MB300 Communication library (MB300CommLib) contains function block types for MB300 communication. The MasterBus 300 (MB 300) protocol can be used with AC 800M and AC 400. The CI855 communication interface unit for AC 800M is used to connect to AC 400 controllers via MasterBus 300.

Dataset communication between controllers connected to MasterBus 300 is handled by three function blocks. A dataset consists of an address part and up to 24 elements (32-bit values). Values can be a 32-bit integer, a 16-bit integer, a real or 32 booleans.

Each CI855 unit behaves as a unique node on the MasterBus 300 network it is connected to, and has to be configured accordingly in the Control Builder hardware tree.

MMS Communication Library

The MMS Communication library (MMSCommLib) contains MMS data types, function block types and control module types for establishing communication with systems using the MMS protocol. MMS (Manufacturing Message Specification) is used as a common application layer protocol. MMS defines communication messages transferred between units, and has been specifically designed for industrial applications.

MMS is the base protocol in Control Network. All communication between Control Builders/OPC Servers and controllers uses MMS, for example, project download, firmware download and online communication. Alarm and event handling also uses MMS.

If the MMS Communication library is used, the communication between controllers can be defined using access variables and function block types and/or control module types from the MMS Communication library.

It is also possible to define the communication between controllers without using MMSCommLib, by using the IAC feature and communication variables.

For more information on MMS communication, see the *AC 800M Communication Protocols (3BSE035982*)*.

MODBUS RTU Communication Library

The MODBUS RTU Communication library (ModBusCommLib) contains data types and function block types for communication via the MODBUS protocol.

MODBUS can be used for point-to-point or multidrop communication. Communication takes place serially and asynchronously, based on the master/slave principle, and in half duplex. MODBUS slave communication is not supported, only master communication.

MODBUS TCP Communication Library

The MODBUS TCP communication library (ModBusTCPCommLib) contains function blocks types supporting the MODBUS TCP protocol. The types are used for MODBUS TCP communication through Ethernet ports on CI867.

MODBUS is a request response protocol and offers services specified by function codes and supports both master and slave functionality.

The master functionality provides the possibility to access registers and coils in other MODBUS TCP devices for both write and read operations. It is also possible for masters to retrieve status/diagnostic information from the slaves.

The slave functionality provides the possibility for other devices to access Access Variables. Both read and write operations are possible.

Modem Communication Library

The Modem Communication library (ModemCommLib) contains function block types used for serial communication over a modem. To use a modem connection, the modem must be configured to a serial (Com) port and the COMLI protocol must be added and configured (for more information, see Control Builder online help).

For more information about modem communication, see also the *AC 800M Communication Protocols (3BSE035982*)*.

Siemens S3964 Communication Library

The Siemens S3964 Communication library (S3964CommLib) contains function block types to establish communication with a system supporting the Siemens 3964R protocol.

Siemens 3964R is a point-to-point protocol, which means that only one Siemens system can be connected to each channel. The Siemens system requires an Interpreter RK 512 unit.

SattBus Communication Library

The SattBus Communication library (SattBusCommLib) contains function block types supporting SattBus. The types are used to communicate through Ethernet, using the SattBus name-oriented model.

SattBus is only available for TCP/IP on Ethernet.

MTM Communication Library

The MOD5-to-MOD5 communication library, MTMCommLib, provides function blocks to implement variable communication client in MOD5 controller to AC 800M communication.

The MTMCommLib contains function block types.

The MOD5-to-MOD5 (MTM) protocol consists of request and response messages that are exchanged each second.

The requests sent to other connected systems are determined by the control application. The response sent at each second is determined by the requests received at the previous second from other connected systems. The application programmer accesses the protocol functions through standard function blocks.

The library uses the functions blocks MTMConnect, MTMReadCyc, MTMDefCyc, and MTMDefERCyc to translate the request and to answer the MOD5 commands.

Serial Communication Library

The Serial Communication library (SerialCommLib) contains function block types for communication with external devices (for example printers, terminals, scanner pens) via serial channels with user-defined protocols. You can write an application which controls the characters sent and checks whether the correct answer is received, using serial channel handling function blocks.

The following use cases help in understanding the libraries used in serial communication.

Establishing a valid connection for serial communication

The prerequisites to establish a valid serial port connection for reading data from a physical device or writing data to a physical device are:

- Download the 61131-3 application that contains SerialCommLib and SerialHWLib.
- Instantiate the SerialConnect function block.

After the connection is established, the protocol is configured with the default behavior (read and write messages ended by an EOM (End of Message)). The default behavior is described by the parameters like En_C, Channel, Partner, Valid, Error, Status, and ID, which are present in the function block.

If a malfunction of the connected CI853 communication module is detected, the module can be replaced by a new one, and the connection to the serial port is automatically reestablished.

Adding a CRC calculation to a message in serial communication

The prerequisites to add a CRC calculation to a message are:

- Establish a valid connection to the serial port.
- Instantiate the SerialSetup function block in the 61131-3 application.

After the CRC calculation is added, the settings of CRC remain intact even after a disconnect operation.

Enabling basic listening for serial communication

The prerequisites to enable the basic listening of serial communication data from a device are:

- Establish a valid connection to the serial port.
- Instantiate the SerialListen function block in the 61131-3 application.

The input parameters for basic listening are message length, end of message, and number of trailing characters.

After the basic listening is enabled, the string message (which is the output seen in the Rd parameter) is received by the input device.

Enabling basic writing of serial communication data

The prerequisites to enable the basic writing of serial communication data to a device are:

- Establish a valid connection to the serial port.
- Instantiate the SerialWrite function block in the 61131-3 application.

After the basic writing is enabled, the output is an acknowledgment from the Sd parameter.

Example (Buffer handling)

A *SerialListen* function block is set up to read a specified message length of for example 5 characters (*MsgLength* = 5).

While the *Enable* parameter has the value True and the buffer contains characters the *Ndr* parameter will be True and 5 characters at a time will be passed to the *Rd* parameter.

If an incoming message "012345678901234" has been received with a size of 15 characters (3x5) and is stored in the buffer the following will occur:

First scan: *Rd* = 01234 (012345678901234), Buffer = 5678901234

Second scan: *Rd* = 56789 (012345678901234), Buffer = 01234

Third scan: *Rd*= 01234 (012345678901234), Buffer is empty

There will be no fourth scan since the buffer is empty.

If the message length is not a multiple of the *MsgLength* parameter the buffer will keep the remaining characters until the number of characters in the buffer again is greater than or equal to the *MsgLength* parameter value.

If an incoming message "0123456789012" has been received with a size of 13 characters (2x5+3) and is stored in the buffer the following will occur:

First scan: *Rd* = 01234 (0123456789012), Buffer = 56789012

Second scan: *Rd* = 56789 (0123456789012), Buffer = 012

There will be no third scan as the buffer does not contain at least 5 characters. The buffer will retain these values until additional characters are added to the buffer and it once again equals, or exceeds, 5 characters in length. At that time, the first 5 characters will be passed to the *Rd* parameter.

By setting the *En_C* parameter of the *SerialConnect* function block to value False (disconnecting), the buffer of the serial channel will be cleared.

TCP and UDP Communication Libraries

The UDP communication library (UDPCommLib) and TCP communication library (TCPCommLib) library provide function blocks that can be used to implement protocols running on UDP or TCP.

The typical usage of these libraries is when the controller needs to communicate with external equipment. Some examples are:

- Communication with different road-infrastructure network nodes such as variable speed signs, traffic direction and information signs.
- Vision cameras – Many vision cameras implement the Telnet protocol (ASCII TCP communication over standard port number 23).
- Information server – The controller may function as both client and server on the network. Example of server use is a SCADA application where a supervisory system connects to different servers and collects information periodically.

UDP communication does not establish a connection prior to sending/receiving. The UDPCommLib supports broadcasting with which one node can send a message that is received by many nodes.

TCP is a point-to-point connection. Using TCPCommLib also ensures that the messages are delivered without loss.

The only hardware configuration that is needed in Control Builder is to attach the UDPProtocol and TCPProtocol hardware types (from UDPHwLib and TCPHwLib respectively) under the **IP** position in the AC 800M controller harware tree.

Supported Protocols

Table 20 lists all supported protocols.

Table 20. Protocols supported by Control Builder

Protocol	Port/Interface
MMS on Ethernet	CN1, CN2 (TP830)
MMS on RS-232C (PPP)	COM3 (TP830), CI853
MasterBus 300	CI855
SattBus on TCP/IP	CN1 (TP830)
COMLI(1)	COM3 (TP830), CI853
Siemens 3964R(2)	COM3 (TP830), CI853
MODBUS RTU(3)	COM3 (TP830), CI853
MODBUS TCP on Ethernet(1)	Ch1, Ch2, CI867
IEC 61850	Ch1, CI868
PROFIBUS DP	CI854
DriveBus	CI858
INSUM	CI857
MOD5-to-MOD5	CI872
AF 100	CI869
PROFINET IO	CI871
EtherNet/IP	Ch1, CI873
UDP	Ch1, Ch2
TCP	Ch1, Ch2

(1) Both master and slave
(2) Master only
(3) Master only

For more information on supported protocols, see the *AC 800M Communication Protocols (3BSE035982*)*.

Control Network

Control Network is a private IP network domain especially designed for industrial applications. This means that all communication handling will be the same, regardless of network type or connected devices. Control Network is scalable from a very small network with a few nodes to a large network containing a number of network areas with hundreds of addressable nodes (there may be other restrictions such as controller performance).

Control Network uses the MMS communication protocol on Ethernet and/or RS-232C to link workstations to controllers. In order to support Control Network on RS-232C links, the Point-to-Point Protocol (PPP) is used.

For information on time stamps and clock synchronization within Control Network, see the *AC 800M Communication Protocols (3BSE035982*)*. Time synchronization is also briefly described in Section 2, Alarm and Event Handling.

Control Network, as well as other protocols and fieldbuses, is configured using Control Builder (via the Project Explorer interface). Control Network settings are specified in the parameter lists, accessed by right-clicking CPUs, Ethernet ports and/or PPP connections.

The address of controller Ethernet ports should in some cases be set using the IPConfig tool. See the *Compact 800 Engineering Compact Control Builder AC 800M Getting Started(3BSE041584*)*.

For information on communication parameter settings, see Control Builder online help for the object in question. Select the object in Project Explorer, then press F1 to display the corresponding online help topic.

Network Redundancy

The *Redundant Network Routing Protocol* (RNRP), developed by ABB, handles alternative paths between nodes and automatically adapts to topology changes.

For more information on redundancy and RNRP, see the Automation System Network manual.

Statistics and Information on Communication

Statistics concerning all MMS communication and Inter Application Communication (IAC) in a system are displayed in the Remote System dialog. Information can be viewed at any engineering station that is connected to the network, by selecting **Tools > Maintenance > Remote System**, followed by **Show Remote Systems**.

You can get the following MMS-related information:

- **Tools > Maintenance > Remote System > Show MMS Variables** shows which MMS variables are present in the selected remote system
- **Tools> Maintenance > Remote System > Show MMS Connections** shows all connections, including information on the type of connection, the destination system, and a number of statistics.

The information regarding IAC (using communication variables) can be accessed from **Tools > Maintenance > Remote System > Show Diagnostics for Communication Variables**. See Diagnostics for Communication Variables on page 345.

There is also a function block type System Diagnostics that is stored in the Basic library. This function block will (among other things) show Communication variables, IAC, and Ethernet statistics.

For more information on the contents of the Remote System dialog and the System Diagnostics function block type, see Control Builder online help.

Variable Communication

Communication between applications uses access variables and communication variables.

Access Variables

Access variables are defined in the access variable editor, which is displayed by double-clicking Access Variables in the Controllers folder. The access variable editor can also be displayed from the application editor, by double-clicking an access variable field in the Access Variables column.

Access variables can use the MMS, COMLI, MODBUS TCP and SattBus protocols. MMS and SattBus variables are declared in the Access Variable Editor under the corresponding tab, COMLI and MODBUS TCP variables under the Address tab. Paths to local variables are given using the syntax `ApplicationName.ProgramName.FunctionblockName.VariableName`

Communication Variables

Communication variables are used for cyclic communication between top level diagrams, programs and top level single control modules. These objects can exist in the same application, the same controller, or in another controller. The name of the communication variable must be unique on the project to resolve the IP-address during compilation.

Communication variables behave differently depending on where the *in* and *out* variables are placed:

- *In* and *out* variables are in the same application and connected to the same IEC 61131-3 task
  - In this case, the *in* and *out* variable represents the same physical memory location; hence no communication is setup.

- *In* and *out* variables are in the same application, but connected to different IEC 61131-3 tasks; or the *in* and *out* variables are in different applications in the same controller
  - In this case, fast data copying is performed at each 61131-3 task scan for the *in* variable. This type of IAC is called internal IAC, where the data is copied between different memory locations, and this does not involve any real communication. This is controlled by the task time, hence no external communication is setup.
- *In* and *out* variables are in different applications in different controllers (external communication)

  In this case, the actual external IAC occurs, and the client receives new values based on the configured interval time. The protocol used is IAC_MMS, which is based on User Datagram Protocol (UDP).
  Five different interval time categories are used and these are configured on the *IAC_MMS* hardware unit in Control Builder.

Communication variables are declared in the editor for diagrams, programs and top level single control modules in Control Builder.

The communication using the declared communication variables happens only if the **IP** and **IAC MMS** hardware types are inserted under the controller in the hardware tree in Control Builder.

For more information about variable communication, see Variables and Parameters on page 69.

StartAddr

All read and write function blocks have a StartAddr parameter. The StartAddr identifies the first requested variable in the remote system.

Set a prefix and a start address via the StartAdr parameter. This sets the access variable which identifies the memory area in the remote system from which data is to be read or to which it is to be written.

For further information regarding memory addressing: see IEC 61131-3 Variable Representation for IEC 61131-3 direct addressing and Access Variable Syntax for direct addressing.

Example 1

You can read 16 bits from a subsystem, starting from the decimal address 64 (octal address 100), as follows.

Connect a structured variable declared with 16 Boolean components to the Rd[1] parameter in the COMLIRead function block. Then set the StartAddr parameter to:

Table 21. StartAddr parameter setting (16 bits)

Protocol	IEC 61131-3 Direct Addressing	Direct Addressing (Octal, 8# only)
MODBUS RTU/ MODBUS TCP	%IX8#100 (input) %QX8#100 (output) **%IX10#64 (input)** **%QX10#64 (output)** %IX16#40 (input) %QX16#40 (output)	Not supported
COMLI	**%MX8#100** %MX10#64 %MX16#40	%X100 or X100
Siemens 3964R	**%MX8#100** %MX10#64 %MX16#40	%X100 or X100

Text in bold face indicates the most commonly used values.

If you exclude the base from the format it is assumed to be base 10. For example, %MX64 is interpreted as %MX10#64.

Example 2

You can read a Register 45 from a subsystem, starting from the decimal address 45, as follows:

Connect a structured variable declared with 16 Boolean components to the Rd[1] parameter in the COMLIRead function block. Then set the StartAddr parameter to:

Table 22. StartAddr parameter setting (Register 45)

Protocol	**IEC 61131-3 Direct Addressing**	**Direct Addressing (Octal, 8# only)**
MODBUS RTU/ MODBUS TCP	%MW8#55 %IW8#55 (input) %QW8#55 (output) **%MW10#45** **%IW10#45 (input)** **%QW10#45 (output)** %MW16#2D %IW16#2D (input) %QW16#2D (output)	Not supported
COMLI	%MW8#55 **%MW10#45** %MW16#2D	%R45 or R45
Siemens 3964R	%MW8#55 **%MW10#45** %MW16#2D	%R45 or R45

Text in bold face indicates the most commonly used values.

If you exclude the base from the format it is assumed to be base 10. For example, %MW45 is interpreted as %MW10#45.

Reading/Sending Data

The communication libraries contain all types you need to set up communication for the supported protocols. For most protocols, there are three main types:

Due to variations between various protocols, the name of individual types and parameters may vary slightly between the different communication libraries. However, the communication principles are still the same.

Communication function blocks should not be called more than once per scan. Exceptions to this are stated explicitly in the corresponding online help. Do *not* call communication function blocks in SFC, in IF statements, in CASE statements, etc.

- **Connect Types**
  Connect types are used to initiate a communication channel and establish a connection to a remote system with a unique node address in a network. Connect types are used to open a communication channel. The identity of the opened channel is communicated to the Read and Write types via an identity parameter (the exact name of this parameter varies between protocols). For example, MMSConnect is used by MMSRead and MMSWrite.

  A connection is established when an enable parameter is set to true. This means that a communication channel can be opened whenever needed. The identity of the system to which a connection has been established is communicated to the corresponding read and write types via an *Id* parameter.

  Connect types have a built-in continuous supervisory function, which detects if communication is interrupted after connection has been established.

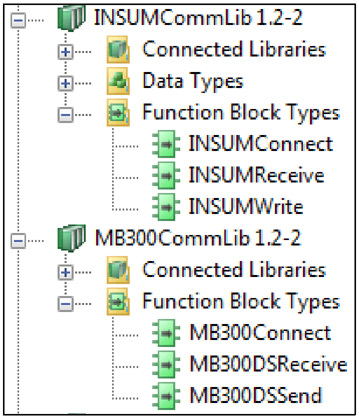
The MMSWrite is used for communication between applications. Communication between applications residing in different controllers is called external, and is asynchronous. Communication between applications within the same controller is called internal. The internal copy is synchronous or asynchronous based on the amount of data copied.
The basic algorithm is based on how much data that can be copied synchronously without disturbing the execution of 1131 tasks, that is the task latency must be less than 2 ms. The total amount of data to be copied is about 800 bytes of variable data. If the total of 800 bytes is exceeded the internal copy may affect the task latency negatively and therefore the internal copy is executed asynchronously.

- **Read Types**
  Read types read data (often an access variable) from a target system. The source system (the communication channel) is indicated by the *Id* parameter, which is passed from the corresponding connect function block or control module.
- **Write Types**
  Write types write data to a target system. The target system (the communication channel) is indicated by the *Id* parameter, which is passed from the corresponding connect function block or control module.

For some protocols, there are also additional types, such as types for cyclic reading of data, data conversion, download of measuring ranges, etc.

Connection Methods

Function blocks from the communication libraries are used to read and write variables from a remote system:



- INSUMCommLib 1.2-2
  - Connected Libraries
  - Data Types
  - Function Block Types
    - INSUMConnect
    - INSUMReceive
    - INSUMWrite
- MB300CommLib 1.2-2
  - Connected Libraries
  - Function Block Types
    - MB300Connect
    - MB300DSReceive
    - MB300DSSend

Figure 107. Function blocks in the communication libraries.

In the application program, a common *Connect* function block is used in a client (master) to establish connection to a server (slave). The function blocks *Read* and *Write* can then be used repeatedly. Refer to online help for a description of the parameters concerned. Variables to be accessed must be declared in the server Access variable editor.

To display the editor, right-click the Access Variables object and select Editor.

Example 1:

Controller 2 (client) connects to Controller 1 (server) by means of a *Connect* function block. Refer to online help for a description of how *Partner* and *Channel* are specified for different communication protocols. *Read* and *Write* function blocks with the same identity (ID) as the Connect block can then be used repeatedly.

As an example, Controller 2 has a Read function block in its application program that sends a Read request to Controller 1 for an access variable named %R100. This name must exist in the access variable list in Controller 1, which then reads the value of Program1.A (%R100) and sends it to Controller 2. The value is then written to the application variable named in *Rd*.

In the same way, the value of a variable in the Controller 1 access variable list can be changed by means of a Write function block in Controller 2.

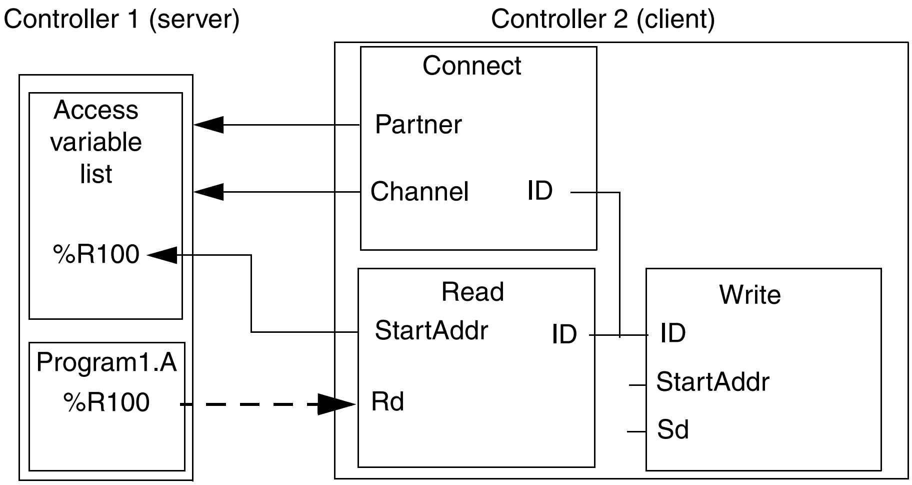


Figure 108. Variable read by controller 2, from controller 1.

The function blocks *ReadCyc* and *WriteCyc* perform in a similar manner, but are used to cyclically read or write to/from a server system with the interval specified by the *SupTime* parameter.

Example 2:

Write and read requests are triggered by the *Req* parameter being set to True after having been False for at least one scan. This problem can be avoided if two function blocks are executed, one after the other. In this way, a request is always outstanding. Additional requests triggered by the *Req* parameter will be ignored by the function block, until the *Done* (or *Ndr*) parameter has become True.

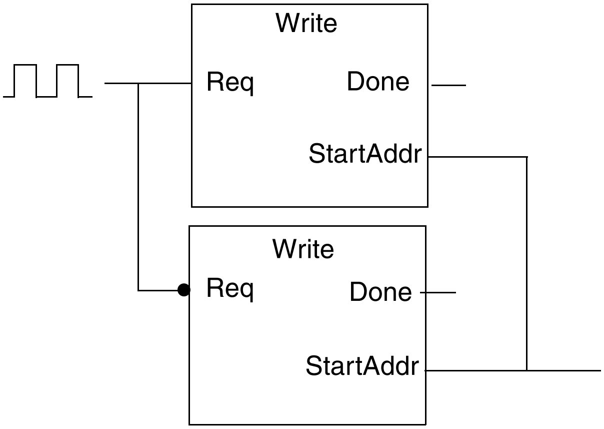


Figure 109. Resetting the Req parameter using two function blocks.

Communication Concepts

When setting up communication with external devices and other controllers, it is also important to be familiar with the following:

- The client/server concept (master/slave), see Client/Server Communication on page 282,
- The publisher/subscriber (also called subscriber/provider) concept, see Publisher/Subscriber Communication on page 283.
- There is also the choice between cyclic and asynchronous communication, see Cyclic vs. Asynchronous Communication on page 284.

Client/Server Communication

The main principle of client/server communication is the following:

- The client is the active party, which requests (reads) data from the server.
- The server is a passive provider of information that simply answers to requests from the clients.

Client/server communication could also be described as master/slave communication. In that case, the client is the master, and the server is the slave.

Figure 110 shows the principle.

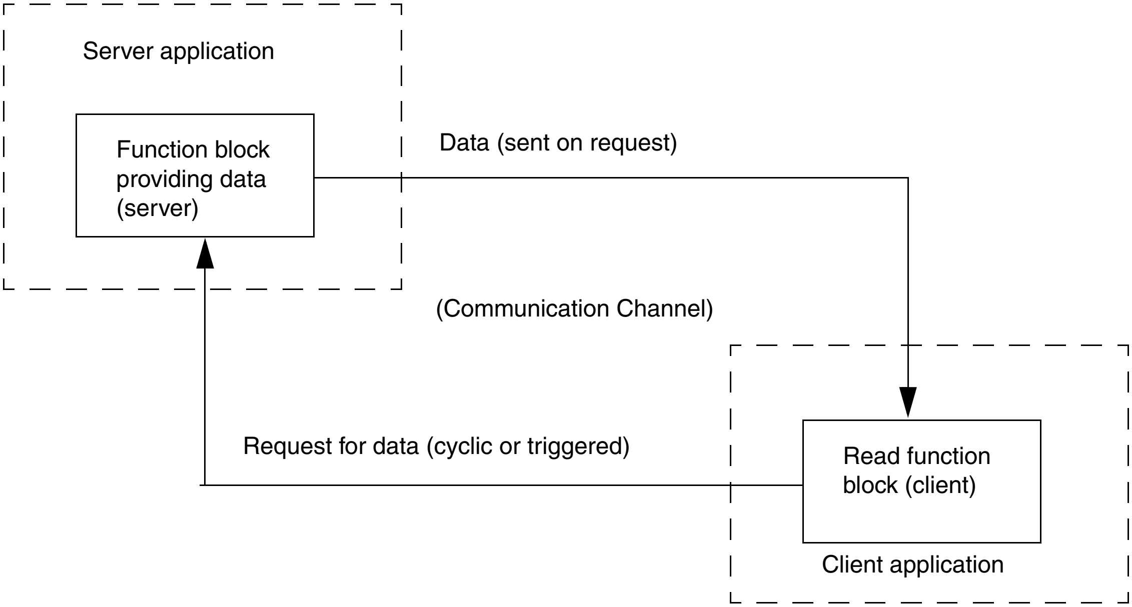

Server application
Function block providing data (server)
Data (sent on request)
(Communication Channel)
Request for data (cyclic or triggered)
Read function block (client)
Client application

Figure 110. Client/server principle. The client reads data from the server. The server sends data to the client when requested.

Publisher/Subscriber Communication

The main principle of publisher/subscriber communication is the following:

- The publisher publishes (the publisher is also known as the provider) data cyclically, in a pre-determined location.
- The subscriber is a consumer of information, which subscribes to published data.

Figure 111 shows the publisher/subscriber principle.

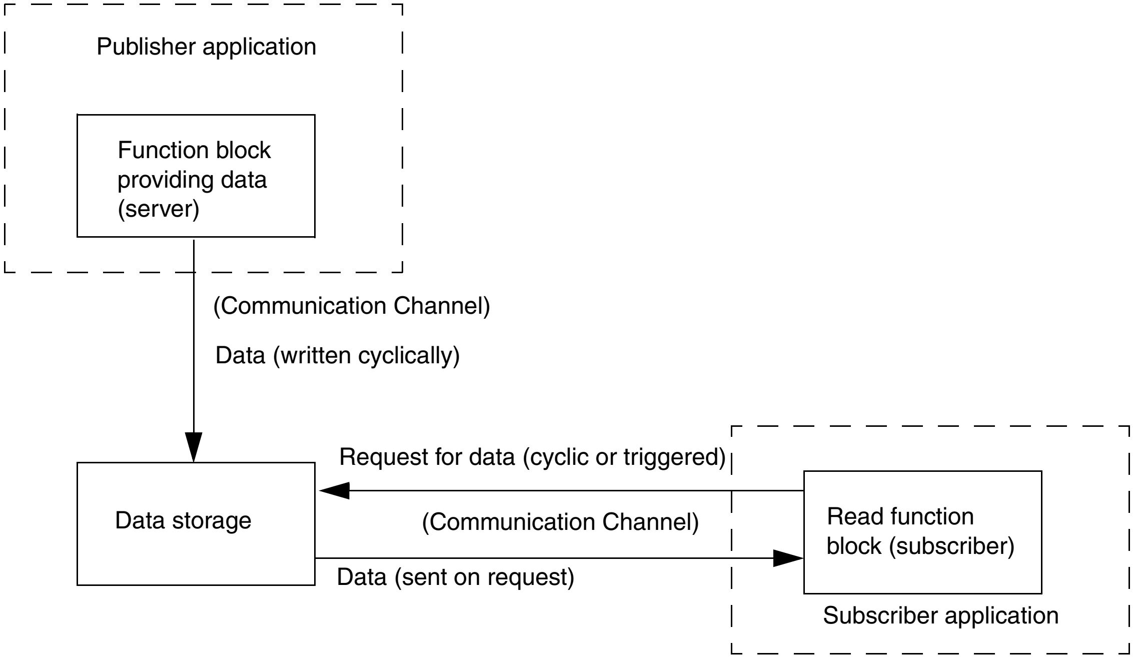

Publisher application
Function block providing data (server)
(Communication Channel)
Data (written cyclically)
Data storage
Request for data (cyclic or triggered)
(Communication Channel)
Data (sent on request)
Read function block (subscriber)
Subscriber application

Figure 111. Publisher/subscriber principle. The publisher publishes data to a pre-defined location, which is read by the subscriber.

Cyclic vs. Asynchronous Communication

An important decision when setting up communication is whether communication should be cyclic, that is, take place regularly, with a certain time interval, or asynchronous, that is, take place when triggered by a certain event or condition.

Which method to use depends on things such as:

- How much does the execution of communication code affect performance?
- How often can a value be expected to change?
- How important is it that a change in a certain value is communicated immediately?

For more information about communication, performance and design, see Application Programming manual.

For information on how to make part of your code execute with a different interval, see Control the Execution of Individual Objects on page 92.

Fieldbus Communication

Fieldbuses offer communication on a dedicated bus, using a special fieldbus communication protocol. Fieldbus devices often contain distributed code, which means that they need to be set up not only from Control Builder, but also using a fieldbus-specific configuration tool.

For detailed information on how to configure the fieldbuses, refer to the corresponding, fieldbus-specific documentation. For detailed information on how to configure communication with fieldbus devices, see the corresponding Control Builder online help.

PROFIBUS DP

PROFIBUS (PROcess FIeld BUS) is a fieldbus standard, especially designed for communication between systems and process objects. This protocol is open and vendor independent. It is based on the standard EN 50 170. With PROFIBUS, devices from different manufacturers can communicate without special interface adjustments. PROFIBUS can be used for both high speed, time critical transmission and extensive, complex communication tasks.

PROFIBUS has defined the three types of protocol: PROFIBUS FMS, DP and PA. With AC 800M access to PROFIBUS DP and PA is supported.

PROFIBUS DP is connected to the controller via the CI854/CI854A communication interface unit. The connection to PROFIBUS PA can be established by use of the Linking Device LD 800P that links between PROFIBUS DP and PROFIBUS PA.

The original version of PROFIBUS DP, designated PROFIBUS DP-V0, has been expanded to include version DP-V1 and DP-V2. With CI854/CI854A support for DP-V1 and the acyclic services (toolrouting) is given. In addition CI854/CI854A supports line and slave redundancy and CI854A supports master redundancy as well.

The PROFIBUS DP-V0 configuration and parameter data for slave devices are engineered in Control Builder and downloaded via CI854/CI854A.

PROFIBUS slave types are usually supplied with a *.gsd file. This file describes the properties of the slave type. The *.gsd file must be converted with the Device Import Wizard, in order to be used in the project.

PROFINET IO

PROFINET is a manufacturer-independent Fieldbus standard for applications in manufacturing and process automation. PROFINET technology is described in fixed terms in IEC 61158 and IEC 61784 as an international standard.

PROFINET IO uses Ethernet communication to integrate simple distributed I/O and time-critical applications.

PROFINET IO describes a device model oriented to the PROFIBUS framework, which consists of places of insertion (slots) and groups of I/O channels (subslots). The technical characteristics of the field devices are described by the General Station Description (GSD) on an XML basis. The PROFINET IO engineering is performed in a way familiar to PROFIBUS. The distributed field devices are assigned to the controllers during configuration.

The PROFINET IO is interfaced to the IEC 61131 controller AC 800M, using the PROFINET IO module CI871.

PROFINET IO is based on IEEE 802.3. PROFINET IO uses Ethernet, TCP, UDP, and IP as the basis for communication. It is designed to work with other IP-based protocols on the same network.

The transmission of time-critical process data within the production facility, occurs in the Real-Time (RT) channel.

DriveBus

The DriveBus protocol is used to communicate with ABB Drives and ABB Special I/O units. DriveBus is connected to the controller via a CI858 communication interface unit.

Advant Fieldbus 100

Advant Fieldbus 100 (AF 100) is a high performance fieldbus, which is used for:

- Communication between Advant Controllers.
- Communication between Advant Controllers and S800 I/O Stations, AC 800M controllers, and so on.

Advant Fieldbus 100 supports three transmission media:

- Twisted pair (Twp)
- Coaxial (RG59 and RG11)
- Optical media.

An AF 100 bus can be built up with all the three media, where a part of one kind of media is a specific segment.

The CI869 communication interface that is attached to the AC 800M controller provides connectivity to other AC 800M, AC 160 or connectivity server over AF 100. An AC 800M controller with the communication interface CI869 behaves as an AF 100 station, receiving data from other AF 100 stations/devices. The CI869 has integrated Twisted Pair modems.

The Advant Fieldbus 100 supports two different kinds of communication:

- Process data—Dynamic data used to monitor and control a process
- Message transfer—Used for parameters, program loading, and diagnostic purposes.

The protocols used by the supported fieldbuses are described in detail in the *AC 800M Communication Protocols (3BSE035982*).*

MMS Communication

How to Choose Function Block/Control Modules in MMSCommLib

MMSCommLib contains of function block types and control modules for different communication purposes. See Figure 112 which types to be used at communication between two controllers.

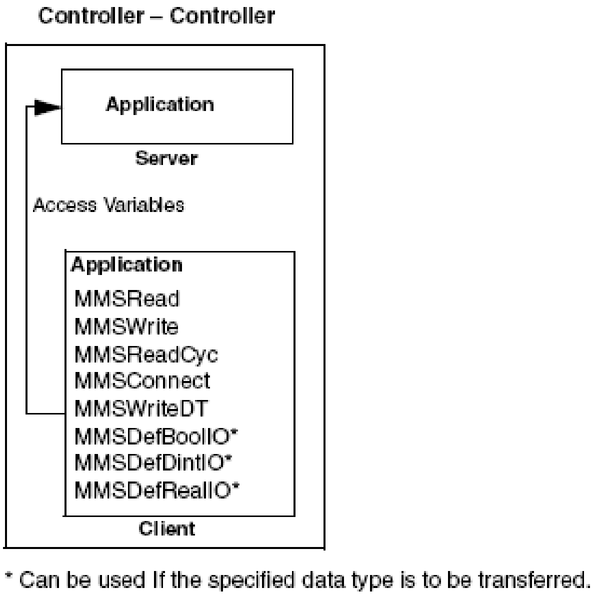


Figure 112. Function block types to be used at

Section 4 Online Functions

Introduction

When a controller project is in online mode and test mode, it is possible to inspect the code while running it, and interact with the code. Furthermore, you can issue operations to the controller. There are also functions to help the user to find online errors and to document the control project.

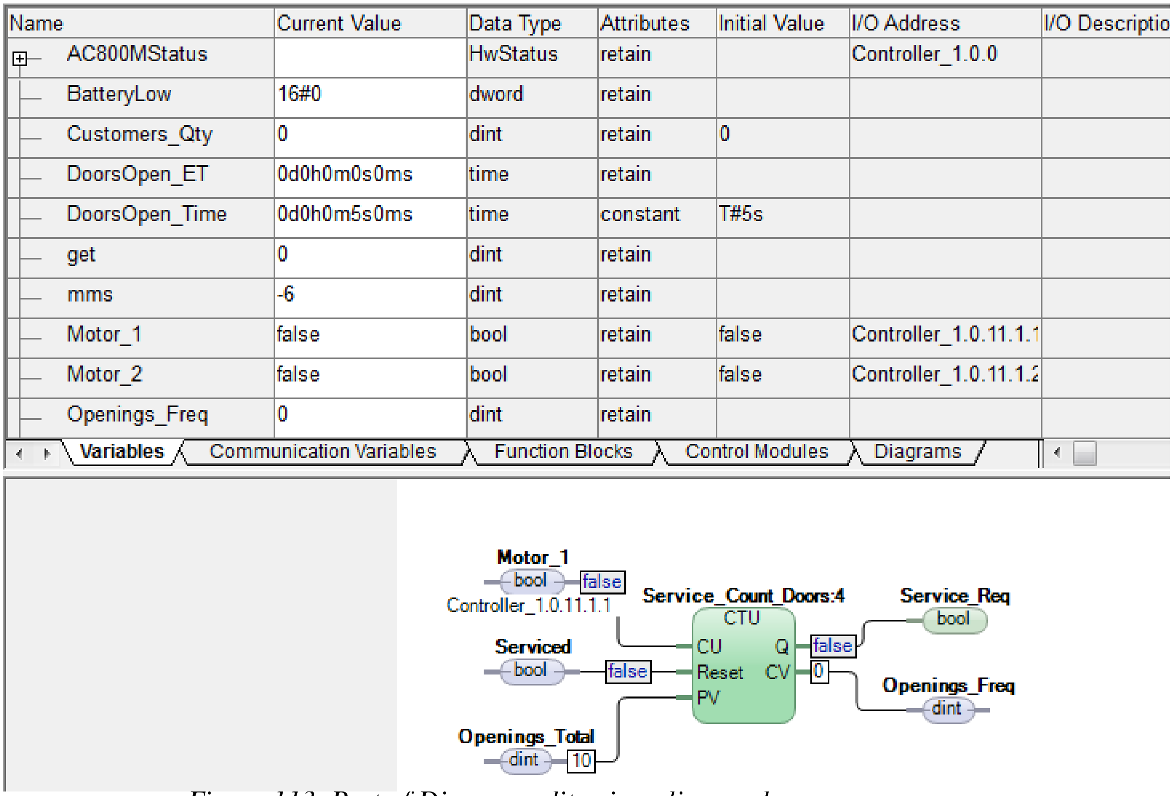
The following functions are available in online mode and test mode:

- Online editors, see Online Editors on page 290.
- Dynamic display of I/O channels and forcing, see Dynamic Display of I/O Channels and Forcing on page 294.
- Scaling analog signals, see Scaling Analog Signals on page 296.
- Unit status and channel status, see Supervising Unit Status on page 296.
- Communication variable status, see Supervising Communication Variable Status on page 299.
- Hardware and task status indications, see Status Indications on page 304.
- Tasks, see Tasks on page 306.
- Interaction windows, see Interaction Windows on page 307.
- Status and error messages, see Status and Error Messages on page 309.
- Reports and analysis, see Search and Navigation in Online and Test Mode on page 310.
- Project documentation, see Project Documentation on page 314.

Online Editors

From the Project Explorer in online mode, you have access to editors similar to those in offline mode, such as the application editor, diagram editor, program editor, hardware configuration editor and function block editor. By using the online editors the code currently running in the controller(s) can be inspected. Variable values and parameters can be changed.

You can open one or several new online editor windows from the Project Explorer by double-clicking on the Program Organization Unit (POU, see Application Types and Instances on page 30) you want to view. You can also select the POU, right click, and select **Online Editor** (or **CMD Editor**).



Name	Current Value	Data Type	Attributes	Initial Value	I/O Address	I/O Descriptio
⊞ AC800MStatus		HwStatus	retain		Controller_1.0.0	
BatteryLow	16#0	dword	retain			
Customers_Qty	0	dint	retain	0		
DoorsOpen_ET	0d0h0m0s0ms	time	retain			
DoorsOpen_Time	0d0h0m5s0ms	time	constant	T#5s		
get	0	dint	retain			
mms	-6	dint	retain			
Motor_1	false	bool	retain	false	Controller_1.0.11.1.1	
Motor_2	false	bool	retain	false	Controller_1.0.11.1.2	
Openings_Freq	0	dint	retain			

Figure 113. Part of Diagram editor in online mode

In online mode there are fewer menu entries in the menu bar than in the offline editor. **Edit** and **Insert** are not available in online mode. The options available in online menus are also somewhat different from those in offline mode. Columns in the editor that are dimmed are not accessible.

An online editor window consists of a title row, menu bar, tool bar, and a status bar at the bottom. The window is split into three panes, as follows.

- In the upper declaration pane the variables and parameters of the POU are displayed in forms that resemble Excel data sheets. Each sheet, with its tab, has a unique appearance with respect to the number of columns and their names. Select a tab to see its sheet, available columns and their names. See also Online Change of Variable Values in the online help.
- The middle code pane displays the various code blocks in the POU.
- The lower description pane displays descriptions of the types and POUs.

It is possible for the user to enter editor settings in the Setup Editor dialog, using the **Tools > Setup** menu.

From the online editor window you can activate the POU editor window using the **Tools > Edit Type** menu or the **Edit Type** button .

You can activate an online window for the POU parent via the **Tools > View Parent** menu or the **View Parent** button .

See the Control Builder online help for more information about the Setup Editor dialog, **Edit Type** and **View Parent**.

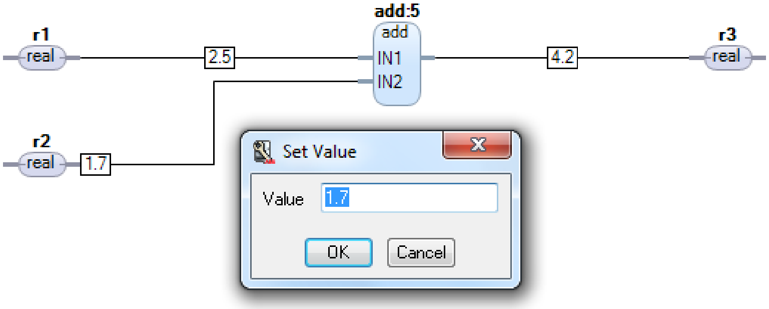
To access filter select a column in the grid and select **Tools > Filter or Filter button** .

From the 'Filter' dialog one can decide which rows to display or hide by selecting or deselecting criteria items. The Criteria items can also be text filtered. An icon in the column header informs shows an active filter on that column.

Alphabetical sorting of the column is possible by selecting **Tools > Sort A to Z** or **Sort Z to A,** or by clicking the Sort A to Z /Sort Z to A button in toolbar .
If column is not selected, **Sort A to Z** and **Sort Z to A** are disabled.
In offline Editor, when sorting the parameter column, a warning is presented which informs that the parameter order might be changed.

Diagram Editor in Test Mode and Online Mode

In the diagram editor, in Test mode and Online mode, the current values are displayed in labels. Double-click on label, the **Set Value** dialog box opens (See Figure 114).

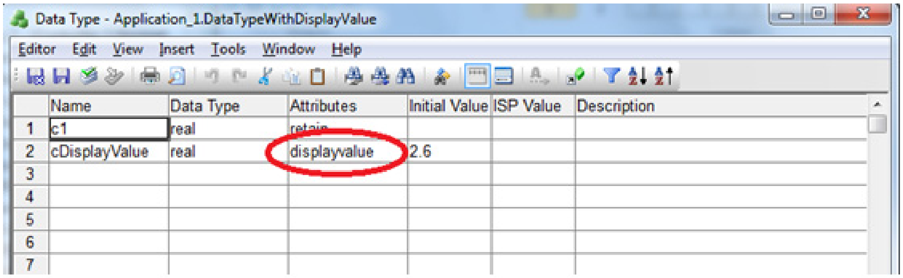


Value 1.7

Figure 114. Set Value dialog

If the data type is bool, right click the displayed value (*true* or *false*) and set **On** or **Off** (to toggle the value).

For graphical connections of structured data type, the online value label is not shown. However, if one of the components is marked with the *displayvalue* attribute in the data type editor (see Figure 115), a label is shown in the diagram editor.



	Name	Data Type	Attributes	Initial Value	ISP Value	Description
1	c1	real	retain			
2	cDisplayValue	real	displayvalue	2.6		
3						
4						
5						
6						
7						

Figure 115. Component marked as displayvalue

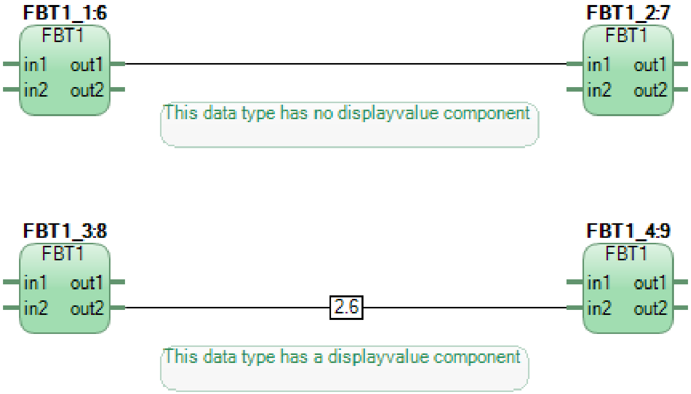


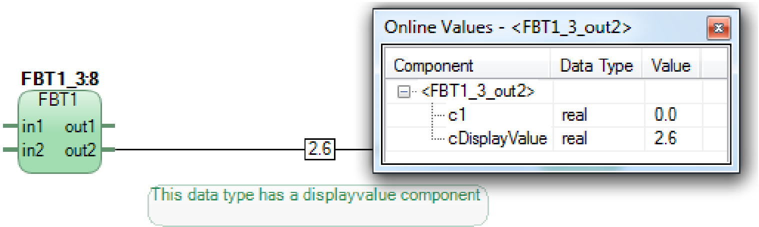
Figure 116. Graphical connections of structured data type

For example, in Figure 116, both are graphical connections of structured data type but only the lower connection has a component marked as *displayvalue*.

The *displayvalue* attribute can be assigned to only one component in a structured data type.
It is also possible to assign this attribute through a combination of other attributes (for example, *coldretain displayvalue*, *nosort retain displayvalue*, and so on). In this case also, only one component can have this type of attribute (with *displayvalue*).

To view components in multilevel structures, the attribute *displayvalue* has to be set on every level, that is. the attribute has to be set not only for the simple data type to be viewed, but also for the sub-component the simple datat ype to be viewed belongs to, and so on.

To view or change the components of a structured graphical connection, right-click on the graphical connection and select **Show Online Values** from the context menu. The **Online Values** dialog box opens (see Figure 117).



Online Values - <FBT1_3_out2>

Component	Data Type	Value
<FBT1_3_out2>		
c1	real	0.0
cDisplayValue	real	2.6

Figure 117. Online Values dialog box

It is possible to open several Online Value dialog boxes at the same time.

Tooltips are also available for online labels. This is useful if the online value is large so that it cannot be displayed as a label along with the graphical connection, or a truncated string value is displayed. Move the cursor over the graphical connection or the truncated online value label (if it is displayed) to view the tooltip that shows the whole value.

Dynamic Display of I/O Channels and Forcing

In test mode and online mode, you can use the hardware configuration editor for dynamic online display of I/O channel values and forcing.

Forcing of I/O channels is performed in the hardware configuration editor under the *Status* tab, or in the POU editor in online mode. All I/O channels that can be connected to a variable in an application can also be forced in online mode, except for channels such as *UnitStatus* on each I/O unit and *AllUnitStatus* on the current controller (see Supervising Unit Status on page 296).

Normally, only channels with variable connections to application programs can be forced. However, if no variable is connected, you have to change the parameter *Copy unconnected channels* under the Settings tab for the current controller to obtain a status update. The I/O channels you can copy are *None*, *Inputs* or *Outputs*, or both the *Inputs* and *Outputs*.

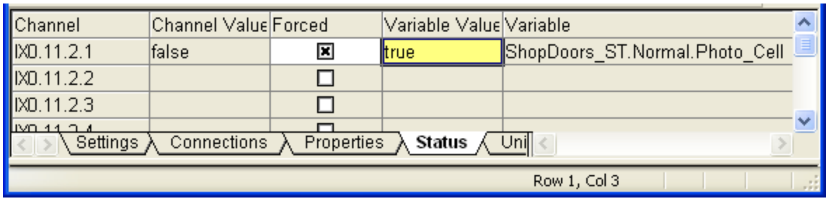
When selected, the unconnected I/O channels are copied once a second so their status is available in the Status tab like normally connected I/O channels.

Copy unconnected channels is for test purposes only and should never be selected for a controller in a running plant, since it will increase CPU load.

Application programs requiring information about forcing and forced values, can use the I/O data types when connecting variables to I/O channels. In this way, you can use the *Forced* component (which indicates if the I/O channel is forced) and the *IOValue* component (contains the value of the I/O channel) of the I/O data type.

When a channel is forced, all copying between the I/O value and the application value stops. The forced value is different for inputs and outputs. For inputs, forcing changes the variable value sent to the application. For outputs, forcing changes the physical I/O channel value. In this way, the application can see both the *Variable* (application) value and the *Channel* (I/O) value.

Forcing can be activated or deactivated using a check box in the *Forced* column for the channel. The background of the forced *Variable Value* changes to yellow to indicate forcing. To change the channel value, type in a new value for the *Variable Value*. This value overrides the values for the channel.



Channel	Channel Value	Forced	Variable Value	Variable
IX0.11.2.1	false	☒	true	ShopDoors_ST.Normal.Photo_Cell
IX0.11.2.2		☐		
IX0.11.2.3		☐		

Figure 118. I/O channel with the variable Photo_Cell forced to true.

More information is given in Control Builder the online help. Search the Index for “I/O”.

Scaling Analog Signals

It is possible to temporarily change the scaling values for analog signals in online mode.

If scaling values for an analog signal are changed in online mode, the change will be lost if you enter offline mode, make configuration changes and then perform a download.

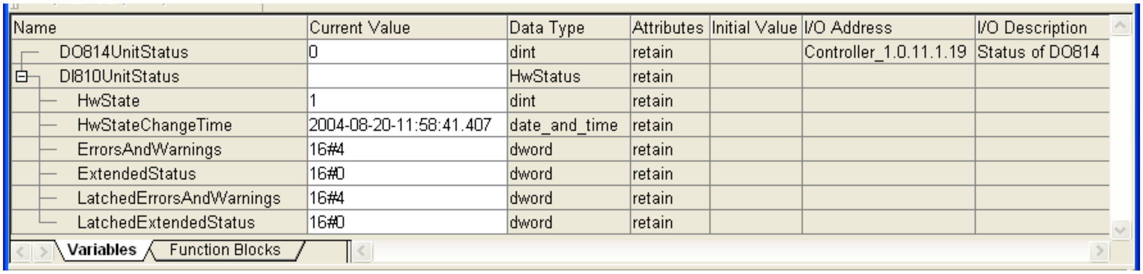
Supervising Unit Status

Each hardware unit has a *UnitStatus* channel that describes the current error status of the unit. Both dynamic and static warnings and errors are collected in this channel.

The data type, for the variable connected to the *UnitStatus* channel of the hardware unit, can be either of *dint* data type or of *HwStatus* data type. If a variable of *dint* data type is connected to the *UnitStatus* channel, the possible unit status values are: 0 (OK), 1 (Error), or 2 (Warning).

The *HwStatus* data type contains the same information as shown under the *Unit Status* tab of the hardware configuration editor, that is, unit status information and status message acknowledgement functions. These components will be available by using the *HwStatus* data type as a variable connection to the *UnitStatus* channel.

In the example below, see Figure 119, the *DO814UnitStatus* variable of *dint* data type is connected to *UnitStatus* of DO814 (unit status is 0=OK!). The *DO810UnitStatus* variable of *HWStatus* type is connected to *UnitStatus* of DI810 (*HWState* is 1, that is, unit status is Error).



Name	Current Value	Data Type	Attributes	Initial Value	I/O Address	I/O Description
DO814UnitStatus	0	dint	retain		Controller_1.0.11.1.19	Status of DO814
⊟ DI810UnitStatus		HwStatus	retain			
HwState	1	dint	retain			
HwStateChangeTime	2004-08-20-11:58:41.407	date_and_time	retain			
ErrorsAndWarnings	16#4	dword	retain			
ExtendedStatus	16#0	dword	retain			
LatchedErrorsAndWarnings	16#4	dword	retain			
LatchedExtendedStatus	16#0	dword	retain			

Figure 119. The UnitStatus connection gives access to the status of individual hardware units.

Find Out What is Wrong by Using HWStatus

You cannot find out exactly what is wrong by using the simple data type *dint*, only that something is wrong. Table 10 on page 105 shows that, in addition to using the dint type, you can also use the data type *HWStatus*. By using the structured data type *HWStatus*, instead of the simple data type *dint*, you may also find out what is wrong with the unit.

Among other things, the structured data type *HWStatus* contains the component *ErrorsAndWarnings*, which contains a bit pattern, representing the different errors that may occur in the unit. Each bit in the word represents a unique error.

Figure 120 illustrate how the component *ErrorsAndWarnings* in *HWStatus* can be accessed.

For example, the word takes the value of 16#80020000 (hexadecimal notation), if the CPU battery suffers from low voltage.

For more information on error codes, see Control Builder online help.

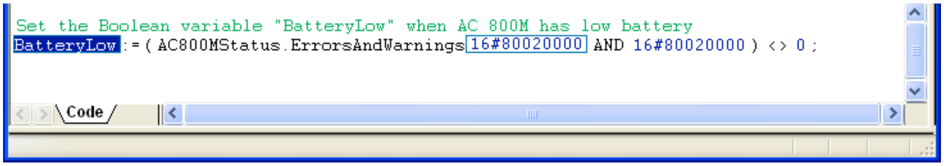
By combining *AC800MStatus.ErrorsAndWarnings* with the bit pattern 80020000[1] and using the *AND* operator, it is possible to trigger an error (or warning) from the hardware unit, together with the specific error code for "low CPU battery voltage". The result is assigned to the boolean variable *BatteryLow.* The ST code for this condition is as follows:

```
(*Set the Boolean variable "BatteryLow" when AC 800M has low
battery*)
```

[1] Typed in ST editor in hexadecimal notation as 16#80020000.

```
BatteryLow := (AC800MStatus.ErrorsAndWarnings AND
16#80020000) <>0;
```

In online mode it will be displayed as below in Figure 120.



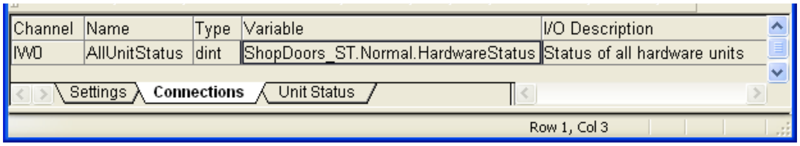
```
Set the Boolean variable "BatteryLow" when AC 800M has low battery
BatteryLow := ( AC800MStatus.ErrorsAndWarnings 16#80020000 AND 16#80020000 ) <> 0 ;
```

Figure 120. The variable AC800MStatus (of HWStatus type) has been used to access the component ErrorsAndWarnings.

AllUnitStatus

Each controller hardware object has one channel called *AllUnitStatus*, containing the summarized status of all hardware units added to the controller. The most serious unit status (dint) is forwarded up to the controller object, that is, the unit status of the controller is error if one unit has an error, and one has a warning.

AllUnitStatus can be used in the same way as *UnitStatus*, that is, the variable connected to *AllUnitStatus* can be of *dint* data type or of *HWStatus* data type.



Channel	Name	Type	Variable	I/O Description
IW0	AllUnitStatus	dint	ShopDoors_ST.Normal.HardwareStatus	Status of all hardware units

Figure 121. The AllUnitStatus connection gives access to the status of all units for a controller.

The variable connected to *AllUnitStatus* can be used in the application program, to write different conditions depending on status value (see *UnitStatus* Example Figure 120).

Binary Channels

Access All Inputs and All Outputs

Some units return a binary value, as a number of inputs divided on 8 or 16 channels. Typically, this applies to different types of sensors. These values can be collected via an overall channel, namely “All input”’. This means that, instead of reading all variable values from each channel, one variable can be connected to the channel "All inputs" (IW0, see Table 10 on page 105), provided the variable is of *dword* data type. This technique can also be used for digital outputs. However, for digital output units, you must choose either to connect all individual channels or connect one variable to the channel "All outputs" (QW0, see Table 10 on page 105). You cannot use both methods simultaneously.

ISP and OSP values are not set for variables connected to *All Inputs*/*All Outputs*!

ISP/OSP (**I**nput/**O**utput **S**et as **P**redetermined) will not work when using the channel "*All Inputs*" or "*All Outputs*". I/O values will be lost in an error situation.

Check Channel Status

There are two ways to check the channel status for an I/O unit. You can either use the structured data type *BoolIO*, that is, read the component *Status* via *BoolIO*, or you can connect a variable of type *dword* to the "Channel status" (IW0, see Table 10 on page 105).

The component *Status* in *BoolIO* only gives you the status for that connected channel, whereas a variable of type *dword* that is connected to channel "Channel status" will read the status for all channels, given with bit 0 equivalent to channel 1, bit 1 equivalent to channel 2, etc. However, a variable of type BoolIO that is connected to each channel contains more information, since the component Status is a 32 bit dword, whereas *AllChannel* is a 16 bit dword. Connecting each channel to BoolIO gives more information, but also more variables to connect.

Connecting a variable to *AllChannel* will give you less information, but only one variable to connect.

Do not try to connect the component *Status* (inside *BoolIO*) directly to the channel. You must connect BoolIO. For information about connecting structured data types to IO channels, see I/O Data Types on page 104 and the variable example given in Figure 33 on page 104.

Supervising Communication Variable Status

There are two methods to supervise the status of communication variables:

- Using the *:status* notation
- Using the *GetCVStatus* function

Supervising Communication Variable Using :Status Notation

For communication variables, the status can be supervised using the *:status* notation.

For example:

```
dword1:=CVMain:status;
```

In this example, the *:status* notation is used to obtain the status of the communication variable, *CVMain*. The status appears as dword.

See also, Understanding the Complete Status Code on page 302.

Supervising Communication Variable Using GetCVStatus

For communication variables , the status can be supervised using the function, *GetCVStatus*, which is available in the System library. But, the *:status* method has better performance than the *GetCVStatus* function.

The *GetCVStatus* function accepts the communication variable as input, and provides the complete status and extracted statuses through different output parameters. These output parameters for extracted statuses can be connected to variables to control the logic.

The available parameters for extracting the status are:

- **Quality** – (dword) – The OPC quality of communication.
  For GOOD, this parameter returns *16#C0*.
  For BAD, this parameter returns *0*.
- **ManualAckRequired** – (bool) – Whether manual acknowledgment is required for the communication variable to restart the communication after failure.
  This paramter returns *true* if manual acknowledgment is required, else it returns *false*.
- **ServerIsSimulated** – (bool) – Whether the controller that runs the server application is either hardware simulated or Soft Controller.
  This paramter returns *true* if the controller that runs the server application is either hardware simulated controller or Soft Controller. Otherwise, it returns *false*.

Understanding the Complete Status Code

The displayed complete status code of a communication variable depends on:

- The error (if any)
- The discrete values for the following factors:
  - Quality of communication
  - Server is simulated or not
  - Manual acknowledgment is required or not, after error is generated

To understand the complete status code, first convert it from hexadecimal to binary (32 bits).

Table 23 describes the bit-wise description of the used bits in the binary status of communication variable. Bit 0 is the least significant bit.

Table 23. Bit-wise description of communication variable status in binary code

Bit	Description
Bit 5	Not initialized. This bit is set in the following cases: • Initial download of application • Cold download of application • Restart of application after power-fail • Restart of application after short-reset This is reset when: • First frame is received • Out variable is downloaded for internal IAC
Bit 6 and Bit 7	Quality of OPC (*11* - GOOD, *00* - BAD)
Bit 8	The server is hardware simulated or it is a Soft Controller
Bit 12	Manual acknowledgment is required to restart communication after error generation.
Bits that represent communication errors[1]	

Table 23. Bit-wise description of communication variable status in binary code

Bit	Description
Bit 16	The values are not communicated in time, but no timeout have occurred. The OPC quality bits are still good (11). This is used for external communication using IAC.
Bit 17	The values are not communicated in time, and a timeout has occurred. The OPC quality bits are bad (00). This is used for external communication using IAC.
Both Bit 16 and Bit 17 are set	The IP address has not been resolved for the communication variable.
Bit 18	The type does not match the type of the corresponding out variable. This is used for both internal and external communication using IAC.
Both Bit 16 and Bit 18 are set	The corresponding out-variable is declared, but not downloaded yet. This status is only relavent for internal IAC and occurs only when the out variable has existed and then has been removed.
Both Bit 17 and Bit 18 are set	The communication is not configured.
Bit 16, Bit 17, and Bit 18 are set	The task where the corresponding out variable is connected is not running. This is only relevant for internal IAC.
Bit 19	General error code
Bits that represent protocol handling errors[1]	
Bit 27	Wrong message type in the response message.
Bit 25 and Bit 27 are set	The out-variable cannot be found.
Bit 24, Bit 25, and Bit 27 are set	The Initiate request was unsuccessful.
Bit 26 and Bit 27 are set	The protocol version between client and server does not match.

Table 23. Bit-wise description of communication variable status in binary code

Bit	Description
Bit 24, Bit 26, and Bit 27 are set	The heap is full.
Bit 25, Bit 26, and Bit 27 are set	Permanent MMS error
Bits 24 to 31are set	Unspecified error

[1] The status represented by a single bit is different from the status when this bit is set as a combination with other bits, in the same error category.

Status Indications

Status indications are not displayed in Test mode.

In the Project Explorer, dynamic status indications for the hardware units and tasks are displayed as shown below.

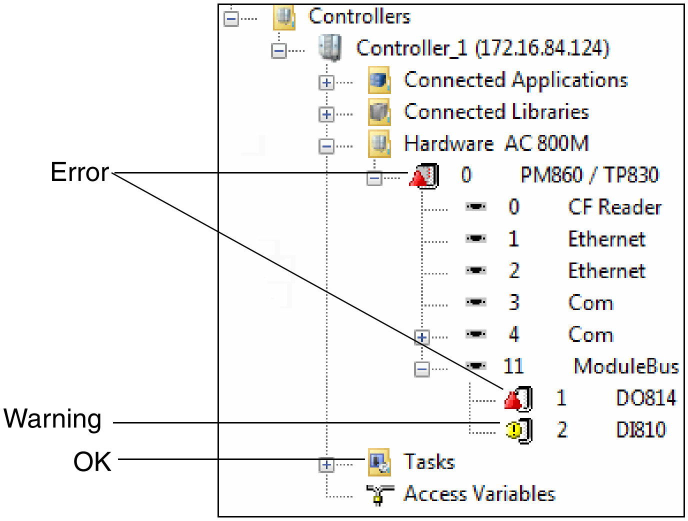


Figure 122. Status indications of hardware and tasks in Project Explorer.

- OK
  No errors or warnings.
- Error! ▲
  Hardware objects are marked with a red triangle icon if an error is detected in the hardware, for example, if a hardware unit is missing.
  The task is marked with a red triangle when a serious error has occurred, for example, when a task is aborted as a consequence of too long execution time. The error is described in the Remark field of the Task Properties dialog. See Task Abortion on page 146 for more information.
- Warning! (!)
  Hardware objects are marked with a warning icon if there is an overflow or underflow at an analog channel, if the forcing of a channel is detected, or if an unacknowledged fault disappears. The task icon is marked with a warning icon if the task is not used (“Not in use”), in the case of overload, or when the task is in debug mode and the task is halted, that is, non-cyclic mode (see Debug Mode in the *Compact 800 Engineering Compact Control Builder AC 800M Getting Started(3BSE041584*)* manual. The warning is described in the Remark field of the Task Properties dialog. See Task Control on page 129 for more information about tasks.

An error has higher priority than a warning, for example, an error is indicated if an error occurs at the same time as channel forcing is detected.

A collapsed object folder shows status indications for all underlying objects, that is, status indication is always forwarded up to the controller icon. It is not until an object folder is fully expanded that you can be sure that status indications are shown next to the unit they actually belong to. If, for example, a single task has a warning, both its task folder icon and its controller icon are marked with a warning. Status indications are displayed up to the controller level only.

Acknowledge Errors and Warnings

Warnings concerning tasks do not have to be acknowledged.

All hardware unit errors and warnings have to be acknowledged by the user. Use the status tab in the hardware editor to obtain information about the error or the warning.

There is a possibility to acknowledge errors and warnings for all hardware subobjects by right click the main hardware object (Hardware AC 800M in Figure 122) and select **Clear Latched Unit Status**.

See Control Builder online help for more information about dynamic online display of I/O channel values and forcing and how to acknowledge errors and warnings.

Tasks

Use the Task Overview dialog to display task information in online mode.

For each task, you can make changes to the Requested Interval Time, Offset, Priority and Latency using the Task Properties dialog. The maximum encountered intervals and the maximum encountered execution time can be reset.

It is not possible to change the task priority to/from 0 (Time-Critical priority) in online mode.

Debug mode can be used, but for debugging only. Functions based on the real-time clock (PID controllers, timers etc.) do not work properly when debug mode is used (also, see Debug Mode in the *Compact 800 Engineering Compact Control Builder AC 800M Getting Started (3BSE041584*)* manual.

If debug mode is used in a running plant, task execution will be stopped.

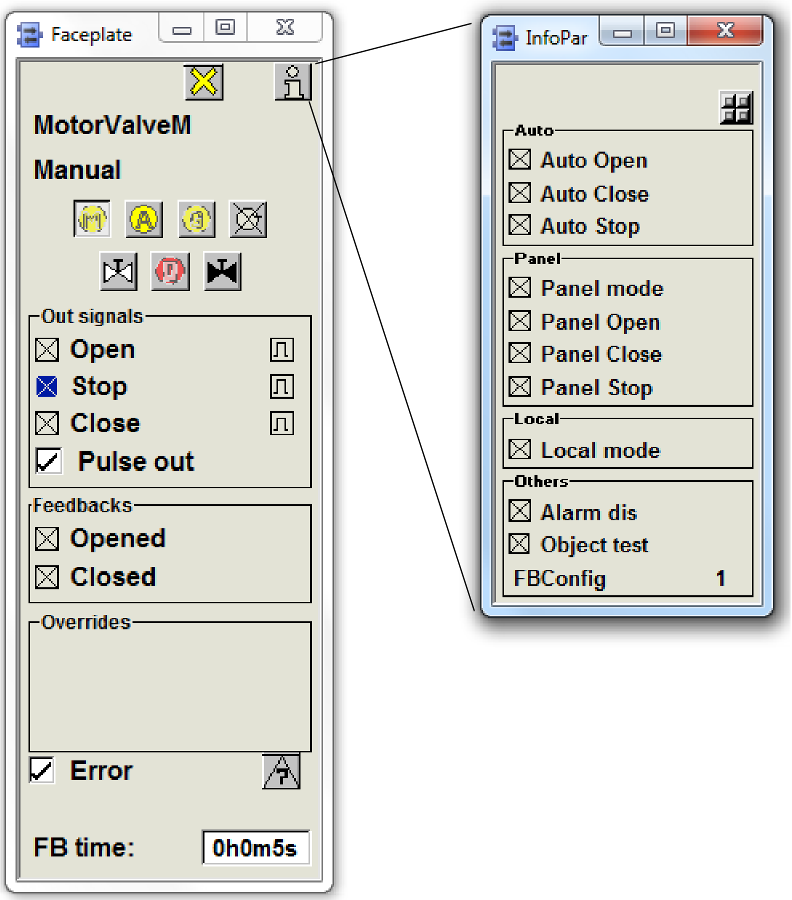
You can also select **Always update output signals last in execution**, or select **Always update output signals first in next execution**.

For further basic information about tasks, see Task Control on page 129. For Latency information, see Latency Supervision on page 144. See also Control Builder online help for how to carry out task changes.

Interaction Windows

An interaction window contains the graphics of a control module and is only accessible in online mode. An interaction window may contain both supervisory features, such as signal status, and interactive features, such as push buttons. The window can be accessed from:

- A control module in the Project Explorer.
- A function block in the Project Explorer. This is, however, only available under the condition that at least one control module exists and is connected to the selected function block type. By default, the first control module in the list will appear in the interaction window (this can be changed in offline-mode by right-clicking on the type name in the Project Explorer and selecting **Properties> Set Interaction Window Control Module**).
- An online program editor containing a control module.
- An online program editor containing a function block (compare with item 2 above).
- From interaction window objects in a control module.



MotorValveM

Manual

Out signals

☒ Open

☒ Stop

☒ Close

☑ Pulse out

Feedbacks

☒ Opened

☒ Closed

Overrides

☑ Error

FB time: 0h0m5s

Auto

☒ Auto Open

☒ Auto Close

☒ Auto Stop

Panel

☒ Panel mode

☒ Panel Open

☒ Panel Close

☒ Panel Stop

Local

☒ Local mode

Others

☒ Alarm dis

☒ Object test

FBConfig 1

Figure 123. The left window is an interaction window activated from an application window interaction object. The right window (supervision only) appears after clicking the info interaction window button.

Status and Error Messages

There are function block types, control module types and functions that contain a parameter named *Status*. The *Status* parameter shows, in online mode and in test mode, a status code that correspond to a status message. The status code changes depending on the current state of the function block, control module or function.

There are function-specific status codes that are used within its range of application only, for example, communication-specific status codes. Some status codes are general and are used for most function blocks and control modules, and for functions with a *Status* parameter.

The different status messages are described in Control Builder online help.

Function block types and control module types with a *Status* parameter also have an *Error* parameter. The *Error* parameter is set to true if the *Status* parameter < 0, for example, if *Status* is -35 (Maximum size limit has been exceeded). Status codes >1 is used as warnings and do not set the *Error* parameter.

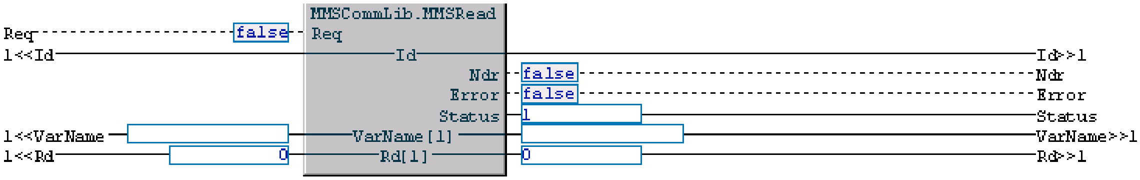


Figure 124. A function block with Status parameter and Error parameter (operation successful=1).

The *Error* and *Status* parameters can be used in the application program, for example, a condition can be written in the program for a specific status code.

Search and Navigation in Online and Test Mode

The Search and Navigation tool can be used to conduct simple searches and iterative searches when the project is in Online mode or Test mode.

This functionality makes it possible to search for input/output of a certain signal as a result of a single search, irrespective of name changes at parameter connections. This means all information concerning reading and writing from the whole Application/Controller(s) about a signal is found in the search.

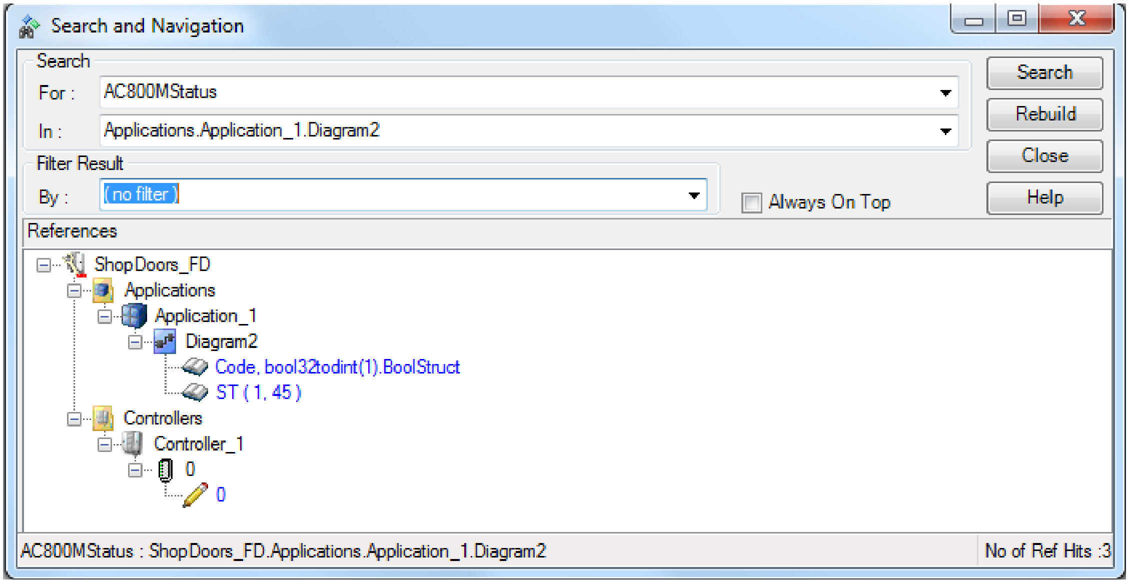
The appearance of the Search and Navigation dialog in the Online mode and Test mode depends on the setting of the following options in the Search and Navigation Settings dialog box:

- **Allow editing of the Search Fields in Online/Test Mode**
- **Iterative searches in Online/Test Mode**

By default, the first option above is not set and the second option is set. See Search and Navigation Settings on page 168.

Iterative Search

In Online mode or Test mode, if the option **Iterative searches in Online/Test Mode** is set (the checkbox is checked) in the Search and Navigation Settings dialog, the iterative search hits are directly presented in one pane – the References pane. See Figure 125.



Search
For : AC800MStatus
In : Applications.Application_1.Diagram2

Filter Result
By : (no filter)

□ Always On Top

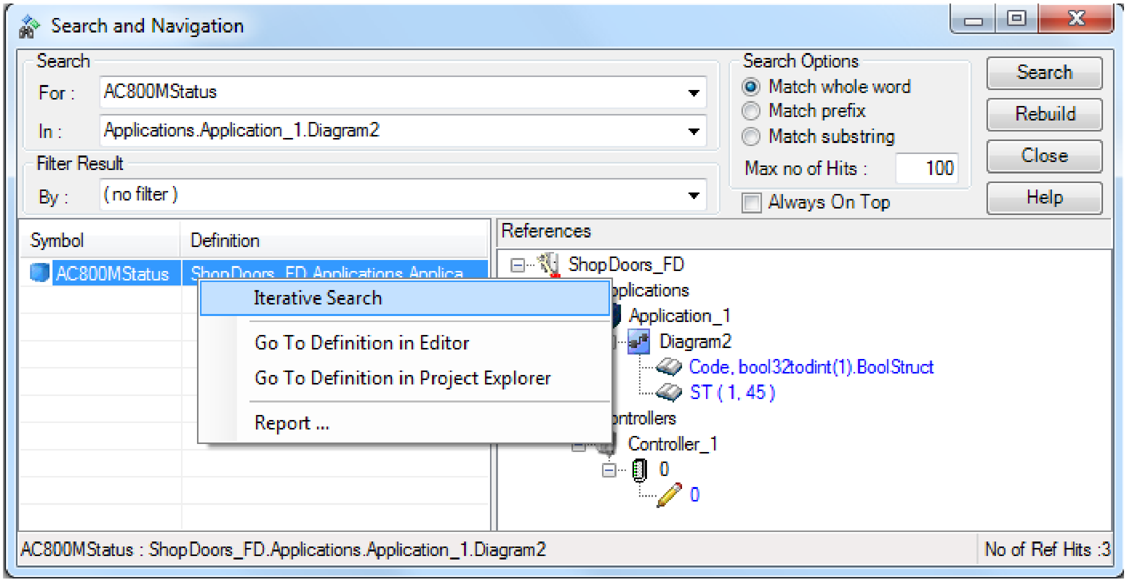
```
ShopDoors_FD
  Applications
    Application_1
      Diagram2
        Code, bool32todint(1).BoolStruct
        ST ( 1, 45 )
  Controllers
    Controller_1
      0
        0
```

AC800MStatus : ShopDoors_FD.Applications.Application_1.Diagram2   No of Ref Hits :3

Figure 125. Iterative search results for the variable AC800MStatus in Online mode

In Online mode or Test mode, if the option **Iterative searches in Online/Test Mode** is not set (the checkbox is not checked) in the Search and Navigation Settings dialog, the search hits are presented in two panes—the Symbol and Definition pane, and the References pane. In this case, right click the symbol and select **Iterative Search** to start its iterative search. See Figure 126.

It is also possible to search for another item in the window and obtain the new results.



Search and Navigation

Search
For : AC800MStatus
In : Applications.Application_1.Diagram2

Filter Result
By : (no filter)

Search Options
● Match whole word
○ Match prefix
○ Match substring
Max no of Hits : 100
□ Always On Top

Search
Rebuild
Close
Help

Symbol	Definition
AC800MStatus	ShopDoors_FD.Applications.Applica

Iterative Search
Go To Definition in Editor
Go To Definition in Project Explorer
Report ...

References
- ShopDoors_FD
  - pplications
    - Application_1
      - Diagram2
        - Code, bool32todint(1).BoolStruct
        - ST (1, 45)
  - ontrollers
    - Controller_1
      - 0
        - 0

AC800MStatus : ShopDoors_FD.Applications.Application_1.Diagram2

No of Ref Hits :3

Figure 126. Search results for the variable AC800MStatus in Online mode, with the option for Iterative Search

After the **Iterative Search** option is selected (see Figure 126), the search results for the selected symbol are replaced by new search results in the References pane, which shows the header as *References (iterative search).*

General Considerations for Search in Online/Test Mode

The tree view in the References pane shows where the signal is read or written.

It is possible to navigate from the Search and Navigation dialog to the references of a found symbol by double clicking a reference. Then a suitable editor is displayed and the symbol is highlighted in the editor.

The references are followed both upwards towards its first definition in a parent node, and downwards to the leaves of the project structure, in order to cover all usage. Every time a reference is followed, there is a new query to the search database. By means of those user hidden repetitive queries, all relevant information is collected from a single search.

There are following differences in online/test mode (compared to offline mode):

- Search In: drop-downs can only contain search paths for objects that you can see in online/test mode, for example, libraries cannot be searched.
- References only show information concerning where the symbol is used, as can be seen in online and test mode.The references tree (i.e. the tree presented in the references pane of the Search and Navigation dialog) presents instance paths in online mode and test mode.
- It is only possible to navigate to online editors and to the Project Constant dialog. The online editors that can be navigated to are the following:
  - POU editor
  - Connection editor
  - Control Module Diagram editor
  - Hardware configuration editor
  - Access variables editor
  - Diagram editor

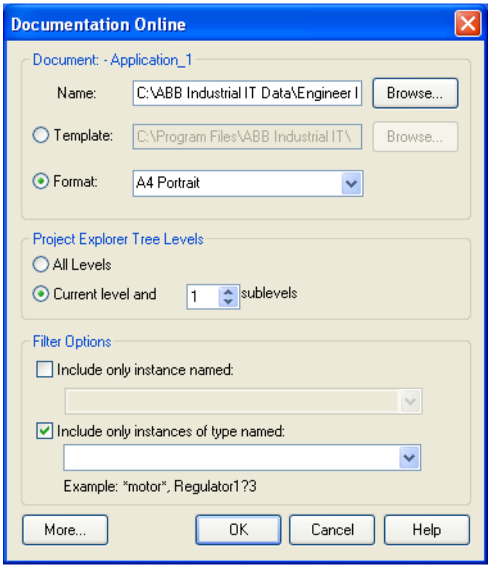
  In online mode, it is also possible to navigate from the Search and Navigation function to the corresponding object in the Project Explorer.

Project Documentation

Project Documentation in online mode is used to document (part of) the application tree in online or test mode. You can select any application object, set the “tree depth” in relation to the selected object, to document part of the tree only. You can also use filter conditions for a more specific search. Unlike the offline mode, the values of variables, parameters, etc. are included. For example, it is possible to filter out all coldretain variables and parameters in an application. The output is a Microsoft Word file, hence Microsoft Office must be installed.

All project documentation will be connected to a standard template.

1. Enter online or test mode and select an application object in Project Explorer.
2. Select **File > Documentation Online...** to open the Project Documentation dialog.



Document: - Application_1

Name: C:\ABB Industrial IT Data\Engineer I

○ Template: C:\Program Files\ABB Industrial IT\

● Format: A4 Portrait

Project Explorer Tree Levels

○ All Levels

● Current level and 1 sublevels

Filter Options

□ Include only instance named:

☑ Include only instances of type named:

Example: *motor*, Regulator1?3

Figure 127. The Documentation Online dialog.

3. See Control Builder online help for information about dialog settings and selections.

See Project Documentation on page 202 for information about Project Documentation in offline mode.

Section 5 Maintenance and Trouble-Shooting

This section provides important information for maintenance and trouble-shooting Compact Control Builder products. It mainly advises you on how to maintain your system, and how to collect information from a malfunctioning control system. The latter information is particularly valuable if your supplier's service department is to be involved.

Introduction

Software maintenance and trouble-shooting includes the following activities:

- Backup and Restore on page 317 gives a short overview of backup and restore.
- Files for Separate Backup on page 320 describes how to configure handling and logging of system alarms and events, using the Error Handler.
- Trouble-Shooting on page 325 lists a number of error symptoms, and suggest actions upon these.
- Error Reports on page 360 describes how to write a complete error report, so that the support engineers get a complete picture of an error situation.

Backup and Restore

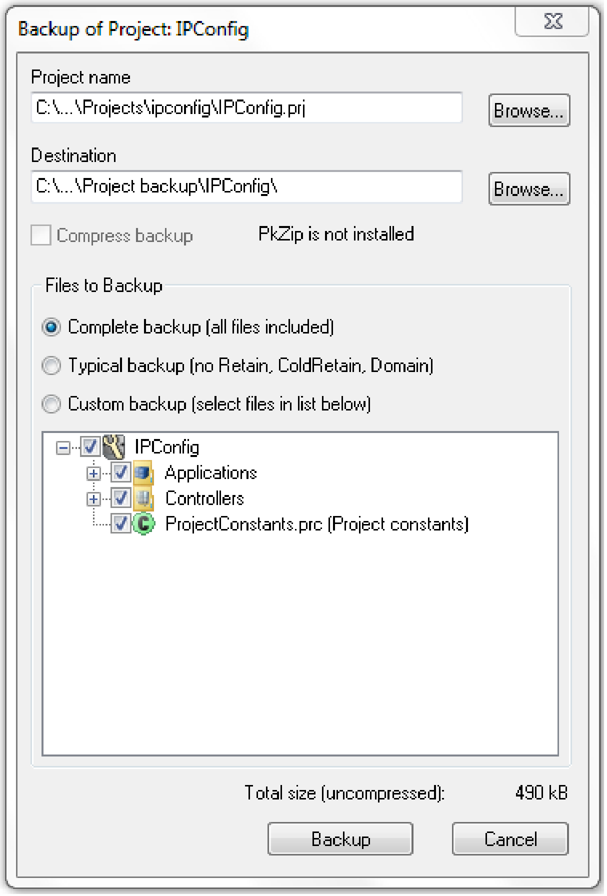
Introduction

This function provides a backup of your project, and enables you to move a project from one Control Builder station to another with the restore function. You can choose to backup a complete project or select parts of the project.

Backup

Compact Control Builder suggest the current project in Project Explorer for backup, or you can browse via a button to another project on your hard disk. Furthermore, Control Builder suggests a destination folder, named Project Backup which will be created next to the Project folder.

To Backup a project, select (in Project Explorer) **Tools>Maintenance>Project Backup**. A Project Backup dialog window will open, (Figure 128).



Backup of Project: IPConfig

Project name: C:\...\Projects\ipconfig\IPConfig.prj

Destination: C:\...\Project backup\IPConfig\

□ Compress backup PkZip is not installed

Files to Backup

● Complete backup (all files included)

○ Typical backup (no Retain, ColdRetain, Domain)

○ Custom backup (select files in list below)

- ☑ IPConfig
  - ☑ Applications
  - ☑ Controllers
  - ☑ ProjectConstants.prc (Project constants)

Total size (uncompressed): 490 kB

Figure 128. Backup menu in Project Explorer.

Complete Backup

This option includes all files that are needed to restore the project on another computer.

Typical Backup

A Typical backup of a project includes all source code files that are needed to restore the project on another computer. However, Retain, Cold Retain or Domain files will not be included with this option.

Custom Backup

Advanced users may want to choose explicitly which files to back up. This option provides a list of all files included in the project.

Restore

The restore function is used to install a backup, for example, after a disk crash, or when moving a project to another system. You may decide to make a Complete, Typical or Custom restore.

When you are restoring a complete project, all the project-related files are copied from the backup folder to the project folder.

Files for Separate Backup

There are some settings files that are stored locally. These need to be backed up separately:

- **OPC Server Configuration and System Setup Files**
  The OPC Server stores configuration files (`*.cfg`) and system setup files (`*.sys`) on local disc. These files are stored in the OPC server working directory and need to be manually copied to safe media on a regular basis. See the *AC 800M OPC Server (3BSE035983*)* manual for more information.
- **Control Builder Settings File**
  Each Control Builder client saves its settings in the file `systemsetup.sys`. This file is saved on local disk, in the Control Builder working directory, and has to be manually backed up to safe media on a regular basis.

Controller Configuration

The Error Handler is used to configure controller behavior on system alarms and events of different severities, and how different errors are logged.

Error Handler settings are made for each controller, in the Controller Settings dialog. There are certain settings that cannot be changed (they are dimmed in the dialog). You can add additional actions, but you cannot change the original settings.

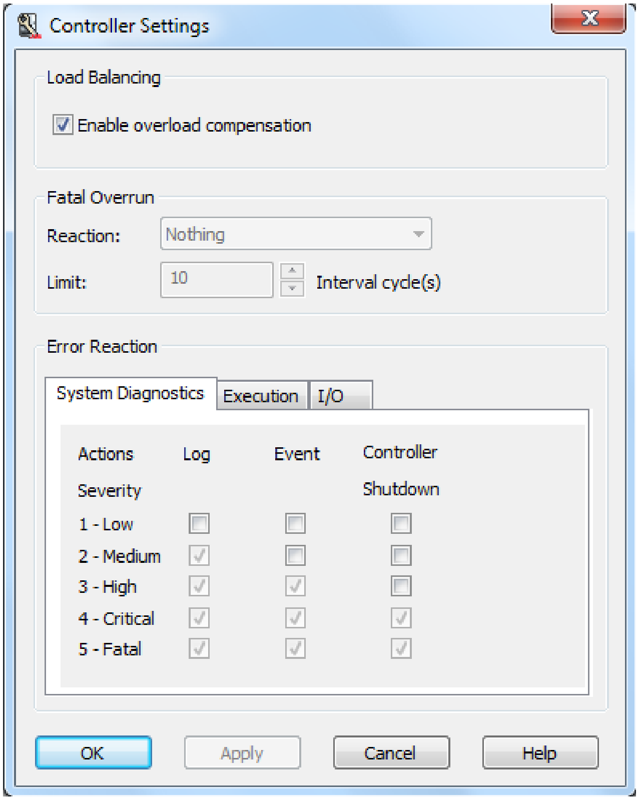
- Controller Settings in Controllers on page 320 describes how to configure the Error Handler in a controller.

Errors can be reported from the code using the ErrorHandler function block type or the ErrorHandlerM control module type. Using these types, errors identified by the code can be handled in the same way as other errors. For more information on how to configure the ErrorHandler(M) types, see corresponding online help.

The ErrorHandler(M) types should be used with care, since they can be used to reset the controller.

Controller Settings in Controllers

Figure 129 shows the Controller Settings dialog for a AC 800M controller. It is displayed by right-clicking the controller in Project Explorer and selecting **Properties > Controller Settings**.



Controller Settings

Load Balancing

☑ Enable overload compensation

Fatal Overrun

Reaction: Nothing

Limit: 10 Interval cycle(s)

Error Reaction

System Diagnostics | Execution | I/O

Actions	Log	Event	Controller
Severity			Shutdown
1 - Low	□	□	□
2 - Medium	☑	□	□
3 - High	☑	☑	□
4 - Critical	☑	☑	☑
5 - Fatal	☑	☑	☑

Figure 129. Controller Settings dialog for an AC 800M controller.

If load balancing is enabled, overrun and latency supervision is automatically disabled, see Overrun and Latency on page 142.

The default setting for a controller is that load balancing is enabled and overrun and latency supervision disabled. If you disable load balancing overrun and latency supervision is automatically enabled.

Fatal overrun settings are used only if overrun and latency supervision is enabled (this part will be dimmed if load balancing is enabled, see Figure 129).

The Fatal Overrun part of the dialog lets you set how many overruns (missed scans) that are allowed before a fatal error is considered to have occurred. The Reaction setting is used to select which action the controller should take when a fatal overrun error occurs. The options are Nothing, Stop Application, and Reset Controller (The default option is *Nothing*). The default setting for the Limit is 10 interval cycles.

It is important to avoid configuring the error handler in such a way that a fatal overrun error has two corresponding reactions, one that is set in the Fatal Overrun part of the dialog (for example, Stop Application) and one that is set in the Error Reaction dialog (for example, Controller Shutdown for the corresponding severity). Note that severity Fatal and Critical always lead to a controller shutdown.

If settings are inconsistent, you will receive a warning when trying to save the new settings.

For a controller, the Error Reaction part lets the user set the following, see Table 24.

Table 24. Error Reaction. This part of the dialog is used to set controller actions at system alarms of different severity.

Severity	**Log**	**Event**	**Controller Shutdown**
1 Low	Configurable for all	Configurable for all	Configurable for all
2 Medium	Always for system diagnostics and execution Configurable for I/O	Configurable for all	Configurable for all
3 High	Always for system diagnostics and execution Configurable for I/O	Always for system diagnostics and execution Configurable for I/O	Configurable for all
4 Critical	Always	Always	Always
5 Fatal	Always	Always	Always

The above table shows controller reactions (fixed and configurable) when alarms of different severities are received by the Error Handler in a controller.

There are three tabs in the Error Reaction part of the dialog:

- The System Diagnostics tab contains settings for system alarms generated by the System Diagnostics module, for example, CEX module errors, protocol handler errors.
- The Execution tab contains settings for system alarms generated during execution of IEC-61131 code, for example, latency errors, CRC check failures.
- The I/O tab contains settings for I/O module errors.

The following definitions have been used for the severity of system errors when designing error handling for different modules:

- **1 Low**
  Minor, of diagnostic or informative sort. Does not affect system integrity or the functionality of the reporting module.
- **2 Medium**
  An error, such as I/O channel failure, communication failed, or similar, has occurred. Does not affect system integrity, but affects functionality in the reporting module.
- **3 High**
  Severe error, but not critical, for example I/O module failure. May affect system integrity. Functionality in the reporting module is affected. Redundancy may maintain the system integrity
- **4 Critical**
  A severe error has occurred, for example, a task has stalled, ModuleBus stalled, I/O cluster down. Will affect system integrity, since the reporting module has failed. Redundancy may maintain the safety of the system.
- **5 Fatal**
  Systematic software errors have been found. The whole reporting subsystem has failed. Redundancy will not maintain the system integrity. This severity is only used when there is no possibility to safely continue using a backup PM.

Error Handler Log Entries

If an error of a certain severity is configured to be logged, it will generate a Controller System log (see Controller System Log on page 336) entry with the following general structure.

```
E yyyy-mm-dd hh:mm:ss:ms ErrorHandler PM: Error descr.(x,y,R)
```

- Such an entry should be read according to the below table.

Table 25. How to read a log entry generated by the Error Handler.

Part	Description	Allowed Value(s)
`E`	Error	
`yyyy-mm-dd`	Date	
`hh:mm:ss:ms`	Time when error was time stamped	
`ErrorHandler PM:`	Error detected by	`ErrorHandler PM:` =Processor Module
`Error descr.`	A text describing the error	
`(x,y,ERS)`	x=error type	`1` (System Diagnostics) `2` (Execution), `3` (I/O)
	y=severity	`1` (Low) `2` (Medium) `3` (High) `4` (Critical) `5` (Fatal)
	ERS=action type	`E` (Event) `R` (Reset) `S` (System Alarm)

The Online upgrade is not allowed when the changes are downloaded from another engineering station.

During Online Upgrade, the valid signal of the control modules MMSReadxxxM might drop just after the Online Upgrade switch, if there are other communication ongoing (for example serial communication). For safe P2P communication it is recommended to use MMSDefHI/MMSReadHI control modules.

This occurs while using the following control modules:
MMSDef128BoolM/MMSRead128BoolM
MMSDef64BoolM/MMSRead64BoolM
MMSDef16BoolM/MMSRead16BoolM
MMSDef2DintM/MMSRead2DintM
MMSDef2DwordM/MMSRead2DwordM
MMSDef2RealM/MMSRead2RealM

-

Trouble-Shooting

General

When a control system error occurs, it is important to investigate it as soon as possible. In doing this, the possibility of finding and eliminating the problem will be substantially increased. The reasons are:

- The personnel involved will not have forgotten what happened.
- The application software involved will not have been changed.
- The systems involved will not have been changed (location, setup etc.).
- You may need a work-around quickly, to be able to continue your work.

- Some errors only occur under very special circumstances and/or in special hardware/software configurations. The person who reports the problem may have the only installation/configuration where we know it could occur.

A well-described error, with all vital information included, will always increase the probability of correcting the error quickly and effectively. Error Reports on page 360 provides some hints when writing an error report.

The task of trouble-shooting is usually very difficult, and requires a great deal of intuition and ability to draw conclusions from known facts. This subsection aims to provide some guidelines on solving problems.

Here are some basic troubleshooting questions which should first be answered.

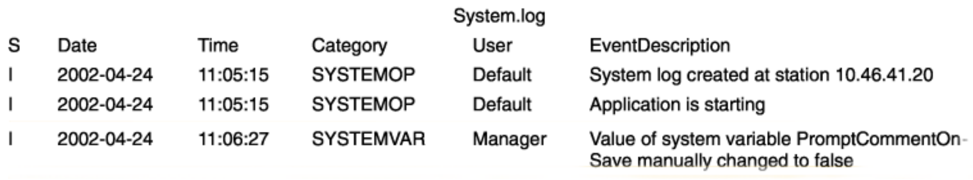
- What is the problem?
- Is it a known problem? Check the available information (for example, Release Notes and Product Bulletins) and discuss it with colleagues.
- Has the system worked previously (with the same hardware)? If so, the problem may have occurred due to poor installation or due to setup problems.
- Has anything been modified recently? The problem is often to be found in modifications. If possible, revert to the previous state, and test.
- Can the problem be linked to any special event?
- Is it possible to reproduce the problem?

Log Files

The Industrial IT products described in this subsection have built-in logging routines that continuously write to log files. Log files will contain important information whenever a failure occurs during a programming session, or when a controller is running. These files and the crash files (see section Crash Dumps for Analysis and Fault-Localization on page 341) are very useful for troubleshooting and contain crucial information for analyzing malfunctions.

System Log File

The *system log* is created the first time Control Builder is started (or if there is no log file), and is used to store general information concerning Control Builder. Examples of information logged are start/stop of Control Builder and changes in the setup of Control Builder via the **Tools** menu. The System log can be read via the menu entry **Tools > Maintenance > Analysis > System Log**. Figure 130 shows an example of the system log.



```
                                              System.log
S   Date         Time       Category     User       EventDescription
I   2002-04-24   11:05:15   SYSTEMOP     Default    System log created at station 10.46.41.20
I   2002-04-24   11:05:15   SYSTEMOP     Default    Application is starting
I   2002-04-24   11:06:27   SYSTEMVAR    Manager    Value of system variable PromptCommentOn-
                                                    Save manually changed to false
```

Figure 130. An example of the system log

The path and file name of the System log are given in Table 26.

Table 26. The System log file path.

Denomination	Path/Note
Control Builder System Log	**Path / File name** C:\ABB Industrial IT Data\Engineer IT Data[1]\ Compact Control Builder AC 800M\LogFiles\System.log **Note** Only one version of this file exists.

[1] The default working directory is shown.

Session Log Files

At start-up, Control Builder, OPC Server for AC 800M, MMS Server for AC 800M, SoftController, automatically creates a *session log* file on the hard disk. These files contain information generated during one session, that is, from the time the product is started, until it is stopped. New files will be created upon each new start-up.

At start-up, information about hardware and software versions, and later, information on system events, such as mode changes (Offline to Online, or vice versa) and error print-outs, will be logged in the session log. Session logs are continuously updated in a running system, and whenever a problem occurs it is a good idea to look at the logs to see if there are any printouts. It is possible to read log files for the current session via the menus.

Session logs are saved from the previous nine sessions. It is important to save a file containing information about a problem, with a new name, before it is overwritten.

Ten successive start-ups will generate the following session log files; Session.log (from last start-up), Session.log _bak1 (next to last), Session.log _bak2, etc to Session.log _bak9 (the first start-up or oldest saved start-up). This means that when you start-up the system a eleventh time Session.log _bak9 will be overwritten and the previous Session.log will be renamed as Session.log _bak1 and a new Session.log will be created.

You will lose the oldest saved file because all the files are pushed one step after each start-up. This means that (_bak8) is pushed to (_bak9), (_bak7) to (_bak8) etc and Session.log to (_bak1).

- Session.LOG
- Session.LOG_bak1
- *Session.LOG_bakn.......*
- Session.LOG_bak9
- ~~Session.LOG_bak9~~

The paths and file names of the session logs are given in Table 27.

Table 27. Session log file paths.

Denomination	Path/Note
Control Builder session log	**Path / File name** C:\ABB Industrial IT Data\Engineer IT Data(1)\ Compact Control Builder AC 800M\LogFiles\Session.log **Note** Session log files stored from the last 9 sessions: Session.log Session.log_bak1, Session.log_bak2, *Session.log_bakn....* Session.log_bak9
OPC Server session log	**Path / File name** C:\ABB Industrial IT Data\Control IT Data(1)\OPC Server for AC 800M\ LogFiles\Session.log **Note** Session log files are stored from the last 9 sessions: Session.log Session.log_bak1, Session.log_bak2, *Session.log_bakn....* Session.log_bak9

Table 27. Session log file paths. (Continued)

Denomination	Path/Note
MMS Server session log	**Path / File name** C:\ABB Industrial IT Data\Control IT Data[1]\ MMS Server for AC 800M\ Session.log **Note** Session log files are stored from the last 9 sessions: Session.log Session.log_bak1, Session.log_bak2, *Session.log_bakn....* Session.log_bak9
SoftController session log	**Path / File name** C:\ABB Industrial IT Data\Control IT Data[1]\ SoftController \ Session.log **Note** Session log files are stored from the last 9 sessions: Session.log Session.log_bak1, Session.log_bak2, *Session.log_bakn....* Session.log_bak9

[1] The default working directory is shown.

OPC Server (Session.log) Example

The list example shows an extract from an OPC Server session log file and how to interpret the given data in four separate error occurrences. Important information has been highlighted with typeface bold.

E = error, **AE** = Alarm Event, **DA** = Data Access.

```
E 2003-11-07 11:11:54.867 On Unit= SubAlarmEvent ConnectionError-
172.16.0.11 OPC Server (6500) Connection error to AE subscribed
controller

E 2003-11-07 11:12:03.335 On Unit= SubDataAccess ConnectionError-
172.16.0.11 OPC Server (5500) Connection error to DA subscribed
controller

E 2003-11-07 11:12:04.913 Off Unit= SubAlarmEvent ConnectionError-
172.16.0.11 OPC Server (6500) Connection error to AE subscribed
controller

E 2003-11-07 11:12:27.398 Off Unit= SubDataAccess ConnectionError-
172.16.0.11 OPC Server (5500) Connection error to DA subscribed
controller
```

1. The first event description tells us that the OPC server lost connection (On) to controller for Alarm and Event subscription (and when this error occurred).
2. The second event description tells us that the OPC server also lost connection (On) to controller for Data and Access subscription.
3. The third event description tells us that the OPC server regained connection (Off) to controller for Alarm and Event subscription.
4. The forth event description tells us that the OPC server regained connection (Off) to controller for Data and Access subscription.

As you can see, letter (E) stands for error and it occurs both when error activates (On) and when the same error is gone (Off).

Control Builder Start Log

Control Builder creates a *Start Log* file for logging the last Offline to Online transfer (in Test or Online mode). Information, such as warnings and error messages, will be logged. The Start log is very useful when investigating errors that might occur during or just after an Offline -> Online transition. Sometimes the Start log will give a natural explanation of what at first looks like an error (for example, lost Cold Retain values).

The nine latest Start logs are saved.

It is important to save a file containing information about a problem, with a new name before it is overwritten. Furthermore, check that the date and time in the Start log correspond with the time when the problem occurred.

The path and file name of the Control Builder start log, are given in Table 28.

Table 28. The Control Builder start log file path.

Denomination	Path/Note
Control Builder Start log	**Path / File name** C:\ABB Industrial IT Data\Engineer IT Data[1]\ Compact Control Builder AC 800M\LogFiles\startlog.txt **Note** The nine latest Start log files are saved: startlog.txt startlog.txt_bak1,startlog.txt_bak2, *startlog.txt_bakn....* startlog.txt_bak9

[1] The default working directory is shown.

Field Bus Parameter Log Files

During compilation and simulation, CI851, CI854 master parameters will be automatically calculated.

The calculation is performed for all controllers in the project and for all masters connected to the controllers. The result is sent to text files, which is stored in the same place as the Control Builder log files. The text files have no backup, and are replaced at every compilation and simulation.

The path and file name of the Field bus parameter log files, are given in Table 29.

Table 29. The Field bus parameter log files path.

Denomination	Path/Note
CI851 parameter log file	**Path / File name** C:\ABB Industrial IT Data\Engineer IT Data[1]\ Compact Control Builder AC 800M\LogFiles\Profibus_DP_Calculation.txt
CI854 parameter log file	**Path / File name** C:\ABB Industrial IT Data\Engineer IT Data[1]\ Compact Control Builder AC 800M\LogFiles\Profibus_DPV1_Calculation.txt

[1] The default working directory is shown.

Device Import Wizard Log File

When Device Import wizard is used a log file is created. If any failure during the import occurs, errors and/or warnings are written to the log file, together with a text describing the error/warning.

For a successful creation of a hardware definition file the log file contains some entries: date and time of use, version of wizard and parser component, contents of the device description file and contents of the generated hardware definition file.

When the file size of a log file reaches 10MB it will be renamed next time the Device Import Wizard is invoked and a new log file is created. If there are an backup file at that time, it will be deleted.

Table 30. The Device Import Wizard log file path

Denomination	Path/Note
Device Import Wizard log file	**Path / File name** C:\ABB Industrial IT Data\Engineer IT Data[1]\ Compact Control Builder AC 800M\LogFiles\DIW.log

[1] The default working directory is shown

PROFINET configuration log file

The Control Builder creates a log file **PROFINET_Configuration.txt** during download. This log file will have the result of the download compilation for the current and previous configurations. The log file can store data upto 10 MB and is stored in the LogFiles directory in Control Builder. The current compilation result is stored at the end of the log file.

If the log file exceeds the maximum size of 10 MB, then the file is automatically saved as **PROFINET_Configuration1.txt** and a new **PROFINET_Configuration.txt** is created. A maximum of nine old log files will be saved before the oldest file gets overwritten. The log file also contains internally calculated data that are not available in the Control Builder.

Table 31. The Device Import Wizard log file path

Denomination	Path/Note
PROFINET Configuration log file	**Path / File name** C:\ABB Industrial IT Data\Engineer IT Data[1]\ Compact Control Builder AC 800M\LogFiles\PROFINET_Configuration.txt

[1] The default working directory is shown

Control Builder System Information Report

The *system information report* is a list of hardware, software and setup information for an engineering station. This information is generated by a menu command and presented in a text editor.

To generate a new report perform either of these two alternatives.

- Select menu **Help > About Compact Control Builder AC 800M> List all Information**
- In the Control Builder Setup Wizard, click **Show Settings** button.
  This alternative generates almost the same information as the alternative above, but fewer Environment variables are printed.

It is important to generate a new file containing information that was valid at the time the problem occurred.

The path and file name of the Control Builder System information report file are shown in Table 32.

Table 32. The Control Builder system information report file path.

Denomination	Path/Note
Control Builder System information report	**Path / File name** C:\ABB Industrial IT Data\Engineer IT Data[1]\ Compact Control Builder AC 800M\LogFiles\ SystemInformation.txt

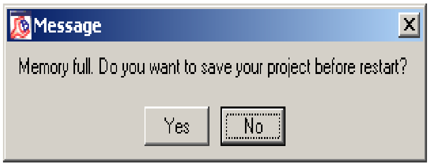
[1] The default working directory is shown.

Heap Statistics Log

There is *heap statistics* log file for SoftController. Every time a message "memory full" occurs (see Figure 131) in these products, the system software will automatically generate a *heap statistics log* file containing information about the content of the **heap**[1].

If "memory full" occurs in a situation that cannot be explained as normal, then this file should be included in an error report to your supplier's service department.

When a system is unable to store more information in the heap, an error message will be displayed. In most cases (more than 98%), this is due to an attempt to store too much information in too small a heap. If this occurs for a product running on an engineering station, increase the heap size for that product, using the Setup Wizard.


Message

Memory full. Do you want to save your project before restart?

Figure 131. The "memory full" message.

The paths and file names of the *heap statistics* log files are given in Table 33

Table 33. The heap statistics log file path

Denomination	Path/Note
SoftController heap statistics log	**Path / File name** C:\ABB Industrial IT Data\Control IT Data(1)\SoftController \heapstat.dat **Note** The file is intended to be stored and included in an error report.

Controller System Log

Controllers have a circular log buffer that can hold a certain amount of information, normally all information that has been generated during the last 5 to 8 start-ups.

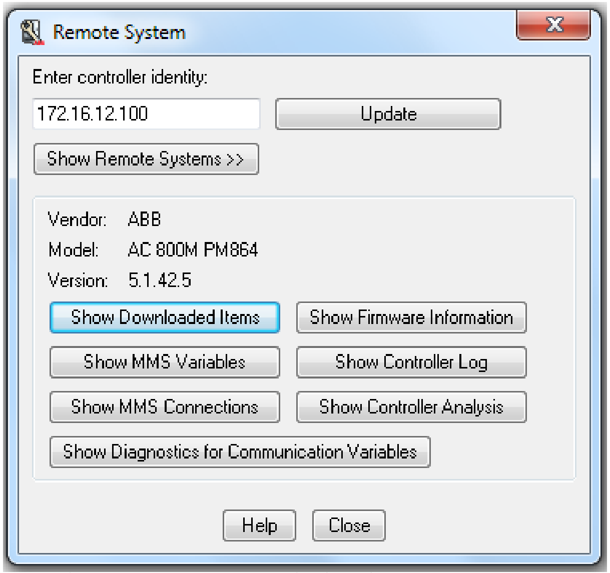
[1] A product, for example, a soft controller, uses a general memory area to store information. This area is called a **heap**. In the engineering station this area does not necessarily reside in the RAM memory.

A lot of the information gathered in a controller log file can be of great assistance, but a controller file is circular, which means that the last error often disguises more important previous errors. This means that the original error can be hard to discover. Therefore, you are advised to **first save the log file to a safe location** (no risk of deleting history) and then fault-find your way back. After renaming the first controller log file, it is safe to fetch as many controller log files as necessary.

The Controller System log is never deleted. Provided that the battery backup is working properly, the information can be retained during a power failure. This function makes it possible to restart a faulty system immediately to regain control of the process, without losing vital information about the error.

You must first save the Controller system log file on a safe location before fault-finding; it is much more difficult to identifying the original error after several startups.

The recommended way to access the Controller System log information is to fetch it via Control Builder. Selecting **Tools > Maintenance > Remote System…** will show a Remote System dialog, see Figure 132.



Remote System

Enter controller identity: 172.16.12.100

Vendor: ABB
Model: AC 800M PM864
Version: 5.1.42.5

Figure 132. The Remote System dialog box.

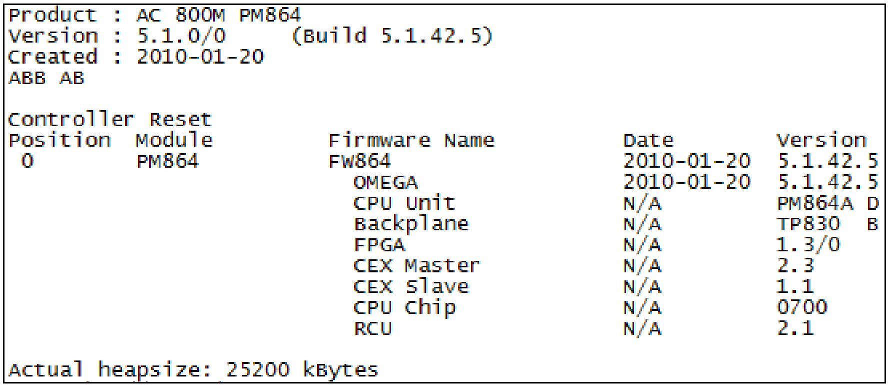
Enter the controller identity (the IP address) and click on the **Show Controller Log** button to show the Controller System Log.

A redundant controller creates one log file for the primary unit and one for the backup unit, hence two different log files.

The information will be shown in a text editor and also be stored in a file.

However, the first controller log can still be overwritten. The 'First-in-First-out' principle is still valid for controller logs if you activate the ‘Show Controller Log’ function from the Project Explorer.

Figure 133 below, is an excerpt of the controller system log.



```
Product : AC 800M PM864
Version : 5.1.0/0     (Build 5.1.42.5)
Created : 2010-01-20
ABB AB

Controller Reset
Position  Module        Firmware Name          Date         Version
 0        PM864         FW864                  2010-01-20   5.1.42.5
                          OMEGA                2010-01-20   5.1.42.5
                          CPU Unit             N/A          PM864A D
                          Backplane            N/A          TP830   B
                          FPGA                 N/A          1.3/0
                          CEX Master           N/A          2.3
                          CEX Slave            N/A          1.1
                          CPU Chip             N/A          0700
                          RCU                  N/A          2.1

Actual heapsize: 25200 kBytes
```

Figure 133. One section of the controller system log showing the actual firmware in the controller.

The path and file name of the Controller System log file are given in Table 34.

Analyzing Controller Logs

During compile and download the logs are fetched, analyzed and saved if the controllers configuration is empty and the logs contains crashes.

If the logs contains crashes then they are saved with following names:

Controller aa.bb.ccc.ddd yyyy-mm-dd-hh.mm.ss.ttt CPU.log
Controller aa.bb.ccc.ddd yyyy-mm-dd-hh.mm.ss.ttt BackupCPUlog
Controller aa.bb.ccc.ddd yyyy-mm-dd-hh.mm.ss.ttt CI.log

If controllers configuration is empty but none of the logs contain crash information, then the files are stored with following names indicating that this was a download to an empty controller:

Controller aa.bb.ccc.ddd (empty) CPU.log
Controller aa.bb.ccc.ddd (empty) BackupCPUlog
Controller aa.bb.ccc.ddd (empty) CI.log

aa.bb.ccc.ddd represents the IP-address.
yyyy-mm-dd-hh.mm.ss.ttt represents the current date and time.

The analysis is also done when logs are fetched through Remote System dialog. If the logs contains crashes the file name includes date and time. If crashes are not found in the logs, then they are saved with following default names:

Controller aa.bb.ccc.ddd CPU.log
Controller aa.bb.ccc.ddd BackupCPU.log
Controller aa.bb.ccc.ddd CI.log

aa.bb.ccc.ddd represents the IP-address.

Controller Logs Sent to Computers at Shutdown of Controller

At a controller shutdown, the Controller System log is automatically sent out on the Control Network as a broadcast message. It is fetched and stored in the working folder for the MMS Server on all computers running an MMS Server.

If the Controller System log, fetched via the Remote System dialog, after a shutdown is empty due to a battery failure in the controller, the log will still be present at all computers running an MMS Server. It is then possible to find it in the following path:

C:\ABB Industrial IT Data\Control IT Data\MMS Server for AC 800M\
Controller aa.bb.ccc.ddd CPU.log

In this path you will also find the communication interface log file (Controller aa.bb.ccc.ddd CI.log).

Table 34. The controller system log and communication interface log file paths .

Denomination	Path/Note
Controller System log Primary CPU	**Path / File name** **All controllers:** C:\ABB Industrial IT Data\Engineer IT Data(1)\Compact Control Builder AC 800M\LogFiles\Controller aa.bb.ccc.ddd CPU.log **Note** aa.bb.ccc.ddd is the IP address of the controller. See Controller System Log on page 336. The nine latest Controller System logs are saved: Controller aa.bb.ccc.ddd CPU.log Controller aa.bb.ccc.ddd CPU.log_bak1, Controller aa.bb.ccc.ddd CPU.log_bak2, etc Controller aa.bb.ccc.ddd CPU.log_bak9
Controller System log Backup CPU	**Path / File name** **All controllers:** C:\ABB Industrial IT Data\Engineer IT Data(2)\Compact Control Builder AC 800M\LogFiles\Controller aa.bb.ccc.ddd BackupCPU.log **Note** aa.bb.ccc.ddd is the IP address of the controller. See Controller System Log on page 336. The nine latest Controller System logs are saved: Controller aa.bb.ccc.ddd BackupCPU.log Controller aa.bb.ccc.ddd BackupCPU.log_bak1, Controller aa.bb.ccc.ddd BackupCPU.log_bak2, etc Controller aa.bb.ccc.ddd BackupCPU.log_bak9

Table 34. The controller system log and communication interface log file paths (Continued).

Denomination	Path/Note
Communication Interface log	**Path / File name** **All controllers:** C:\ABB Industrial IT Data\Engineer IT Data[1]\Control Builder M Professional\LogFiles\Controller aa.bb.ccc.ddd CI.log **Note** aa.bb.ccc.ddd is the IP address of the controller. See Controller System Log on page 336. The nine latest Communication Interface logs are saved: Controller aa.bb.ccc.ddd CI.log Controller aa.bb.ccc.ddd CI.log_bak1, Controller aa.bb.ccc.ddd CI.log_bak2, etc Controller aa.bb.ccc.ddd CI.log_bak9

[1] The default working directory is shown.

[2] The default working directory is shown.

The Communication Interface log (Example, the log in CI867 and CI868) is not battery protected. Hence, the log will be erased when the power to the controller is cut.

Crash Dumps for Analysis and Fault-Localization

If a crash occurs (in Control Builder, OPC Server, SoftController, MMS Server for AC 800M, two new files are generated at the same location as the session log files. The first one is a dump file and the second is a rewritten session log file. These two files contain crucial information that should be delivered to the support personnel

If a Control Builder crash occurs at 16:20 on the 19:th of May, then a dump file and a rewritten session log file will look like:

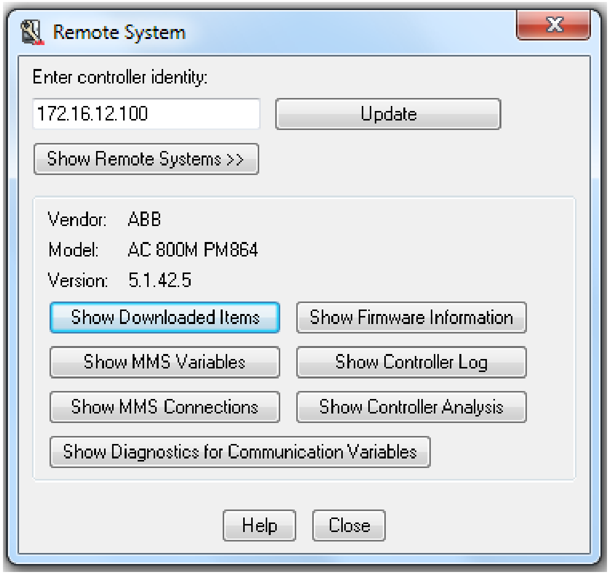
ControlBuilderStd 2006-05-19 16.20.29.184.dmp

ControlBuilderStd 2006-05-19 16.20.29.184 Session.LOG

Remote Systems Information

A connected remote control system[1] can be inspected and maintained from Control Builder. This can be an important tool when troubleshooting the system.

Select **Tools > Maintenance > Remote System** to open the Remote System dialog, see Figure 134.



Remote System

Enter controller identity: 172.16.12.100

Vendor: ABB

Model: AC 800M PM864

Version: 5.1.42.5

Figure 134. Remote System dialog.

The “Show Remote System” function can only list nodes on the same physical network! Thus, you must connect a Control Builder PC on the same Ethernet network; you cannot Show Remote System on nodes beyond routers, sub-networks etc.

[1] Remote systems are controllers, OPC servers, and engineering stations connected to the same Control network as your own local system.

The following remote system functions are available, see the Table 35 below. Click on a button in the dialog to retrieve information.

Table 35. The available remote system dialog functions.

Menu Item	Function
Show Remote Systems	Shows a list of all addresses to the control systems (including MMS process numbers) connected to the same network as the requesting system.
Show Downloaded Items	Shows information about controller configuration and about the application(s) running in the selected remote controller system, such as application name, application status, compilation date and time, compiling engineering station identity, and the checksum of the application. You can also remove a running application here. You can also access the source code report from the Show Downloaded Items dialog, see Source Code Report Generated for Project in the *Compact 800 Engineering Compact Control Builder AC 800M Getting Started (3BSE041584*)* manual.
Show Firmware Information	Shows information from a controller, such as unit position, type of hardware unit, name and version of the current firmware and firmware creation date. Firmware can also be loaded to selected controllers here.
Show MMS Variables	Shows all the MMS variables in the system.
Show Controller Log	Shows the Controller System log, described in the section Controller System Log on page 336.
Show MMS Connections	Shows connection information about the remote systems, such as IP address, server/client function, identity of the connected system (destination system), usage, and number and maximum of transactions sent since connection was established.

Table 35. The available remote system dialog functions. (Continued)

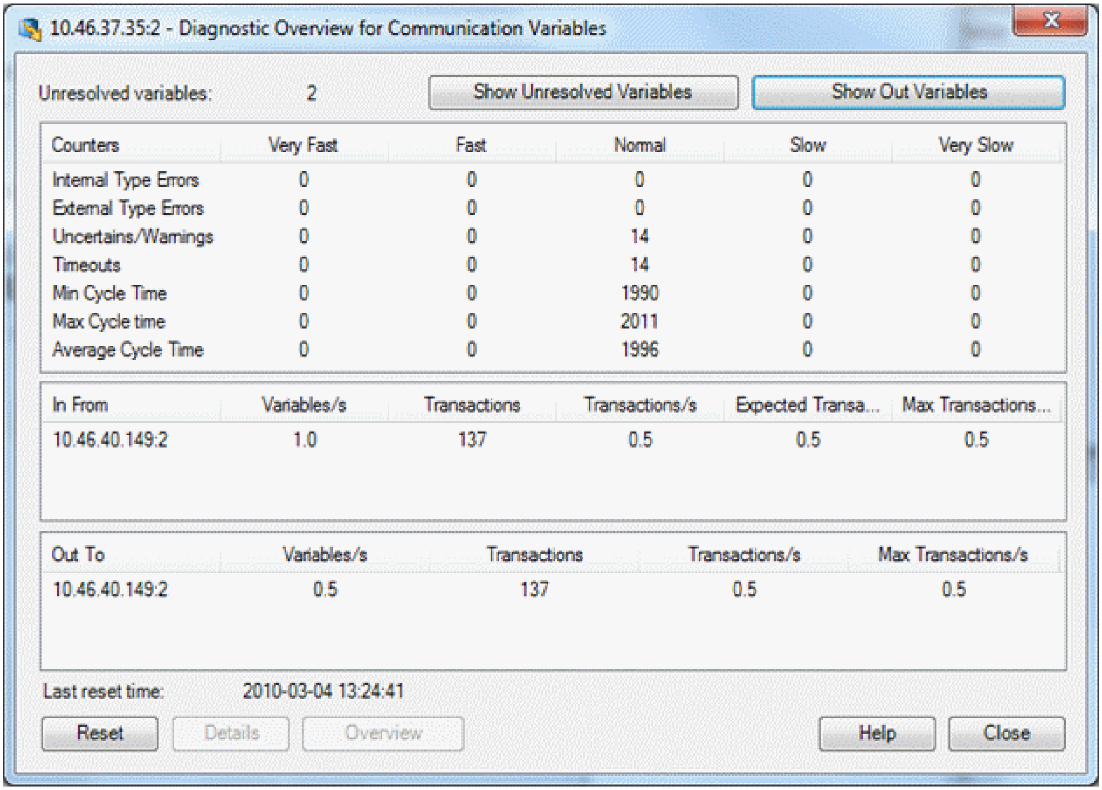
Menu Item	Function
Show Controller Analysis	Shows the Controller Analysis dialog that is used to: • Reset the Module Bus Fail Counters in the selected controller. • Get the selected result/data from the controller. The user can obtain results for "Heap Statistics", "Module Bus Fail Counters", "Module Bus I/O Revisions", "Network Information" and "Thread Execution". The respective result, obtained from the controller log, is saved to a new log file. The file name of the new log contains the "Controller ID" and the selected result. For example, 172.16.85.187_Heap Statistics.log.
Show Diagnostics for Communication Variables	Shows a diagnostic overview of the internal and external communication using the communication variables in the controller. For details, see Diagnostics for Communication Variables on page 345. The dialog displays: • Unresolved communication variables • Different counters for errors/warnings, cycle times, and timeout. • Details about variable transaction in each server connection and client connection. • Out variables of the selected node.

For further information, refer to Control Builder online help. Use the Help button in the Remote System dialog, see Figure 134.

Diagnostics for Communication Variables

The diagnostics tool for communication variables can be launched from the Remote System dialog of the selected controller. Click **Show Diagnostics for Communication Variables** in the Remote System dialog.

The first window that appears is the overview window. This window is a modeless window, that is, it is possible to bring up and work in other windows in parallel.



10.46.37.35:2 - Diagnostic Overview for Communication Variables

Unresolved variables: 2

Counters	Very Fast	Fast	Normal	Slow	Very Slow
Internal Type Errors	0	0	0	0	0
External Type Errors	0	0	0	0	0
Uncertains/Warnings	0	0	14	0	0
Timeouts	0	0	14	0	0
Min Cycle Time	0	0	1990	0	0
Max Cycle time	0	0	2011	0	0
Average Cycle Time	0	0	1996	0	0

In From	Variables/s	Transactions	Transactions/s	Expected Transa...	Max Transactions...
10.46.40.149:2	1.0	137	0.5	0.5	0.5

Out To	Variables/s	Transactions	Transactions/s	Max Transactions/s
10.46.40.149:2	0.5	137	0.5	0.5

Last reset time: 2010-03-04 13:24:41

Figure 135. Diagnostic Overview for Communication Variables dialog

The Diagnostic Overview for Communication Variables dialog contains three panes that display information about the communication variables that are communicating through the applications in the selected controller.

The information is cyclically updated. The update interval is set to 5 seconds.

Counters Pane

The first pane lists different counters for the communication variables in the controller. Each column in the pane corresponds to a cycle time category of the communication variables.

The counters display the following values corresponding to the cycle time category in different columns:

- Internal type errors–Type mismatch during communication between applications within this controller.
- External type errors–Type mismatch during communication with an application in another controller.
- Uncertains/Warnings–Variables that are not updated within the requested time interval.
- Timeouts–Variables that are not updated within the requested timeout interval.
- Min Cycle Time–The lowest detected cycle time.
- Max Cycle Time–The highest detected cycle time.
- Average Cycle Time–The average cycle time.

In From and Out To Panes

The second pane "In From" contains information about the external client connections with respect to communication variables in the selected controller. The third pane "Out To" contains information about the external server connections with respect to communication variables in the selected controller.

Each pane contains columns for:

- Variables/s–An average value, calculated since last reset time.
- Transactions–Number of transactions since last reset time.
- Transactions/s–An average value, calculated since last reset time.
- Max. Transactions/s–Maximum number of transactions per second since last reset time.

- Expected Transactions/s–Number of expected transactions per second from the client. This column appears in the In From pane only.

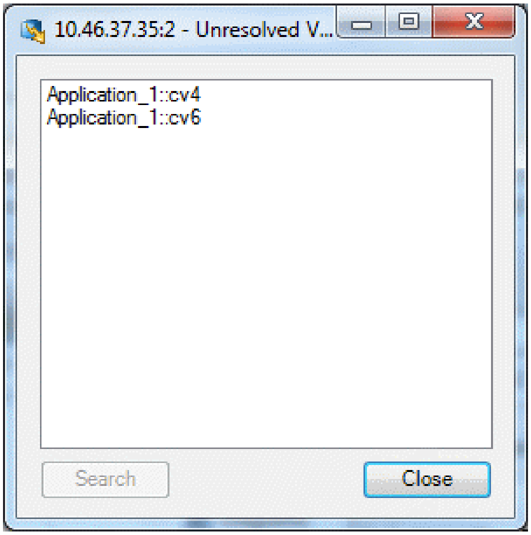
The *Last reset time* shows the time when the Reset button was pressed.

Buttons

There are seven buttons in the overview:

- **Show Unresolved Variables**–Click to open the Unresolved Variables dialog.
- **Show Out Variables**–Click to open the Out Variables dialog.
- **Reset**–Click to reset the information in the controller. New values will be fetched.
- **Details**–Click to open the Detailed Diagnostics dialog for the selected client connection.
- **Overview**–Click to open the Diagnostic Overview for the selected server or client connection.
- **Help**–Click to open the online help topic for the diagnostic tool.
- **Close**–Click to close the window.

Show Unresolved Variables



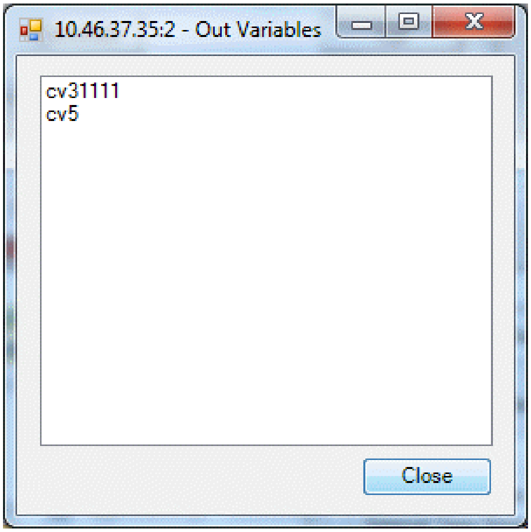
Application_1::cv4
Application_1::cv6

Figure 136. Unresolved Variables dialog

The Unresolved Variables dialog displays the list of unresolved variables. Select the variable and click **Search** to open the Search & Navigation tool for the selected variable.

The Search works in Offline mode and when the setting "Iterative Search in Online Mode" is set to false.

Show Out Variables

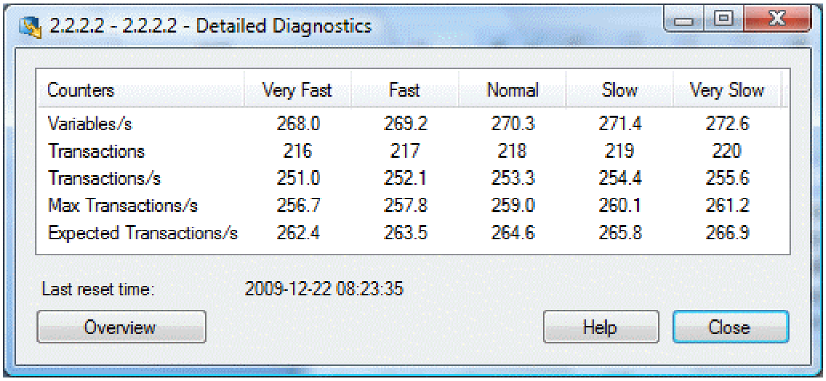


cv31111
cv5

Figure 137. The Out Variables dialog

The Out Variables dialog displays the list of out variables in the controller.

Details



Counters	Very Fast	Fast	Normal	Slow	Very Slow
Variables/s	268.0	269.2	270.3	271.4	272.6
Transactions	216	217	218	219	220
Transactions/s	251.0	252.1	253.3	254.4	255.6
Max Transactions/s	256.7	257.8	259.0	260.1	261.2
Expected Transactions/s	262.4	263.5	264.6	265.8	266.9

Last reset time: 2009-12-22 08:23:35

Figure 138. Detailed Diagnostics dialog

The Detailed Diagnostics dialog displays the information for the different cycle time groups in a selected client connection. The following values are shown:

- Variables per second. An average value, calculated since last reset time.
- Number of transactions since last reset time.
- Transaction per second. An average value, calculated since last reset time.
- Maximum number of transactions per second since last reset time.
- Expected number of transaction per second. A value that is calculated at compile time.

Click **Overview** to open the Diagnostic Overview (Figure 135) for the controller that owns this client connection.

The information is cyclically updated. The interval is set to 5 seconds and it cannot be changed.

Analysis Tools

Control Builder Tools

The Control Builder **Tools** menu contains more useful tools for troubleshooting. Note that a great deal of the information is only valuable for your supplier’s service department.

Select **Tools > Maintenance > Analysis** to open the following menu items, see Table 36.

For further information, refer to Control Builder online help.

Table 36. The menu items of the Analysis tool.

Menu Item	Function
Disable Double-buffering	*Not useful for troubleshooting*
Disable Information Zoom	*Not useful for troubleshooting*
Disable Clipping	*Not useful for troubleshooting*
Image Selector Info in Online Mode	*Not useful for troubleshooting*
Image Selector Information	*Not useful for troubleshooting*
Show control modules in Online Mode	*Not useful for troubleshooting*
Write Variable Memory	Used for counting modules and instances.
Write Exported Variables	*Not useful for troubleshooting*
Write Variables in View	*Not useful for troubleshooting*
Start log	Shows the Control Builder Start log, described in Control Builder Start Log on page 332.
System log	Shows the Control Builder System log, described in System Log File on page 326.

Statistics for Application

The user can get the statistics about the application, for example, the number of instances that exists in the application. This is useful when the maximum number of instances has been exceeded. From the context menu of the selected application, select **Statistics** as shown in Figure 139.

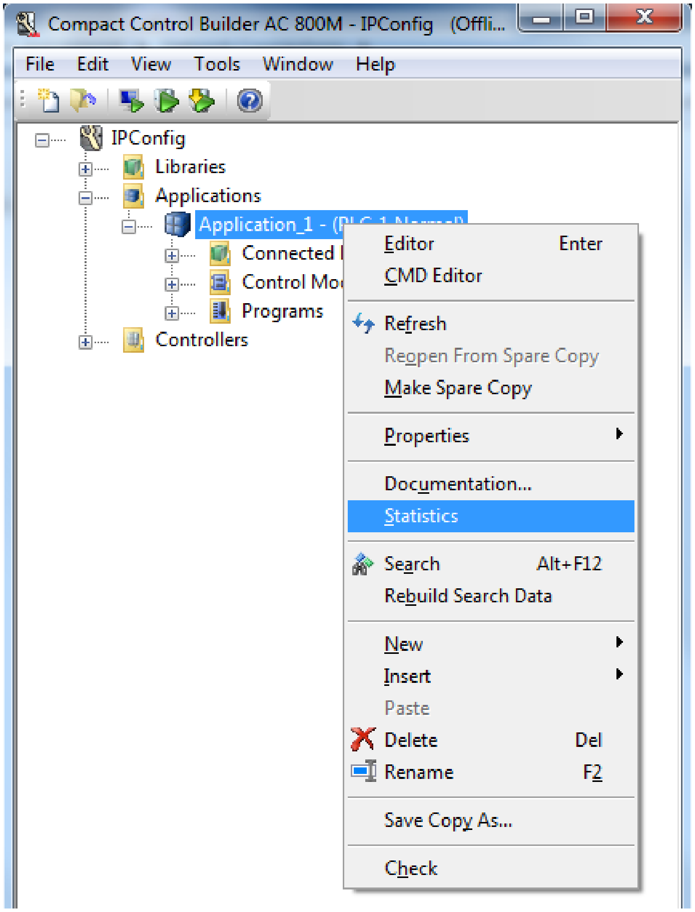
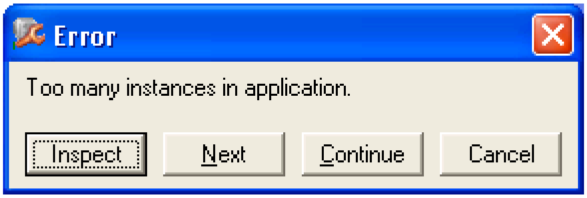


Figure 139. Obtaining statistics for the application

The maximum number of instances in an application is 65536. When this number is exceeded, the following dialog is shown.


Error

Too many instances in application.

Figure 140. Error message shown at download, when an application has too many instances.

System Diagnostics

System Diagnostics Function Block

The Basic library contains a function block type called *System Diagnostics*. You can use this function block type to measure and display the following functions.

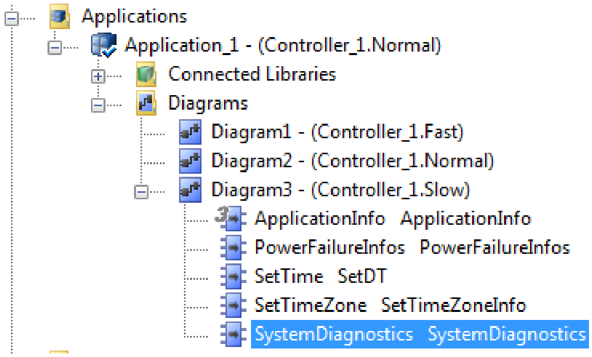
- Cyclic load resulting from task execution,
- Stop time and memory usage during a controller download,

  A stop at each download occurs When a new application version is downloaded. The length of this stop is mainly affected by the number of variables marked as retain or cold retain. Each variable marked retain or cold retain must keep the value at a download with warm restart. The copying takes time and copying more values requires more time. The attribute retain should only be set for variables if they really require such an attribute, as this attribute increases the stop time during download of program changes to the controller. When the new version of the application has been created in the controller, the old application is stopped (i.e start of stop time) then all values are copied from the old application to the new. The new application version is then started (i.e end of stop time). During the copying instances, the application exists in two versions, one old and one new. This is the reason for the extra memory needed.

- Current memory in use,
- Maximum memory used since the last cold start,

- Alarm and event information,
- Total CPU Load,
- Ethernet statistics:
  - number of data packages sent,
  - number of sent data packages that were lost,
  - number of data packages received,
  - number of received data packages that were lost.

The System Diagnostics function block is, as default, located in one of the *Diagram* folders of the Project Explorer tree, see Figure 141.



```
Applications
  Application_1 - (Controller_1.Normal)
    Connected Libraries
    Diagrams
      Diagram1 - (Controller_1.Fast)
      Diagram2 - (Controller_1.Normal)
      Diagram3 - (Controller_1.Slow)
        ApplicationInfo  ApplicationInfo
        PowerFailureInfos  PowerFailureInfos
        SetTime  SetDT
        SetTimeZone  SetTimeZoneInfo
        SystemDiagnostics  SystemDiagnostics
```

Figure 141. The System Diagnostics function block

Values can be updated either on command or cyclically using the Interaction Window, which is opened by selecting the *System Diagnostics* function block, right-clicking, and then selecting **Interaction Window**.

The System Diagnostics Interaction window is only available in Test/Online mode.

System Diagnostics Interaction Window.

The System Diagnostics Interaction window contains system memory and program download information. The interaction windows can be displayed in two versions, *Simple* and *Advanced*.

The values shown in Test mode are not those valid in Online mode. You cannot use this information to check in advance which controller size you have to purchase.

The *Simple* Interaction window contains the following information:

Table 37. The Simple Interaction window

Function	**Description**
System	Displays the TCP/IP address of the supervised system.
Cyclic load	Displays cyclic load due to task execution in percent.
Latest update	Displays the time of the last update.
Cyclic update	Cyclic update is activated by checking the check box. Cyclic update interval is set in time format, for example 5 m (5 minutes).
Total Load CPU	Shows the total CPU load for the controller. The total load is available as a parameter of type dint, called *TotalSystemLoadPerCent*.
Ethernet Statistics	By clicking the **Ethernet** button, you display Ethernet statistics in a separate window. This window shows the number of sent/received packages, and how many of those that were lost. These statistics are available as parameters. There are also parameters for resetting the counters. See online help for the SystemDiagnostics function block.

Click on the **Advanced** button, and the *Advanced* Interaction window will appear. It contains the following additional information.

Table 38. The Advanced interaction window.

Function	**Description**
Memory size	The allocated heap size, see Figure 142.
Used memory	The part of the heap used in bytes and percent of the total heap size.
Max used memory	The maximum part of the heap used in bytes and percent of the total heap size.
Memory quota	The part of the total heap size available when program changes are sent to the controller. If the memory quota is exceeded an error icon is displayed. Note. This setting is only used for a warning indication.
Stop time	Stop time during the last download.
Init peak memory	Memory used during initiation phase.
Used memory at stop	The part of the heap used during the stop phase in bytes and percent of the total heap size.
Max used memory at stop	The maximum part of the heap used during the stop phase in bytes and percent of the total heap size.
Memory quota at download	The part of the total heap size available when program changes are sent to the controller. If the memory quota is exceeded an error icon is displayed.

In the System Diagnostics function block, “Memory size” is the total physical memory, minus executing firmware. This is sometimes also called the “heap”.

Memory usage is also displayed in the dialog “Heap Utilization” which can be displayed for each controller. The available memory is called “Non-Used Heap” and the rest is called “Used Shared Heap”.

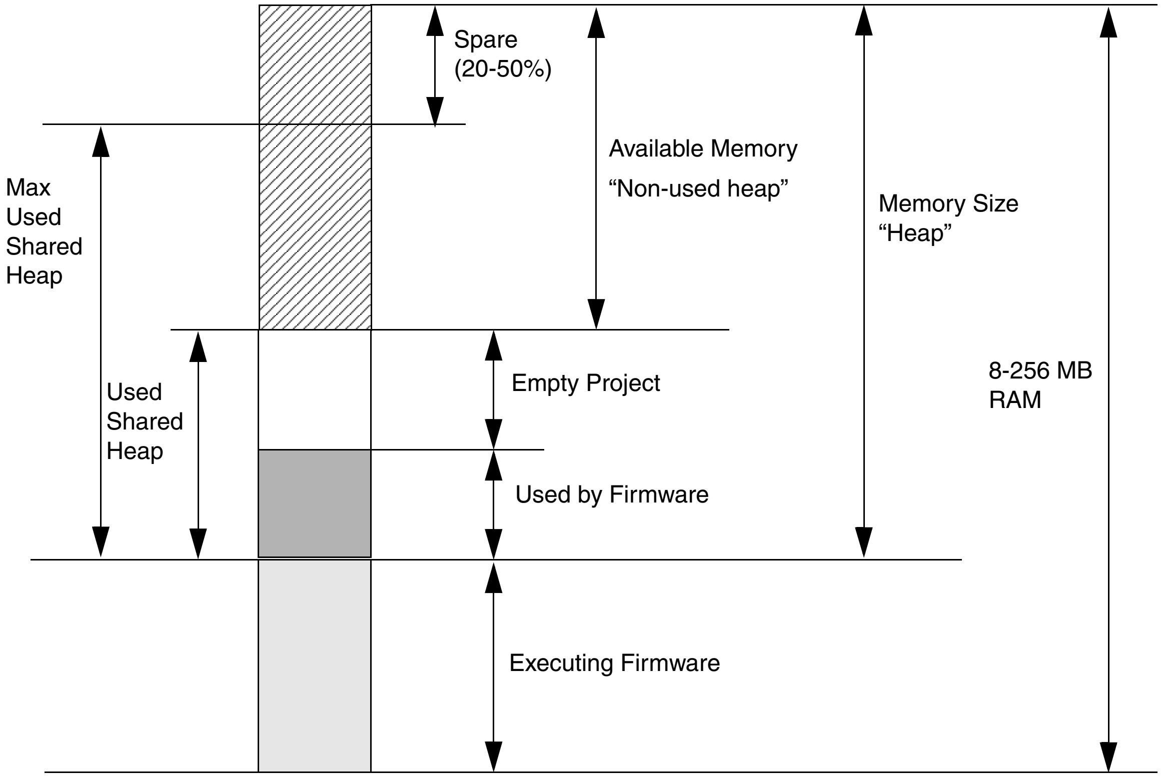


Figure 142. Memory organization

Trouble-Shooting Error Symptoms

Below are some examples of error symptoms and suggested measures.

Table 39. Examples of error symptoms and suggested measures.

Error Symptom	Measure
Control Builder fails.	1.Click **OK**. 2.Copy the two crash dump files (see Crash Dumps for Analysis and Fault-Localization on page 341), the Start Log and the Heap Statistics Log files (if there are any). 3.Read the Session Log, and see if there is any information that indicates the source of the problem. 4.Try to start Control Builder. If it starts, select **Help>About Compact Control Builder>List all information** in the Project Explorer and the Control Builder System Information Report will be created. 5.Try to reproduce the fault, if possible. If the problem is reproducible, export the project with all dependencies and include the .afw file in the error report. 6.Check basic things, such as if the hard disk full. 7.If the fault appears during Offline to Online transfer, and it is possible to reproduce the fault, check the message written in the message pane, just prior to fault occurrence. This will give a hint about what operation (for example, sorting, compiling) and what application is involved in the problem. 8.Make an error report and include the log files.
A *Memory Full* message appears. The Heap Statistics log (SoftController) states that the heap is full.	Increase the heap size in SoftController, see Heap Statistics Log on page 336. Open **Help > About** and check the amount of free memory. Free memory should not be lower than 30%.

Table 39. Examples of error symptoms and suggested measures. (Continued)

Error Symptom	Measure
A *Too many instances in application* message appears. The maximum number of above 65534 instances has been reached.	1.Try to reduce your application, see Statistics for Application on page 352.
The MMS Server, OPC Server, or SoftController fails.	1.Click **OK**. 2.Locate the two crash dump files (see Crash Dumps for Analysis and Fault-Localization on page 341). 3.Read the Session Log, and see if there is any information that points to the source of the problem. 4.Make an error report and include the log file.
The controller fails. The red F LED is lit, and the green R LED is off.	1.Press the **Init** push-button on the controller until the **R**un LED starts to blink. Note that the controller will be empty if the red F LED is lit, that is, the application program has been deleted. 2.Fetch the Controller System log and save it, see Remote Systems Information on page 342. 3.Study the log, and find the marked reason for the stop (normally, at the end of the log). 4.If an OPC Server for AC 800M is involved in communication, check the OPC Server function. 5.Make an error report and include the saved log files. 6.Reload the application. 7.If possible, try to reproduce the problem. If the problem is reproducible, backup the project. Note that behavior similar to the example above is when there is no firmware installed in the controller (for example, when a new controller has been installed).

Error Reports

An error report contains information to the problem in question. A detailed report is particularly valuable if your supplier's service department is to be involved.

The following information should *always* be included in an error report.

- Name of the person reporting the error (and the project, site, customer, etc.).
- Product (including the type of product and version).
- A listing of all information from the faulty system, such as the appropriate logs and reports, see Log Files on page 326. The latter includes a great deal of information such as software version and revision, setup, etc. If the fault occurred during, or just after downloading a new version of the application program, the Control Builder Start Log and the Control Builder Session Log from the engineering station that performed the download should be included. Whenever a problem involving I/O handling occurs, it is very important to include a complete description of the I/O configuration.
- A description of the problem. Add all information that could help solve the problem, for example, what happened just before the error occurred, and other important circumstances. If it is possible to reproduce the error, describe the circumstances under which the error occurs. Sometimes it is advisable to create a small application to demonstrate the error, and add it to the error report.

ℹ If several systems are involved, information about the system configuration must be included (hardware type, etc.).

Appendix A Array, Queue and Conversion Examples

In this section you will find examples on how to handle arrays, queues, and some examples on how to use bit conversion functions.

Arrays

It is possible to create a one-dimensional array with elements of any type, that is, the elements can be a struct with variables of any type, or a single variable of any type. Using PutArray and/or CopyArray, it is possible to build a tree structure of arrays. Array elements are accessed direct via an index. A lower and upper boundary of the index should be defined. The array must first be created using CreateArray.

The size of an array is limited to 65,524 components (variables of simple data type).

Example

In this example, there is a data type *trec1* with the components *b* (bool), *i* (dint), and *st* (string).

The following variables are also needed:

Name	Data Type	Initial Value
MyArray	ArrayObject	
Irec	trec1	
Irec1	trec1	
Irec2	trec1	
Irec3	trec1	
Status	dint	
FirstScan	bool	TRUE

Create and initialize an array with 20 array elements of the type *trec1*.

Use an IF – THEN statement for the CreateArray function and let it be controlled by a variable, which is executed once during startup.

```
IF FirstScan THEN
FirstScan := false;
CreateArray(MyArray,1,20,lrec,status);
end_if;
```

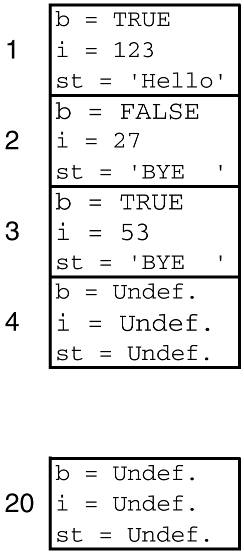
Set up values for the different variables:

```
lrec1.b := TRUE
lrec1.i := 123
lrec1.st := A variable contaning the string 'Hello'
lrec2.b := FALSE
lrec2.i := 27
lrec2.st := A variable contaning the string 'BYE'
lrec3.b := TRUE
lrec3.i := 53
lrec3.st := A variable contaning the string 'BYE'
```

Set up the array contents:

```
PutArray (MyArray,1,lrec1,status);
PutArray (MyArray,2,lrec2,status);
PutArray (MyArray,3,lrec3,status);
```

The array now contains the following:



```
1   b = TRUE
    i = 123
    st = 'Hello'
2   b = FALSE
    i = 27
    st = 'BYE   '
3   b = TRUE
    i = 53
    st = 'BYE   '
4   b = Undef.
    i = Undef.
    st = Undef.

20  b = Undef.
    i = Undef.
    st = Undef.
```

SearchStructComponent

SearchStructComponent is a boolean function which searches for a specific part in a record component. The corresponding components in *Exrecord* are scanned to find a part in the component which matches the *SearchComponent*.

```
Variable = SearchStructComponent(Struct, SearchIndex,
SearchCount, SearchStruct, SearchComponent, FoundStruct,
Status)
```

Table 40.

Parameter	Data type	Direction
Struct	AnyType	in_out
SearchIndex	dint	in_out
SearchCount	dint	in
SearchStruct	AnyType	in_out
SearchComponent	AnyType	in_out
FoundStruct	AnyType	in_out
Status	dint	in_out

The data type *SearchComponent* is either a single variable or a record containing a couple of variables corresponding to a subset of the record component in *Struct*. The *SearchComponent* could be either a boolean, integer, real or string data type or a sub record which contains these data types. The *SearchRecord* shall consist of a variable of *SearchType* and variables of the data types as the remaining variables in the record component and at the same positions.

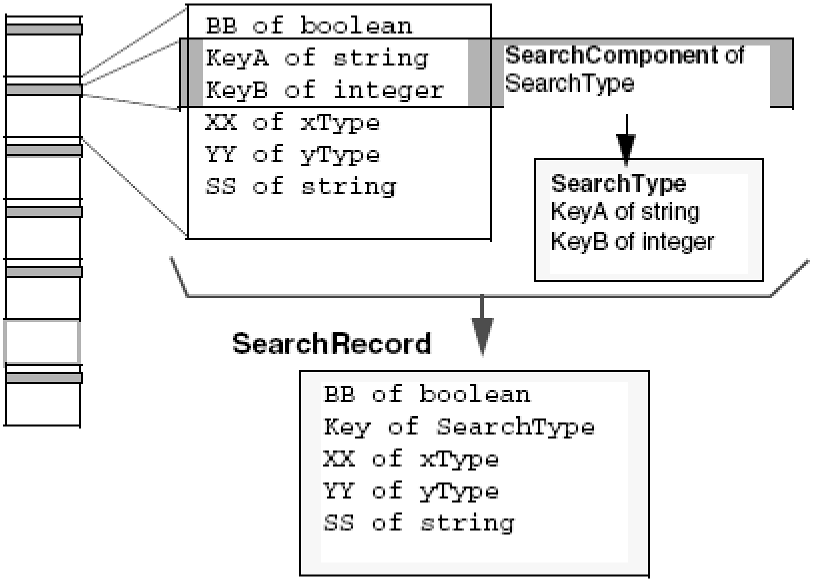


Figure 143. An example of the SearchComponent and a SearchRecord.

The *SearchComponent* may contain structured data types but the match is only carried out on the boolean, integer, real and string data types. The variables in *SearchComponent* of string data types must have the same length and content for a match. The content of string is not case sensitive and the space characters are treated as any other character. On match the whole record component is copied to *FoundStruct* and the function returns true.

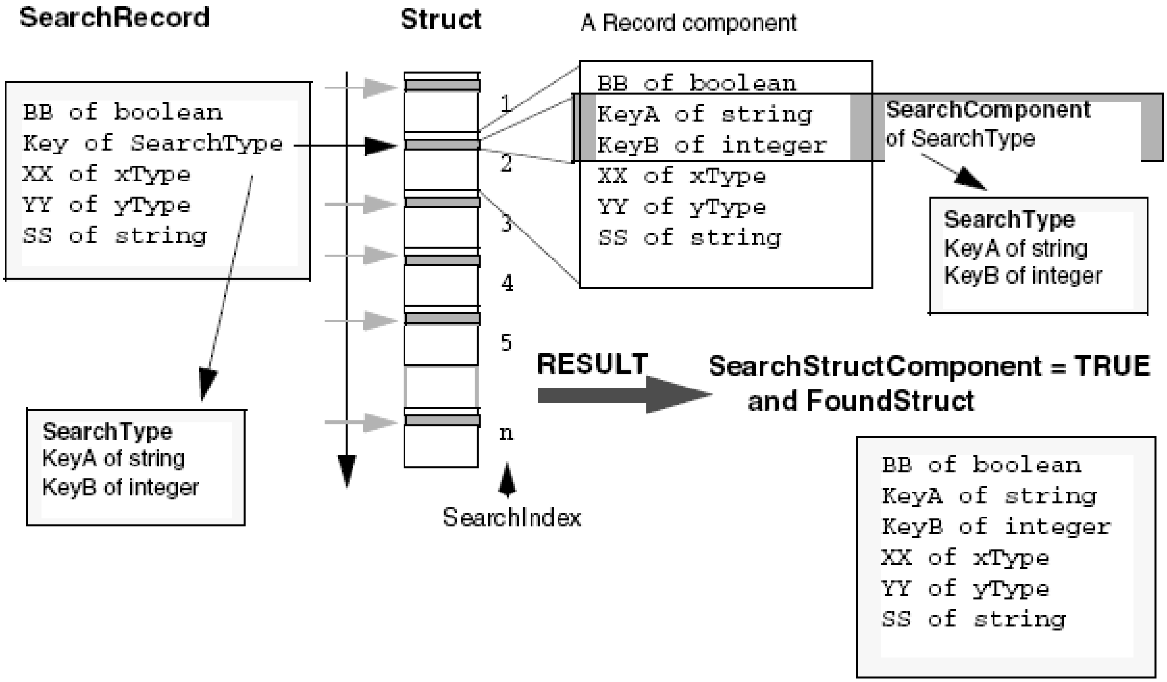


Figure 144. The working principal of the SearchStructComponent.

The search starts in the index *SearchIndex + 1* and ends at the first equivalent component located or, if there are no more sub-records, in the last component of the record.

A maximum number of record components given by *SearchCount* are scanned. The component, in which a match occurs, is returned in *FoundStruct* and the index is returned in *SearchIndex*.

Note that *SearchIndex* always points to the last record component that was scanned, even if no matching occurs. This index can then be used in a repeated call to find all occurrences of *SearchComponent* within the record.

Restrictions

The following data types in *ExRecord* will NOT be copied: *QueueObject* and *tObject*.

The status returns:

- (1 Success)
  - The Search was successful
- (- 5 ErrTypeMismatch)
  - 1: Found sub-record was not of the same type as the *structRecord*.
  - 2: *SearchComponent* was not a subset of *SearchRecord*
- (- 6 ErrSizeMismatch)
  - 1: *SearchRecord* was not of the same size as the *StructRecord*.
  - 2: *SearchComponent* size is zero.
- (-30 ErrInvalidPar)
  - 1: *SearchIndex* was less than 0 or greater than the number of the *Struct* minus one.
  - 2: *SearchCount* was less or equal to zero.
  - 3: *SearchComponent* has no valid components (i.e., boolean, real, integer or string)

InsertArray

InsertArray(Array, Index, ArrayElement, Status)

Procedure: Inserts a new element in an array. All successive elements are moved one step, and the last element overwritten. Inserts the contents of *ArrayElement* into the record at position Index in the array *Array*. The records at position *Index* + 1 to position *LastIndex* will be moved one position higher. The contents (even objects) of the record at position *LastIndex* will be lost. Variables of the data type *tObjects* will not be copied, unless the variable is an *ArrayObject*, then this array and its whole tree structure of arrays will be copied into an identical tree structure. If the record at position Index lacks some array in the tree structure, the array will be created.

Table 41.

Parameter	Data type	Direction
Array	ArrayObject	in_out
Index	dint	in
ArrayElement	AnyType	in_out
Status	dint	in_out

SearchArray

SearchArray(Array, SearchIndex, SearchCount, SearchElement, SearchComponent, FoundElement, Status)

This boolean function searches the array *Array* for a certain component in an array element. All elements in the array are scanned to find an element with a component (e.g. a string, or an entire record) that matches the search variable component.

The component *SearchComponent* in the element *SearchElement* is tested for equality with corresponding components in each array element. The function returns true if there is a find.

The search starts in the index *SearchIndex* + 1 and ends at the first equivalent component located or if there are no more elements in the array to be scanned. A maximum of number of array elements indicated by *SearchCount* are scanned. The array element, in which a find occurs, is returned in *FoundElement* and the index for the find is also returned in *SearchIndex*.

Note that SearchIndex always points to the last element that was scanned, even if no find occurs. This index can then be used in a repeated call in order to find all occurrences of SearchComponent within the array.

An error status is returned if:

- the index *SearchIndex* points outside array limits.
- the counter *SearchCount* is less then or equal to 0.
- the element *SearchElement* is not of the same type as *FoundElement*.
- the element *SearchElement* has a different size than *FoundElement*.
- the *SearchComponent* is not a part of the element *SearchElement*.

Table 42.

Parameter	Data type	Direction
Array	ArrayObject	in_out
SearchIndex	dint	in_out
SearchCount	dint	in
SearchElement	AnyType	in_out
SearchComponent	AnyType	in_out
FoundElement	AnyType	in_out
Status	dint	in_out

Example

Table 43. Data Type Definitions

Name	Data Type
trec1	Struct
b	Boolean
i	dint
s	String
tSearchStruct	STRUCT
b	Boolean
SSR	tSearchSubRec
tSearchSubStruct	Struct
i	dint
s	String

Table 44. Variables

Name	Data type	Initial value
Array	ArrayObject	
HitBoolean	Boolean	
HitRec	trec1	
Lrec	trec1	
lrec1	trec1	
lrec2	trec1	
lrec3	trec1	
Status	dint	
SearchRec	tSearchStruct	
FirstScan	Boolean	TRUE

Create and initialize an array with 20 array elements of type trec1.

The Create function may be in a Start_Code and in that case it is not necessary to use the IF -THEN statement and Firstscan variable.

```
IF Firstscan THEN
Firstscan = false;
CreateArray(Array,1,20,lrec,status);
ENDIF;
```

Set up values for the different variables e.g. via interaction objects:

```
lrec1.b <- TRUE
lrec1.i <- 123
lrec1.s <- "hello"
lrec2.b <- FALSE
lrec2.i <- 27
lrec2.s <- "BYE"
lrec3.b <- TRUE
lrec3.i <- 53
lrec3.s <- "BYE"
```

Set up array contents:

```
PutArray (Array,1,lrec1,status);
PutArray (Array,2,lrec2,status);
PutArray (Array,3,lrec3,status);
```

The array now contains the following:

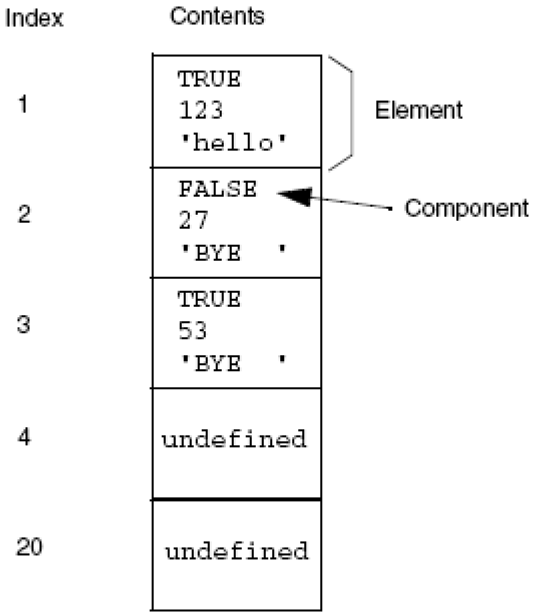


Figure 145. An example of an Array.

Access the array by index:

```
Index = 3;
GetArray(Array,Index,lrec,status);


lrec now contains:
TRUE 53 "BYE "
```

Now access the array by searching. First set up the search component.

```
SearchRec.SSR.i = 27;
```

SearchRec.SSR.s has its default value "BYE" Search a maximum of 10 array elements for the search component. A find occurs where the integer element is 27 and the string element is "BYE", in this case at array index no 2. Start searching in the first element number 1.

```
Index = 0;
IF SearchArray(Array,Index,10,SearchRec,SearchRec.SSR,
HitRec,Status) THEN
IF Status > 0 THEN
HitBoolean = HitRec.b;(Save Boolean content of hit element)
ENDIF;
ENDIF;
```

Queues

A queue may consist of elements of any type, that is, the elements could be a struct with variables of any type, or a single variable of any type. Queue elements can be accessed at both ends of the queue, that is, only the first and last element can be accessed, but any element in the queue can be read. When using PutFirstQueue and GetFirstQueue, the queue act as a stack. When using PutLastQueue and GetFirstQueue, the queue will act as a FIFO queue. The size of the queue is not dynamic, and has to be defined. The number of elements in the queue is dynamic.

The size of a queue is limited to 65,524 components (variables of simple data type).

Example 1

The following structured variable *Item* is needed:

Name	Data Type	Initial Value
b	bool	TRUE
i	dint	123
st	string	'Hello'

The following variables are needed:

Name	Data Type	Initial Value
data1	Item	
data2	Item	
Queue	QueueObject	
Status	dint	
FirstScan	bool	TRUE
flag1	bool	
flag2	bool	

Create and initialize an array with 10 elements of data type item:

In an IF – THEN statement the *CreateQueue* function may be controlled by a first scan variable.

```
if FirstScan then
  FirstScan := false;
  CreateQueue( Queue := Queue,
    Size := 10,
    QueueElement := data1,
    Status := status );
end_if;
if flag1 then
  PutLastQueue( Queue := Queue,
    QueueElement := data2,
    Status := status );
    flag1 := false;
elsif flag2 then
  GetFirstQueue( Queue := Queue,
    QueueElement := data2,
    Status := status );
  flag2 := false;
end_if;
```

Example 2

The following parameters are needed:

Name	Data Type	Description
Size	dint	Max no. of elements in queue
InData	AnyType	In element, of same type as OutData
OutData	AnyType	Out element, of same type as InData
Put	bool	Put InData in queue on up edge
Get	bool	Get OutData from queue on up edge
Clear	bool	Clear contents of queue
Error	bool	Out: type or size of error

The following variables are needed:

Name	Data Type	Description
Queue	QueueObject	Queue object
PutState	bool state	
GetState	bool state	
Status	dint	

Code block 1 called Start_name

```
(*CreateQueue*)
CreateQueue(Queue,Size,InData,status);
Error := status < 0;
```

Code block 2 (queue statement)

```
PutState := Put;
GetState := Get;
if PutState:NEW and not PutState:OLD then
  PutLastQueue(Queue,InData,status);
  Error := status < 0;
end_if;
if GetState:NEW and not GetState:OLD then
  GetFirstQueue(Queue,OutData,status);
  Error := status < 0;
end_if;
if Clear then
  ClearQueue(Queue,status);
  Error := false;
end_if;
```

Conversion Functions

DIntToBCD

The DIntToBCD function converts an integer to a BCD value. An error status is returned if overflow occurs and no BCD value is produced.

Example

The following variables are needed:

Name	**Data Type**
N	dint
BCD	dint
Status	dint

Convert an integer into a BCD value:

`N` = 12345 (`N` is 0 0 0 1 2 3 4 5)

`N` can be divided into eight four-bit nibbles, where each nibble represents one BCD digit. The least significant nibble is 5, the next 4, etc. These nibbles can be written in binary form as below:

All four-bit nibbles				0000	0000	0000	0001	0010	0011	0100	0101
which is equiv. to	00	000	000	000	000	010	010	001	101	000	101
BCD as decimal value	0	0	0	0	0	0	7	4	5	6	5

```
   DIntToBCD ( N, BCD, Status ) ;
```

`BCD` now contains the value 74565.

BCDToDInt

BCDToDInt converts a BCD value to an integer. An error status is returned if the BCD value is illegal (no integer value in these cases).

Example

The following variables are needed:

Name	**Data Type**
N	dint
BCD	dint
Status	dint

Convert the BCD value into an integer:

`BCD` = 74565

BCD as decimal value	0	0	0	0	0	0	7	4	5	6	5
BCD as 32-bit pattern	00	000	000	000	000	010	010	001	101	000	101
BCD as four-bit nibbles				0000	0000	0000	0001	0010	0011	0100	0101

Each nibble represents one BCD digit. The least significant nibble is 5, the next 4, etc. These nibbles can be written in decimal form as: 0 0 0 1 2 3 4 5.

```
BCDToDInt ( BCD, N, Status ) ;
```

`N` now contains the value 12345.

ASCII

ASCII character codes

ASCII (American Standards Committee for Information Interchange) originally defined a set of codes for 128 characters and commands. Manufacturers later extended the ASCII codes to provide another 128 characters.

ASCII is a method of coding characters and command sequences, which is extensively used by manufacturers of peripheral equipment. Many devices transmit information in ASCII code (for example bar-code readers, keyboards) and many devices accept information in this form (for example VDUs and printers).

ASCII-coded strings allow for the transmission of non-printable characters and control characters. ASCII character sequences can be used to change the mode of a VDU display, or the character set of a printer.

Control Builder provides three procedures and one function manipulating ASCII strings (ISO Latin-1 only). These are useful when a device requires ASCII-coded information, and can be used to send ASCII-coded strings to printers, terminals etc.

Any ASCII character code may be used, thus it is possible to send control characters and sequences to switch printers and VDUs into various display modes. (Bold, Double Space, Reverse video etc.).

Before describing the procedures and functions available for ASCII strings, it is useful to examine the way in which an integer is stored in the system memory.

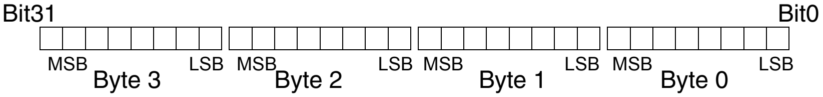


Figure 146. Integers are stored as four bytes in memory.

Integers are represented by a four-byte (32-bit) storage area. In normal usage, the bits are used to store both the value and the sign of the integer. This 4-byte storage space may also be used to store a series of values which represent an ASCII string.

Each ASCII character requires 1 byte of storage space. Therefore, it is possible to store up to 4 ASCII characters in a single memory area reserved for an integer.

The procedures below allow 1, 2 or 4 characters to be stored per integer.

Each ASCII character is coded with an integer value (in binary) between 0 and 255 (decimal). ASCII codes are normally represented as either their decimal equivalent, or as a hexadecimal number. If the character is represented as a hexadecimal number, then 2 digits are required for each character.

The hexadecimal digits, their decimal, and binary bit pattern equivalents are given in the table below:

Table 45. ASCII code representatives

Hexadecimal digit	Decimal digit	Binary bit pattern
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

The letter capital “A” is represented by the ASCII code 65_{10} or 41_{HEX}. Thus the letter “A” is stored as a byte having the bit pattern 0100 0001.

ASCII Conversion

StringToASCIIStruct (String1, NoOfCharsPerDint, DintStruct, Status)

This procedure converts a string to an ASCIIStruct. An ASCIIStruct consists of any number of integer components (see below).

The value of the parameter *NoOfCharsPerDint* determines how many ASCII characters are stored within each ASCII record component. This value can be 1, 2, 4 or –1, –2, –4 only. A negative value means that the sequence of bytes is reversed.

NoOfCharsPerDint determines how many character codes are packed into the four bytes available for the integer. If one character is stored per integer, then only the first eight least significant bits of each integer are used for storage, if positive, or the last eight, if negative.

DintStruct must be defined as follows: the type definition and its components can be given any name, but the components must all be of integer data type. The number of components (of integer type) should be decided based on the length of the string to be converted, and also the number of characters which are to be stored in each integer. The converted string may need to be transmitted to a peripheral device, so the characteristics of this device should also be taken into account.

The maximum length for any string is 140 characters, and if this maximum is to be stored in the minimum number of integer components, then this will require 35 integer components in the integer record (at four ASCII characters per integer). If you anticipate the need to store this number of characters, then an integer record of 35 integer components should be defined.

Status returns an indication of the result of the operation.

Storage with Different Character Packing Factors

When *NoOfCharsPerDint* is set to 1, each integer variable holds the value for one ASCII character. Thus the character capital “A” is stored as decimal 65 in the integer, as a bit pattern of 0100 (Nibble1) and 0001 (Nibble0).

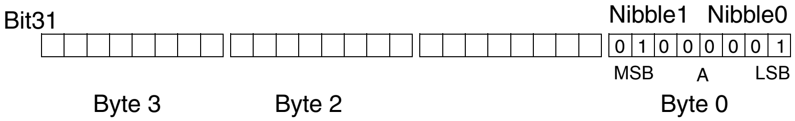


Figure 147. The ASCII code for “A” stored in an integer (packing = 1 character per integer)

When *NoOfCharsPerDint* is set to 2, each integer variable stores the value for two ASCII characters. The characters “AB” are stored as decimals 65 and 66 in the integer. The value 65 for “A” is stored in the first byte of the integer, and that for “B” in the second byte.

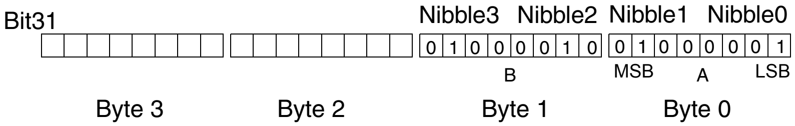


Figure 148. The ASCII codes for “AB” stored in an integer (packing = 2 characters per integer)

When *NoOfCharsPerDint* is set to 4, each integer variable contains the value for four ASCII characters. The characters “ABCD” are stored as decimals 65, 66, 67 and 68 in the integer. The value 65 for “A” is stored in the first byte of the integer, “B” in the second byte, “C” in the third byte, and “D” in the fourth byte.

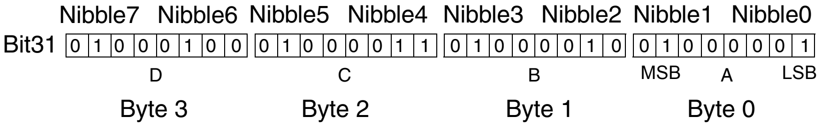


Figure 149. The ASCII codes for “ABCD” stored in an integer (packing = 4 characters per integer)

Definition of DintStruct type

The appropriate length of an integer struct to store ASCII code is defined by the number of components required as follows.

Suppose we want to be able to store the maximum string length at a packing factor of 4 characters per integer. A data type called, for instance, *ASCIIMaxStringType,* should be defined consisting of 35 components which must be of integer data type called, for example *Chars1_4*, *Chars5_8* etc.

Usage

A string interaction is used to input the value of a string, (to a string variable called *String1*), which is to be converted to ASCII code. The code is stored in an integer struct called *IntStruct* which has 4 components (*Comp1* to *Comp4*).

The procedure call:

```
StringToASCIIStruct(String1,1,IntStruct,Status1)
```

will write to the integer record components.

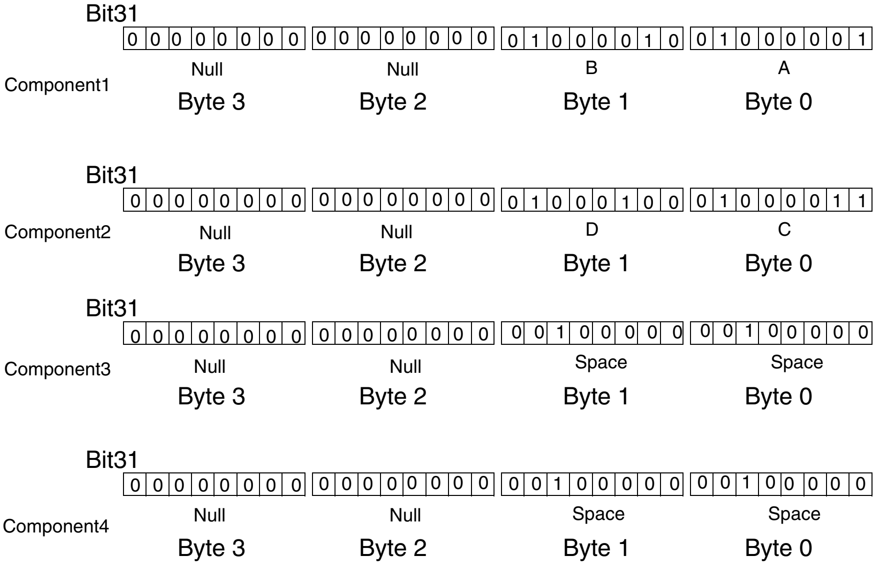
If the input string is “ABCD”, then the components will have the values 65, 66, 67 and 68, respectively. The literal value of 1 for the *NoOfCharsPerDint* determines that there is to be one character code in each component.

If *NoOfCharsPerDint* had been set to 2, then the first integer component would have the value 16961 (which is the decimal equivalent of 65 in the first byte and 66 in the second), and the second component would have the value 17475, which is the decimal equivalent of 67 in the first byte and 68 in the second. The other two bytes in each integer component are set to 0000.

Unused components

NoOfCharsPerDint determines how many bits are allocated for storage (8 bits – 1 byte per character) for a component. For example, if *NoOfCharsPerDint* is set to 2, then only the first two bytes are used in each component for data storage. The remaining bytes are set to 0 (zero).

This is illustrated below:



Bit31

	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 1 0 0 0 0 1 0	0 1 0 0 0 0 0 1
Component1	Null	Null	B	A
	Byte 3	Byte 2	Byte 1	Byte 0

Bit31

	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 1 0 0 0 1 0 0	0 1 0 0 0 0 1 1
Component2	Null	Null	D	C
	Byte 3	Byte 2	Byte 1	Byte 0

Bit31

	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 1 0 0 0 0 0	0 0 1 0 0 0 0 0
Component3	Null	Null	Space	Space
	Byte 3	Byte 2	Byte 1	Byte 0

Bit31

	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 1 0 0 0 0 0	0 0 1 0 0 0 0 0
Component4	Null	Null	Space	Space
	Byte 3	Byte 2	Byte 1	Byte 0

Figure 150. The diagram shows four integer components of an integer record. NoOfCharsPerDint has been set to 2, so that each component stores two ASCII characters. The character string "ABCD" has been transferred to the struct.

Note the following

If there are two characters per integer, the allocated storage areas Byte 0 and Byte 1 contain either the code for the string character, or if there is no character available, the code for a space (20_{HEX}). Unused bit positions (Bytes 2 and 3 in this case) contain zero.

Note:

- Characters from the string to be transferred are read from the current pointer position in the source string.
- Space characters are inserted into the allocated storage areas within each component. They are also inserted into all records to which no characters have been transferred, for example, if the actual string requires less than the number of components available for storage.
- An error status is returned to the value of *Status,* if the string to be transferred is longer than the storage space allocated. In this case, no transfer of any part of the string occurs.

ASCIIStructToString(DIntStruct, NoOfCharacters, NoOfCharsPerDint, String1, Status)

This procedure is the reverse of *StringToASCIIStruct* described above. It takes an integer struct, which contains the codes for an ASCII string, and recreates the string from the values in the components of the record. (See *StringToASCIIStruct* for full details of the structure of the integer struct and the encoding method.)

The component values of the integer struct, *DIntStruct* are read and translated to the value of the destination string, *String1*.

The value of the parameter *NoOfCharacters* determines how many ASCII characters are read from the source record, *DIntStruct*, and the value of the parameter *NoOfCharsPerDInt* informs the procedure how many characters are to be expected in each integer component. *Status* returns an indication of the result of the operation.

The *DIntStruct* parameter must be structured as an integer struct, that is, it must have integer components only. (See details in *StringToASCIIStruct*.)

NoOfCharacters and *NoOfCharsPerDInt* may be variables, module parameters or literals.

Usage

Suppose the integer struct *DIntStruct* from the previous example is to be converted back to a string. The destination string is called *String1* and the three characters are to be copied. It is known that the original storage protocol defined 2 characters per integer component.

The following code will perform the task:

```
ASCIIStructToString(DIntStruct,3,2,String1,Status2)
```

After execution the value of *String1* value will be “ABC”.

Note

- The number of characters per integer of the original record must be known, only values of 1, 2, 4 or –1, –2, –4 are allowed.
- The new output string will be inserted at the current pointer position in the destination string.
- An error status is reported as a value to *Status* if the generated string results in a new string which is longer than the permitted length for the destination string.

Appendix B System Alarms and Events

This section is divided in sub-sections for system alarms and system simple events and it describes system alarms and system simple events from a controller perspective. Additional information can also be found in the Control Builder online help.

General

OPC Server

System alarms and system simple events generated within OPC server can be divided in two general groups regarding to originating part of the OPC server (source).

- Software
- Subscriptions

Controller

System alarms and system simple events generated within controller can be divided in two general groups regarding to originating part of the controller (source).

- Software generated system alarms and system simple events.
- Hardware generated system alarms and system simple events.

OPC Server – Software

All system alarms and system simple events triggered by base code executing in OPC Server belong to this group. This group is further divided into appropriate parts uniquely identified by source name suffix.

- _SWFirmware – for common base code
- _SWDataAccess – for OPC Data Access specific code
- _SWAlarmEvent – for OPC Alarm and Event specific code

The SrcName shall be automatically formed as:

SrcName = SystemIP address- SrcNameSuffix

Example: SrcName = 172.16.85.90:200-_SWFirmware

SrcNameSuffix = _SWFirmware

System Alarm **HeapFull**

SrcNameSuffix = _SWFirmware;
Condition name = HeapFull;
Message = "(1000) The Heap is full";
SeverityLevel = High;

SrcNameSuffix = _SWDataAccess

System Simple Event **SaveColdRetainFailed**

Generated when OPC Data Access server can not save cold retain files for an application.

SrcNameSuffix = _SWFirmware;
Message = "(5000) Save Cold Retain failed for {1}";
{1} = The name of the application.
SeverityLevel = Medium;

SrcNameSuffix = _SWAlarmEvent

System Simple Event **AlarmNotUnique**

Generated when OPCAE server discover that there are two alarms with same combination SouceName ConditionName defined in two different controllers.

SrcNameSuffix = _SWAlarmEvent ;
Message = "(6000) Alarm not unique {1}, {2}";
{1} = Source name of the alarm
{2} = Condition name of the alarm
SeverityLevel = Medium;

System Simple Event **AlarmHandler overflow**

Generated when an item in the EventHandler must be deleted because of overflow. If there is space again in the EventHandler, the system initializes an AlarmSummary and updates the missing information. The size of the EventHandler is limited by the system variable MaxNoOfAlarms.

SrcNameSuffix = _SWAlarmEvent ;
Message = "(6001) AlarmHandler overflow. MaxNoOfAlarms exceeded";
SeverityLevel = Medium;

System Simple Event **FailedToSubscribe**

Generated when a try from OPC AE server to subscribe to a certain control system was not successful. The corresponding control system name shall be concatenated to this message.

SrcNameSuffix = _SWAlarmEvent;
Message = "(6002) Failed to subscribe on {1}";
{1} = The IP address of the control system.
SeverityLevel = Medium;

System Simple Event **Overflow in queue to OPC client**

Generated after an overflow of the event queue to an OPC client queue and when the queue is filled less than 75% of the actual size. The system event is generated and sent to the client to announce the overflow. On overflow the latest event is thrown away. The size of every event queue to an OPC client queue is limited by the system setting "Queue size".

SrcNameSuffix = _SWAlarmEvent;
Message = "(6003) Overflow in queue to OPC client";
SeverityLevel = Medium;

OPC Server – Subscription

OPC server can subscribe a number of controllers from both Data Access and Alarm and Event part. Thus, each subscribed controller may have one or two system alarms for its disposal, depending on number of subscription to controller from OPC server. These system alarms must be created in a moment of corresponding connection i.e. subscription establishing.

The **SrcNameSuffix** for *Data Access* subscriptions group is:

SrcNameSuffix = SubDataAccess
Example: SourceName = 172.16.85.90:22-SubDataAccess

The **SrcNameSuffix** for *Alarm and Event* subscriptions group is:

SrcNameSuffix = SubAlarmEvent
Example: SourceName = 172.16.85.90:22-SubAlarmEvent

The **ConditionName** for these system alarms is supposed to provide a unique combination of SrcName and ConditionName (since SrcName is the same for whole category). Thus, ConditionName has form that contains controller IP address.

Example: ConditionName = 172.16.85.90:2-ConnectionError

The following category of system alarms and system simple events handle errors and warnings concerning connection towards subscribed controllers.

SrcNameSuffix = SubDataAccess

Each controller subscribed from Data Access should have one system alarm for its disposal. Note that these system alarms shall be:

- defined when a new subscription (connection) is established
- activated when an error occurs on this connection
- inactivated when all errors are corrected or disappeared
- deleted when subscription is removed

Condition name has form that includes subscribed controller IP address. It is created dynamically but last part is always the same: "-ConnectionError".
Example: Condition name = 10.46.37.121:2-ConnectionError.

System Alarm **ConnectionError to DA subscription**

SrcNameSuffix = SubDataAccess;
Condition name = -ConnectionError;
Message = "(5500) Connection error to DA subscribed controller";
Severity Level = Critical;

SrcNameSuffix = SubAlarmEvent

Each controller subscribed from Alarm and Event should have one system alarm for its disposal. Note that these system alarms shall be:

- defined when a new subscription (connection) is established
- activated when an error occurs on this connection
- inactivated when all errors are corrected or disappeared
- deleted when subscription is removed

Condition name has form that includes subscribed controller IP address. It is created dynamically but last part is always the same: "-ConnectionError".
Example: Condition name = "10.46.37.121:2-ConnectionError".

System Alarm **ConnectionError to AE subscription**

SrcNameSuffix = SubAlarmEvent;
Condition name = -ConnectionError;
Message = "(6500) Connection error to AE subscribed controller";
Severity Level = Critical;

Controller – Software

All system alarms and system simple events triggered by base code belongs to this group.

This is important to note that system alarms and system simple events issued by protocol specific code may belong to this group. Normally system alarms and system simple events issued by protocol specific code are handled within 'Hardware group'. Under certain circumstances when it is necessary to define errors or warnings that are not cowered by HW state error handling, this group i.e. corresponding dedicated SrcNameSuffix should be used. The following set of source name suffixes are defined for this group.

- _SWFirmware - for base code
- _SW1131Task - for 1131 task execution specific code
- _SWTargets - for HW and OS abstraction layer of the base code
- _SWInsum-, _SWS100-, _SWMB300-, _SWProfibus-, _SWModbus- [1]for protocol specific code

SrcNameSuffix = _SWFirmware

System Alarm **HeapFull**

SrcNameSuffix = _SWFirmware;
Condition name = HeapFull;
Message = "(1000) The Heap is full";
SeverityLevel = High;

[1] System alarms and system simple events generated by respective communication protocol are described in the online help function for respective protocol.

System Alarm **ErrorHandler sum alarm**

SrcNameSuffix = _SWFirmware
Condition name = ErrorHandler;
Message = "(1001) ErrorHandler sum alarm created";
SeverityLevel = Medium;

System Alarm **Data transfer failed during FW-upgrade of Alarm&Even**t

This alarm is generated when Alarm&Event failed in the transfer of Alarm&Event data from Primary CPU to Trainee CPU. It shows how many items of different Alarm&Event data that failed. The consequence after upgrade could be that inactive alarms disappear but active alarms will be activated again.

SrcNameSuffix = _SWFirmware;
Condition name = HeapFull;
Message = "(1002) Alarm&Event failed in FW-upgrade. No of Static alarms = {1}. No of Simple events = {2}. No of Dynamic alarms = {3}. No of SOE-events = {4}";
{1} = Number of failed items.
{2} = Number of failed items.
{3} = Number of failed items.
{4} = Number of failed items.
SeverityLevel = High;

System Simple Event **EventNotificationLost**

An event notification was lost. This can happen when the particular OPC-Server or printer queue containing event notification is full. A system simple event is generated when there is space again in this queue. After this the missing information about alarms in the subscribing systems-OPC Servers is updated, but this does not mean that all missed events are regenerated.

SrcNameSuffix = _SWFirmware;
Message = "(1010) Lost event notification(s) to {1}";
{1} = The remote systems (the OPC Servers) IP address when generated event indicates full OPC-Server queue or with string "local printer" when there is a lost event notification from a filled buffer in printer queue.
Severity Level = Medium;

System Simple Event **Alarm definition failed**

An attempt to define a process alarm in controller, or a system alarm in controller or in OPC server was not successfully completed.

SrcNameSuffix = _SWFirmware;
Message = "(1011) Alarm definition failed for {1}, {2}";
{1} = Source name
{2} = Condition name
Severity Level = Low;

System Simple Event **Undeclared External event**

A low level event issued by external device is received, but no declaration was found in applications.

SrcNameSuffix = _SWFirmware;
Message = "(1012) Undeclared external event; {1}";
{1} = Signal ID and new value delivered by low level event.
Severity Level = Medium;

System Simple Event **Event notification(s) lost during firmware upgrade**

Generated if events are lost during firmware upgrade

SrcNameSuffix = _SWFirmware;
Message = "(1014) Event notification(s) lost during firmware upgrade"
SeverityLevel = Medium

System Simple Event **Alarm definition(s) failed during firmware upgrade**

Generated if there are attempting to create alarms during firmware upgrade.

SrcNameSuffix = _SWFirmware;
Message = "(1015) Alarm definition(s) failed during firmware upgrade"
SeverityLevel = Medium

System Simple Event **CommandedSwitchover**

The system event below is issued when a commanded switchover has successfully been executed.

SrcNameSuffix = _SWFirmware;
Message = "(1020) CPU Switchover was commanded";
SeverityLevel = Medium;

System Simple Event **CommandedSwitchoverFailed**

The system event below is issued when a commanded switchover has been unsuccessfully executed.

SrcNameSuffix = _SWFirmware;
Message = "(1021) CPU Switchover command failed";
SeverityLevel = Medium;

System Simple Event **Reset of backup CPU was commanded**

The system event below is issued when a commanded reset of backup CPU has successfully been executed.

SrcNameSuffix = _SWFirmware;
Message = "(1022) Reset of backup CPU was commanded";
SeverityLevel = Medium;

System Simple Event **Reset of backup CPU command failed**

The system event below is issued when a commanded reset of backup CPU has unsuccessfully been executed.

SrcNameSuffix = _SWFirmware;
Message = "(1023) Reset of backup CPU command failed";
SeverityLevel = Medium;

System Simple Event **Error found in DataToSimpleEvent**

The system event below is generated during calls to DataToSimpleEvent function block.

SrcNameSuffix = _SWFirmware;
Message = "(1030) AE setting NamValItem/LogStrings to low";
Message = "(1031) Error in FB parameters";
Message = "(1032) Data overflow in communication buffer";
SeverityLevel = Medium;

System Simple Event **Reset of controller forces performed**

System event generated from Access Management. Message when Override Control has made a reset of controller forces.

SrcNameSuffix = _SWFirmware;
Message = "(1033) Reset of controller forces performed";
SeverityLevel = Medium;

System Simple Event **Ack of event denied**

System event generated from Access Management, when acknowledgement of an alarm is denied.

SrcNameSuffix = _SWFirmware;
Message = "(1034) Acknowledge of event denied ({1}, {2})";
{1} = source name of the alarm
{2} = condition name of the alarm
SeverityLevel = Medium;

System Simple Event **No configuration image found at compact flash card**

The system event below is issued when a compact flash card, without a configuration image, is detected during startup of controller.

SrcNameSuffix = _SWFirmware;
Message = ">(1040) No configuration image found at compact flash card";
SeverityLevel = Medium;

System Simple Event **Configuration image found at compact flash card is corrupt**

The system event below is issued when a compact flash card, with a corrupt configuration image, is detected during startup of controller

SrcNameSuffix = _SWFirmware;
Message = "(1041) Configuration image found at compact flash is corrupt";
SeverityLevel = Medium;

System Simple Event **Configuration image found at compact flash does not match controller**

SrcNameSuffix = _SWFirmware;
Message = "(1042) Configuration image found at compact flash does not match controller"
SeverityLevel = Medium

System Simple Event **Configuration load is started from compact flash**

SrcNameSuffix = _SWFirmware;
Message = "(1043) Configuration load is started from compact flash"
SeverityLevel = Medium

System Simple Event **Configuration image found at compact flash has different format**

SrcNameSuffix = _SWFirmware;
Message = "(1044) Configuration image found at compact flash has different format"
SeverityLevel = Medium

System Simple Event **Configuration image found at compact flash does not match controller**

The system event below is issued when a compact flash card, with a configuration image created for another type of CPU, is detected during startup of controller.

SrcNameSuffix = _SWFirmware;
Message = "(1042) Configuration image found at compact flash does not match controller"
SeverityLevel = Medium;

System Simple Event **Configuration load is started from compact flash**

The system event below is issued when a compact flash card, with a valid configuration image, is detected during startup of controller.

SrcNameSuffix = _SWFirmware;
Message = "(1043) Configuration load is started from compact flash"
SeverityLevel = Medium;

System Simple Event **Configuration image found at compact flash has not equal format**

The system event below is issued when a compact flash card, with a configuration image created in a format not supported, is detected during startup of controller.

SrcNameSuffix = _SWFirmware;
Message = "(1044) Configuration image found at compact flash has different format"
SeverityLevel = Medium;

System Simple Event

SrcNameSuffix = _SWFirmware;
Message = “(1045) Write attempt to constant variable {1} of instance {2}";
Severity Level = High;

System Simple Event

SrcNameSuffix = _SWFirmware;
Message = “(1046) System variable LogConstAbuse set to 0 since limit on {1} messages reached";
Severity Level = High;

This message can occur on process alarms when the alarms have not executed yet. For example, after an OLU. It should only occur temporarily and will disappear when the execution has started and the alarm have changed state or when OPC/AE clients (example PPA) are refreshed.

Message = “(1047) The message text is temporarily unavailable since the alarm is issued before 1131 has been run.";
Severity Level = Medium;

SrcNameSuffix = _SW1131Task

System Alarm **TaskAbort**

SrcNameSuffix = _SW1131Task;
Condition name = TaskAbort;
Message = "(2000) Execution time too long in Task {1}";
{1} = Task name will be added to message, for example, "Execution time too long in Task Fast"
Severity Level = Fatal;

System Simple Event **Interval time in ordinary tasks inc**

SrcNameSuffix = _SW1131Task;
Message = "(2001) Interval time in ordinary tasks increased {1}%";
{1} = The increase of the interval time in percent with the precision of one decimal.
Severity Level = Medium;

System Simple Event **Interval time in ordinary tasks dec**

SrcNameSuffix = _SW1131Task;
Message = "(2002) Interval time in ordinary tasks decreased {1}%";
{1} = The decrease of the interval time in percent with the precision of one decimal.

Severity Level = Medium;

System Simple Event **Interval Time was changed**

Only used for tasks executing at Time-Critical priority.

SrcNameSuffix = _SW1131Task;
Message = "(2003) Interval time changed to {1} ms. Task={2}";
{1} = New interval time ,
{2} = Name of the task.
Severity Level = Medium;

System Alarm **Latency high in normal tasks**

The alarm is activated when actual latency is 70 % of max latency.

SrcNameSuffix = _SW1131Task;
Message On = "(2004) Latency high in task {1}, {2} ms"
{1} = Name of the task,
{2} = Actual latency.
Message Off = "(2004) Latency high inactive "
Condition name = High Latency
SeverityLevel = Medium

System Alarm **Latency high in time critical task**

The alarm is activated when actual latency is 70 % of max latency.

SrcNameSuffix = _SW1131Task;
Message On = "(2005) Latency high in task {1}, {2} ms"
Message Off = "(2005) Latency high inactive "
{1} = Name of the task,
{2} = Actual latency.

Condition name = High Latency
SeverityLevel = Medium

SrcNameSuffix = _SWTargets

System Simple Event **RCU error detected in the Primary CPU**

SrcNameSuffix = _SWTargets;
Message = "(4000) Primary CPU: RCUError(0x{2})";
{2} = Content of the RCU Error Register in hexadecimal format.
Severity Level = High;

This event is issued from the RCU Driver if redundancy has been shut down due to an internal error in the RCU Driver found at the end of synchronization.

System Simple Event

SrcNameSuffix = _SWTargets;
Message = “(4025) Failed to set RCU Driver state to

eRCUTakeoverPossible";
Severity Level = High;

This event is issued from the RCU Driver if redundancy has been shut down due to an internal error in the RCU Driver found at the start of synchronization.

System Simple Event

SrcNameSuffix = _SWTargets;
Message = “(4026) Failed to set RCU Driver state to eRCUNormal";
Severity Level = High;

This event is issued from the RCU Driver if Online Upgrade has been suspended due to an internal error in the RCU Driver.

System Simple Event

SrcNameSuffix = _SWTargets;
Message = “(4027) Failed to set RCU Driver state to eRCUOLU";
Severity Level = High;

System Simple Event **RCU test error detected in the Primary CPU**

SrcNameSuffix = _SWTargets;
Message = "(4001) Primary CPU: RCUTestError({2}, 0x{3})";

{2} = Test Number
1 = RCU Register test
2 = Log Parity test
3 = Log test
4 = Log Range test
5 = I O Emulation test
6 = CPU Bus Timeout test

{3} = The Error status is printed in hexadecimal format.

Severity Level = High;

System Simple Event **Dual test error detected in the Primary CPU**

SrcNameSuffix = _SWTargets;
Message = "(4002) Primary CPU: DualTestError({2}, 0x{3})";
{2} = The Dual Test status (see Table 46)

{3} = The Error status is printed in hexadecimal format.
Severity Level = High;

Table 46. Dual Test status.

Message	Description
CPUCEXBusMsgSendError	Failed to send test message to the Backup CPU
CPUCEXBusMessageError	Failed to receive test message from the Backup CPU
CheckpointTestError	Failed to upgrade memory of the Backup CPU

System Simple Event **Backup CPU CEX-Bus test error detected in the Primary CPU**

SrcNameSuffix = _SWTargets;
Message = "(4003) Primary CPU: BkpCEXBusTestError({2}, 0x{3})";
{2} = The Test status (see Table 47)
{3} = The Error status is printed in hexadecimal format.
Severity Level = High;

Table 47. Test status from Backup CPU

Message	Description
CPUCEXBusMsgSendError	Failed to send test message to the Backup CPU
CPUCEXBusMessageError	Failed to receive response message from the Backup CPU
CEXBusTestError	Failed to test the CEX-Bus interface in the Backup CPU

System Simple Event **Error detected in the Primary CPU**

SrcNameSuffix = _SWTargets;
Message = "(4004) Primary CPU: {2} in state {3}";
{2} = The name of the detected error (see Table 48)
{3} = The state when the error was detected.
Severity Level = High;

Table 48. The name of the detected error.

Message	Description
SDCError	RCU Service data channel error
RCUConnectorOpen	The RCU Link cable is not connected to the own CPU
RCUOtherConnectorOpen	The RCU Link cable is not connected to the peer CPU
RCUDrvErro	Failed when calling the RCU driver

Table 48. The name of the detected error.

Message	Description
InitCommError	Failed to initialize interrupt handling with the peer CPU
InformCommParamError	Failed to inform other CPU about communication parameters
GetCommParamError	Failed to get communication parameters from other CPU
BkpCPUNotAlive	The Backup CPU is not alive
BkpCPUCEXBusError	Backup CPU not connected to the CEX-bus
BkpCPUIllegalExternalState	Backup CPU has an illegal External state
Timeout	Backup CPU has not sent a response message within a specified timeout time
CloningStartError	Failed to start cloning in state Upgrading
CloningNotCompletedError	Cloning not completed in state Unconfirmed
CloningError	Cloning failed in state Synchronized
BkpFirmwareError	Backup CPU's firmware id not equal to Primary CPU's firmware id

System Simple Event **A Backup CPU is recognized and started**

SrcNameSuffix = _SWTargets;
Message = "(4005) Primary CPU: Backup CPU started";
Severity Level = Medium;

System Simple Event **The system has reached the Synchronized state**

The Backup CPU is ready to take-over if the Primary CPU fails

SrcNameSuffix = _SWTargets;
Message = "(4006) Primary CPU: Synchronized state";
Severity Level = Medium;

System Simple Event **Switchover has occurred**

SrcNameSuffix = _SWTargets;
Message = "(4007) Switchover to {2} has occurred";
{2} = "Lower CPU" or "Upper CPU"
Severity Level = Medium;

System Simple Event **Report of Backup CPU error after a switchover**

SrcNameSuffix = _SWTargets;
Message = "(4008) Primary CPU: {2} in {3}";
{2} = The error reported from the backup CPU
{3} = The position reported from the backup CPU
Severity Level = Medium;

System Simple Event **The Backup CPU has stopped**

SrcNameSuffix = _SWTargets;
Message = "(4009) Primary CPU: Backup CPU stopped ({2})";
{2} = Stop reason (seeTable 49)
Severity Level = High;

Table 49. Stop reason.

Message	**Description**
BkpCPUCEXBusError	Backup CPU not connected to the CEX bus
BkpHaltRequest	A Backup CPU problem has been detected in the Primary CPU. The Backup CPU however seems fully alive
BkpCPUNotAlive	The Backup CPU has stopped or been removed without reporting its status to the Primary CPU
Status sent from backup CPU	Backup CPU status received via the CEX bus

System Simple Event **The Primary CPU has halted**

SrcNameSuffix = _SWTargets;
Message = "(4010) Primary CPU: CPU halted";
Severity Level = High;

System Simple Event **RCU error detected in the Backup CPU**

SrcNameSuffix = _SWTargets;
Message = "(4020) Backup CPU: RCUError(0x{2})";
{2} = The contents of the RCU Error Register in hexadecimal format.
Severity Level = High;

System Simple Event **RCU test error detected in the Backup CPU**

SrcNameSuffix = _SWTargets;
Message = "(4021) Backup CPU: RCUTestError({2}, 0x{3})";
{2} = Test Number (see Table 50)
{3} = Error Status. in hexadecimal format.
Severity Level = High;

Table 50. Test Number

Test Number	Error Status
1	RCU Register test
2	Log Parity test
3	Log test
4	Log Range test
5	I/O Emulation test
6	CPU Bus Timeout test

System Simple Event **Dual test error detected in the Backup CPU**

SrcNameSuffix = _SWTargets;
Message = "(4022) Backup CPU: DualTestError({2}, 0x{3})";
{2} = Dual Test status (see Table 51)
{3} = Error Status. in hexadecimal format.
Severity Level = High;

Table 51. Dual Test status.

Message	Description
CPUCEXBusMsgSendError	Failed to send test message to the Primary CPU
CPUCEXBusMessageError	Failed to receive test message from the Primary CPU
RCUDrvError	Failed when calling the RCU driver to set threshold value for the Log Data Buffer

System Simple Event **Error detected in the Backup CPU**

SrcNameSuffix = _SWTargets;
Message = "(4023) Backup CPU: {2} in state {3}";
{2} = The name of the detected error (see Table 52)
{3} = The state when the error was detected.
Severity Level = High;

Table 52. The name of the detected error.

Message	Description
SDCError	RCU Service data channel error
RCUConnectorOpen	The RCU Link cable is not connected to the own CPU
RCUOtherConnectorOpen	The RCU Link cable is not connected to the peer CPU
RCUDrvError	Failed when calling the RCU driver
InitCommError	Failed to initialize interrupt handling with the peer CPU
InformCommParamError	Failed to inform other CPU about communication parameters
GetCommParamError	Failed to get communication parameters from other CPU

Table 52. The name of the detected error. (Continued)

Message	Description
EqualityCheckFailed	Memory upgrading of Backup CPU has failed
RCUMessageHaltReceived	A Halt request has been received from the Primary CPU
PrimCPUExitConnection	Primary CPU has exit connection

System Simple Event **The Backup CPU has halted**

SrcNameSuffix = _SWTargets;
Message = "(4024) Backup CPU: CPU halted";
Severity Level = High;

System Simple Event **Stopped due to ModuleBus inaccessible from Backup CPU**

This event is issued from the MBTestMC unit if the Backup CPU has been stopped due redundancy supporting modules on the module bus turned out to be inaccessible from the Backup CPU.

SrcNameSuffix = _SWTargets;
Message = "(4030) Stopped due to ModuleBus inaccessible from Backup CPU";
Severity Level = "High";

This event is issued from the RCU Driver if the Backup CPU has been halted due to an overload situation in the redundancy control HW.

System Simple Event

SrcNameSuffix = _SWTargets;
Message = “(4028) RCU LDB overflow has occured in Backup/trainee PM";
Severity Level = High;

This event is issued if the Backup CPU has been halted during start-up due to that it uses the same MAC address as the Primary CPU. (This can happen if the original Primary CPU unit has been removed from a redundant controller and the same unit is later re-inserted as spare part in the same running controller.)

System Simple Event

SrcNameSuffix = _SWTargets;
Message = “(4042) Backup CPU has the same MAC Address as Primary CPU";
Severity Level = High;

System Simple Event **Switched over due to ModuleBus inaccessible from Primary CPU**

This event is issued from the MBTestMC unit if a switch-over occurred due to redundancy supporting modules on the module bus turned out to be inaccessible from the Primary CPU.

SrcNameSuffix = _SWTargets;
Message = "(4031) Switched over, ModuleBus inaccessible from Primary CPU";
Severity Level = High;

Events from Network Interface Supervision

System Simple Event **Backup CPU halted: Bad Network interface**

This event is issued from the NIS primary task if the Backup CPU has been halted due to both network interface in Backup CPU are not working properly.

SrcNameSuffix = _SWTargets;
Message = "(4040) Backup CPU halted: Bad Network interface";
Severity Level = High;

Events from Checking of Available MAC address in Backup

System Simple Event **No MAC address in Backup CPU**

This event is issued to the primary PM if the backup PM has no MAC address.

SrcNameSuffix = _SWTargets;
Message = "(4041) No MAC address in backup PM";
Severity Level = High;

Events from Modulebus driver

System Simple Event **Diverse pointer check**

This event is issued from the check of pointers to the DPM which is used in all accesses to read/write data to/from IO modules.

SrcNameSuffix = _SWTargets;
Message = "(4050) Fatal Error in diverse pointer check";
Severity Level = Fatal;

System Simple Event **Failed to send message to queue**

SrcNameSuffix = _SWTargets;
Message = "(4051) Mbus msgQ failed: control of Primary/Backup Leds not run";
Severity Level = Low;

System Simple Event **Null pointer**

SrcNameSuffix = _SWTargets;
Message = "(4052) Null pointer check failed";
Severity Level = Fatal;

System Simple Event **Failed to create message queue**

SrcNameSuffix = _SWTargets;
Message = "(4053) Failed to create message queue";
Severity Level = High;

System Simple Event **Test of RAM Error in MBM1 failed**

SrcNameSuffix = _SWTargets;
Message = "(4054) Cyclic test of Ram Error in MBM1 failed";
Severity Level = Critical;

System Simple Event **Runtime RAM Error in MBM1**

SrcNameSuffix = _SWTargets;
Message = "(4055) Runtime Ram Error in MBM1";
Severity Level = Critical;

System Simple Event **Diagnostic test of CRC32 calculator in FPGA failed**

SrcNameSuffix = _SWTargets;
Message = "(4056) Cyclic test of CRC32 calculator failed in {1}";
{1} = Cause of failure. Example: checkFailed, timeout
Severity Level = Critical;

System Simple Event **Switch PM is performed via errorHandler**

SrcNameSuffix = _SWTargets;
Message = "(4057) Failure in SM detected by PM";
Severity Level = Critical;

System Simple Event **Switch PM is performed via errorHandler due to Bus Error**

SrcNameSuffix = _SWTargets;
Message = "(4058) Try to switch PM due to Bus Error";

Severity Level = Critical;

System Simple Event **CPU interface error in MBM1**

SrcNameSuffix = _SWTargets;
Message = "(4059) CPU interface error in FPGA";
Severity Level = Critical;

Events from the MMU

System Simple Event **Software errors**

SrcNameSuffix = _SWTargets;
Message = "(4060) Software error detected by MMU";
Severity Level = Fatal;

System Simple Event **Memory violation**

SrcNameSuffix = _SWTargets;
Message = "(4061) Attempted write access in write-protected memory";
Severity Level = Fatal;

System Simple Event **MMU checker error**

SrcNameSuffix = _SWTargets;
Message = "(4062) Unexpected write in protected memory";
Severity Level = Critical;

System Simple Event **DMA checker error**

SrcNameSuffix = _SWTargets;
Message = "(4063) DMA Checker time. Test failed";
Severity Level = Critical;

System Simple Event **Primary CPU: DMA memory violation**

SrcNameSuffix = _SWTargets;
Message = "(4064) Primary CPU: DMA memory violation at {2}"
{2} = General fail address information
SeverityLevel = High

Events from FW Integrity Verification

Indication that FW CRC did not match original in primary PM.

SrcNameSuffix = _SWTargets;
Message = "(4070) FW Integrity Verification primary:CRC did not match original";
Severity Level = Medium;

Indication that FW CRC did not match original in backup PM.

SrcNameSuffix = _SWTargets;
Message = "(4071) FW Integrity Verification backup:CRC did not match original";
Severity Level = Medium;

Indication that FW CRC did not match in stand alone PM.

SrcNameSuffix = _SWTargets;
Message = "(4072) FW Integrity Verification standalone:CRC did not match original";
Severity Level = Medium;

Address parameter failure in FW Integrity Verification.

SrcNameSuffix = _SWTargets;
Message = "(4073) FW Integrity Verification: Address parameter failure";
Severity Level = Medium;

System Simple Event **CRC error in FW Integrety Verification**

SrcNameSuffix = _SWTargets;
Message = "(4074) FW Integrity Verification trainee CRC did not match original"
SeverityLevel = Critical

Events from the Heap: Software Errors

SrcNameSuffix = _SWTargets;
Message = "(4080) Software error detected by Heap manager";
Severity Level = Fatal;

Events from the Heap: Memory Violation

SrcNameSuffix = _SWTargets;

Message = "(4081) Heap violation during allocation of an element";
Severity Level = Fatal;

Message = "(4082) Heap violation during deallocation of an element";
Severity Level = Fatal;

Message = "(4083) Null element is deallocated in the heap";
Severity Level = Fatal;

Message = "(4084) Corrupt element is deallocated in the heap";
Severity Level = Fatal;

Message = "(4085) Corrupt elements are detected after a power fail";

Severity Level = Fatal;

Message = "(4086) The Protected Heap is out of memory";
Severity Level = Low;

Message = "(4087) The Shared Heap is out of memory";
Severity Level = Low;

Message = "(4093) The max boundary size of an element is exceeded in the Shared Heap";
Severity Level = Medium;

Message = "(4094) The max boundary size of an element is exceeded in the Protected Heap";
Severity Level = Medium;

Events from the Heap: Heap Checker Error

System Simple Event **MemFree error - CPU Switch**

SrcNameSuffix = _SWTargets;
Message = "(4088) Heap Checker detects a corrupt element during deallocation of an element";
Severity Level = Critical;

System Simple Event **MemFree error - no CPU Switch**

SrcNameSuffix = _SWTargets;
Message = "(4089) Heap Checker detects a corrupt element during deallocation of an element";
Severity Level = Fatal;

System Simple Event **Synchronous heap check error - logging**

SrcNameSuffix = _SWTargets;
Message = "(4090) Corrupt element during synchronous heap check";
Severity Level = Low;

System Simple Event **Cyclic heap check error - CPU Switch**

SrcNameSuffix = _SWTargets;
Message = "(4091) Corrupt element during cyclic heap check";
Severity Level = Critical;

System Simple Event **Cyclic heap check error - no CPU Switch**

SrcNameSuffix = _SWTargets;
Message = "(4092) Corrupt element during cyclic heap check";
Severity Level = Fatal;

System Simple Event **Max boundary size exceeded in the Shared Heap**

SrcNameSuffix = _SWTargets
Message = "(4093) The max boundary size of an element is exceeded in the Shared Heap."
SeverityLevel = Medium

System Simple Event **Max boundary size exceeded in the Protected Heap**

SrcNameSuffix = _SWTargets
Message = (4094) The max boundary size of an element is exceeded in the Protected Heap."
SeverityLevel = Medium

Events from Irq Supervisor

These messages are short (twelve characters) since most of them have to be printed from interrupt context when an irq error has occurred, which means there is only a very small time margin.

SrcNameSuffix = _SWTargets;

Message = "(4100) Irq error. Unable to spawn Reset Irq Supervisor thread";
Severity Level = Medium;

Message = "(4101) Irq error. MSCallout array full; not possible to add SuperviseIrq; the IrqSupervision thread will be suspended";
Severity Level = Medium;

Message = "(4102) Irq error. Irq supervisor: Irq timed out; primary PM will be shut down";
Severity Level = Medium;

Message = "(4103) Irq error. Irq supervisor: Irq timed out; backup PM was shut down";
Severity Level = Medium;

Message = "(4104) Irq error. Irq supervisor: Irq timed out error in standalone PM";
Severity Level = Medium;

Message = "(4105) Irq error. Unable to create a OS periodic timer, the IrqSupervision thread will be suspended";
Severity Level = Medium;

Message = "(4106) Iirq error. Unable to raise thread priority, the IrqSupervision thread will be suspended";
Severity Level = Medium;

Message = "(4107) Irq supervisor: Irq timed out; trainee PM was shut down"
SeverityLevel = Medium

Events from CEX Bus Interrupt Handler

SrcNameSuffix = _SWTargets;

Message = "(4110) Hanging CEX IRQ: All CEMs on the upper CEX bus segment are disabled";
Severity Level = Medium;

Message = "(4111) Hanging CEX IRQ: All CEMs on the lower CEX bus segment are disabled";
Severity Level = Medium;

Message = "(4112) Hanging CEX IRQ: The upper PM has been shut down";
Severity Level = Critical;

Message = "(4113) Hanging CEX IRQ: The lower PM has been shut down";
Severity Level = Medium;

Message = "(4115) Invalid IRQ CEM {1}: All CEMs on this CEX bus segment are disabled";
{1} = Module number of interrupting CEM
Severity Level = Medium;

Message = "(4116) Invalid IRQ CEM {1}: All CEMs on this CEX bus segment are disabled";
{1} = Module number of interrupting CEM.
Severity Level = Medium;

Message = "(4117) Invalid CEX IRQ backup PM: The upper PM has been shut down";
Severity Level = Medium;

Message = "(4118) Invalid CEX IRQ backup PM: The lower PM has been shut down";
Severity Level = Medium;

Message = "(4119) Spurious CEX IRQ: {1} spurious IRQs since system startup";
{1} = Number of spurious IRQ since start
Severity Level = Low;

Message = "(4120) Hanging CEX IRQ: All CEMs on the dir CEX bus segment are disabled";
Severity Level = Medium;

Message = "(4121) Hanging CEX IRQ: All CEMs on the indir CEX bus segment are disabled";
Severity Level = Medium;

Message = "(4122) Hanging CEX IRQ: The PM has been shut down";
Severity Level = Critical;

Message = "(4123) Invalid IRQ CEM {1}: All CEMs on this CEX bus segment are disabled";
{1} = Module number of interrupting CEM
Severity Level = Medium;

Message = "(4124) Invalid IRQ CEM {1}: All CEMs on this CEX bus segment are disabled";
{1} = Module number of interrupting CEM
Severity Level = Medium;

Message = "(4125) Insufficient memory to create the Reset BC thread";
Severity Level = Medium;

Events from DMA Supervisor

SrcNameSuffix = _SWTargets;

Message = "(4126) Error in DMA Supervisor configuration";
Severity Level = Fatal;

Events from Internal Diagnostics Engine

SrcNameSuffix = _SWTargets;

Message = "(4130) Software error detected by Diagnostic Engine";
Severity Level = Medium;

Message = "(4131) Diagnostic Engine: FDRT deadline passed";
Severity Level = Medium;

Message = "(4132) Diagnostic Engine: Diurnal deadline passed";
Severity Level = Medium;

Events from RAMTest

SrcNameSuffix = _SWTargets;

Message = "(4133) RAMTest Primary Parity error self test;
Severity Level = Critical;

Message = "(4134) RAMTest Backup Parity error self test";
Severity Level = Critical;

Message = "(4135) RAMTest Standalone Parity error self test";
Severity Level = Critical;

Message = "(4136) RAMTest Primary Address line test 0x{1}";
{1} = Fail address
Severity Level = Critical;

Message = "(4137) RAMTest Backup Address line test 0x{1}";
{1} = Fail address
Severity Level = Critical;

Message = "(4138) RAMTest Standalone Address line test 0x{1}";
Severity Level = Critical;
{1} = Fail address

Message = "(4139) RAMTest Primary Internal error";
Severity Level = Fatal;

Message = "(4140) RAMTest Backup Internal error";
Severity Level = Fatal;

Message = "(4141) RAMTest Standalone Internal error";
Severity Level = Fatal;

Events from the RCU CRC Checker

SrcNameSuffix = _SWTargets;

Message = "(4142) Hardware error detected by RCU CRC Checker";
Severity Level = Critical;

Events from RAMTest

Message = "(4143) RAMTest Trainee Parity error self test"
SeverityLevel = = Critical

Message = "(4144) RAMTest Trainee Address line test 0x{1}"
{1} = Fail address
SeverityLevel = Critical

Message = "(4145) RAMTest Backup Internal error"
SeverityLevel =Critical

Events from SSPActiveTest

Message = "(4146) SSP error detected by SSPActiveTest"
SeverityLevel = Fatal

Events from HWSetupVerification

These events are issued if HW Setup Verification detected an error in HW Setup. The message also contains a test label, specifying the failing test.

SrcNameSuffix = _SWTargets;

Message = "(4150) HW Setup Verification in Primary: {1}";
{1} = Subtest strings used to specify the failing test method.
Severity Level = Medium;

Message = "(4151) HW Setup Verification in Backup: {1}";
Severity Level = Medium;
{1} = Subtest strings used to specify the failing test method.

Message = "(4152) HW Setup Verification in Standalone: {1}";
{1} = Subtest strings used to specify the failing test method.
Severity Level = Medium;

Message = "(4153) HW Setup Verification in Trainee: {1}"
{1} = Subtest strings used to specify the failing test method.
SeverityLevel = Critical

Events from EXTCLKSupervision

These events are issued from the EXTCLK Supervision if etiher the EXTCLK frequency is or the FPGA divider is working incorrect.

SrcNameSuffix = _SWTargets;

Message = "(4160) EXTCLK Error Allowed range {1} us";
{1} = Sleep-time information
Severity Level = Medium;

Message = "(4161) EXTCLK Supervision Error: FATAL error";
Severity Level = Medium;

Events from HRESETSupervision

This event is issued from the Oscillator Supervision task if etiher the SPPL or EXTCLK frequency is working incorrect.

SrcNameSuffix = _SWTargets;
Message = "(4170) HRESET Error asserted by {1}";
{1} = Strings used to specify the signals generating HRESET
Severity Level = High;

Events from Modulebus Driver

System Simple Event **Comparision of CRC32 from SM and PM failed**

SrcNameSuffix = _SWTargets;
Message = "(4180) MBM1 SM vs PM CRC32 failed, address 0x{1}";
{1} = Address (hexadecimal)
Severity Level = Low;

System Simple Event **Failed to create SMDrv in Modulebus**

SrcNameSuffix = _SWTargets;
Message = "(4181) Failed to create SMDrv From Modulebus";
Severity Level = Medium;

System Simple Event **BusErrorIn interrupt routine**

SrcNameSuffix = _SWTargets;
Message = "(4182) Bus Error In Modulebus ISR address 0x{1}";
{1} = Address (hexadecimal)
Severity Level = Critical;

System Simple Event **BS Exception in MBM1scanner**

SrcNameSuffix = _SWTargets;

Message = "(4183) BS EXCEPTION In MBM1 Scanner";
Severity Level = Critical;

Message = "(4184) Incoming safety header failure, address 0x{1}"
{1} = Address (hexadecimal)
SeverityLevel = Medium

Message = "(4185) Primary shutdown due to suspect SM"
SeverityLevel = Medium

Message = "(4186) No answer from SM address 0x{1}, error code 0x{2}"
SeverityLevel = Medium

Message = "(4187) Failure in safety IO, address 0x{1}, error code 0x{2}"
{1} = Address (hexadecimal)
{2} = Error code (hexadecimal)
SeverityLevel = Medium

Events from ModuleBus

System Simple Event

Message = "((4901) Event overflow in module: {1}{2}"
{1} = Path to ModuleBus unit.
{2} = Unit number.
SeverityLevel = Medium

Controller – Hardware

Hardware generated system alarms are automatically available when the hardware is configured. They may however be disabled.

All Hardware Units in the hardware configuration have one system alarm and one system simple event each for its disposal. The intention is to have a sum alarm and a sum event for different errors and warnings that can be detected on the hardware unit.

Table 53. Parameters for Hardware Generated System Alarms and Events

Parameters	Descriptions
Class	All hardware generated system alarms and events have the same value of parameter 'Class' that is determined by the value of CPU setting 'AE System AE class'.
Severity	Values of severity are defined through the CPU setting 'AE System AE high severity' for hardware generated system alarms, respective 'AE System AE medium severity' for hardware generated system simple events.

Table 53. Parameters for Hardware Generated System Alarms and Events

Parameters	Descriptions
Message	The message contains reference to more detailed information, because each alarm is a sum alarm that can indicate many different errors on the unit. This information is given in the description of Errors and Warnings in Control Builder. The error code is stored in two 32 bit words first word is *ErrorsAndWarnings* and the second is *ExtendedStatus*. In each hardware generated system alarm or event message, *ErrorsAndWarnings* and *ExtendedStatus* bit patterns are translated into a text in the OPC-server. General status bits are translated into a explaining text e.g. "I/O configuration error". Device specific bits from *ErrorsAndWarnings* are translated into a text in the OPC-server, if a matching text is available in the hardware definition. Otherwise they are displayed as "Device specific bit xx" in the message e.g. "Device specific bit 31". The same goes for *ExtendedStatus*. If a matching text is not available in the hardware definition, unit specific bits from *ExtendedStatus* are displayed as "Extended status bit xx" in the message e.g. "Extended status bit 0". The bits for every unit are explained later in this section. **Example** "Controller_1 (0000) I/O configuration error, Device specific bit 31, Extended status bit 0" If the Unit in this example is a PM865, "Device specific bit 31"= "Battery low" and "Extended status bit 0" = "Backup CPU stopped" In the controller log *ErrorsAndWarnings* and *ExtendedStatus* are presented as HEX format. **Example**: "E 2004-03-08 10:25:06.677 On Unit= 2 HWError Controller_1 Errorcode=16#80004000 16#00000001 (0000) See HW-tree

Table 53. Parameters for Hardware Generated System Alarms and Events

Parameters	Descriptions
SrcName	The syntax for the source name in the SrcName parameter is dynamically based on the IP address together with the SrcNameSuffix that is the hardware unit address in the hardware tree configuration. **Example:** IP address (172.16.85.33) + SrcNameSuffix (2.5.101) = "172.16.85.33-2.5.101".
CondName	All hardware generated system alarms have "HWError" as common condition name in the CondName parameter.
AckRule	Ack Rule 5 is used for these system alarms,.

Alarms and Events Common for all Units

Table 54 lists those status bits that have the same meaning for all hardware units.

Note however that different units have different capabilities. A specific unit will typically only be able to generate alarms and events for an assortment of the common status bits.

Table 54. General status bit ErrorsAndWarnings

Bit	Status Bit	Value	Indication	Generation	Severity	Description
0	ConnectionDown	16#00000001	Error	Alarm	High	Connection down
1	IoError	16#00000002	Error	Alarm	Medium	I/O error
2	ModuleMissing	16#00000004	Error	Alarm	High	Module missing
3	WrongModuleType	16#00000008	Error	Alarm	High	Wrong module type
4	StatusChannelError	16#00000010	Warning	Alarm	Medium	Channel error
5	IoWarning	16#00000020	Warning	Event	Low	I/O warning
6	StatusUnderflow	16#00000040	Warning	Alarm	Low	Underflow
7	StatusOverflow	16#00000080	Warning	Alarm	Low	Overflow
8	StatusForced	16#00000100	Warning	Event	Low	Forced

Table 54. General status bit ErrorsAndWarnings (Continued)

Bit	Status Bit	Value	Indication	Generation	Severity	Description
9	WatchdogTimeout	16#00000200	Error	Alarm	High	Watchdog timeout
10	DeviceFailure	16#00000400	Error	Alarm	High	Device failure
11	DeviceNotFound	16#00000800	Error	Alarm	High	Device not found
12	WrongDeviceType	16#00001000	Error	Alarm	High	Wrong device type
13	IOConnectError	16#00002000	Error	Alarm	Medium	I/O connection error
14	IOConfigError	16#00004000	Error	Alarm	Medium	I/O configuration error
15	HWConfigError	16#00008000	Error	Alarm	High	Hardware configuration error
16	GeneralError [1]	16#00010000	Error	–	–	–
17	GeneralWarning [1]	16#00020000	Warning	–	–	–
18	RedWarningPrimary [2]	16#00040000	Warning	Event	Low	Warning on primary unit
19	RedWarningBackup [2]	16#00080000	Warning	Event	Low	Warning on backup unit
20	RedErrorBackup [2]	16#00100000	Warning	Alarm	Medium	Error on backup unit
21	*Reserved*	16#00200000	–	–	–	–
22	DeviceSpecific10	16#00400000	[3]	[3]	[3]	[3]
23	DeviceSpecific9	16#00800000	[3]	[3]	[3]	[3]
24	DeviceSpecific8	16#01000000	[3]	[3]	[3]	[3]
25	DeviceSpecific7	16#02000000	[3]	[3]	[3]	[3]
26	DeviceSpecific6	16#04000000	[3]	[3]	[3]	[3]
27	DeviceSpecific5	16#08000000	[3]	[3]	[3]	[3]
28	DeviceSpecific4	16#10000000	[3]	[3]	[3]	[3]

Table 54. General status bit ErrorsAndWarnings (Continued)

Bit	Status Bit	Value	Indication	Generation	Severity	Description
29	DeviceSpecific3	16#20000000	[3]	[3]	[3]	[3]
30	DeviceSpecific2	16#40000000	[3]	[3]	[3]	[3]
31	DeviceSpecific1	16#80000000	[3]	[3]	[3]	[3]

[1] Used together with other status bits.

[2] Used only if hte unit is configured as a redundant unit.

[3] Depends on the specific hardware device ,defined within hardware definition file.

Table 55. General status bit ExtendedStatus

Bit	Status Bit	Value	Indication	Generation	Severity	Description
0	ExtendedStatus1	16#00000001	[1]	[1]	[1]	[1]
1	ExtendedStatus2	16#00000002	[1]	[1]	[1]	[1]
2	ExtendedStatus3	16#00000004	[1]	[1]	[1]	[1]
3	ExtendedStatus4	16#00000008	[1]	[1]	[1]	[1]
4	ExtendedStatus5	16#00000010	[1]	[1]	[1]	[1]
5	ExtendedStatus6	16#00000020	[1]	[1]	[1]	[1]
6	ExtendedStatus7	16#00000040	[1]	[1]	[1]	[1]
7	ExtendedStatus8	16#00000080	[1]	[1]	[1]	[1]
8	ExtendedStatus9	16#00000100	[1]	[1]	[1]	[1]
9	ExtendedStatus10	16#00000200	[1]	[1]	[1]	[1]
10	ExtendedStatus11	16#00000400	[1]	[1]	[1]	[1]
11	ExtendedStatus12	16#00000800	[1]	[1]	[1]	[1]
12	ExtendedStatus13	16#00001000	[1]	[1]	[1]	[1]
13	ExtendedStatus14	16#00002000	[1]	[1]	[1]	[1]
14	ExtendedStatus15	16#00004000	[1]	[1]	[1]	[1]
15	ExtendedStatus16	16#00008000	[1]	[1]	[1]	[1]
16	ExtendedStatus17	16#00010000	[1]	[1]	[1]	[1]

Table 55. General status bit ExtendedStatus (Continued)

Bit	Status Bit	Value	Indication	Generation	Severity	Description
17	ExtendedStatus18	16#00020000	[1]	[1]	[1]	[1]
18	ExtendedStatus19	16#00040000	[1]	[1]	[1]	[1]
19	ExtendedStatus20	16#00080000	[1]	[1]	[1]	[1]
20	ExtendedStatus21	16#00100000	[1]	[1]	[1]	[1]
21	ExtendedStatus22	16#00200000	[1]	[1]	[1]	[1]
22	*Reserved*	16#00400000	–	–	–	–
23	PrimaryIncompatibleFW [2]	16#00800000	Error	Alarm	High	Version of the Running Primary is incompatible
24	BackupIncompatibleFW [2]	16#01000000	Warning	Alarm	Medium	Version of the Running Backup is incompatible
25	PrimaryNotPrefrdFW [2]	16#02000000	Warning	Alarm	Medium	Version of the Running Primary is not preferred
26	BackupNotPrefrdFW [2]	16#04000000	Warning	Alarm	Medium	Version of the Running Backup is not preferred
27	TimeouOnBackup [2]	16#08000000	Warning	Alarm	Low	Watchdog timeout on backup
28	DeviceFailureBackup [2]	16#10000000	Warning	Alarm	Low	Backup device failure

Table 55. General status bit ExtendedStatus (Continued)

Bit	Status Bit	Value	Indication	Generation	Severity	Description
29	SwitchoverInProgress [2]	16#20000000	Warning	Event	Low	Switchover in progress
30	ConfiguredAsRedundant [2, 3]	16#40000000	-	-	-	Redundant mode enabled
31	UnitBPrimary [2]	16#80000000	-	-	-	Unit B acts primary

[1] Depends on the specific hardware device, defined within the hardware definition file.

[2] Used only if the unit is configured as a redundant unit.

[3] If this bit is set and bit 31 is not set, the text *Unit A acts primary* will be shown.

Unit Specific Alarm and Events

The status bit description of alarms and events specific to a hardware unit is available along with the hardware type displayed under the hardware library.

To view the status bit description of alarms and events specific to a hardware unit:

1. Go to **Libraries** > **Hardware** > *HwLib* folder, and expand the **Hardware Types** folder.
2. Right click the required hardware type and select **Unit Specific Alarm and Events** (see Figure 151).

The status bit description of alarms and events is displayed in a separate window (see Figure 152). This data can be used for supervising the unit status, see Supervising Unit Status on page 296.

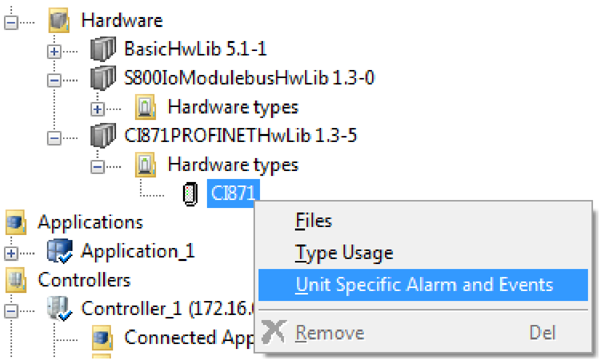
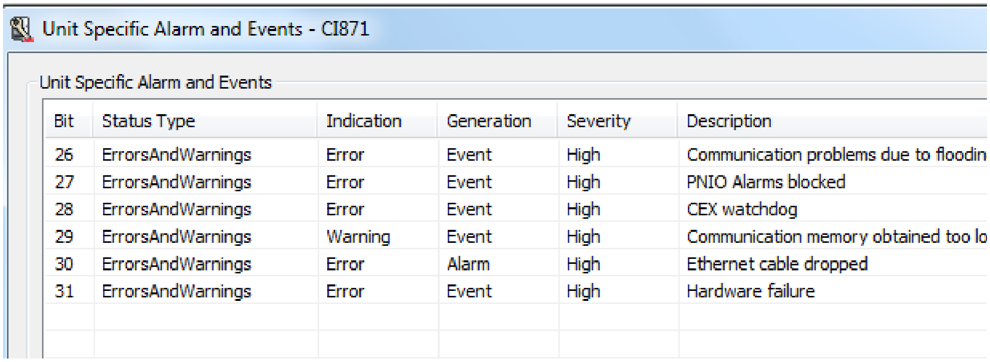


Figure 151. Accessing the Unit Specific Alarm and Events option


Unit Specific Alarm and Events - CI871

Unit Specific Alarm and Events

Bit	Status Type	Indication	Generation	Severity	Description
26	ErrorsAndWarnings	Error	Event	High	Communication problems due to floodin
27	ErrorsAndWarnings	Error	Event	High	PNIO Alarms blocked
28	ErrorsAndWarnings	Error	Event	High	CEX watchdog
29	ErrorsAndWarnings	Warning	Event	High	Communication memory obtained too lo
30	ErrorsAndWarnings	Error	Alarm	High	Ethernet cable dropped
31	ErrorsAndWarnings	Error	Event	High	Hardware failure

Figure 152. Unit Specific Alarm and Events window for CI871 hardware type

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