User Manual

Advantages of the Saia PG5® programming tools

- **Program portability:** Saia PG5 programs can run on all Saia PCD® platforms.
- **Program organization by files** (containing several program blocks) simplifies the shared use of program files between several Saia PCD® controllers.
- **Programming and debugging environments** united in each program editor.
- **Simple programming of Web panel** with the Web Editor.
- **Powerful instruction set** supported by macros and assem bler directives.

Features of the Saia PG5® programming tools

- **Symbol Manager** administers all local, global and network symbols or symbol groups. Automatic address allocation largely dispenses with the need for fixed addressing.
- **Project Manager** administers complex installations of networked PCDs, including displays and documentation.
- **Online functions** for commissioning and error detection via Ethernet-TCP/IP, SBC S-Bus®, modem, etc.
- **Integrated programming environments:**
  – FUPLA (function block diagram)
  – S-Edit (instruction list IL)
  – GRAFTEC (sequential function chart)
- **Integrated network editors** for SBC S-Bus®, PROFIBUS DP, LONWORKS®.
- **Extensive additional libraries** broaden the scope of PG5 functions.

Edition 26/732 E11

Contents

Preface

This document is intended as an introduction to Saia PCD® programmable controllers, rather than as a detailed commissioning manual. It therefore concentrates on the essential points for users who wish to acquire practical expertise quickly. For more comprehensive information, please refer to the help supplied by the programming tool itself, or to the detailed manuals that will be found on the documentation CD.

To ensure ideal conditions for your training, we advise you to obtain the following programs, documentation and material:

- CD Saia PG5 version 2.0
- Documentation CD 26/803
- 1 x PCD2.M5540 [1] controller
- 1 x PCD2.E110 module with 8 digital inputs
- 1 x PCD2.A400 module with 8 digital outputs
- 1 x USB cable

All the necessary instructions for installing PG5 2.1 on your computer are provided on the PG5 version 2.1 CD (see under: CD:\ PG5_InstallationGuide_E.pdf).

Please also note that all the English names of menus, instructions, options and buttons present in the PG5 program are reproduced in *italics* in this manual.

We wish you every success with your training and with future projects involving Saia PCD® products.

Your partner Saia-Burgess Controls AG.

[1] an other PCD may also be suitable

Contents

1 PCD – Quick-start

1.1 Introduction

As your first point of contact with Saia PCD® equipment, we propose a direct approach: tackling the production of a small real-life application. Even without any experience of Saia PCD products, this is easy to do. Everything is set out in detail in this quick-start chapter.

This example shows how to commission a PCD2.M5540. Programming and testing using the Saia PG5® programming tools.

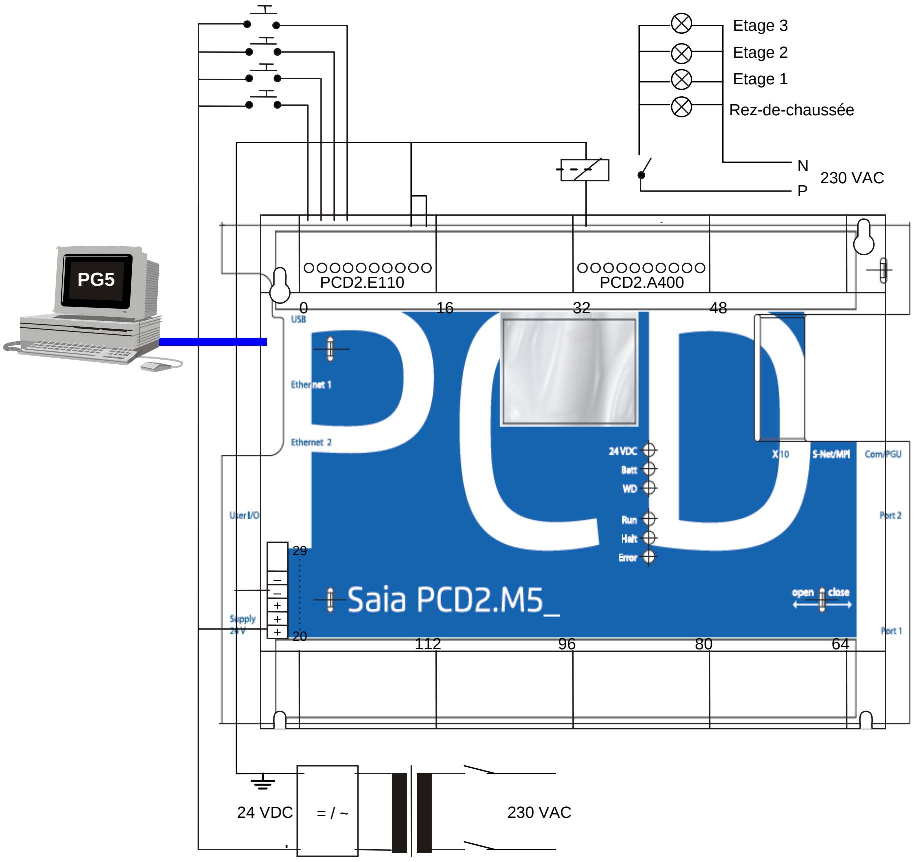
Subsequent chapters in this document repeat in more detail the contents of this quick-start chapter, and provide much more information such as descriptions of available symbols, program structures and instruction list programming.

1.2 Preparing the hardware

1.2.1 Example: Stairway lighting

The commissioning of a Saia PCD® is illustrated using stairway lighting as an example. The building has a ground floor and three upper storeys. Each level has a push-button for switching the lights on. By briefly pressing any of these buttons, all 4 lights in the stairway will be switched on for a period of 5 minutes.
The push-buttons are connected to the 4 inputs of the PCD: I0, I1, I2 and I3.
The 4 lights are switched on/off via a relay. The relay is controlled via a single output (O32) on the PCD.

1.2.2 Connection diagram of PCD2.M5540



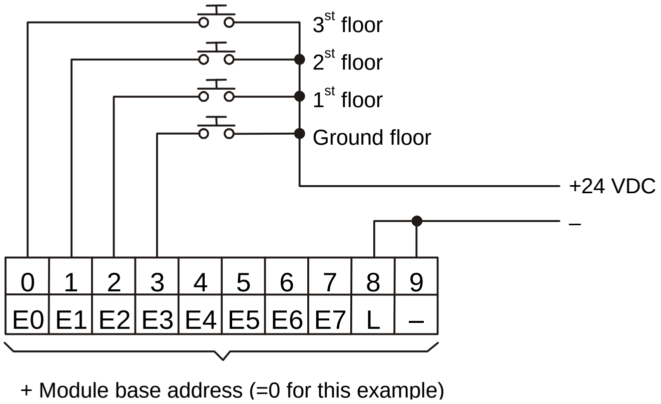
1.2.3 PCD2.M5540 assembly

1. Insert the supplied 3.0 V lithium battery.
2. Plug a PCD2.E110 module into socket 1 (addresses 0 to 15).
3. Push the module towards the middle of the device until the end stop and engage latch. This provides 8 digital inputs for 24 VDC with addresses I0 to I7. Only inputs I0 to I4 will be used.
4. Plug a PCD2.A400 module into socket 3 (addresses 32 to 47) as previously described. This provides 8 digital outputs (O32 to O39) for 24 VDC / 0.5A. Only output O32 will be used.

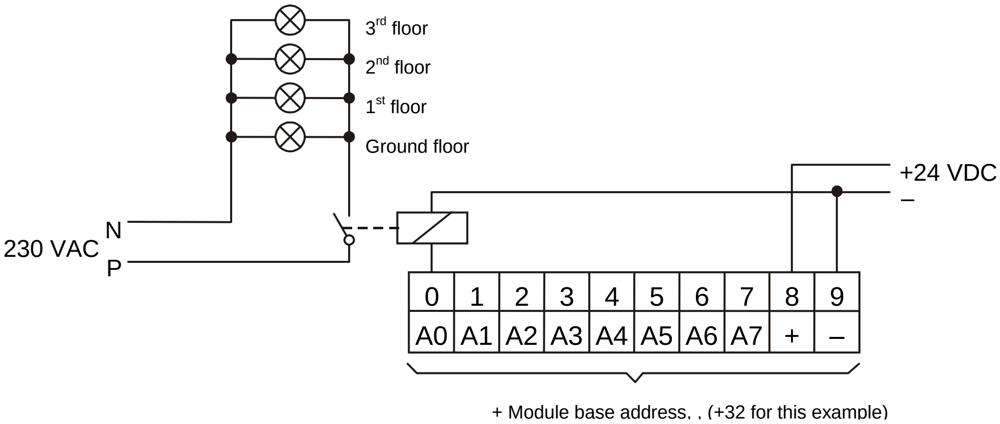
1.2.4 Wiring

1. Connect the 24 VDC supply to screw terminals 20 (+) and 23 (–) .The following supply voltages are allowed: 24 VDC ±20% smoothed or 19 VAC ±15% full-wave rectified

2. The four inputs used are connected according to the hardware description of the PCD2.E110 module. Connect the 4 push-button switches to terminals 0 to 3. Terminals 8 and 9 are connected to the power supply negative.


3st floor
2st floor
1st floor
Ground floor
+24 VDC
–
0 1 2 3 4 5 6 7 8 9
E0 E1 E2 E3 E4 E5 E6 E7 L –
+ Module base address (=0 for this example)

3. Connect terminal 0 to the relay coil , terminal 8 to the 24 VDC supply positive, and terminal 9 to the supply negative.



4. Connect the PC's USB interface to the PCD

Note: For more detailed information about hardware assembly and wiring, please refer to your PCD hardware manual.

1.3 Editing the program

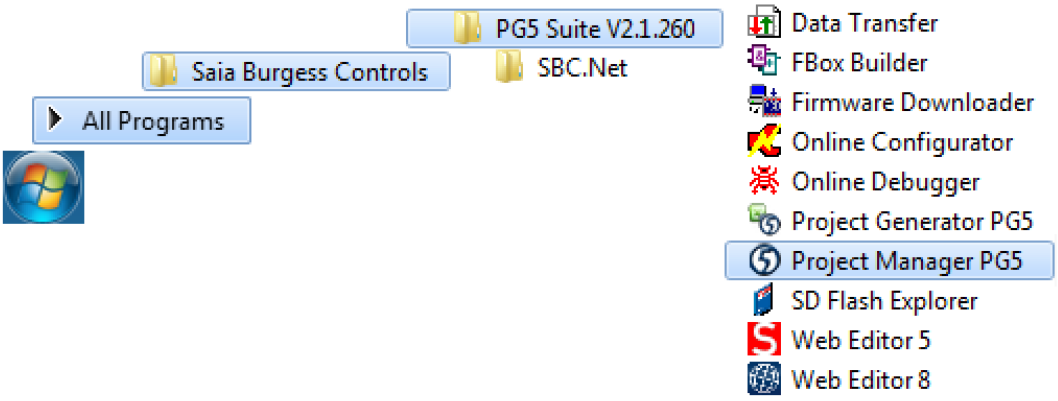
1.3.1 Software Installation

Install the Saia PG5® programming tool for Saia PCD® on the PC (if it has not already been installed), following the instructions supplied on the CD
(CD:\ PG5_InstallationGuide_E.pdf).

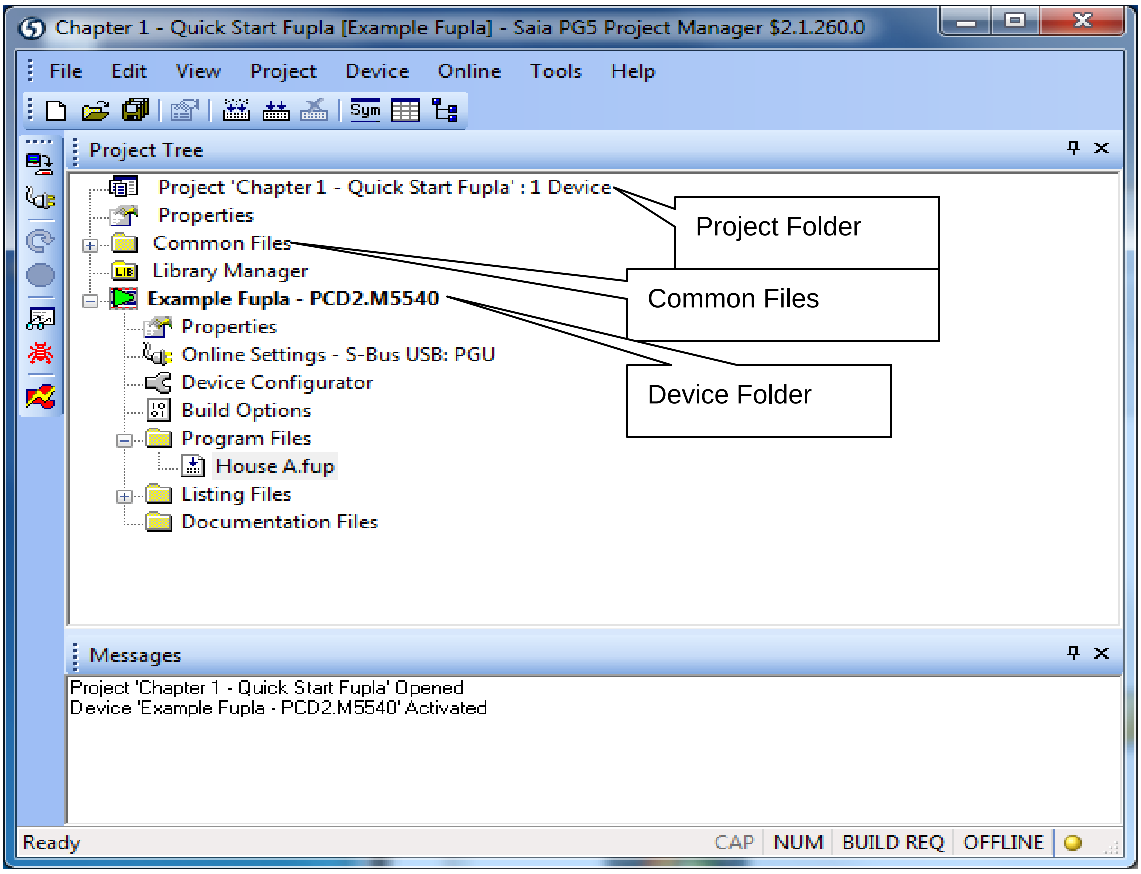
1.3.2 Starting the PG5

Start the PG5's Project Manager:

Start → Programs → Saia Burgess Controls → PG5 Suite 2.1 → Project Manager PG5



The *Saia PG5 Project Manager* window is displayed. The *Project Tree* window shows the structure of the new project. (If this window is not shown, use the *View, Project Tree* menu command.)



Project 'Chapter 1 - Quick Start Fupla' Opened
Device 'Example Fupla - PCD2.M5540' Activated

Folders in the *Project Tree* window contain project information, which is arranged according to certain criteria:

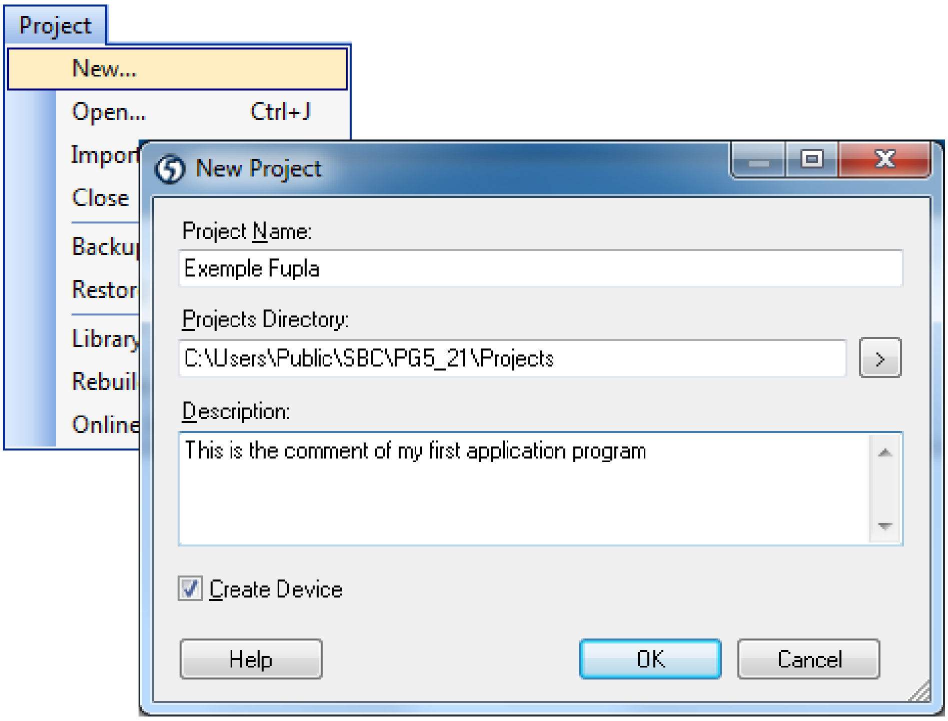
- The name of the main folder shows the project name and the number of devices used in the project.
- Files which are shared by several of the devices can be stored in the *Common Files* folder.
- Next are the device folders (each device represents a PCD).

Each device folder contains the following sub-folders:

- *Online Settings*, *Device Configurator* and *Build Options*.
- *Program Files,* contains the program module files.
- *Listing Files*, contains files generated during the program build *(Build)*. These are not so interesting to the inexperienced user.

1.3.3 Opening a new project

Before starting to write a new program, a new or existing project must be opened that contains the necessary definitions, a few configuration parameters and the files needed for the user program.
If the project does not yet exist, select *Project*, *New…*, define the name of the new project in the *Project Name* field, check the *Create Device* option and confirm with the *OK* button.



Project Name:
Exemple Fupla

Projects Directory:
C:\Users\Public\SBC\PG5_21\Projects

Description:
This is the comment of my first application program

☑ Create Device

1.3.2 Opening an existing project

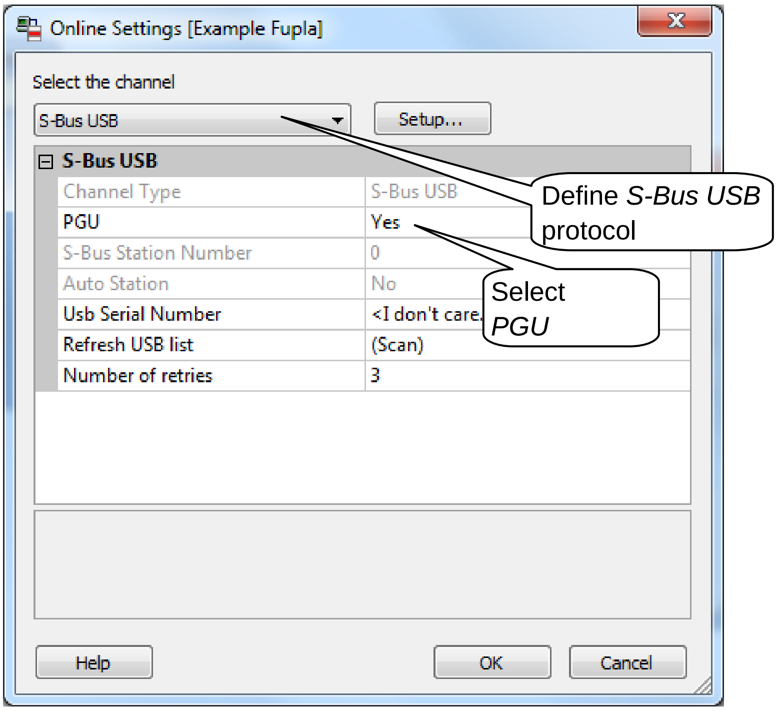
A project which already exists can be opened using the *Project, Open…* menu command. This searches for all project files (.saia5pj) in the project directory, and displays them in a list. Double-click on the project in the list, or select the project from the list and press the *Open* button. Alternatively, you can press the *Browse…* button and find the project or device file directly.

1.3.4 Configuration

Before you can work with a device in the project, configuration parameters must be defined, so that the programming tools and the generated user program will work with the PCD.

Under *Online Settings*, parameters can be set for communication between the PC and the PCD. Several possibilities are available. For this exercise the default protocol (S-Bus USB).

Channel S-Bus USB



Online Settings [Example Fupla]

Select the channel

S-Bus USB

S-Bus USB	
Channel Type	S-Bus USB
PGU	Yes
S-Bus Station Number	0
Auto Station	No
Usb Serial Number	<I don't care
Refresh USB list	(Scan)
Number of retries	3

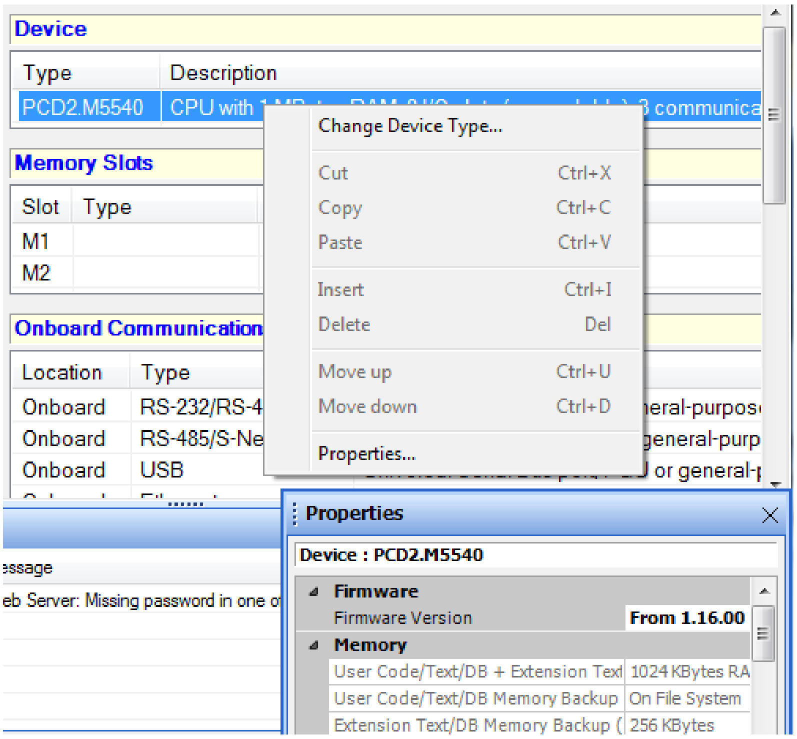
Define *S-Bus USB* protocol

Select *PGU*

The *Device Configurator* defines the device type, memory size, S-Bus station number, communications interfaces, etc., but we won't describe all the options just yet. However, it is important to select the correct device type and memory size. The PCD2.M5540 is always supplied with a standard 1024 Kbyte RAM.

To define a new *device*, select the correct PCD type from the *Change Device Type* context menu.

The properties window is shown with the *Properties* context menu command. Here the memory size of can be defined.



Device

Type	Description
PCD2.M5540	CPU with 1 MB ... 3 communica

Memory Slots

Slot	Type
M1	
M2	

Onboard Communication

Location	Type	
Onboard	RS-232/RS-4	ieral-purpos
Onboard	RS-485/S-Ne	general-purp
Onboard	USB	or general-p

essage

eb Server: Missing password in one of

Properties

Device : PCD2.M5540

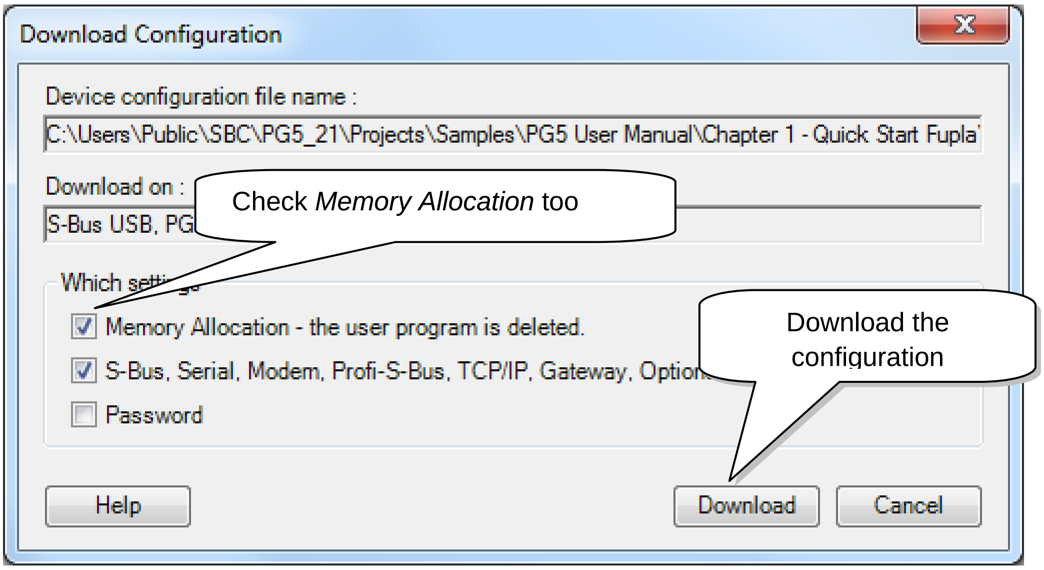
Firmware

Firmware Version	From 1.16.00

Memory

User Code/Text/DB + Extension Text	1024 KBytes RA
User Code/Text/DB Memory Backup	On File System
Extension Text/DB Memory Backup (	256 KBytes

The configuration must always be downloaded into the PCD, using the menu command *Online, Download Configuration…*



Download Configuration

Device configuration file name :

C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Chapter 1 - Quick Start Fupla'

Download on :

S-Bus USB, PG

Which settings

☑ Memory Allocation - the user program is deleted.

☑ S-Bus, Serial, Modem, Profi-S-Bus, TCP/IP, Gateway, Option

☐ Password

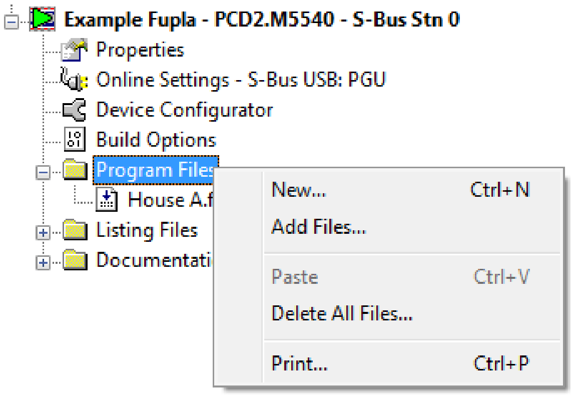
Check *Memory Allocation* too

Download the configuration

1.3.5 Adding a new program file

PCD user programs are stored in one or more files. There are several ways of adding a program file:

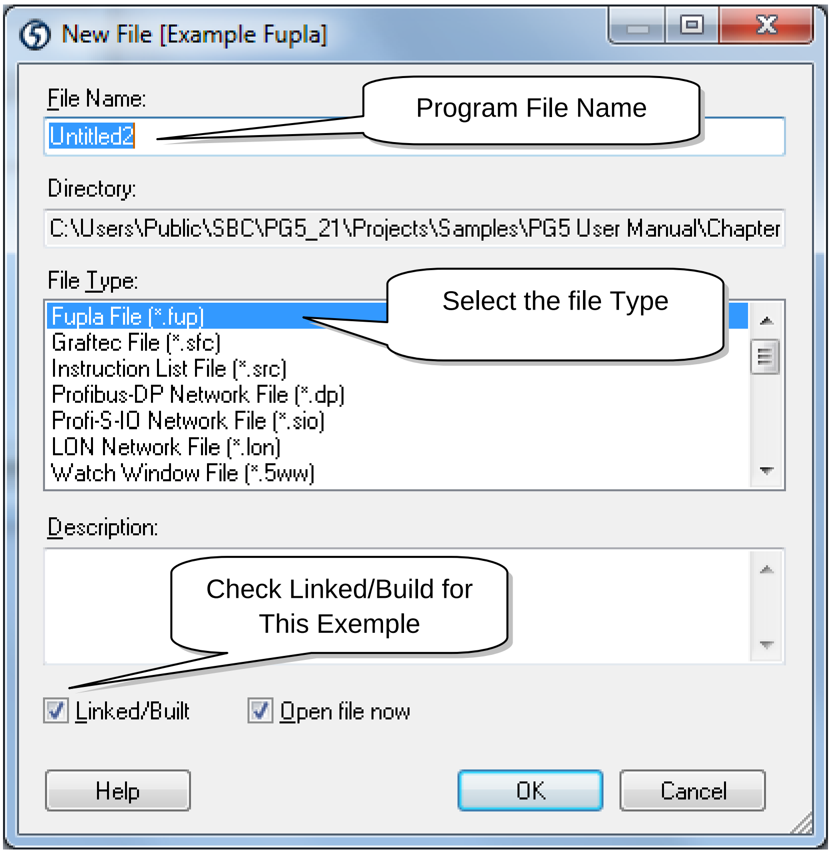
In the *Project Tree window*, select *Program Files*, click the right-hand mouse button to display the context menu and select *New…* (new file).



Alternatively, you can click on the *New File* button on the toolbar, or use the *File, New…* menu command.

In the *New File* window the name and type of the module are defined: two very important items of information.

Several editors are available for writing PCD user programs. The user can choose which editor is best suited to the user program. For this example it is *Fupla File (*.fup).* Fupla is a general-purpose graphical programming language.



File Name: Untitled2

Directory: C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Chapter

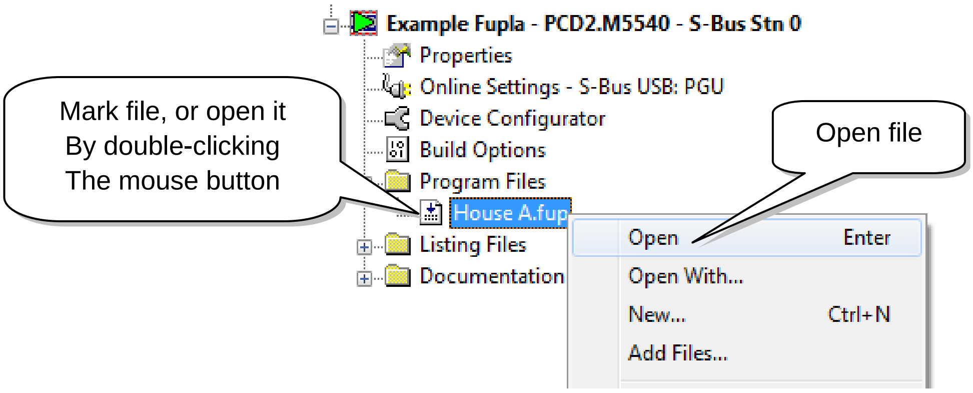
File Type:
- Fupla File (*.fup)
- Grafitec File (*.sfc)
- Instruction List File (*.src)
- Profibus-DP Network File (*.dp)
- Profi-S-IO Network File (*.sio)
- LON Network File (*.lon)
- Watch Window File (*.5ww)

Description:

☑ Linked/Built ☑ Open file now

1.3.6 Opening an existing file

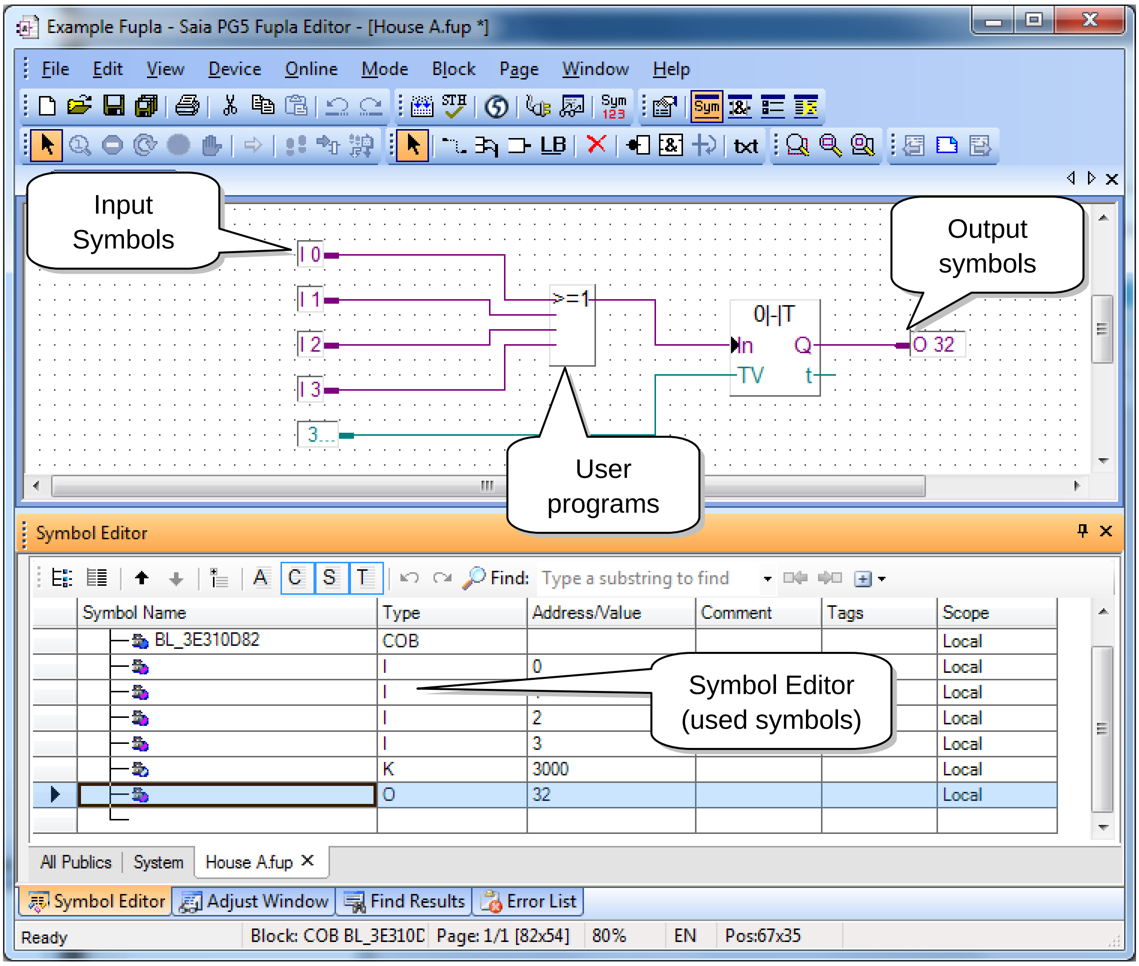
If the folder already contains a program file, the file can be opened as follows:
In the *Project Tree* window, open the *Program Files* folder and double-click on the relevant file. Alternatively, right-click on the file name to open the context menu and select *Open*.



Mark file, or open it By double-clicking The mouse button

Open file

1.3.7 Editing a program


Example Fupla - Saia PG5 Fupla Editor - [House A.fup *]
File Edit View Device Online Mode Block Page Window Help
I 0
I 1
I 2
I 3
3...
>=1
0|-|T
In
Q
TV
t
O 32
Symbol Editor
Find: Type a substring to find
All Publics System House A.fup
Symbol Editor Adjust Window Find Results Error List
Ready Block: COB BL_3E310D Page: 1/1 [82x54] 80% EN Pos:67x35

Input Symbols

Output symbols

User programs

Symbol Editor (used symbols)

Symbol Name	Type	Address/Value	Comment	Tags	Scope
BL_3E310D82	COB				Local
	I	0			Local
	I				Local
	I	2			Local
	I	3			Local
	K	3000			Local
	O	32			Local

Editing symbols

Symbols reference the data needed by the PCD's user program, e.g. the stairway lighting switches. We edit symbols in the connectors on the Fupla page. ‘Read’ symbols are on the left, ‘write’ symbols are on the right.

This stairway lighting example has 4 light switches as inputs (I 0, I 1, I 2 and I 3) and one output (O 32) to drive the stairway lights. The required period of 5 minutes, during which stairway lighting will be on, must be entered in the input connector as a multiple of tenths of a second.
The value of this constant is therefore 3000 (5 min. x 60 sec. x 10 = 3000).

Add Connectors

To add a connector and its symbol to a Fupla page, press the toolbar button *Add Connector* and position the mouse on the Fupla page. A ‘read’ input connector is added by clicking the left-hand mouse button. A ‘write’ output connector is added by holding down the *Shift* key and pressing the left-hand mouse button. The connector you have just added is ready to receive a symbol and a cursor is displayed inside the connector. If you do not wish to edit the symbol inside the connector straight away, press the *ESC* key and place the next connector.

To edit or modify a connector symbol already present on the Fupla page, select the connector by double clicking quickly. A cursor will be displayed inside the connector. It is now possible to enter the address I 0 to I 3, or output O 32, or the constant. Make sure you always leave a space between the letter I and the input address. The same applies for the output.

Show Hide Symbols Editor

To edit the input symbols, 4 consecutive cells in the left-hand column of the program screen are marked with the mouse and addresses I 0 to I 3 are entered. The time constant 3000 (left) and output O 32 (right) are entered in the same way.
Please note that the address type (I or O) and address value (0 to 3 and 32) must be separated by a space character.

The symbols will immediately appear in the *Symbols* window of the Symbol Editor. If the symbol editor is not visible it can be displayed using the *View, Symbols* menu command or by pressing the *Show/Hide Symbol Editor* toolbar button:

Note: By default, each new page may already provide margins with connectors on the left and right. If you prefer new pages not to appear with these connectors, so that you can place them wherever you want, just turn off the relevant option with menu command: *View, Options…, Workspace, New pages with side connectors*.

To remove any empty connectors present on the left or right of the page, select menu: *Page, Remove Unused Connectors.*

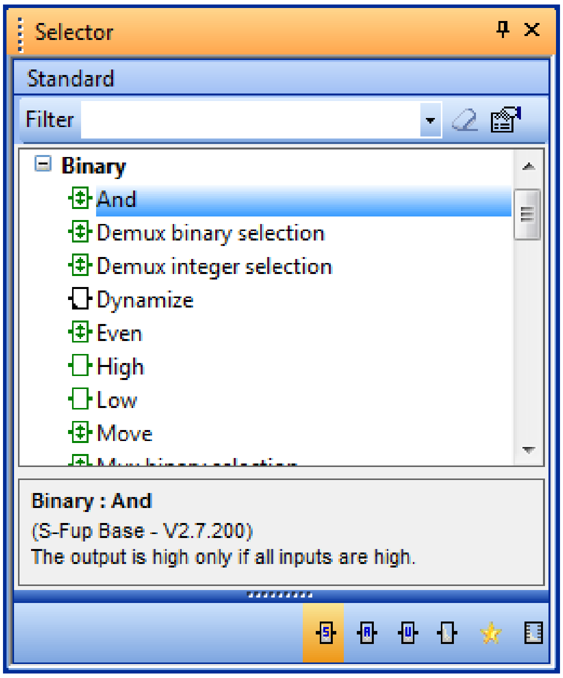
To place connectors once again on a blank page, select menu: *Page, Add Side Connectors.*

Editing program functions

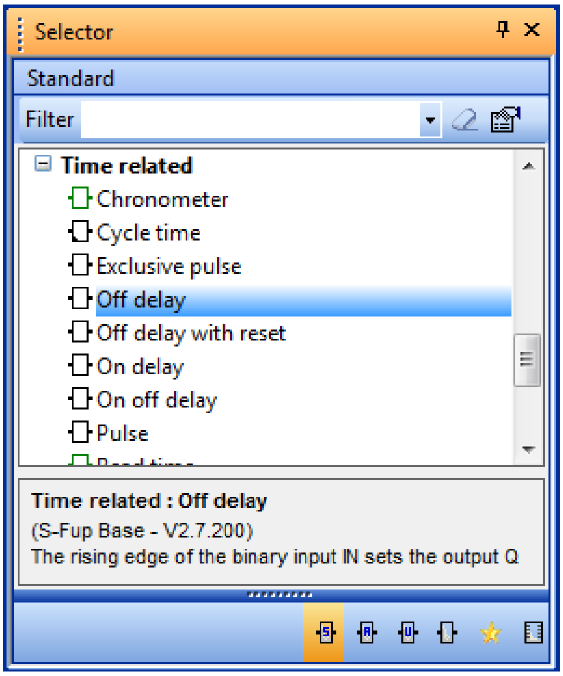
Program functions are inserted in the area between the ‘read’ and ‘write’ connectors. This is done by positioning the graphical symbols of the function boxes (FBoxes) that are used to create user programs.

Function boxes are selected from the *FBox Selector* window.

Show/Hide



Binary : And
(S-Fup Base - V2.7.200)
The output is high only if all inputs are high.



Time related : Off delay
(S-Fup Base - V2.7.200)
The rising edge of the binary input IN sets the output Q

The first function required in this example serves to switch on the lighting in response to a short pulse from a stairway switch. This is an *OR* function, which is found in the *Binary* family.

The second function *Off delay* defines the 5 minute period during which the lights are on. It is found in the *Time related* family.

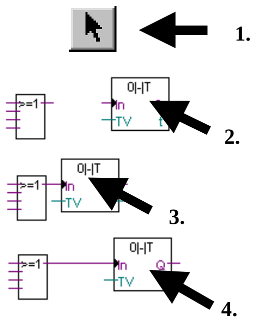
Further information about the FBox can be found by right-clicking on the function in the *FBox Selector* window, and choosing the FBox Info context menu command.

When a function box has been selected from the *FBox Selector* window, the left-hand mouse button is used to place it in the edit window between symbol columns.

With certain function boxes, such as *OR* logic, the number of inputs can be selected. This is done by dragging the mouse vertically and clicking the left-hand mouse button when the number of inputs is correct.

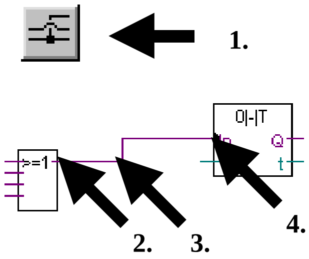
Connecting function

Use this method when connection points are aligned horizontally



1. Press the *Select Mode* button
2. Place the mouse pointer over the FBox and press the left-hand mouse button.
3. Hold the button down and drag the FBox horizontally until the connection is made. Do not release the mouse button.
4. Drag the FBox back to its original position and release the mouse button.

Use this method for the other connections



1. Press the *Line Mode* button
2. Click on the starting point with the left-hand mouse button and release it. Move the mouse pointer to the right as far as required and press the left-hand mouse button again.
3. Move the mouse vertically and click the left mouse button once more.
4. Move the mouse pointer to the FBox connector and press the left-hand mouse button again to finalise the connection.
5. If necessary, line drawing can be aborted by pressing the right-hand mouse button.

Deleting a line, function box, symbol or connector

Press the *Delete Object* toolbar button and click on the line, FBox, Symbol or Connector to be deleted.

1.4 Running and testing the program

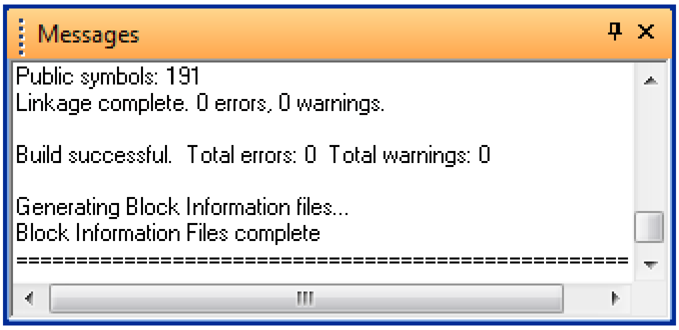
1.4.1 Building the program

Before the program can be executed by the PCD, it must be built (compiled, assembled and linked) using the Project Manager's *Device, Build Changed Files* menu command, or the *Rebuild All Files* toolbar button.

Rebuild All Files

The results of the build are shown in the *Messages* window (Compiling, Assembling, Linking etc.). If the program has been correctly edited, the build function completes with the message: *Build successful. Total errors 0 Total warnings: 0*

Errors are indicated by a red error message. Most errors can be located in the user program by double-clicking on the error message.



```
Public symbols: 191
Linkage complete. 0 errors, 0 warnings.

Build successful.  Total errors: 0  Total warnings: 0

Generating Block Information files...
Block Information Files complete
==================================================
```

1.4.2 Downloading the program into the PCD

The user program is now ready. All that remains is to download it from the PC into the PCD. This is done using Project Manager's *Download Program* toolbar button or the *Online, Download Program* menu command.

Download Program

If any communications problems arise, check the *Online Settings* and the cable connection between the PC and the PCD (PCD8.K111 or USB).

1.5 Finding and correcting errors (*Debugging*)

The first version of a program is rarely perfect. A stringent test is always needed. Program testing is done using the same editor that was used to write the program.

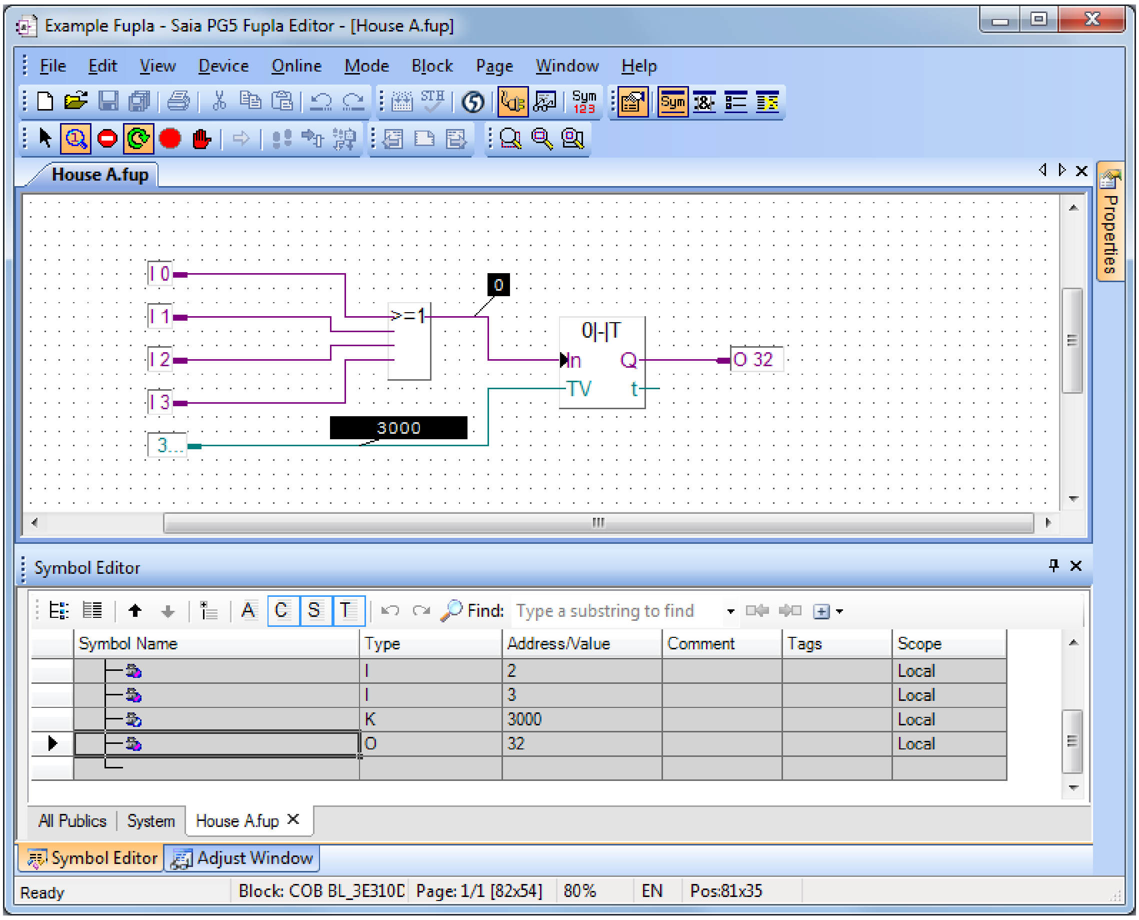
1. Press the *Go On /Offline* button
2. Start program with the *Run* button

Observe the Run LED on the PCD at the same time.
When the *Run* button is pressed, the *Run LED* on the PCD should turn on because the PCD is now executing the user program.

When the *Stop* button is pressed, the Run LED on the PCD should turn off because the PCD has stopped executing the program.

When the editor is *Online* and the PCD is in *Run* mode, the state of each individual symbol can be displayed:

- The logical state of binary data is shown with a heavy or fine line (heavy = 1 and fine = 0)
- Other data values can be displayed by clicking the left-hand mouse button on the connection to show a *Probe* window: use the mouse to select the *Add Probe* button and the link.


Example Fupla - Saia PG5 Fupla Editor - [House A.fup]
File Edit View Device Online Mode Block Page Window Help
House A.fup
Properties
I 0
I 1
I 2
I 3
3...
>=1
0
0|-|T
In
Q
TV
t
O 32
3000
Symbol Editor
Find: Type a substring to find
All Publics System House A.fup
Symbol Editor Adjust Window
Ready Block: COB BL_3E310D Page: 1/1 [82x54] 80% EN Pos:81x35

Symbol Name	Type	Address/Value	Comment	Tags	Scope
	I	2			Local
	I	3			Local
	K	3000			Local
	O	32			Local

1.6 Correcting a program

To modify a program, proceed as follows:

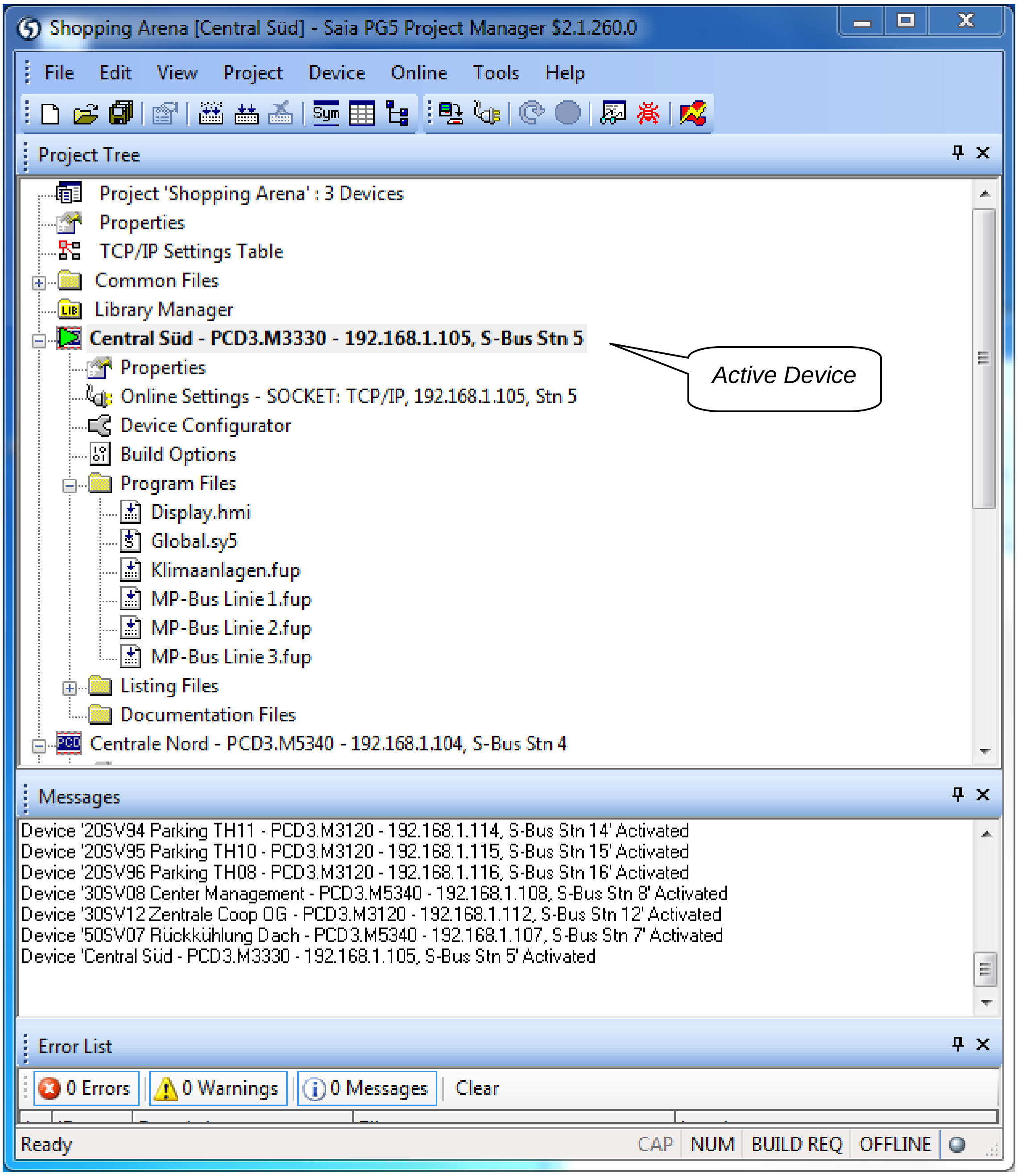
1. Go offline (using the ***Go On /Offline*** button).
2. Modify the program.
3. Build the new program (with the ***Build*** button).
4. Download program to the PCD with the ***Download Program*** button.

Contents

2 Project Management

2.1 Project Organisation

Modern automation processes usually contain several devices connected in a network, where each device carries out a particular function. For example, a building control system might have dedicated devices for handling lighting, heating, ventilation, automatic doors in the underground garage, etc.


Shopping Arena [Central Süd] - Saia PG5 Project Manager $2.1.260.0
File Edit View Project Device Online Tools Help
Sym
Project Tree
Project 'Shopping Arena' : 3 Devices
Properties
TCP/IP Settings Table
Common Files
Library Manager
Central Süd - PCD3.M3330 - 192.168.1.105, S-Bus Stn 5
Properties
Online Settings - SOCKET: TCP/IP, 192.168.1.105, Stn 5
Device Configurator
Build Options
Program Files
Display.hmi
Global.sy5
Klimaanlagen.fup
MP-Bus Linie 1.fup
MP-Bus Linie 2.fup
MP-Bus Linie 3.fup
Listing Files
Documentation Files
Centrale Nord - PCD3.M5340 - 192.168.1.104, S-Bus Stn 4
Active Device
Messages
Error List
0 Errors
0 Warnings
0 Messages
Clear
Ready
CAP NUM BUILD REQ OFFLINE

```
Device '20SV94 Parking TH11 - PCD3.M3120 - 192.168.1.114, S-Bus Stn 14' Activated
Device '20SV95 Parking TH10 - PCD3.M3120 - 192.168.1.115, S-Bus Stn 15' Activated
Device '20SV96 Parking TH08 - PCD3.M3120 - 192.168.1.116, S-Bus Stn 16' Activated
Device '30SV08 Center Management - PCD3.M5340 - 192.168.1.108, S-Bus Stn 8' Activated
Device '30SV12 Zentrale Coop OG - PCD3.M3120 - 192.168.1.112, S-Bus Stn 12' Activated
Device '50SV07 Rückkühlung Dach - PCD3.M5340 - 192.168.1.107, S-Bus Stn 7' Activated
Device 'Central Süd - PCD3.M3330 - 192.168.1.105, S-Bus Stn 5' Activated
```

The *Saia PG5 Project Manager* provides a global view of all the devices and files in a single project. All operations are started from here. For example, adding new program files to the project, opening files to write the programs, configuring the hardware, building and downloading the programs into the *devices*, backup and restore, reporting errors and warnings when building the program, etc.

The *Project Tree* window shows a hierarchical representation of each device and its configuration and program files. To display this window use the *View, Project Tree* menu command.

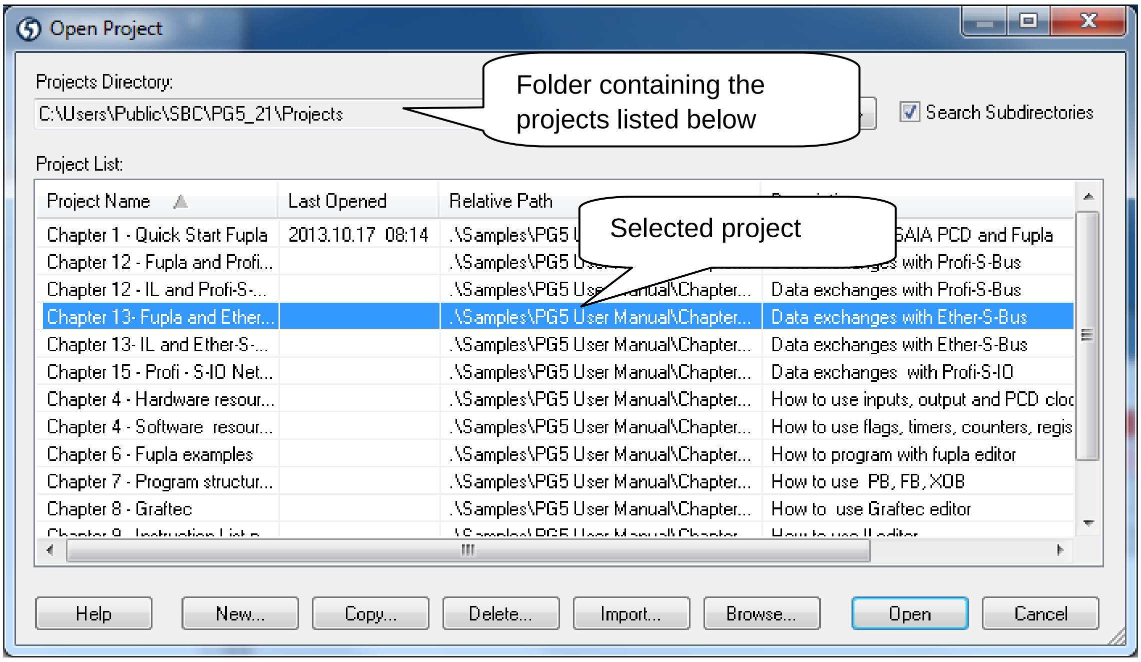
The *Messages* window shows general information messages, and error and warning messages generated when building a program. Display this window with the *View, Messages* menu command.

The other *View* windows show lists of symbols and media used, and the program structure. They also provide a symbol cross-reference feature.

The *active device* is marked with a green triangle. Many of the menus and *Tool Bar* buttons work on the *active device*. To change the *active device*, just select another device in the *Project Tree*, or use the *Device, Set Active* menu command.

2.1.1 Opening a Project

The PG5 is installed with all the examples in this manual. The *Project, Open…* command displays a list of all projects by finding all the project files (.saia5pj) in the *Projects Directory*. Double-click on the project to open it, or select the project and press the *Open* button. Alternatively you can press the *Browse…* button and find a specific project or device file (.saia5pc) in another directory.



Projects Directory: C:\Users\Public\SBC\PG5_21\Projects

☑ Search Subdirectories

Folder containing the projects listed below

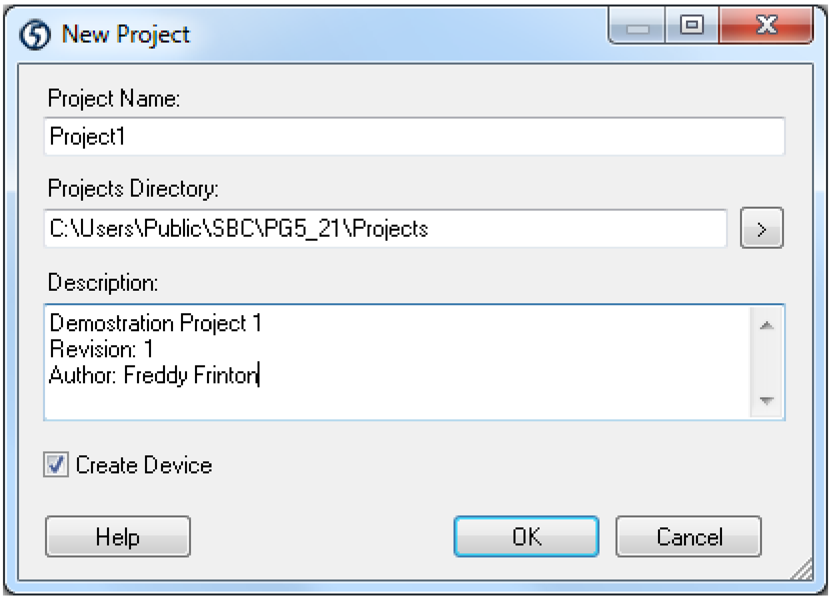
Project List:

Project Name	Last Opened	Relative Path	
Chapter 1 - Quick Start Fupla	2013.10.17 08:14	.\Samples\PG5 U	SAIA PCD and Fupla
Chapter 12 - Fupla and Profi...		.\Samples\PG5 U	with Profi-S-Bus
Chapter 12 - IL and Profi-S-...		.\Samples\PG5 Us	Data exchanges with Profi-S-Bus
Chapter 13- Fupla and Ether...		.\Samples\PG5 User Manual\Chapter...	Data exchanges with Ether-S-Bus
Chapter 13- IL and Ether-S-...		.\Samples\PG5 User Manual\Chapter...	Data exchanges with Ether-S-Bus
Chapter 15 - Profi - S-IO Net...		.\Samples\PG5 User Manual\Chapter...	Data exchanges with Profi-S-IO
Chapter 4 - Hardware resour...		.\Samples\PG5 User Manual\Chapter...	How to use inputs, output and PCD cloc
Chapter 4 - Software resour...		.\Samples\PG5 User Manual\Chapter...	How to use flags, timers, counters, regis
Chapter 6 - Fupla examples		.\Samples\PG5 User Manual\Chapter...	How to program with fupla editor
Chapter 7 - Program structur...		.\Samples\PG5 User Manual\Chapter...	How to use PB, FB, XOB
Chapter 8 - Graftec		.\Samples\PG5 User Manual\Chapter...	How to use Graftec editor

Selected project

2.1.2 Creating a new Project

To start a new project, use the *Project, New…* menu command, enter the name of the project in the *Project Name* field (default = *ProjectX*) and press OK.



New Project

Project Name: Project1

Projects Directory: C:\Users\Public\SBC\PG5_21\Projects

Description:
Demostration Project 1
Revision: 1
Author: Freddy Frinton

☑ Create Device

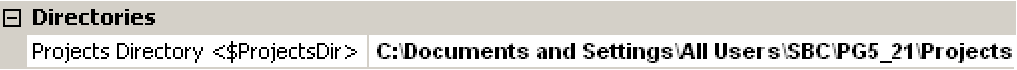
Project Name: The name of the new project.
Projects Directory: Name of folder which will contain the project.
Description: Free text, description of the project.
Create Device: Automatically creates a single device with the same name as the project.

2.1.3 How projects are stored on the PC

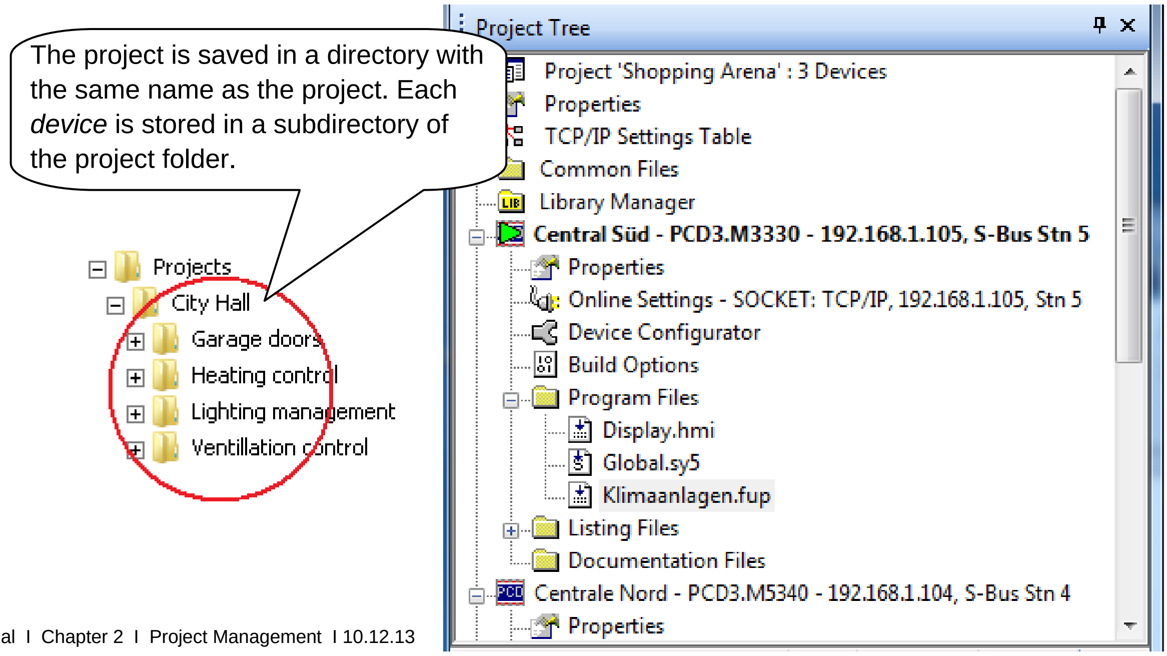
By default, all projects are stored in the following project directories, depending on the Windows version:

XP: **C:\Documents and Settings\All Users\SBC\PG5_21\Projects**
Windows 7: **C:\Users\Public\ SBC\ PG5_21\Projects**

If necessary, the project (and library) directories can be changed using the *Tools, Options…* menu command:



⊟ **Directories**	
Projects Directory <$ProjectsDir>	**C:\Documents and Settings\All Users\SBC\PG5_21\Projects**



The project is saved in a directory with the same name as the project. Each *device* is stored in a subdirectory of the project folder.

- Projects
  - City Hall
    - Garage doors
    - Heating control
    - Lighting management
    - Ventillation control

Project Tree

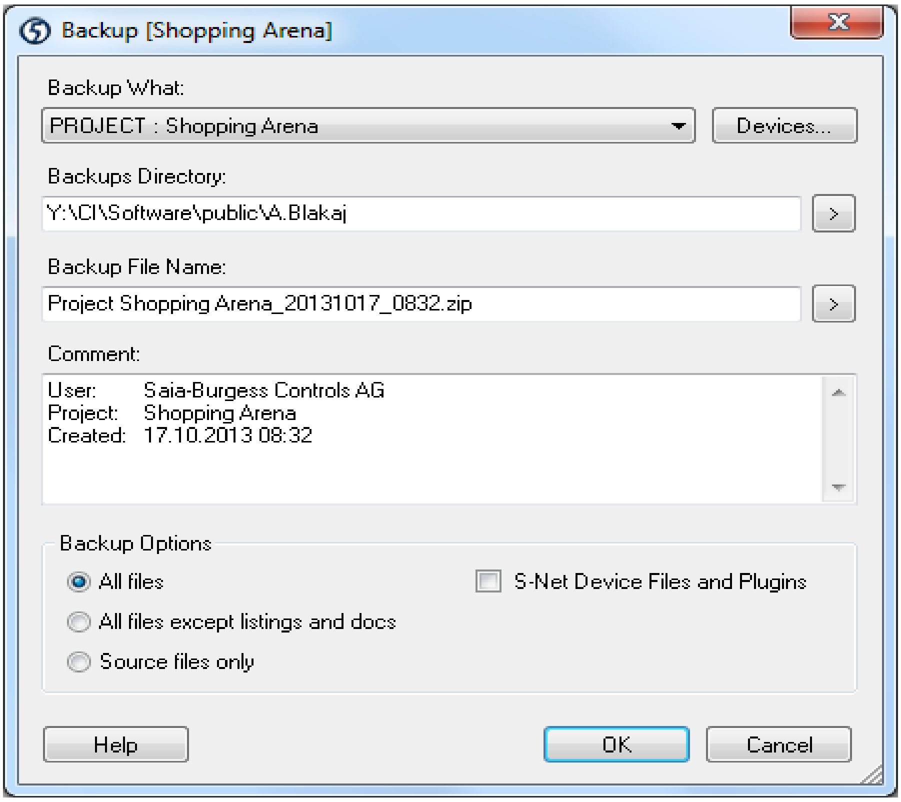
- Project 'Shopping Arena' : 3 Devices
  - Properties
  - TCP/IP Settings Table
  - Common Files
  - Library Manager
  - **Central Süd - PCD3.M3330 - 192.168.1.105, S-Bus Stn 5**
    - Properties
    - Online Settings - SOCKET: TCP/IP, 192.168.1.105, Stn 5
    - Device Configurator
    - Build Options
    - Program Files
      - Display.hmi
      - Global.sy5
      - Klimaanlagen.fup
    - Listing Files
    - Documentation Files
  - Centrale Nord - PCD3.M5340 - 192.168.1.104, S-Bus Stn 4
    - Properties

2.1.4 Backup and restore of a Project or Device

To backup a project it is necessary to keep the same folder structure and all the source files which comprise the project. The *Project, Backup…* menu command compresses either the entire project or just a single device into a standard ".zip" file, which can be restored using the *Project, Restore…* command.

Project, Backup…

Project, Restore…



Backup [Shopping Arena]

Backup What:

PROJECT : Shopping Arena ▾ | Devices...

Backups Directory:

Y:\CI\Software\public\A.Blakaj

Backup File Name:

Project Shopping Arena_20131017_0832.zip

Comment:

User: Saia-Burgess Controls AG
Project: Shopping Arena
Created: 17.10.2013 08:32

Backup Options

● All files ☐ S-Net Device Files and Plugins

○ All files except listings and docs

○ Source files only

Backup Project or Single Device

Selects whether the entire project, or just a single device in the project will be backed up. By default it is the entire project.

To Compressed File

The path of the compressed ".zip" file which will be created. The default name contains the project or device name plus the date/time in the format:

d:\<path>\<name>_yyyymmdd_hhmm.zip

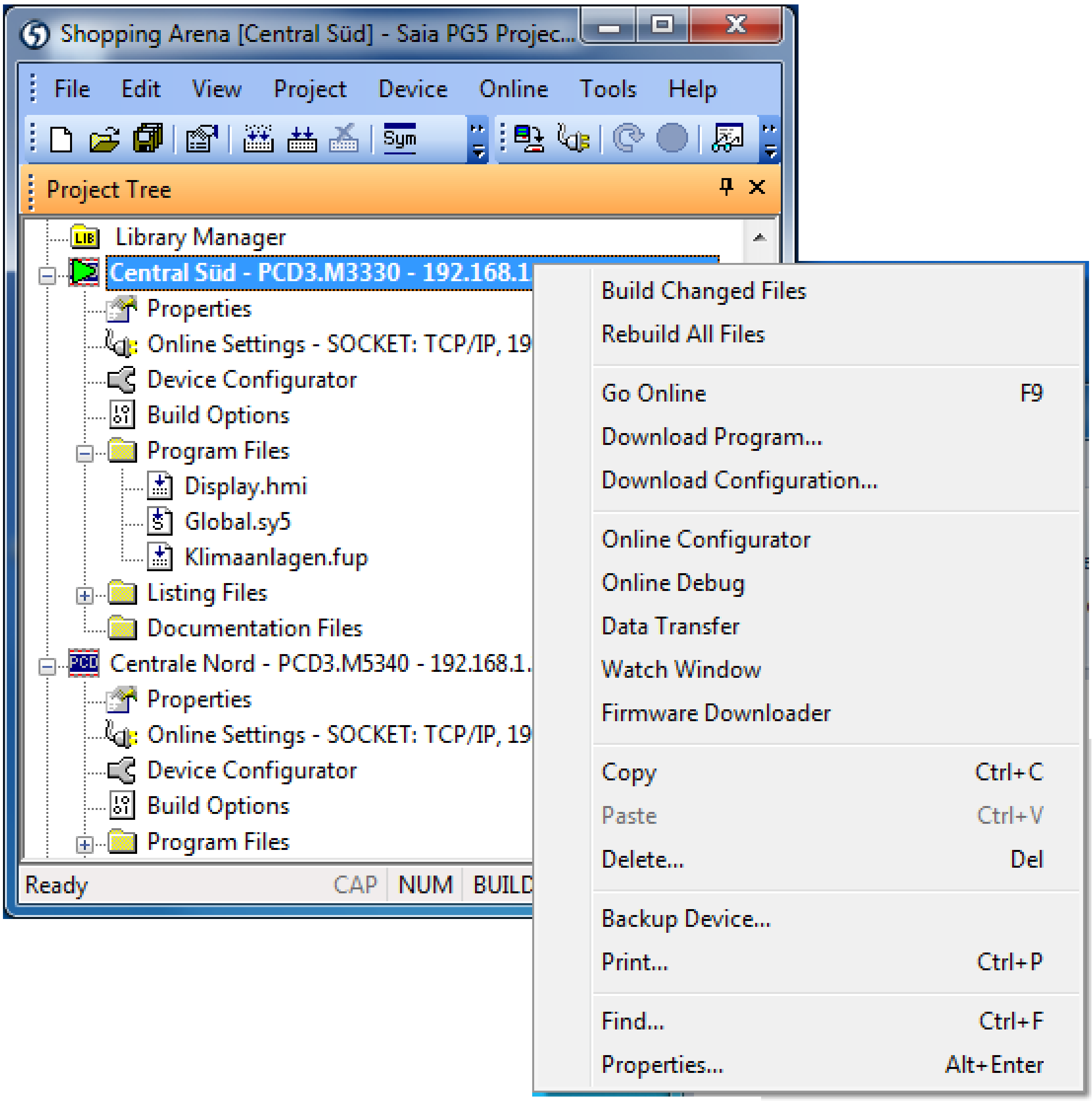
Comment

Free text describing the backup. By default this is filled in with the user name, project name and date/time of the backup.

Backup What

Defines which will be saved. It's not necessary to save all the files, only the source ad configuration files are important.

2.2 The *Project Tree* window



Device context menu

Displayed by the *View, Project Tree* command, the *Project Tree* provides a structured view or the project information.

2.2.1 *Project* folder

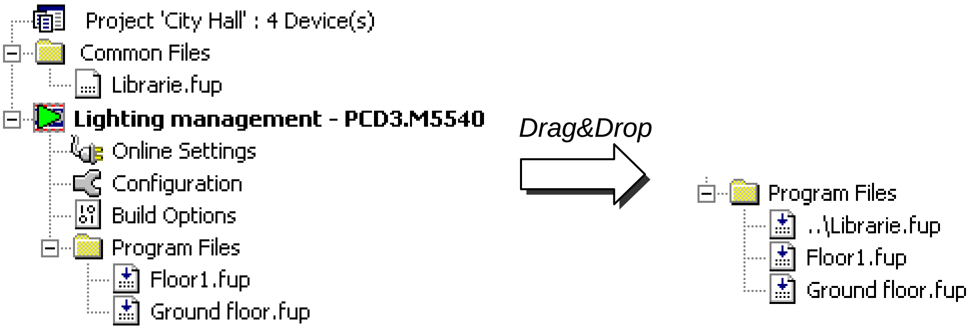
The top-level folder represents the project, with its name and the number of *devices* it contains. Use these commands to manage devices in the project:

Main menu *Device, New…* or context menu *New Device…*
Creates an adds a new *device* to the project.

Main menu *Device, Import…* or context menu *Import Device…*
Imports an existing *device* from another project. If a device is imported from an old PG4 or PG5 version, it will be converted to the new V2 format.

Main menu *File, Properties...* or context menu *Properties…*
Display or modify a project's properties: name, description and read-only attribute.

2.2.2 Common Files folder



This folder contains files that can be shared by more than one device in the project. These files can be copied, pasted or dragged into the *Program Files* folder of each device which shares them. A common file's name shown in the *Program Files* folder begins with two dots "..\", which indicates that the file is in the parent directory, one level up.

The file can be opened from either the *Common Files* or the *Program Files* folders. In both cases the same file can be modified and the changes effect every device which references the file.

These are the main commands you will need for adding common files:

File, New…* or context menu *New File…
Creates and adds a new file to the *Common Files* folder.

Context menu *Add Files…*
Copies one or more existing files into the *Common Files* directory. Not only PG5 program files, but also commissioning and maintenance documents (Word and Excel files etc.) can be added. These files are stored with the PG5 project and can be opened from the *Project Tree* by double-clicking on them.

2.2.3 Libraries folder

Libraries

This folder opens the *Library Manager* window which shows all the available libraries.

The *Installed Libraries* list shows all the libraries found in the library files directory, which can be used by all projects.

The *Libraries Copied To Project* list shows the libraries which have been copied to the open project's local libraries subdirectory. Only the open project can use these libraries. Installed libraries can be copied into the project using drag-and-drop or by selecting the library and pressing the *Copy To Project* button.

User's libraries or versions which are not distributed as standard with the PG5 should always be saved with the project, to guarantee that the project is complete and will always build.

If different versions of the same library are present, the library to be used for the build can be selected with the checkboxes in the *Used* column.

2.2.4 Device folder

Each *device* folder contains the configuration and files for a single controller.

These are the main commands you will need for managing devices:

Context menu *Device, Set Active*
Activates the device selected in the *Project Tree*. The *active device* is indicated by a green triangle, and many main menu and *Tool Bar* buttons work on the *active device*.
Note: This command is only shown if the option *Tools, Options…, Project Manager Activate Device according to Project Tree location* is set to *No*. If *Yes*, then the *Project Manager* will automatically active the device according to the selection in the *Project Tree*.

File, Properties…* or context menu *Properties…
Display or modify the properties of a device: name, description, read-only option.

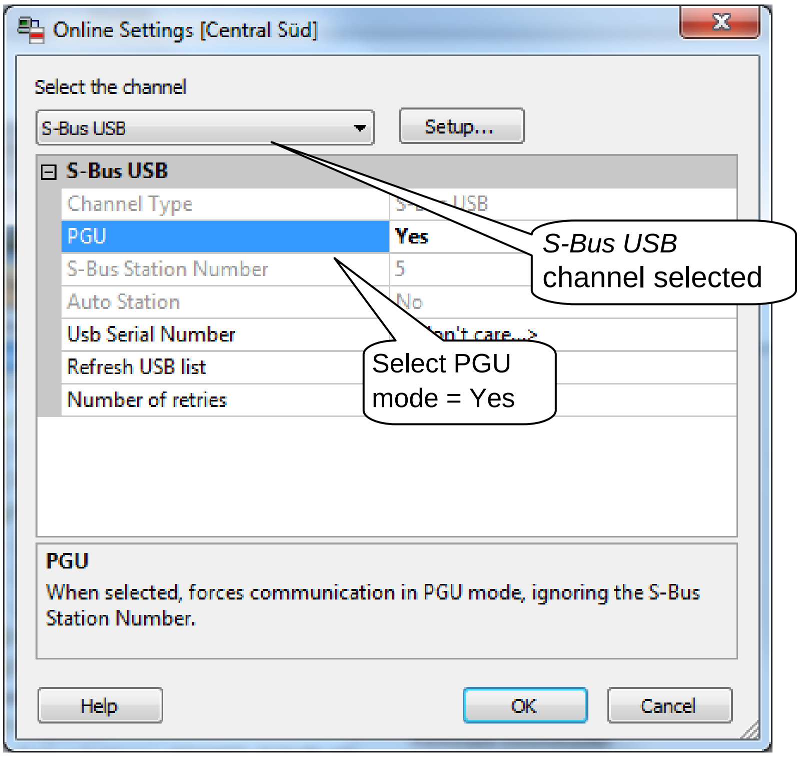
[Edit,] Copy, Paste, Delete
Copy/Paste allows an entire device to be duplicated in the project, with all its files and configuration. *Delete* removes a device and all its files to the Recycle Bin.

2.2.5 *Online Settings*

Online

This branch opens the *Online Settings* window which defines the communications for connecting to the PCD. Several protocols are available: *PGU*, *S-Bus*, *S-Bus USB*, etc., but only the *PGU* and *S-Bus USB* allow the full protocol communications needed by the *Device Configurator*.

***Channel* S-Bus USB**



Online Settings [Central Süd]

Select the channel: S-Bus USB

S-Bus USB	
Channel Type	S-Bus USB
PGU	Yes
S-Bus Station Number	5
Auto Station	No
Usb Serial Number	<Don't care...>
Refresh USB list	
Number of retries	

PGU
When selected, forces communication in PGU mode, ignoring the S-Bus Station Number.

S-Bus USB channel selected

Select PGU mode = Yes

The *Add* button allows new channels to be created with their own types and parameters. These are then visible in the *Online Settings* list of *Channels*.

2.2.6 Connecting the PC to the PCD

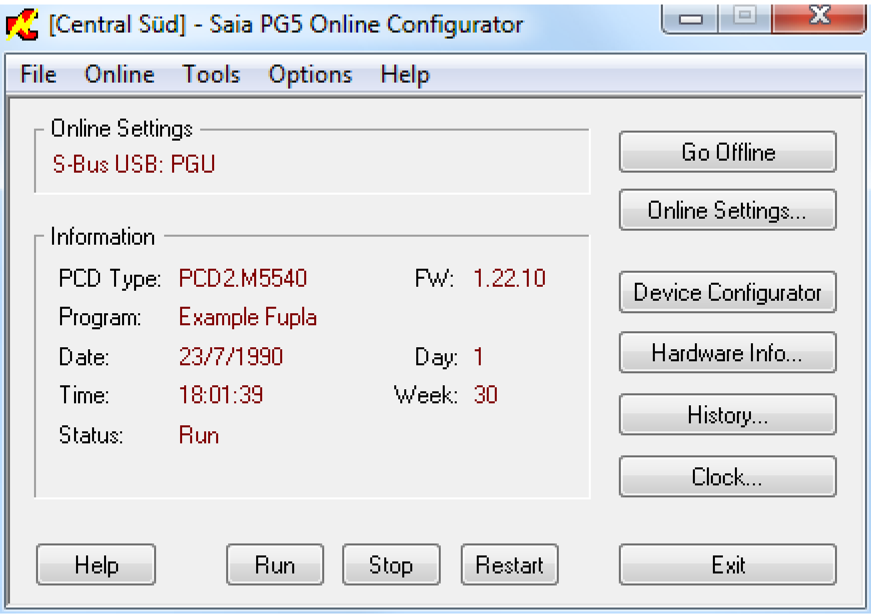
Channel S-Bus USB

The USB connection is only available for the new PCD2 and PCD3 devices. Use any standard USB cable.

Verifying the connection

Online Configurator

Use the *Online Configurator* toolbar button or menu command to connect to the PCD and display its details. If the information in red is shown then the connection is working properly (the details will vary according to the connected PCD).



[Central Süd] - Saia PG5 Online Configurator

Online Settings

S-Bus USB: PGU

Information

PCD Type: PCD2.M5540 FW: 1.22.10

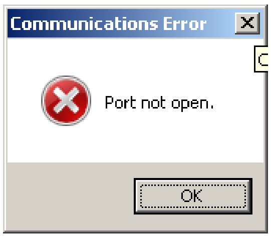
Program: Example Fupla

Date: 23/7/1990 Day: 1

Time: 18:01:39 Week: 30

Status: Run

If the connection cannot be made, an error message like this is displayed. Check the PCD has power, and verify the *Online Settings* and the cable connection.



Communications Error

Port not open.

2.2.7 *Device Configurator*

Configuration

The *Device Configurator* defines the hardware and physical features of the controller, such as the device type, memory, communications channels, fitted modules and I/Os, etc. It also verifies that the power supply provides enough power, and it can print labels for the I/O modules.

To commission a PCD, it is necessary to configure at least the PCD type and its memory size. Other items such as communications and I/Os can be configured later.

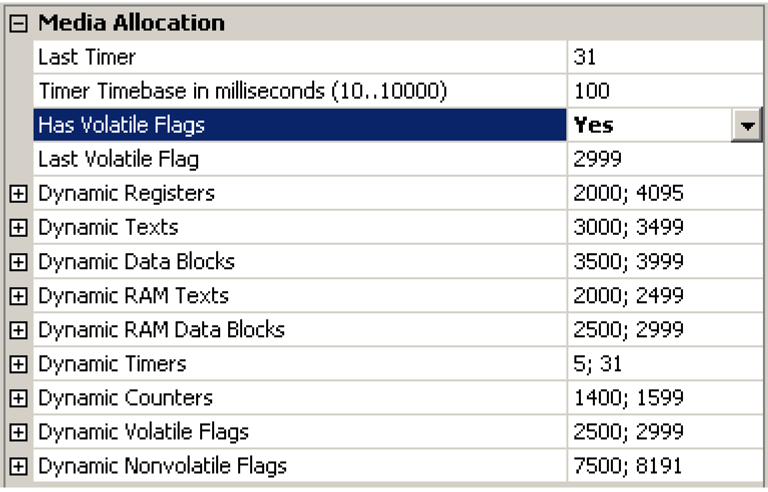
The easiest way to start the configuration is to connect the PCD with the USB cable, and read the actual configuration from the PCD using the *Online, Upload Configuration…* menu command or corresponding toolbar button.

If the PCD's memory has not been configured, it may show default settings, so please always verify that this matches your hardware and application.

2.2.8 Build Options

Build Options

These options are used when the user program is built.

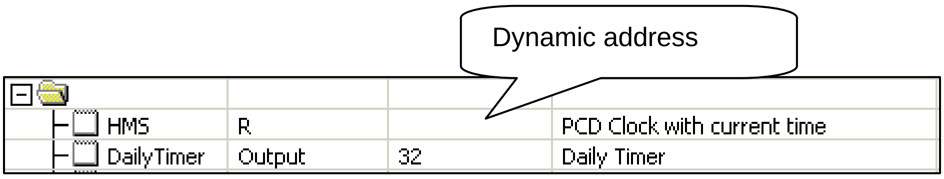


⊟ **Media Allocation**	
Last Timer	31
Timer Timebase in milliseconds (10..10000)	100
Has Volatile Flags	**Yes**
Last Volatile Flag	2999
⊞ Dynamic Registers	2000; 4095
⊞ Dynamic Texts	3000; 3499
⊞ Dynamic Data Blocks	3500; 3999
⊞ Dynamic RAM Texts	2000; 2499
⊞ Dynamic RAM Data Blocks	2500; 2999
⊞ Dynamic Timers	5; 31
⊞ Dynamic Counters	1400; 1599
⊞ Dynamic Volatile Flags	2500; 2999
⊞ Dynamic Nonvolatile Flags	7500; 8191

Media Allocation

This section reserves address ranges for dynamic Registers, Counters, Timers and Flags. When the program is built, addresses are automatically assigned to dynamic symbols defined in the user program and Fupla FBoxes.

A dynamic symbol is one for which no absolute address has been defined:



⊟			
HMS	R		PCD Clock with current time
DailyTimer	Output	32	Daily Timer

It is not always necessary to change the dynamic address ranges. The default settings are usually adequate for most applications.

However, if an error message like this appears during the building of a large program:
Fatal Error 2368: Dynamic space overflow for type: R
then it will be necessary to extend the dynamic address range for the media type shown in the error message.

If the controller is fitted with EPROM or Flash for main memory, then the RAM Texts and RAM DB dynamic ranges must be configured from address 4000 upwards, so that these Texts and DBs are in writeable RAM memory.

Last Timer

Timers and Counters share the same address ranges. The Last Timer value defines the partition between Timers and Counters (it generates the DEFTC instruction). Dynamic Timer addresses must be below or up to this value, and dynamic Counter addresses must be above. For example, if Last Timer is 31, then Timers are T 0..31 and Counters are C 32..1599.

Timer Timebase in milliseconds

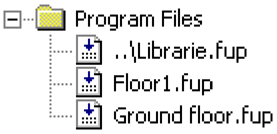
The default timebase at which Timers decrement is once every 0.1 seconds (100ms). If necessary this can be set to another value. Note that the timebase has no influence on Fupla programs. Only IL programs are affected by this parameter.

NOTE: Do not to define an unnecessarily large number of Timers or an unnecessarily small timebase, because this will slow down your program's cycle times.

Dynamic Nonvolatile Flags

By default, all Flags are non-volatile. Volatile Flags are always set to 0 at start-up, nonvolatile Flags retain their values. If necessary, the *Last Volatile Flag* parameter allows a volatile range to be defined. (The picture above shows Volatile Flags for addresses F 0 to F 2999.)

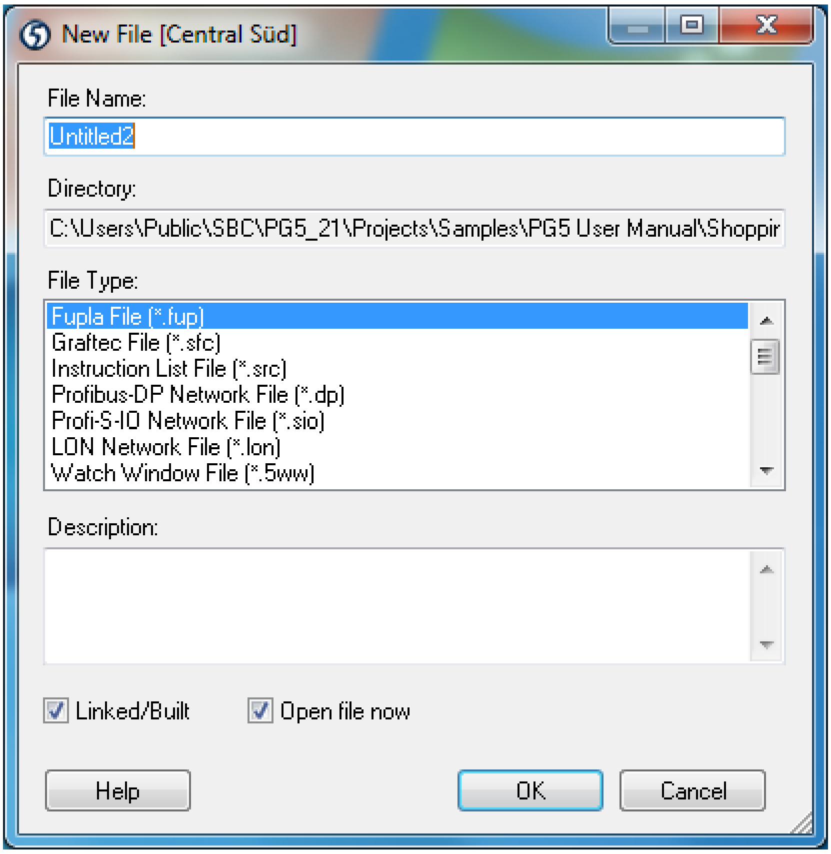
2.2.9 Program Files folder



Program Files
..\Librarie.fup
Floor1.fup
Ground floor.fup

This folder holds the files that make up the device's program. These are the main commands you will need for managing program files:

File, New…* or context menu *New File…
Creates and adds a new file to the folder:



New File [Central Süd]

File Name:
Untitled2

Directory:
C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Shoppir

File Type:
Fupla File (*.fup)
Graftec File (*.sfc)
Instruction List File (*.src)
Profibus-DP Network File (*.dp)
Profi-S-IO Network File (*.sio)
LON Network File (*.lon)
Watch Window File (*.5ww)

Description:

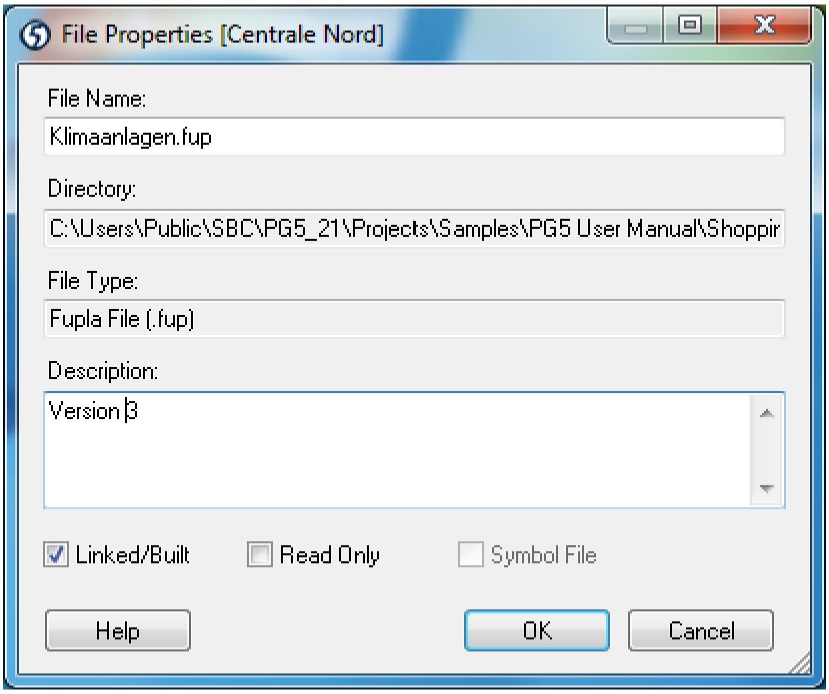
☑ Linked/Built ☑ Open file now

File Name: Name of the file to be created.
Directory: Directory of the device, cannot be edited.
File Type: The type of file to be created.
Description: Free text which can be used for a description of the file, history, version information etc.
Linked/Built: If not checked then the file will be ignored by the build. It will not be part of the user program.
Open File Now: Checked by default, the file will be opened immediately in the associated editor.

Device, Add Files…* or context menu *Add Files…
Adds one or more files to *Program Files* list. Files can be copied into the device directory, or can be linked by a path, according to the *Copy files into device directory* option on the *Add Files* dialog box.

File, Properties…* or context menu *Properties…

Display or modify the selected file's properties: name, description, *Linked/Built* and *Read Only* and *Symbol File* options. Check *Symbol File* if the file contains only the definitions of Global symbols.



File Properties [Centrale Nord]

File Name:
Klimaanlagen.fup

Directory:
C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Shoppir

File Type:
Fupla File (.fup)

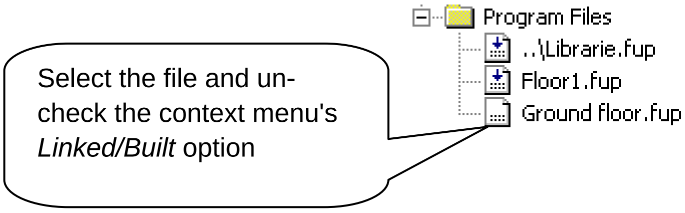
Description:
Version 3

☑ Linked/Built ☐ Read Only ☐ Symbol File

[*Edit,*] *Copy, Paste, Delete*

Copy/Paste allows a file to be duplicated in the current *Program Files* list or any device in the project. *Delete* removes a device and all its files to the Recycle Bin.

Files which comprise the device



Select the file and un-check the context menu's *Linked/Built* option

Files with an arrow in the icon are processed by the build. These files are part of the PCD's program and their code and data are loaded into the PCD's memory.

Files without an arrow on the icon are **not** processed by the build. These files are ignored and are not downloaded into PCD memory. This can be useful for test and commissioning code which will not be present in the final program.

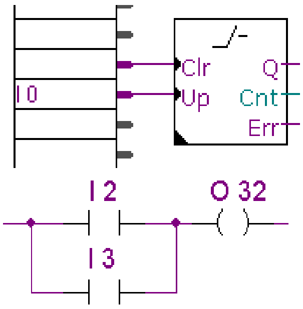
2.2.10 File Types

A device can have several program files of different types. Each type of file has a corresponding editor for a specific field of application.

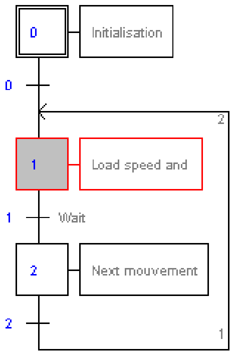
Instruction List Editor (*.src)
Allows programming in text form using IL instructions. Suitable for all applications. Code is fast and efficient, but it requires a lot of programming experience.

```
COB  0
     0
STH  I 0
DYN  F 9
INC  C 53
ECOB
```

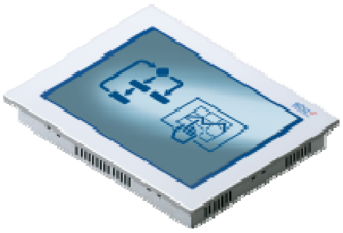
Fupla Editor (*.fup)
Allows programs to be drawn in the form of function plans and contact diagrams. Requires no programming experience. Many libraries are available for the rapid implementation of HEAVAC applications and communications networks (modem, LON, Belimo, EIB, etc.).



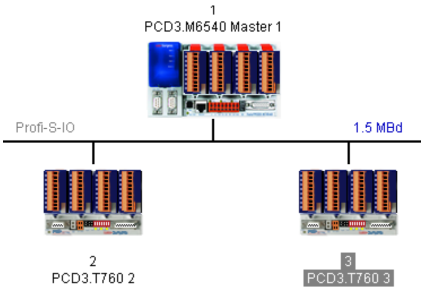
Graftec Editor (*.sfc)
This is a tool for structuring programs in IL (instruction list) and Fupla. Particularly suitable for sequential applications with waits for internal or external events.
It is the ideal tool for programming machines with commands for motors, actuators, etc.



Web Editor Version 8 project (*.sln)
Editor of web pages for process monitoring and control. Pages can be stored inside a PCD, a web panel (PCD7.Dxxx) or on the hard drive of the PC. Web panels and PCs display the pages on a standard browser such as Internet Explorer, and can use any network for communications.

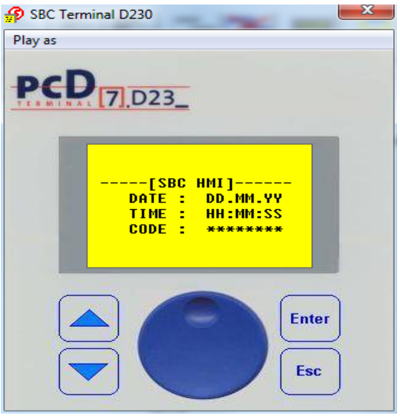


S-Net Network Configurator (*.dp, *.lon, *.srio)
For configuring device networks and communications: Profibus DP, LON et SRIO.



HMI Editor (*.hmi)

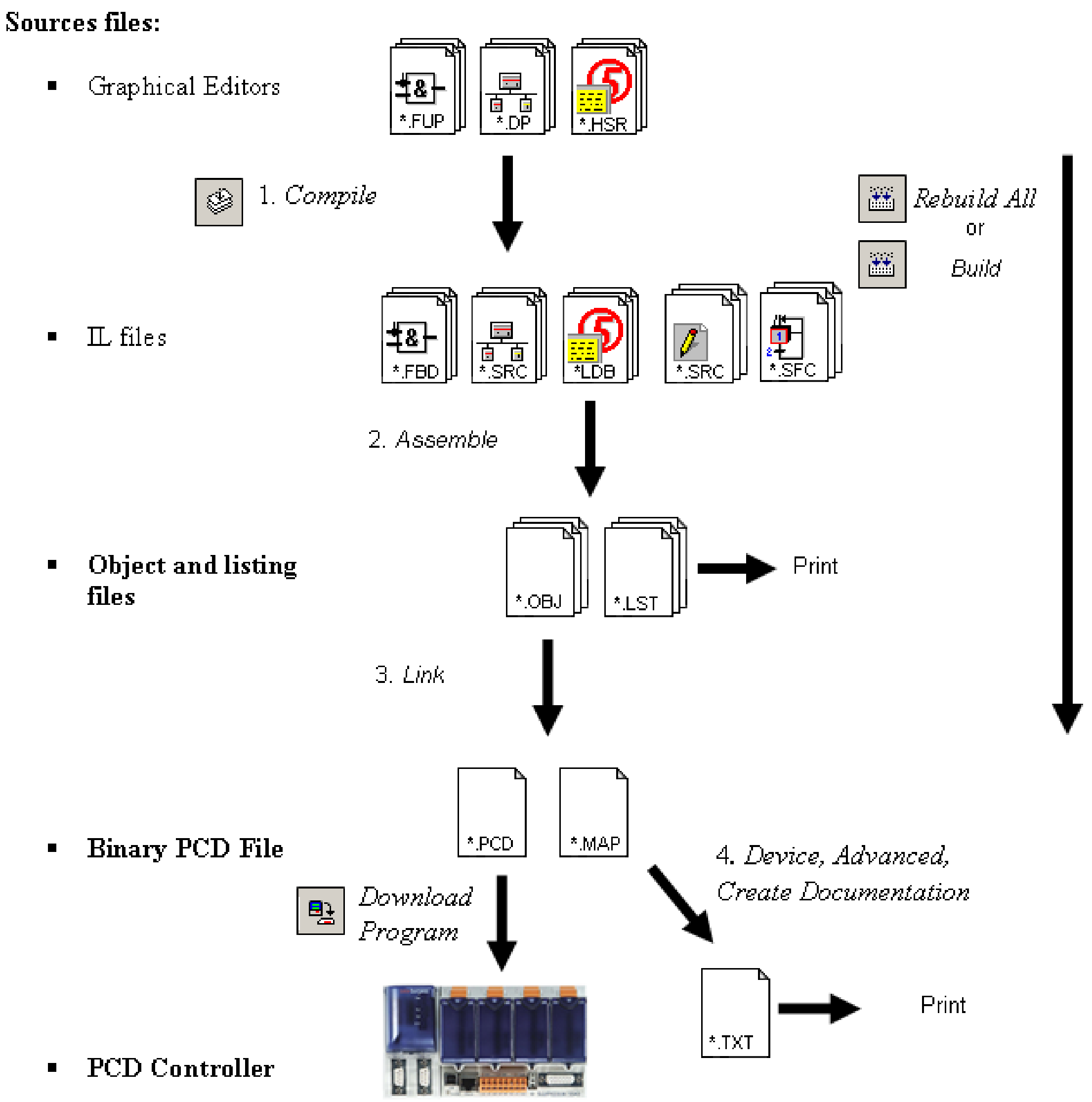
Allows configuration of simple menus with PCD7.D1xx and PCD7.D2xx terminals (installed in addition to PG5).



```
-----[SBC HMI]------
   DATE :  DD.MM.YY
   TIME :  HH:MM:SS
   CODE :  ********
```

2.3 Building the Program

The PCD cannot directly process the text files created by the editors. These files must first be compiled and/or assembled, and then linked to create a binary executable ".pcd" file, as shown in the diagram below.



1. Compilation converts graphical files into Instruction List files (*.fbd, *.src, *.hsr)
2. Assembling produces binary object files (*.obj), and an assembly report (*.lst) which can be printed or used for troubleshooting certain assembler errors.
3. Linking combines object files (*.obj) to form a single binary executable file (*.pcd) for downloading into the PCD.
4. IL documentation files are generated by the Project Manager's *Device, Advanced, Create Documentation* command. The resulting files are shown in the *Documentation Files* folder.

2.3.1 *Build Changed Files, Rebuild All Files, Rebuild All Devices*

Rebuild All

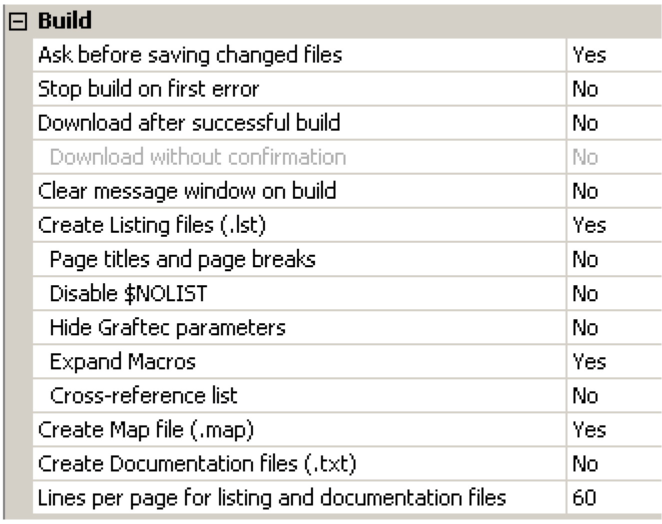
The *Device, Rebuild All Files* command starts the compilation, assembling and linking of all the *Linked/Built* files for the *active device*.

The *Device, Build Changed Files* command does the same thing but only for the files modified since the last build. This is much faster, especially for big programs.

The *Project, Rebuild All Programs…* command does a *Rebuild All Files* for each device in the project. Once complete, the *Messages* window shows the number of devices built with and without errors. Double-click on the red Build Errors message to move to the error messages for that device.

2.3.2 General *Build Options*

The build options which are shared by all projects and devices are configured from the *Tools, Options* command, *Build* section.



⊟ **Build**	
Ask before saving changed files	Yes
Stop build on first error	No
Download after successful build	No
Download without confirmation	No
Clear message window on build	No
Create Listing files (.lst)	Yes
Page titles and page breaks	No
Disable $NOLIST	No
Hide Graftec parameters	No
Expand Macros	Yes
Cross-reference list	No
Create Map file (.map)	Yes
Create Documentation files (.txt)	No
Lines per page for listing and documentation files	60

Ask before saving changed files
If *Yes*, the PG5 requests authorization to save source files which have been changed but not saved before building the program. If *No*, files are saved automatically.

Stop build on first error
Set to *Yes* to stop the build when the first error appears in the *Messages* window.

Download program after successful build
When *Yes*, the program is automatically downloaded into the PCD after every successful build.

Download without confirmation
Normally the download starts with a dialog box notifying the user, and the download must be started by pressing the *Download* button. If this option is *Yes*, then the download starts immediately without displaying the dialog box. This options is disabled unless *Download program after successful build* is selected.

Clear message window on build
The contents of the *Messages* window is deleted at the start of every build.

Create Listing files (.lst)
Creates and assembler report file (.lst). These can be viewed the *Listing Files* folder.

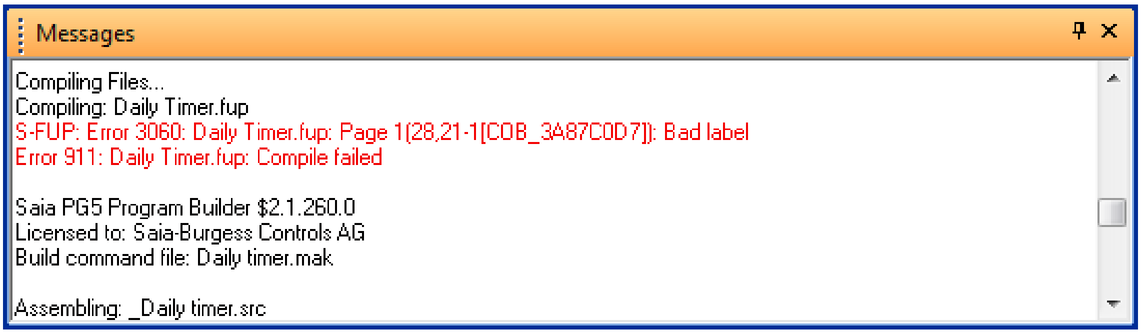
Create Map file (.map)
Creates the linker report file (.map). This can be viewed the *Listing Files* folder.

2.4 *Messages* Window

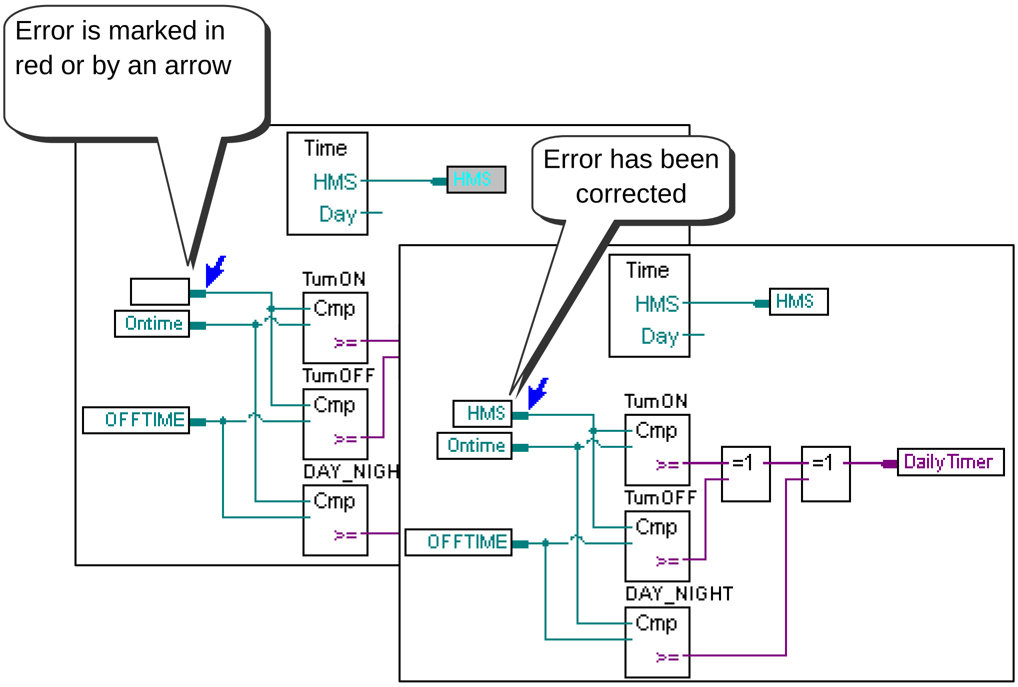
The *Messages* window provides information on the progress of a program build. It notes the different stages of the build: compilation, assembling and linking. If the program has been edited correctly, the build ends with the message:

Build successful. Total errors 0 Total warnings: 0

Errors are indicated with a message in red. Double-clicking on an error message will open the editor and select the location of the error, if possible.
Selecting the error message and pressing F1 will display help on the error, if it's available.



```
Compiling Files...
Compiling: Daily Timer.fup
S-FUP: Error 3060: Daily Timer.fup: Page 1(28,21-1[COB_3A87C0D7]): Bad label
Error 911: Daily Timer.fup: Compile failed

Saia PG5 Program Builder $2.1.260.0
Licensed to: Saia-Burgess Controls AG
Build command file: Daily timer.mak

Assembling: _Daily timer.src
```

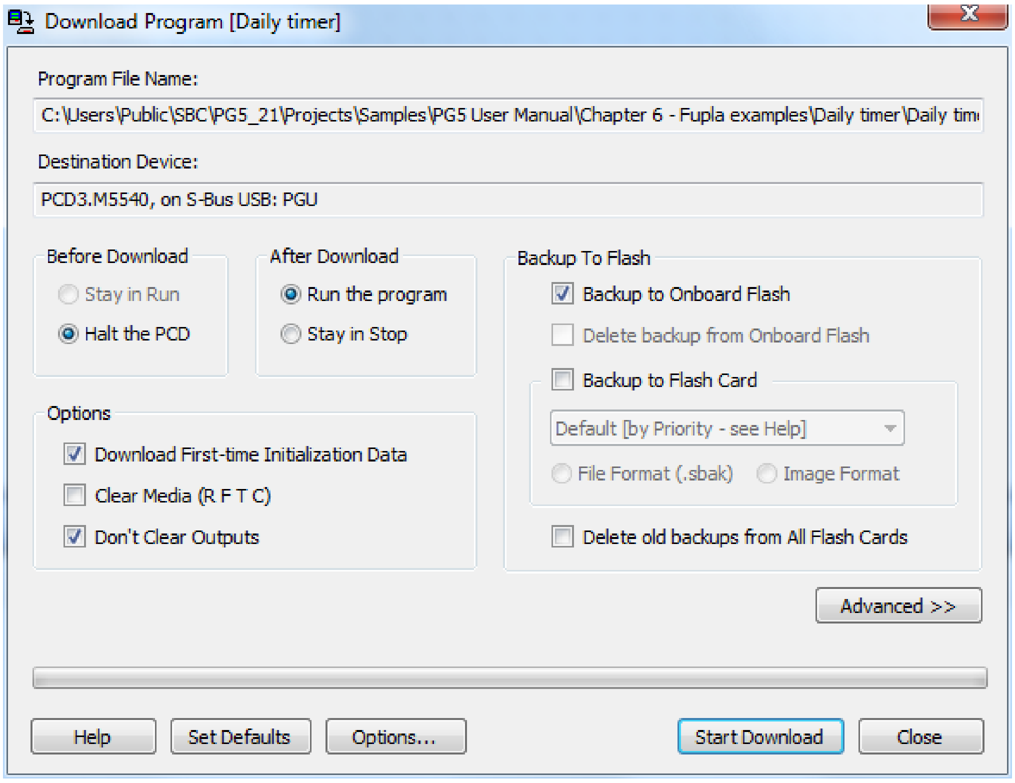


2.5 Downloading the Program into the PCD

2.5.1 *Download Program*

Download Program

If the build is successful, the *Online, Download Program* command or toolbar button will download the executable program into the PCD's memory.



Download Program [Daily timer]

Program File Name:
C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Chapter 6 - Fupla examples\Daily timer\Daily tim

Destination Device:
PCD3.M5540, on S-Bus USB: PGU

Before Download
○ Stay in Run
● Halt the PCD

After Download
● Run the program
○ Stay in Stop

Backup To Flash
☑ Backup to Onboard Flash
□ Delete backup from Onboard Flash
□ Backup to Flash Card
Default [by Priority - see Help]
○ File Format (.sbak) ○ Image Format
□ Delete old backups from All Flash Cards

Options
☑ Download First-time Initialization Data
□ Clear Media (R F T C)
☑ Don't Clear Outputs

Program File Name
By default, this is the path of the *active device's* PCD file.

All
Downloads the entire program (*Code, Text/DB, Extension Memory, Downloadable Files*)

Changed Blocks
Downloads only the blocks (COB, PB, FB, SB, ST, TR, XOB) which have changed since the last download. This option should only be used to save time when downloading minor corrections while developing a program. The *Changed Blocks* button can be used to display a list of changed blocks. See help for more details.

Download in Run
Allows *changed blocks* to be downloaded without halting program execution. Proper operation of the program depends on what changes have been made – see Help for details.

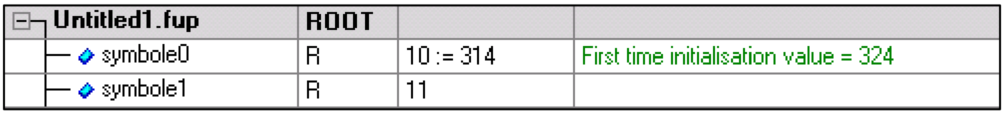
Do NOT use this option unless you are sure that the changes are correct.

Selected Segments
Only downloads the sections defined by the *Selected Segments* options:
Code Segment = Program, *Text/DB Segment* = Texts and DBs 0…3999, *Extension Memory* = Texts and DBs 4000+, Downloadable files = Configuration files such as BacNet configuration.

First-time Initialisation Data
Specific media (R T C F) can be initialised when the program is downloaded. *First-time initialisation data* is defined using `:=`

```
symbol EQU type [address] := initialisation_value
```

or



⊟ Untitled1.fup	ROOT		
symbole0	R	10 := 314	First time initialisation value = 324
symbole1	R	11	

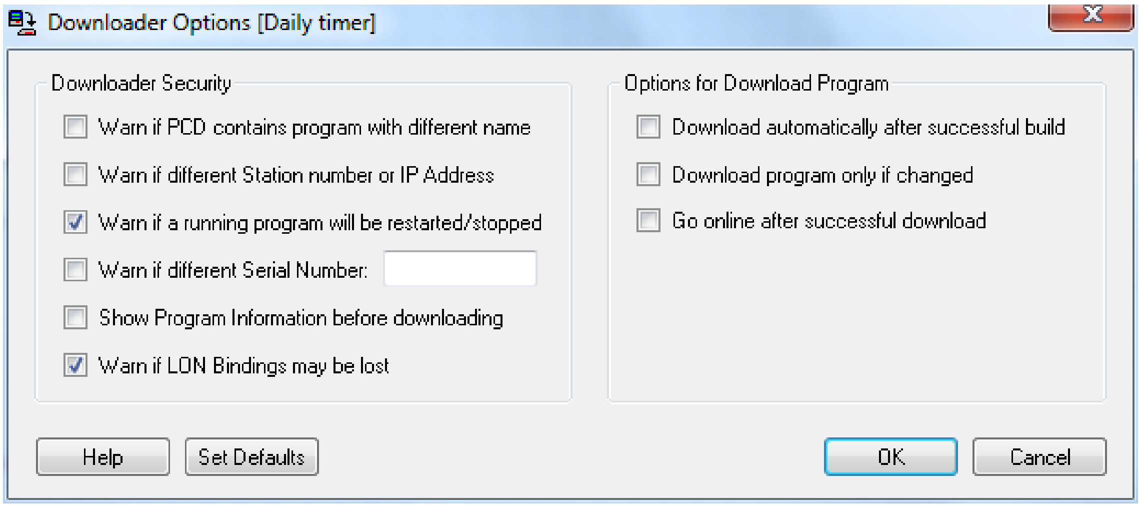
First-time initialisation data is not initialised every time the program starts, but only when a **new** program starts. Other data can be initialised by code in the start-up XOB 16.

Copy User Program to Flash

Once the program has been successfully downloaded into RAM memory, it will be saved in backup Flash memory, if fitted.

2.5.2 *Download Options*

Additional *download options* can be defined with the *Tools, Options* menu command, or the *Options* button on the *Download Program* dialog box. They allow the program download procedure to be personalized.



Downloader Options [Daily timer]

Downloader Security
- ☐ Warn if PCD contains program with different name
- ☐ Warn if different Station number or IP Address
- ☑ Warn if a running program will be restarted/stopped
- ☐ Warn if different Serial Number:
- ☐ Show Program Information before downloading
- ☑ Warn if LON Bindings may be lost

Options for Download Program
- ☐ Download automatically after successful build
- ☐ Download program only if changed
- ☐ Go online after successful download

Download program only if changed

Does not download unchanged programs. There is no need to download a program which has not changed.

Download only the changed blocks

See previous page.

Verify all PCD memory writes

All data written to the PCD will be read back and compared. This option should not normally be selected, because it doubles the program download time. Use it only if you suspect a rare problem with the PCD's memory chip.

Run the program after successful download

Automatically puts the device into Run after downloading the program.

WARNING: This option should only be selected if you are sure the program will run correctly, or there is no possible risk to people or property if it fails.

Go online after successful download

Automatically puts the device online after a successful download.

Backup user program to Flash after download

Automatically copies the program to Flash[1] backup memory.

If this option has not been selected, a copy can still be made after the download, using the *Online, Flash Memory, Copy Program To Flash* command.

[1] PCD2.M170, PCD2.M480, PCD4.M170 et PCD3

Warn if PCD contains program with different name
Compares the name of the program in the PCD with the name of the program to be downloaded. If the program names differ, a message will be displayed to prevent downloading into the wrong PCD.

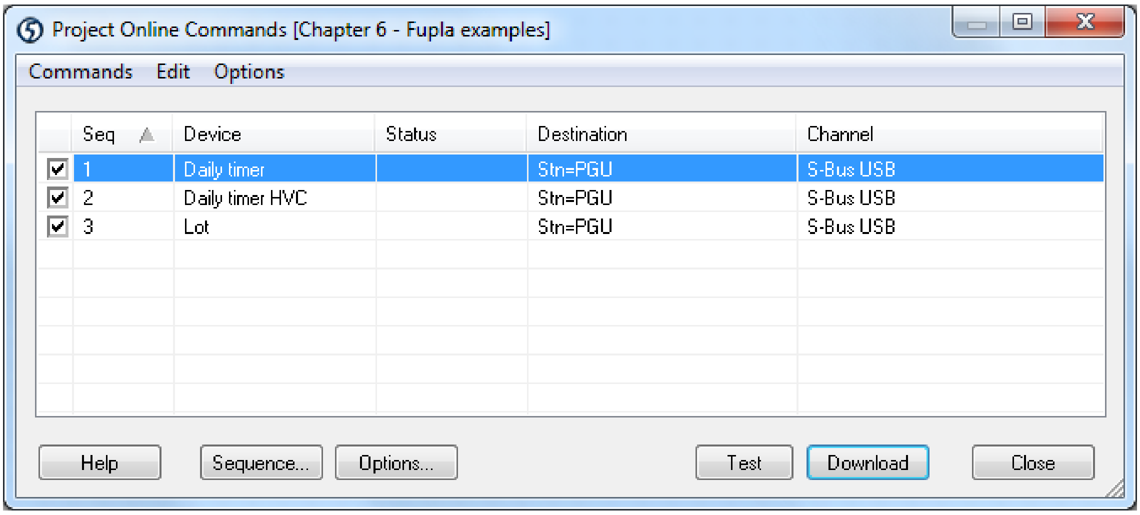
Warn if a running program will be stopped
Downloading a program will stop the PCD. Depending on the application or process, it could be dangerous to stop a running program, e.g. if it's controlling a Large Hadron Collider or nuclear power station. Selecting this option allows a warning message to be displayed before the program is stopped.

Do not clear Outputs on download or restart
This option can be useful with HEAVAC applications. It prevents ventilation or lighting from being switched off while a program is being downloaded. It should not be selected with other applications.

Auto close Up/Download dialog boxes on success
If this option is selected, the *Up/Download* dialog boxes close automatically after a successful download, and will only remain open if there was an error.

2.6 Commands for All Devices

If the PC and all the project's devices are connected together on a network, then *Project, Online Commands* dialog box provides some useful commands for controlling or downloading to all devices on the network.



	Seq	Device	Status	Destination	Channel
☑	1	Daily timer		Stn=PGU	S-Bus USB
☑	2	Daily timer HVC		Stn=PGU	S-Bus USB
☑	3	Lot		Stn=PGU	S-Bus USB

The dialog box shows a list of all devices in the project, and has checkboxes for selecting the devices to receive the commands. By default all devices are checked. The device list's context menu contains some commands for manipulating these checkboxes.

Options, Device Sequence
By default, commands are sent to the devices in the order in which they are defined in the *Project Tree* (alphabetical order). This option displays a dialog box which allows the order to be changed.

Options, Options For 'Download Programs'
Believe it or not, this configures the options for the *Download Programs* command.
NOTE: Some of these options could be very important, they define when the devices will be put into *Stop* or *Run*.

Commands, Test

This command verifies that each selected device is online and able to receive commands. If it fails, check the *Online Settings* for the device and make sure it is connected and power is on.
Commands, Download Programs
Downloads the programs into all the selected devices.
Commands, Set Clock
Copies the PC's date/time to every selected device.
Commands, Run/Stop
Puts all selected devices into *Run* or *Stop*.

2.7 Self Downloading Files

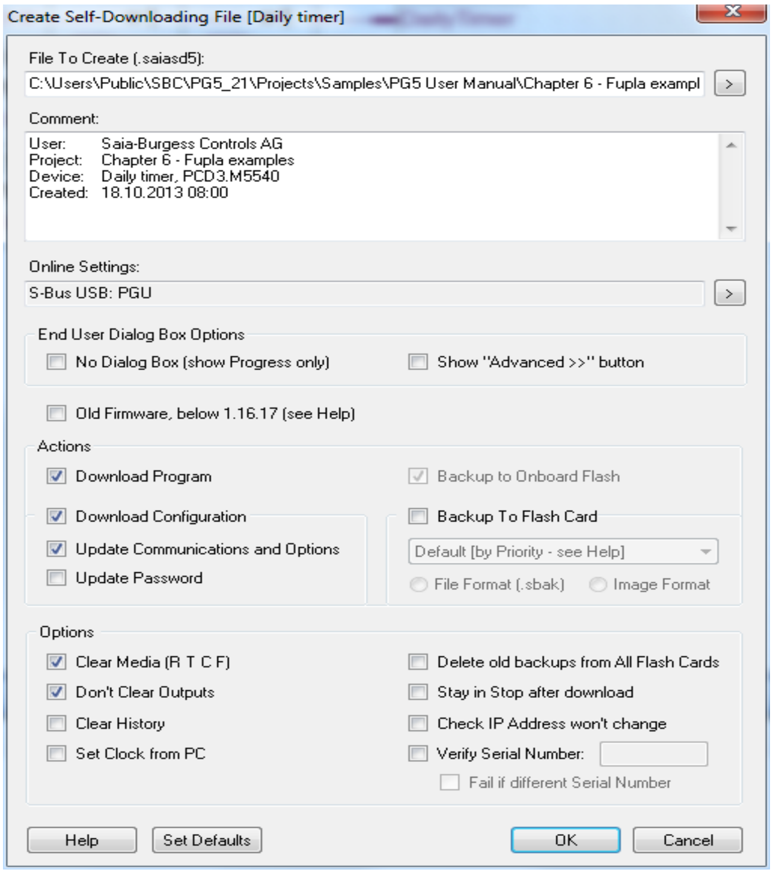
The self-downloading files feature makes it much easier to download programs and configurations into PCDs on site.

A self-downloading '.*saiasd5*' file is created, which contains all the information needed to update the PCD's program and configuration. The PG5 programmer then simply sends this file by e-mail to the person in charge at the PCD job site.

When you open a '*.saiasd5*' file, the *Download Self Downloading File* dialog box is displayed. Certain parameters and options on it will match predefined those in the PG5 project. The person present at the job site can either leave these options as they are, or modify them before downloading to the PCD.

This means that no special knowledge of the PG5 is needed to download programs and configurations into the PCDs. The utility works without having to install the PG5 or user licences. However, the *Stand Alone Online Tools* package must still be installed on the PC.

2.7.1 Creating a self-downloading file


Create Self-Downloading File [Daily timer]

File To Create (.saiasd5):
C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Chapter 6 - Fupla exampl

Comment:
User: Saia-Burgess Controls AG
Project: Chapter 6 - Fupla examples
Device: Daily timer, PCD3.M5540
Created: 18.10.2013 08:00

Online Settings:
S-Bus USB: PGU

End User Dialog Box Options
☐ No Dialog Box (show Progress only) ☐ Show "Advanced >>" button

☐ Old Firmware, below 1.16.17 (see Help)

Actions
☑ Download Program ☑ Backup to Onboard Flash
☑ Download Configuration ☐ Backup To Flash Card
☑ Update Communications and Options Default [by Priority - see Help]
☐ Update Password ○ File Format (.sbak) ○ Image Format

Options
☑ Clear Media (R T C F) ☐ Delete old backups from All Flash Cards
☑ Don't Clear Outputs ☐ Stay in Stop after download
☐ Clear History ☐ Check IP Address won't change
☐ Set Clock from PC ☐ Verify Serial Number:
☐ Fail if different Serial Number

Use the *Device, Advanced, Create Self-Downloading File* command to create a self-downloading file for the *active device*.

The dialog box allows you to configure parameters and options for self downloading at the job site. The options are the same as those we already know from other commands: *Download Configuration and Download Program*, but a few new options have been added.

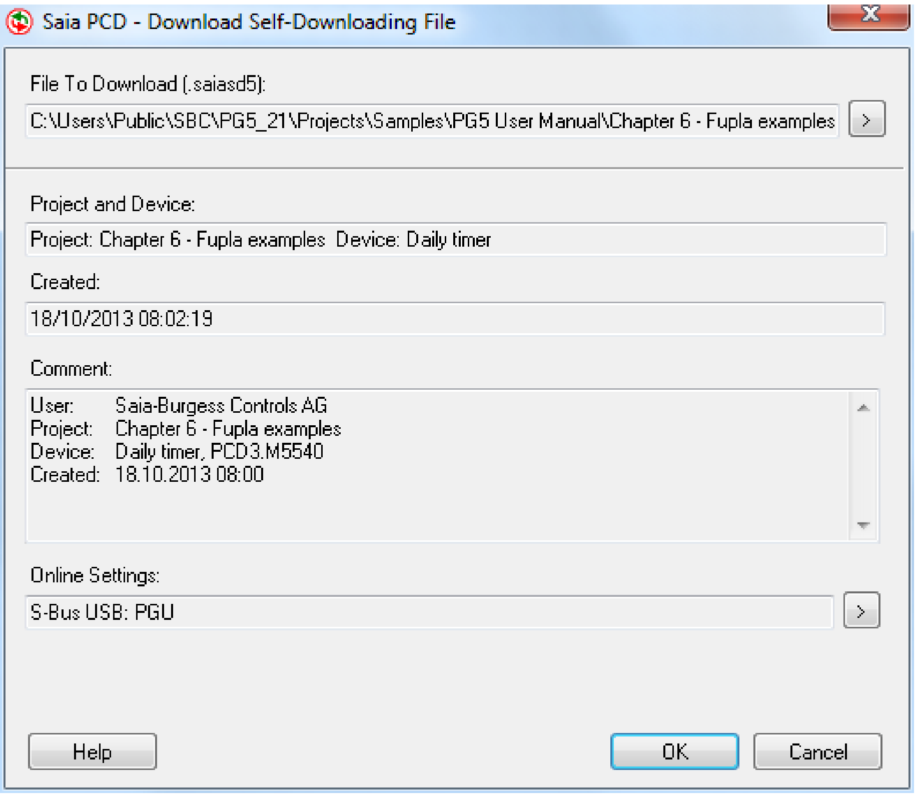
It is advisable to check that the *Online Settings* and *Device Configuration* are correct, and to perform a successful *build* before creating the '*.saiasd5*' file.

File To Create (*.saiasd5)
Enter the path of the file to be created. Use the browse button **>** to select a path.
No Dialog box (Progress only)
Downloads the *'.saiasd5'* file without displaying the *Download Self-Downloading File* dialog box. The download starts immediately and only a progress dialog box is shown.
Show "Advanced >>" button
Hides the advanced settings from the end-user, so none of the settings can be changed before downloading the file.
Verify Serial Number
The downloader checks that the PCD's serial number matches the one defined in the *Serial Number* field. This serial number is unique to each PCD and can therefore be used to ensure that the download goes to the intended PCD.
NOTE: The serial number is only supported by the latest PCD3 systems. The *Online Configurator* can be used to read it online, using the menu *Online, Information command.*

2.7.2 Downloading a self-downloading file

The *Stand-alone Online Tools* package must be installed on the PC. For more details please refer to the PG5 installation guide.

Simply open the '*.saiasd5'* file from *Windows Explorer* by double-clicking on it. A dialog box like the one shown below will be displayed, so the destination and details can be verified before starting the download. If the '*Advanced >>*' button is shown, additional options can be configured before the download, but that's not usually necessary. Start the download process by pressing with the *OK* button.


Saia PCD - Download Self-Downloading File

File To Download (.saiasd5):
C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Chapter 6 - Fupla examples

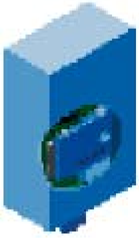
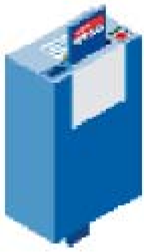
Project and Device:
Project: Chapter 6 - Fupla examples Device: Daily timer

Created:
18/10/2013 08:02:19

Comment:
User: Saia-Burgess Controls AG
Project: Chapter 6 - Fupla examples
Device: Daily timer, PCD3.M5540
Created: 18.10.2013 08:00

Online Settings:
S-Bus USB: PGU

2.8 Flash Backup Memory

Order No:	PCD7.R5xx	PCD3.R5xx	PCD.R600
Slots:	M1/M2	I/O slot 0..3	I/O slot 0..3
Systems:	PCD1.Mxxx0 PCD2.M5, PCD3	PCD3	PCD3

All PCD models have internal Flash memory, and can also be fitted with removable memory with a much greater capacity, using dedicated or I/O slots. Unlike RAM, Flash memory has the advantage that data is not lost when power is switched off. This Flash memory can be used to store a backup copy of the user program, a copy of the PG5 source code for the program, and/or to save data in a file accessible for reading and writing by the PCD's user program.

2.8.1 Saving the executable program

The PCD program is stored in RAM memory. If power is lost and the backup battery is flat then the contents of memory can be lost and the program will not run when power is restored. To backup the program (*Code/Text/Extension*), it can be copied to Flash memory which is not altered when power is lost.

The menu *Online, Flash Memory, Copy Program To Flash…* copies the program to the Flash card, and the command *Copy Program From Flash…* restores it.

This can be done automatically by selecting the download option *Backup user program to Flash after download*.

If the user program in RAM is lost, the PCD will automatically restore the program from Flash backup into RAM at start-up.

We recommend using Flash memory on your PCD to protect you from undesirable data loss.

NOTE: The program's source files must be backed up separately, because only the executable file is loaded into the PCD. See the next section.

2.8.2 Saving the program's source code

The program's source files are stored on the hard drive of the PC. Only the executable code created by the *build* is downloaded into the PCD's memory. Without the source files it is not possible to modify the programs for updates or maintenance. It is therefore important to create backups, and to always have the latest version available for the maintenance technicians.

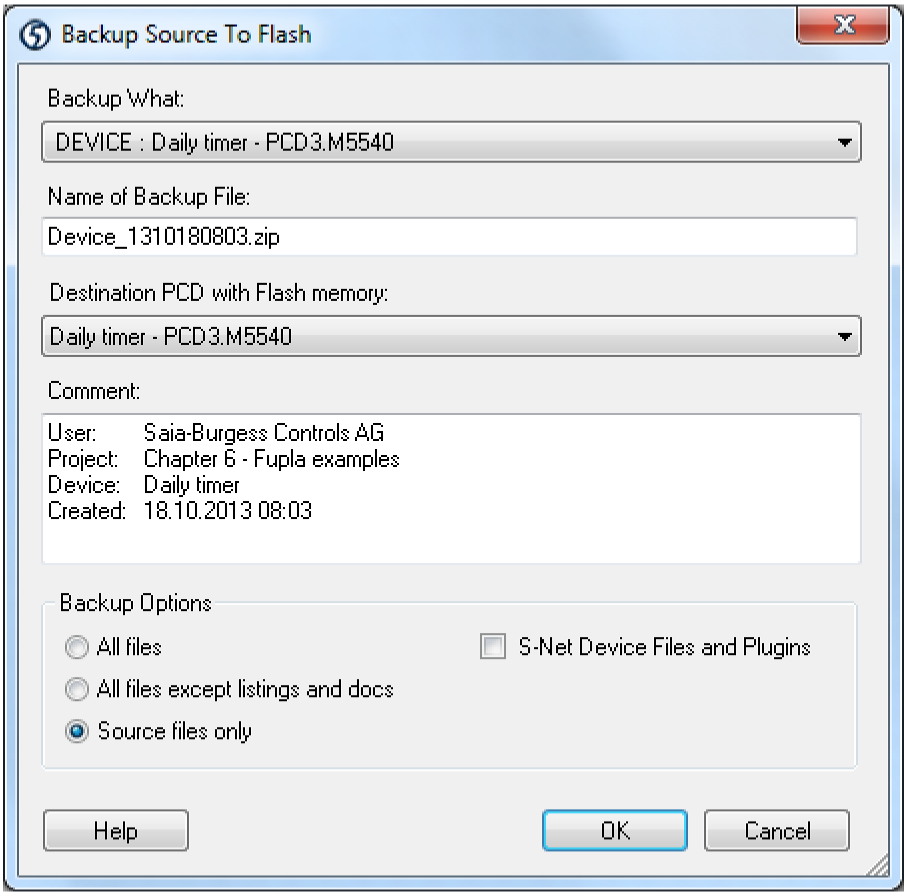
There are two ways to save the source files:

- The *Project, Backup…* command saves all the directories and files into a ".zip" file. This single file makes it easy to retain the directory structure and file layouts. The project is restored from the ".zip" file using the *Project, Restore…* command. See section 2.1.4 for details.

- The command *Online, Flash Memory, Backup Source To Flash…* creates the ".zip" backup file and downloads it to the PCD's Flash memory using FTP via an Ethernet connection. The source is restored by uploading and restoring the file using *Online, Flash Memory, Restore Source From Flash…*. This procedure is described below.

Backup Source to Flash

The command *Online, Flash Memory, Backup Source To Flash…* starts by compressing the entire project or single device into a standard ".zip" file:



Backup Source To Flash

Backup What:

DEVICE : Daily timer - PCD3.M5540

Name of Backup File:

Device_1310180803.zip

Destination PCD with Flash memory:

Daily timer - PCD3.M5540

Comment:

User: Saia-Burgess Controls AG
Project: Chapter 6 - Fupla examples
Device: Daily timer
Created: 18.10.2013 08:03

Backup Options

○ All files

○ All files except listings and docs

● Source files only

□ S-Net Device Files and Plugins

Backup Project or single Device
By default the *active device* is selected, but this can be changed to create a backup of the entire project.

Name of Backup File
The name of the backup file to be created. To be stored in the PCD's Flash file system it must not be longer than 23 characters, including the ".zip".

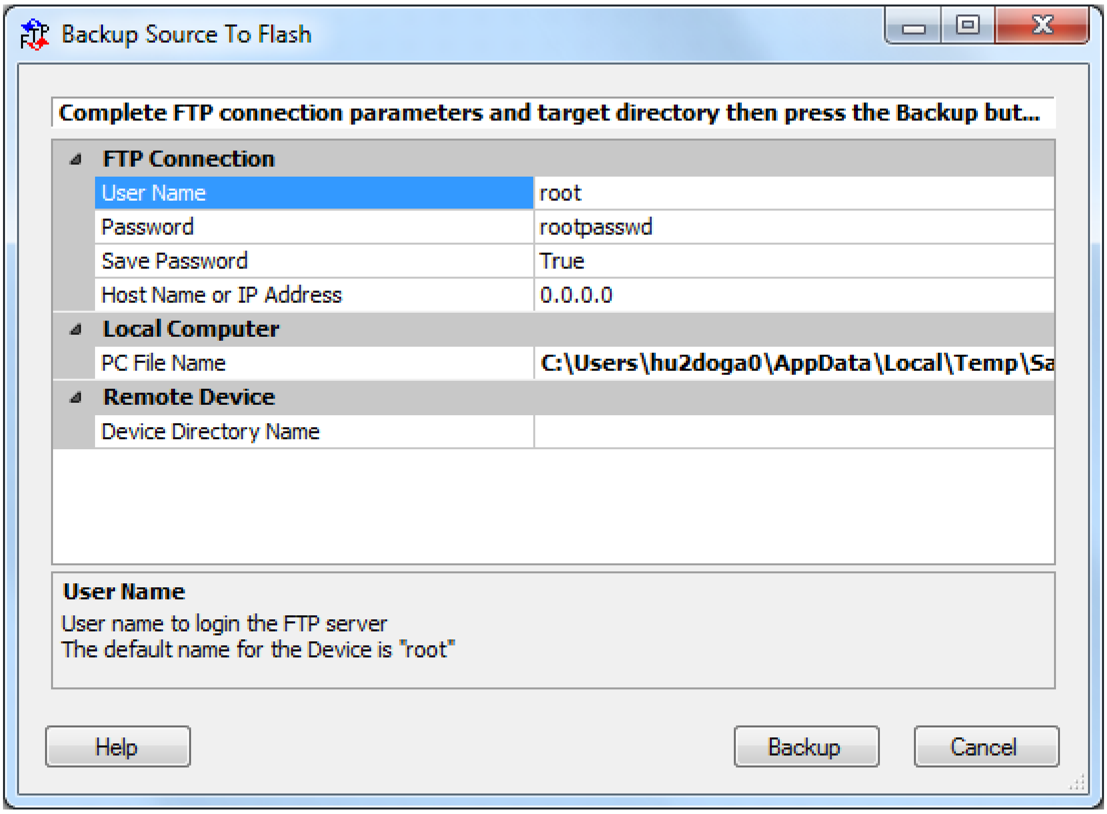
Destination PCD with Flash Memory
Shows the PCD to which the ZIP file will be downloaded.

Comment
Free text, but by default it is filled in with a comment containing the user name, project and device names and the date/time. You can also add a revision number and other details here.

Backup What
Selects which files will be backed up. It is not necessary to backup all files, only the source files are important.

When OK is pressed, the ZIP file is created, then the FTP Downloader is started.

FTP downloader



Complete FTP connection parameters and target directory then press the Backup but...

FTP Connection	
User Name	root
Password	rootpasswd
Save Password	True
Host Name or IP Address	0.0.0.0
Local Computer	
PC File Name	C:\Users\hu2doga0\AppData\Local\Temp\Sa
Remote Device	
Device Directory Name	

User Name
User name to login the FTP server
The default name for the Device is "root"

User Name
Name which identifies the user to the FTP server. If no user is defined, use the default: *root*

Password
Access to the FTP server is protected by a password. If no password has been defined, use the default: *rootpasswd*

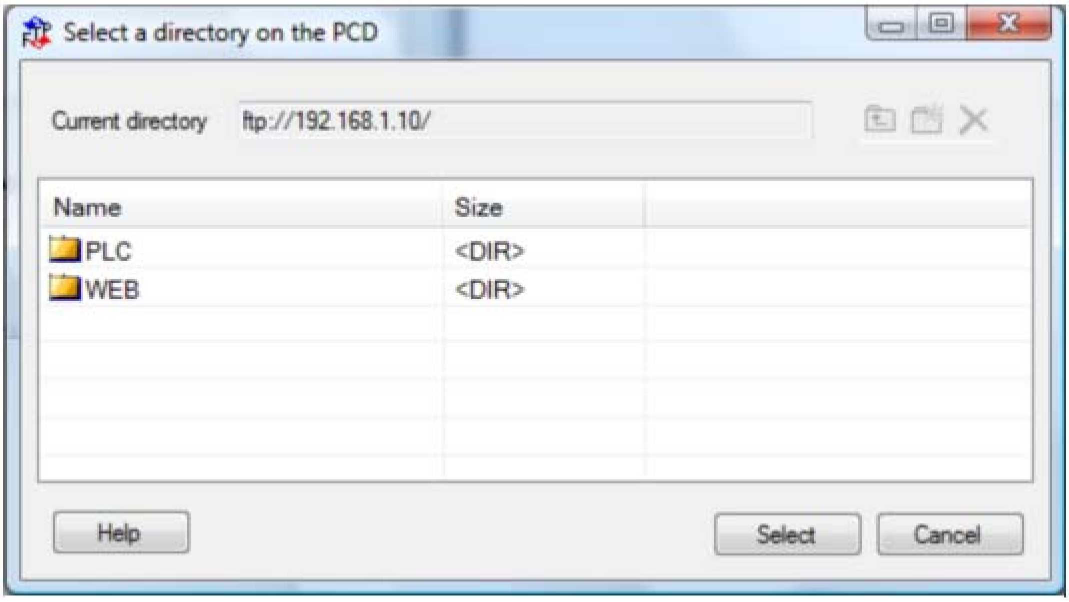
NOTE: The FTP server password and the PCD password may not be the same. The FTP server password is defined in a configuration file in Flash memory called *FTPConfig.txt*. The password to access the PCD is defined by the *Device Configurator*.

Save Password
When *True*, the password is remembered for the next use of this function.

IP Address
IP address of the destination PCD.

PC File Name
The name of the file to be downloaded. By default this is the path of the ".zip" file created in the previous step.

PCD Directory Name
Select this entry and press the button on the right. This obtains a list of Flash memory cards from the FTP server. Select the desired destination for the file.



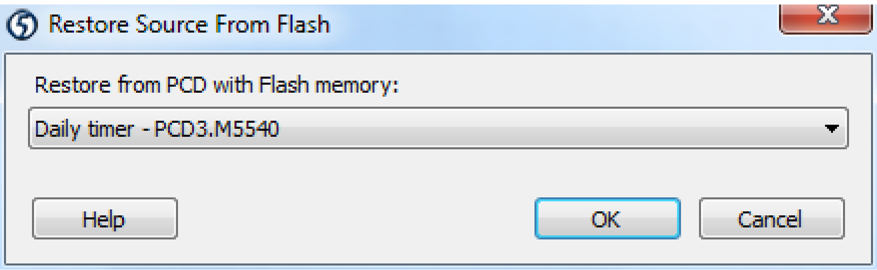
It may take a little time to load and display the above information. If there are several Flash memories fitted, each Flash is shown with its directory structure. Select the Flash and directory. If necessary, directories can be created and deleted with the associated buttons.

M1_FLASH and M2_FLASH
Flash memory cards fitted in slots M1 and M2 of the PCD.
SL0FLASH, SL1FLASH, etc
Flash memory modules fitted in slots 0..3 of the PCD.

NOTE: This feature is supported only by new PCD models fitted with Flash memory that has the new *Flash File System*.

Restoring a project or device from Flash

This is done with the command *Online, Flash Memory, Restore Source From Flash.....* This uploads the ".zip" file from Flash memory and decompresses it.


Restore Source From Flash
Restore from PCD with Flash memory:
Daily timer - PCD3.M5540
Help
OK
Cancel

Pressing OK shows the FTP uploader dialog box with the same parameters as show previously for the download operation. Use the *PCD Directory Name* button to establish communications with the FTP server and to select the Flash memory and directory containing the ".zip" file to be restored. Then confirm the upload a restoration of the project or device.

2.8.3 Backing up data to a file

The FBox library called *File System* supports access to data files in Flash memory. These files can be read and written and can be up and downloaded via FTP.

For more information about the number and types of Flash memory which are available, the configuration of the FTP server, and the possibilities for creating data files using Fupla or IL programs, please refer to the following manuals:

SBC FTP Server and SBC Flash File System
Hardware manual for the PCD3 series
Hardware manual for the PCD2.M5
Hardware manual for the PCD1.Mxxx0

2.9 The *View* Windows

The information displayed in these windows may not be completely accurate if build errors have occurred, but in PG5 V2 they will show all the available information. In V1.x they were always empty if a build error had occured.

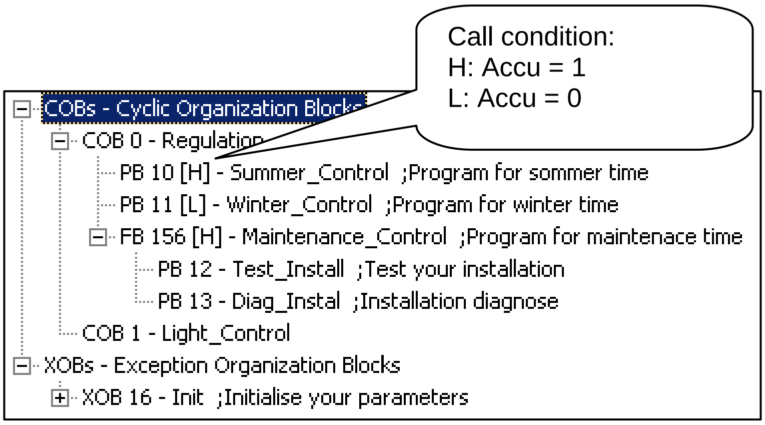
2.9.1 *Block Call Structure*

Block Call Structure

A Saia PCD program is a tree-like structure of organization blocks which contain the application's code. Each block provides a particular service: cyclical programming (COB), sequential programming (SB), sub-programs (PB), functions with parameters (FB), and exception routines (XOB).

The overall structure of the blocks that make up the program can be seen by pressing the *Block Call Structure* toolbar button or selecting the View, Block Call Structure menu command.

The example below shows a program comprising blocks: COB 0, COB 1, XOB16, PB 10, PB11 and FB 156. Note that COB 0 conditionally calls three sub-blocks (PB 10, PB 11 and FB 156). The call condition is indicated in brackets.



```
⊟ COBs - Cyclic Organization Blocks
   ⊟ COB 0 - Regulation
        PB 10 [H] - Summer_Control  ;Program for sommer time
        PB 11 [L] - Winter_Control  ;Program for winter time
      ⊟ FB 156 [H] - Maintenance_Control  ;Program for maintenace time
           PB 12 - Test_Install  ;Test your installation
           PB 13 - Diag_Instal  ;Installation diagnose
     COB 1 - Light_Control
⊟ XOBs - Exception Organization Blocks
   ⊞ XOB 16 - Init  ;Initialise your parameters
```

Call condition:
H: Accu = 1
L: Accu = 0

2.9.2 *Global Symbols* and *Data List* Views

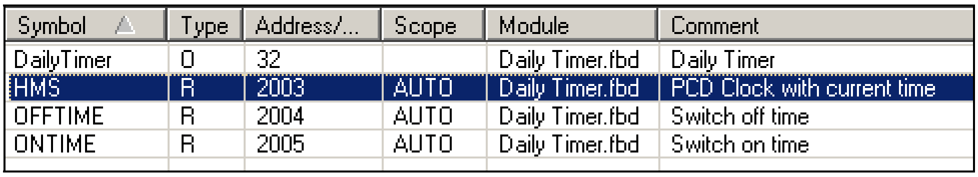
The commands *View, Global Symbols* and *View Data List* display the symbols and data used by the program.

All Publics Symbols

- *All Publics Symbols,* shows all used global symbols from all files in the *active device*, using the Symbol Editor. This list cannot be edited, to edit global symbols you must open the file which defines them.

- *Data List*, shows all symbols and data used by the *active device*. Global and local symbols and absolute addresses are shown. This list cannot be edited.

Data list



Symbol	Type	Address/...	Scope	Module	Comment
DailyTimer	O	32		Daily Timer.fbd	Daily Timer
HMS	R	2003	AUTO	Daily Timer.fbd	PCD Clock with current time
OFFTIME	R	2004	AUTO	Daily Timer.fbd	Switch off time
ONTIME	R	2005	AUTO	Daily Timer.fbd	Switch on time

If a local symbol is defined but is not used in the program, it will not be shown in these windows.

2.9.3 Cross-Reference List

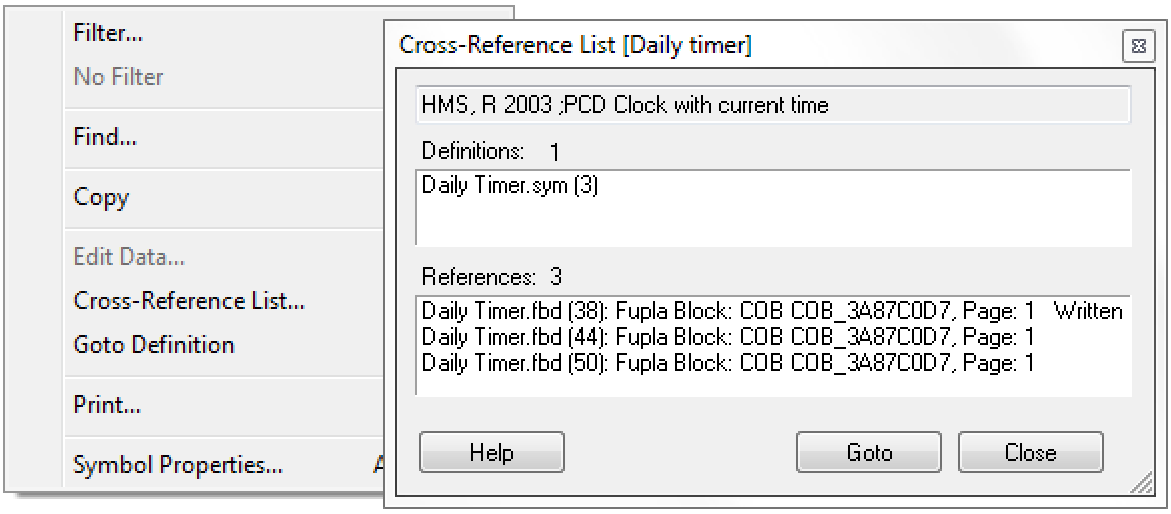
The *All Publics Symbols* and *Data List* views offer the possibility of selecting a symbol and showing its *cross-reference list*, which a list of all program locations where the symbol is used.

Each entry shows the file name and block in which the symbol selected is used, with a line or page number too. It also shows if the could be changed at that location with the word Written.

The *Definitions* list shows where the symbol is defined, e.g. where its IL EQU statement can be found. The *References* list shows where the symbol is used in the program.

For blocks, '>>' indicates where the block itself can be found.

To view the program where the symbol is used, select the definition or reference and press the *Goto* button.



Cross-Reference List [Daily timer]

HMS, R 2003 ;PCD Clock with current time

Definitions: 1

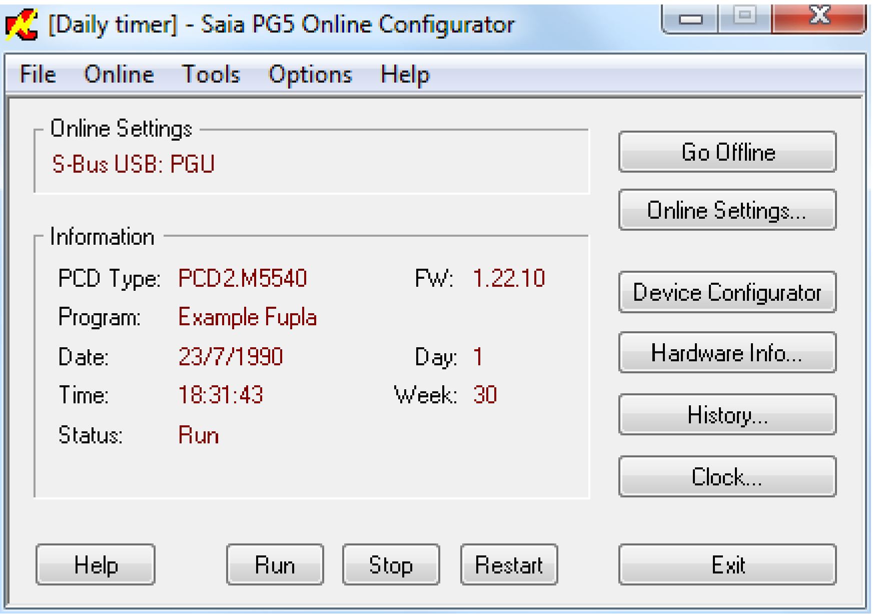
Daily Timer.sym (3)

References: 3

Daily Timer.fbd (38): Fupla Block: COB COB_3A87C0D7, Page: 1 Written
Daily Timer.fbd (44): Fupla Block: COB COB_3A87C0D7, Page: 1
Daily Timer.fbd (50): Fupla Block: COB COB_3A87C0D7, Page: 1

2.10 The Online Configurator

Online Configurator



Online Settings
S-Bus USB: PGU

Information
PCD Type: PCD2.M5540 FW: 1.22.10
Program: Example Fupla
Date: 23/7/1990 Day: 1
Time: 18:31:43 Week: 30
Status: Run

Online Settings	Communications parameters for PCD connection
PCD Type	The connected PCD type
Version	Version of firmware in the PCD
Program Name	Name of the program in the PCD (device name)
Date	Date from PCD's clock, if present
Time	Time from the PCD's clock, if fitted
Day	Day of the week: 1 = Monday, ... 7 = Sunday
Week	Week of year 1..52
Status	Operating mode: Run, Stop, Halt, Conditional Run

If the information shown in red is not present, or an error message dialog box appears, it means that the *Saia PG5 Online Configurator* could not communicate with the PCD.
Please check the following:

- That the PCD is correctly connected with the PCD8.K111 or USB cable, or to the network, and it's powered up.
- That the communications parameters are correct by pressing the Online Settings… button.

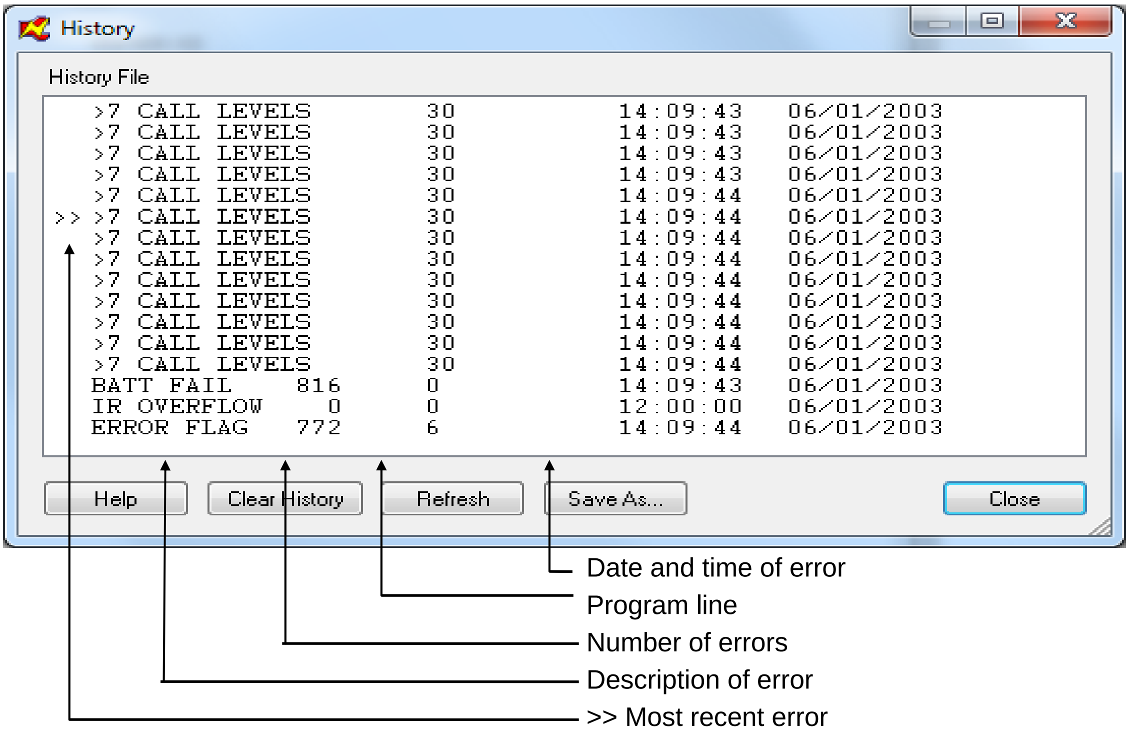
2.10.1 Device Configurator

Uploads the configuration and opens the Device Configurator. Refer to the Device Configurator documentation.

2.10.2 PCD History

History...

The History window shows all the hardware or software errors which have occurred while the PCD was operating. History messages are always added to this list, even if the associated XOB handler is programmed. Examine this list if the PCD's *Error* lamp is lit.



History File

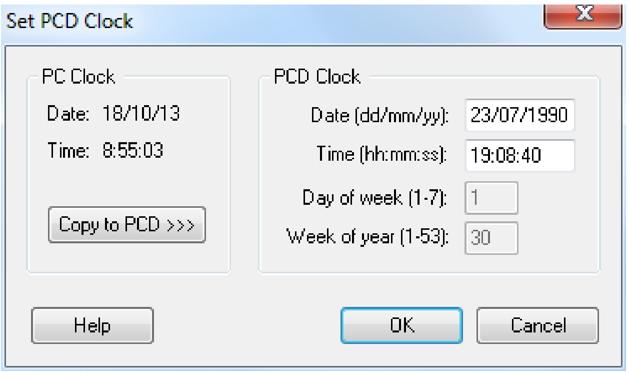
```
   >7 CALL LEVELS        30          14:09:43    06/01/2003
   >7 CALL LEVELS        30          14:09:43    06/01/2003
   >7 CALL LEVELS        30          14:09:43    06/01/2003
   >7 CALL LEVELS        30          14:09:43    06/01/2003
   >7 CALL LEVELS        30          14:09:44    06/01/2003
>> >7 CALL LEVELS        30          14:09:44    06/01/2003
   >7 CALL LEVELS        30          14:09:44    06/01/2003
   >7 CALL LEVELS        30          14:09:44    06/01/2003
   >7 CALL LEVELS        30          14:09:44    06/01/2003
   >7 CALL LEVELS        30          14:09:44    06/01/2003
   >7 CALL LEVELS        30          14:09:44    06/01/2003
   >7 CALL LEVELS        30          14:09:44    06/01/2003
   >7 CALL LEVELS        30          14:09:44    06/01/2003
   BATT FAIL     816     0           14:09:43    06/01/2003
   IR OVERFLOW     0     0           12:00:00    06/01/2003
   ERROR FLAG    772     6           14:09:44    06/01/2003
```

NOTES:

- If the error occurred on a program line, the *Address* shows the line number. If not, it will show a hexadecimal reference.
- XOB 0 (power off) messages are only shown if XOB 0 is programmed.

2.10.3 Setting the PCD's Clock

Clock...

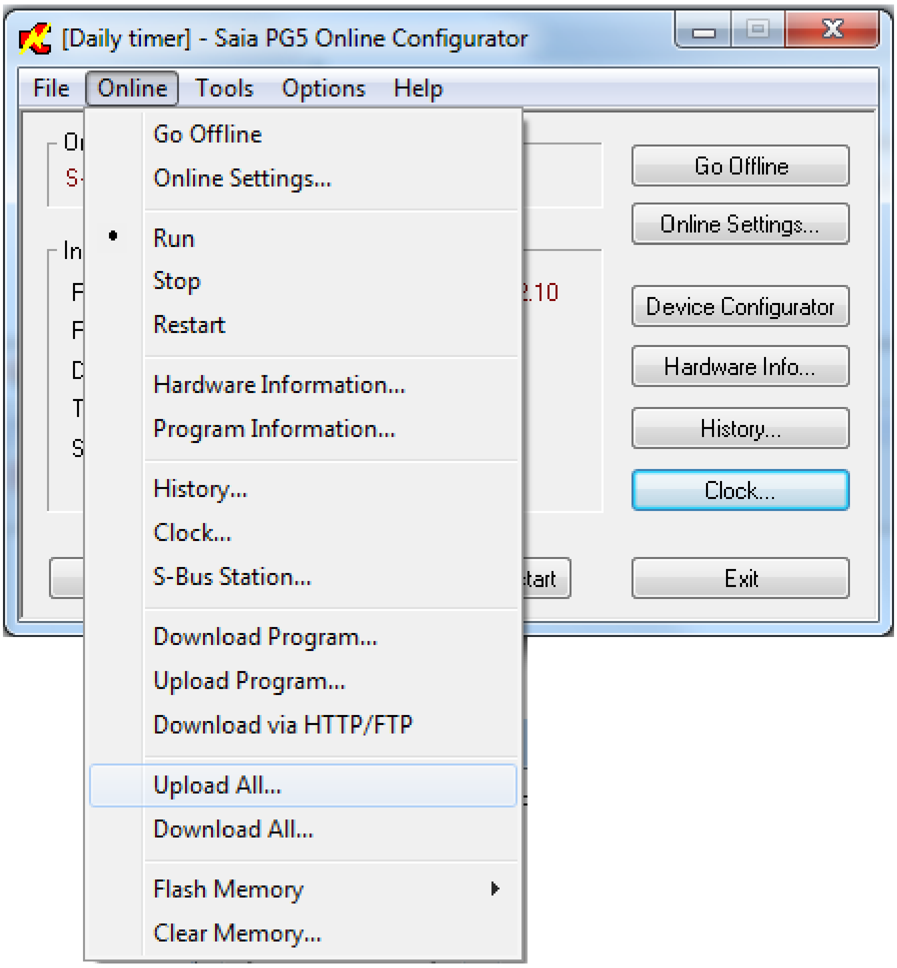


PC Clock
Date: 18/10/13
Time: 8:55:03

PCD Clock
Date (dd/mm/yy): 23/07/1990
Time (hh:mm:ss): 19:08:40
Day of week (1-7): 1
Week of year (1-53): 30

Most PCDs have a built-in real-time clock which provides the date and time. The *Clock…* button displays the above dialog box which allows the date/time to be viewed and adjusted. The *Copy to PCD* >> button immediately copies the date/time of the PC into the PCD's clock. Alternatively, the date and time can be entered manually and are transferred when OK is pressed.

2.10.4 Saving program and data from RAM



This is an interesting command which allows the save and restore of the user program and configuration, and also all the Registers, Flags, Timers, DB, Texts etc. present in the PCD's RAM memory. This is very useful for copying programs to other PCDs, when duplicating an installation, changing the PCD, or simply to restore the PCD to a previously saved state.

Tools, Upload All…
Uploads and saves all of RAM into a file of type ".im5"(PG5 memory image file).

Tools, Download All…
Downloads a ".im5" file into the PCD's RAM.

2.10.5 *Create Diagnostic File*

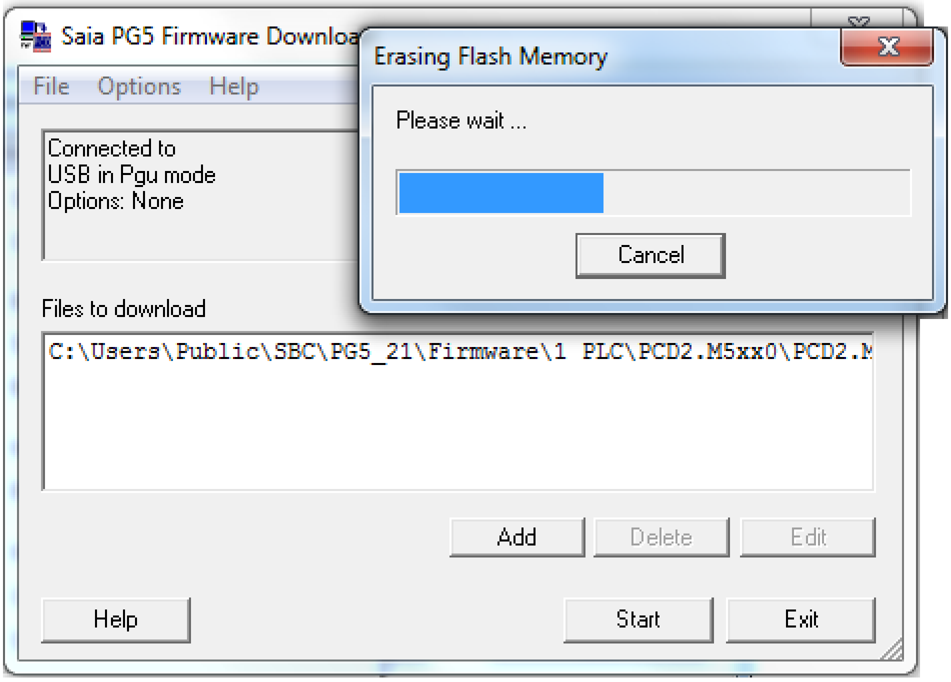
This useful feature creates a file containing all the information needed when requesting help from Saia Burgess Controls technical support team. The file contains details about the PCD type, firmware version etc.

Use the ***Tools, Create Diagnostic File…*** command and note the path of the file which was created.

2.10.6 Firmware Downloader

For a PCD to be able to use the latest functionality it may be necessary to update the *firmware* in the PCD. This is easy to do because all PCDs store the firmware in Flash memory. The current firmware version can be seen on the main window of the *Online Configurator*.

Firmware is downloaded using the *Tools, Firmware Downloader command*, available from Project Manager or the Online Configurator.



Please wait ...

Connected to
USB in Pgu mode
Options: None

C:\Users\Public\SBC\PG5_21\Firmware\1 PLC\PCD2.M5xx0\PCD2.M

The *Add* button adds a new firmware file (.blk) to the *Files to download* list. The list remembers the last file which was downloaded. For special applications the list could contain several files, but for normal use please ensure that only the firmware file for the connected PCD type is present. The most recent firmware files are available in a directory on the PG5 distribution CD.

The *Options, Online Settings…* command defines the communications parameters, usually using *S-Bus USB* or *PGU* mode.

Pressing the *Start* button to begin downloading the firmware. After a few moments, a progress dialog box will appear.

When completed, the *Run*, *Halt* and *Error* LEDs will flash while the PCD does some memory management. Please wait for about 1 minute after they stop flashing before powering off the PCD or continuing to work.

Contents

3 Device configurator

Hardware

The *Saia PG5 Device Configurator* enables configuration of the Device's equipment parameters: *Device* type, memory, communications channels, input/output modules, but it also checks the power consumption by the input/output modules on the internal power supply of the PCD and prints labels for sticking on the I/O modules.

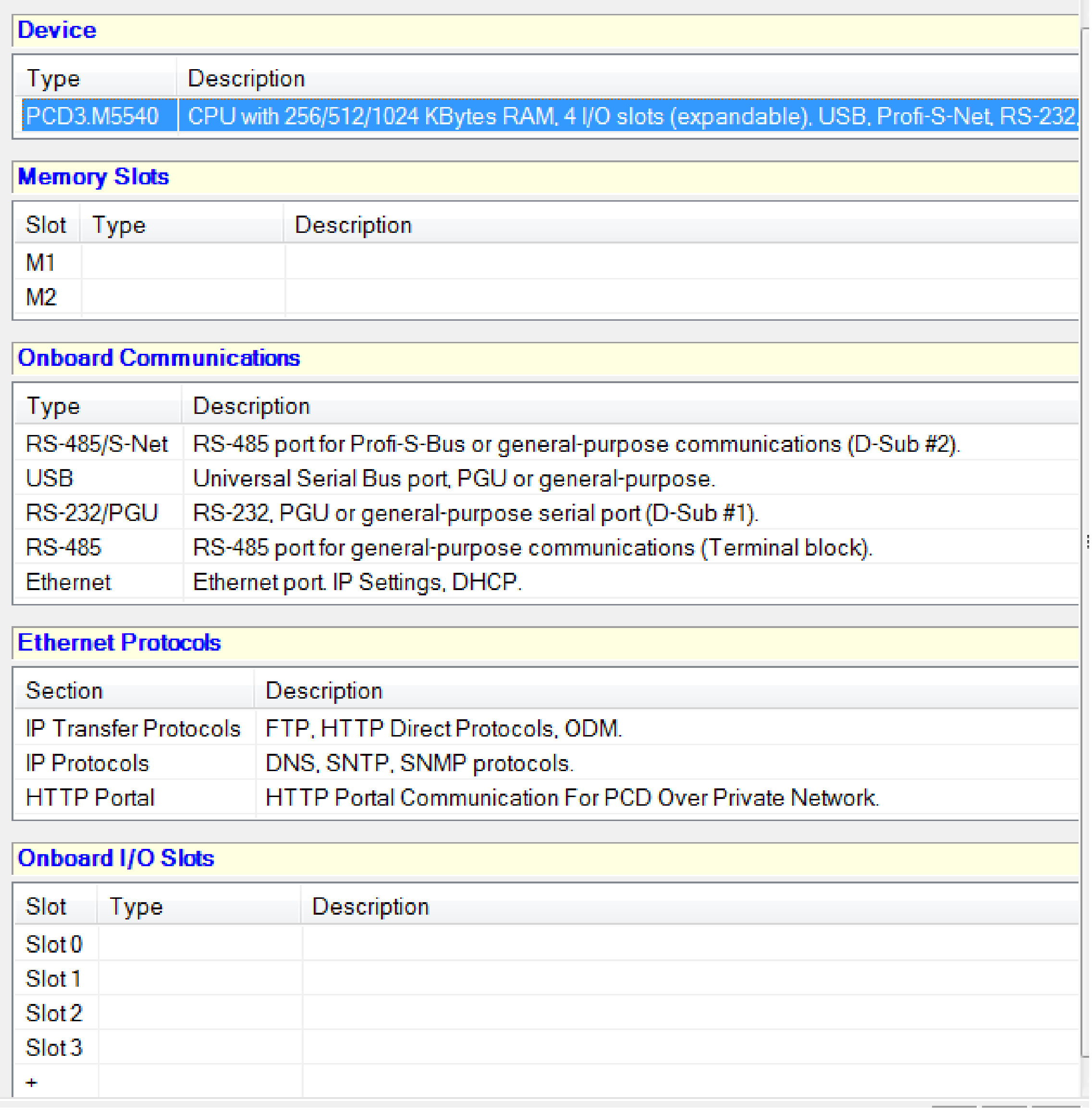
In order to place a PCD device into service it is necessary to define at least the type of PCD and its memory configuration. The other configurations can then be added according to the required services, such as communication networks or I/O handling.

For those familiar with versions PG5 1.4 and older, the *Device Configurator* is an entirely new program, presenting configuration parameters with a new human-machine interface organized in a very different way. Although new configuration options are available, both Devices and their configuration parameters remain the same as before.

3.1 Scanning the Device parameters to the configurator

The simplest method to realize the configuration consists in linking the computer to the PCD using a USB cable and scanning the configuration already present in the PCD's memory using the menu *Online, Upload Configuration…* or the corresponding button in the *tool bar*. If the memory turns out to contain no configuration, PCD firmware undertakes to return the appropriate information, then check the configurations corresponding to your application.

3.2 The main view on the configurator



Device

Type	Description
PCD3.M5540	CPU with 256/512/1024 KBytes RAM, 4 I/O slots (expandable), USB, Profi-S-Net, RS-232,

Memory Slots

Slot	Type	Description
M1		
M2		

Onboard Communications

Type	Description
RS-485/S-Net	RS-485 port for Profi-S-Bus or general-purpose communications (D-Sub #2).
USB	Universal Serial Bus port, PGU or general-purpose.
RS-232/PGU	RS-232, PGU or general-purpose serial port (D-Sub #1).
RS-485	RS-485 port for general-purpose communications (Terminal block).
Ethernet	Ethernet port. IP Settings, DHCP.

Ethernet Protocols

Section	Description
IP Transfer Protocols	FTP, HTTP Direct Protocols, ODM.
IP Protocols	DNS, SNTP, SNMP protocols.
HTTP Portal	HTTP Portal Communication For PCD Over Private Network.

Onboard I/O Slots

Slot	Type	Description
Slot 0		
Slot 1		
Slot 2		
Slot 3		
+		

The main view on the configurator represents the different equipment features making up the Device.

Device slot

Indicates the current *Device* type. If it is selected, it displays the properties of the Device such as RAM/EPROM/Flash internal memory size, the password, use of the S-Bus, of input/output handling, options and power consumption on the I/O bus.
To change the type of the *device*, point the mouse on the current *Device* and select the context menu *Change Device Type …* The *Properties* context menu enables the relevant properties window to be displayed.

Memory slots

Memory slots available in order to receive Flash memory extensions corresponding to the type of the selected *Device*. To configure the memory slots, select and drag the corresponding memory modules from the I/O *Selector* window to their slots. To open the *E/S Selector* window select the menu *View, Selector Window*.

Onboard Communication slots

The internal communication slots represent the available communication interfaces. Depending on the PCD types, the number of communication interfaces is different, they are only configured if they are utilized by the PCD program.

Some slots are pre-defined, others are freely configurable and require definition of the corresponding communication modules by selecting them in the *E/S Selector* window and dragging them to a slot.

Selecting a communication slot displays the parameters of the communication interface in the properties window and enables them to be defined.

Onboard slots

Represents the input/output slots available on the Device. The available E/S modules are configured by selecting them in the *E/S Selector* window in order to drag them to an E/S slot. As is the case with the other slots, selecting one of the E/S slots displays the relevant configuration parameters.

Expansion slots

The expansion slots designated by means of '+' can receive a bus expansion module in order to add extra E/S modules. Configuration of an expansion module is carried out by selecting the corresponding module in the *E/S Selector* window in order to drag it to the extension slot indicated with '+'.

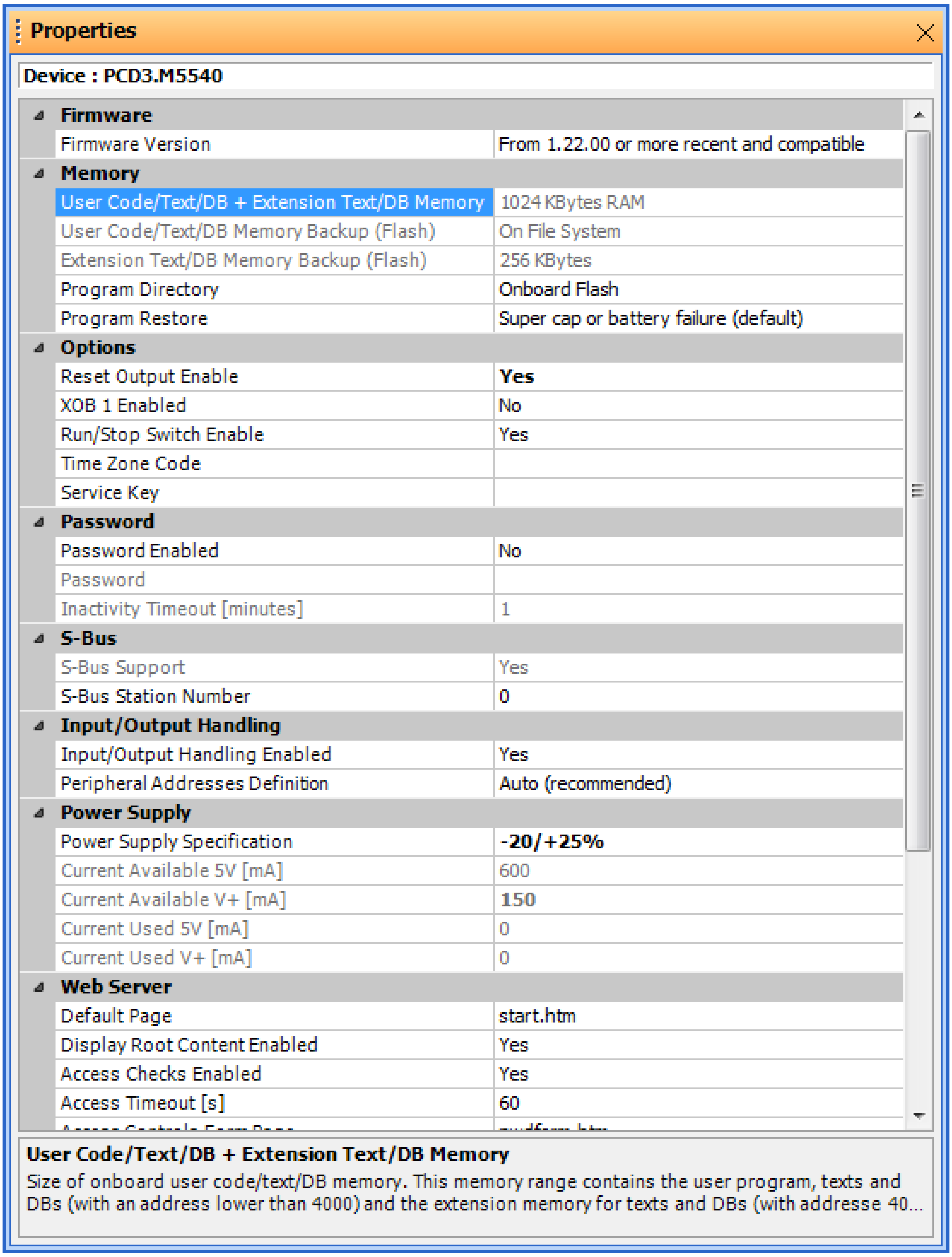
3.3 Loading the configurator parameters to the Device

Equipment configuration of the Device is necessary on first utilization but also in the event of all changes such as memory extension, setting up a communication module, etc.

These parameters are not only configured in the device configurator but also loaded in the Device's memory by means of the *Download Configuration* menu or the corresponding button.

Attention, loading the program from the *Project Manager* does not load the configurations in the Device. The configurations must be loaded from the Device configurator.

3.4 Device properties



Properties

Device : PCD3.M5540

Firmware	
Firmware Version	From 1.22.00 or more recent and compatible
Memory	
User Code/Text/DB + Extension Text/DB Memory	1024 KBytes RAM
User Code/Text/DB Memory Backup (Flash)	On File System
Extension Text/DB Memory Backup (Flash)	256 KBytes
Program Directory	Onboard Flash
Program Restore	Super cap or battery failure (default)
Options	
Reset Output Enable	**Yes**
XOB 1 Enabled	No
Run/Stop Switch Enable	Yes
Time Zone Code	
Service Key	
Password	
Password Enabled	No
Password	
Inactivity Timeout [minutes]	1
S-Bus	
S-Bus Support	Yes
S-Bus Station Number	0
Input/Output Handling	
Input/Output Handling Enabled	Yes
Peripheral Addresses Definition	Auto (recommended)
Power Supply	
Power Supply Specification	**-20/+25%**
Current Available 5V [mA]	600
Current Available V+ [mA]	**150**
Current Used 5V [mA]	0
Current Used V+ [mA]	0
Web Server	
Default Page	start.htm
Display Root Content Enabled	Yes
Access Checks Enabled	Yes
Access Timeout [s]	60

User Code/Text/DB + Extension Text/DB Memory

Size of onboard user code/text/DB memory. This memory range contains the user program, texts and DBs (with an address lower than 4000) and the extension memory for texts and DBs (with addresse 40...

3.4.1 Memory

Code/Text/Extension memory

Represents the RAM available on the Device in order to receive the program as well as texts and data blocks included between addresses 0 …3999, but also texts and data blocks with an address higher than 3999.

This memory may be organized differently on some older PCD's. The extension memory is separate from the *Code/Text* memory. We therefore have two parameters:

Code/Text
Represents the RAM or EPROM available on the Device in order to receive the program as well as texts and data blocks included between addresses 0 …3999

This memory may also be EPROM on some older PCD's. Whereas the new ones provide the opportunity to carry out a program backup on a Flash memory.

Extension Memory
Represents the RAM available for data blocks with addresses higher than 3999.

User Program Memory Backup size (Flash)
Indicates the size of the internal Flash memory of the Device, if it is insufficient, some types of *devices* support a Flash extension memory on one or a number of external slots. See configurations under *Memory Slots*.

The Flash memory is used in order to realize program backup after loading on the Device. Backup must be activated in the menu *Tools, Options* of the *Project Manager* or realized on request by the *Project Manager* by means of selecting the menu *Online, Flash Backup/Restore*.

If a power outage causes a loss of the program in RAM, when power is restored the Device Firmware automatically restores the program present on the Backup memory.

The Flash memory also supports other applications such as data backup or the source files of the project.

3.4.2 *Password*

The Devices have a protection mechanism by means of a password. If there is password protection, only the reduced communication protocol can be used. It only authorizes access to the registers, timers, counters, indicators, inputs, outputs, data blocks and the system clock. The other data, such as the user program, S-Bus configuration and the historical table, cannot be accessed. The orders Run, Stop, Step etc. are placed out of operation.

Setting up communication on a password protected Device displays a dialogue for password entry before enabling use of the full protocol. Selecting the *Cancel* button sets up communication in any case, with the restrictions of the reduced protocol.

In the event of forgetting the password, the PCD memory must be wiped and reprogrammed in order to configure it without a password or with a new password.

Wiping the memory
This is very simple for RAM. It is simply necessary to cut the Device's power supply and remove the battery for a while.
For EPROM, the memory chip must be removed from the Device and wiped by means of the UV lamp, then reprogrammed with an EPROM programmer by means of the user program and a known password.
For Flash memories, the memory chip must be removed from the Device and wiped by means of an EPROM programmer which supports Flash memory chips.

On reading the *hardware settings*, the PCD password is always absent.

Otherwise, this would enable unknown passwords to be read in order to then load them into another PCD which would become inaccessible until the memory was removed and wiped.

3.4.3 S-Bus

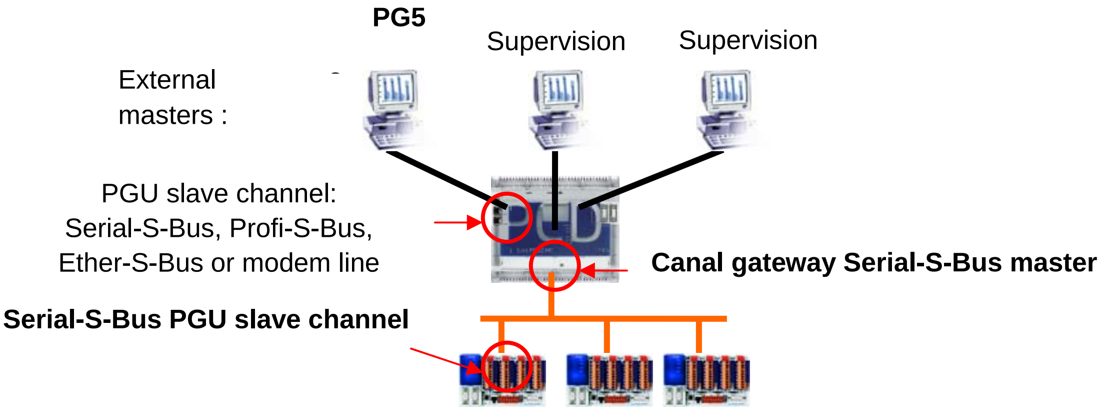
If one of the communication interfaces defined under *Onboard Communication* or *Onboard Slots* is used, start by activating the S-Bus support and defining the S-Bus station number.
The S-Bus station number is common to all of the Device's communication channels.

3.4.4 *Power Supply.*

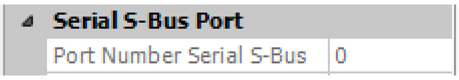
The 5 and 24 Volts power supply required for the functioning of I/O modules is provided by the Device's bus. It is advisable to check that the configuration of the I/O defined under *Onboard Slots* of the configurator is not higher than the values for the maximum available current.

3.5 Serial S-Bus communication properties

Serial S-Bus is a masters/slave network enabling the Devices to be networked on a RS 485/232 series line in order to exchange data between PCDs and supervise the process. It also supports all service functionalities by means of the programming tool PG5 (PGU) and an analogue or ISDN modem.


PG5
Supervision
Supervision
External masters :
PGU slave channel: Serial-S-Bus, Profi-S-Bus, Ether-S-Bus or modem line
Canal gateway Serial-S-Bus master
Serial-S-Bus PGU slave channel

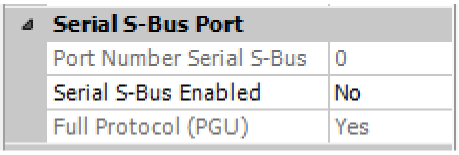
Depending on the series communication slot selected, the properties window enables configuration of the Serial-S-Bus channel as a PGU slave for a series line, PGU slave for a modem line or master gateway. Start by activating the desired configuration then add the active parameters.



Serial S-Bus Port	
Port Number Serial S-Bus	0

Port Number
Number of the communication channel, this number may be used by program instructions in order to designate the assignment channel (SASI) or to transmit data exchange telegrams.

3.5.1 *Full protocol (PGU) Serial-S-Bus* (PGU slave for series line)



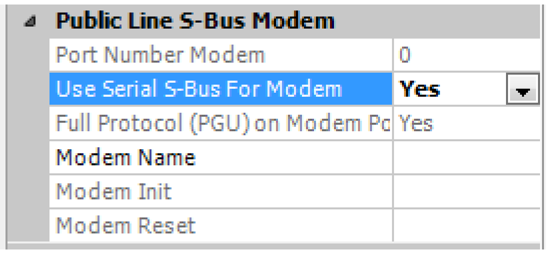
Serial S-Bus Port	
Port Number Serial S-Bus	0
Serial S-Bus Enabled	No
Full Protocol (PGU)	Yes

Extra *Serial-S-Bus* slave communication slots can be configured using a reduced protocol (without the PGU function). Only the PGU slot is configured from the configurator, the slave function, without the PGU function, is configured from the program Fupla/IL with the assistance of the instruction SASI.

Note, the S-Bus address is defined in the device's properties.

3.5.2 *Public Line S-Bus Modem* (PGU slave for a modem line)

This configuration is only available for series communications slots which provide all control lines required for linking with a modem. Provides the same services as *Full protocol (PGU) Serial-S-Bus* but through a telephone line and an analogue or ISDN modem. To enjoy simplified operation, we recommend using SBC modems.



Public Line S-Bus Modem	
Port Number Modem	0
Use Serial S-Bus For Modem	**Yes**
Full Protocol (PGU) on Modem Pc	Yes
Modem Name	
Modem Init	
Modem Reset	

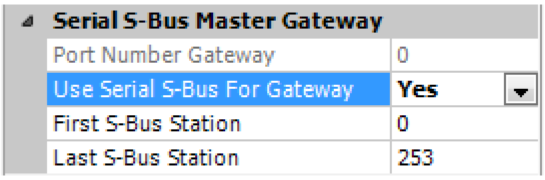
Modem Name
Enables selection of the type of modem used. It is recommended to use Saia PCD modems, thus they are already present in this list, the parameters *Modem Init* and *Modem Reset* are already configured and tested.

Note, the S-Bus address is defined in the device's properties.

3.5.3 *Serial S-Bus Master Gateway.*

The *Gateway* function is commonly used to link two different communication networks, adapt a Saia PG5 programming tool, for VisiPlus supervision, a modem line on the Serial-S-Bus network or for creating a multi-master network.

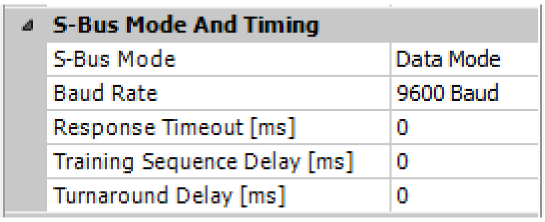
All telegrams received from external masters and which are not meant for the *gateway* station are automatically redirected to the master *gateway* channel.



Serial S-Bus Master Gateway	
Port Number Gateway	0
Use Serial S-Bus For Gateway	**Yes**
First S-Bus Station	0
Last S-Bus Station	253

First/Last S-Bus Station
Enables filtration of telegrams to be sent on the *Gateway* according to the target station numbers.

3.5.4 *S-Bus Mode and Timings*



S-Bus Mode And Timing	
S-Bus Mode	Data Mode
Baud Rate	9600 Baud
Response Timeout [ms]	0
Training Sequence Delay [ms]	0
Turnaround Delay [ms]	0

Mode
Choice of the method applied by S-Bus in order to indicate the start and finish of the messages, must be identical on all stations making up the network. Preferably choose the data mode, this method is suitable for all applications, in particular for the use of modems or standardized network equipment.

Baud rate
Speed of communication, must be identical on all stations in the network.

Response Timeout
Waiting time in milliseconds by the master station in order to receive the response to a telegram. This timing is particularly important when the slave does not respond. If it is too long this will severely slow down communication. If it is too short the responses arrive too late and cause the telegram sent by the master to fail.

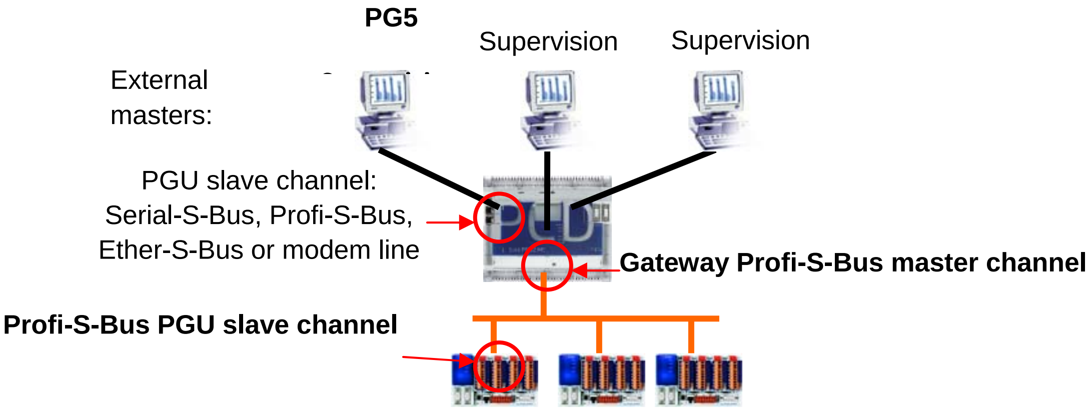
By default the value of the timings is zero, this means that the default timings are applied. In practice we only change them when *Gateways* or modems are used: generally we restrict ourselves to stretching the *Timeout* on the external masters.

Training Sequence Delay (TS)
Timing in milliseconds between activation of the RTS (*Request To Send*) signal and sending of the message. With S-Bus, the activation of RTS enables drivers RS-485 or RS-422 to be selected.

Turnaround Delay (TN)
Minimum timing in milliseconds between the end of a response and transmission of the next telegram. This gives the outlying station time to switch the line from emission mode to reception after having sent a message. The TN is particularly important when PCD7.T100 receptors or modems for private lines are used.

3.6 Profi S-Bus communication properties

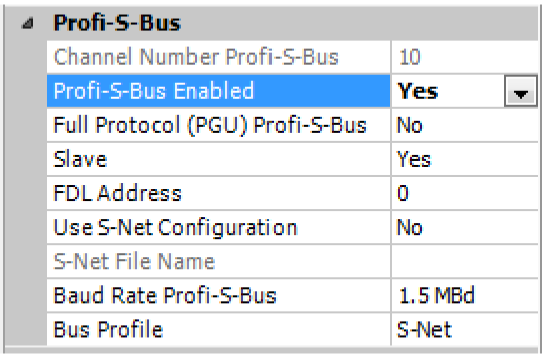
Profi-S-Bus is a multi-master field bus based on the Profibus FDL standards and the SBC S-Bus protocol. It enables the Devices to be networked in order to exchange data between PCDs and supervise the process. It also supports all service functionalities by means of the Saia PG5 programming tool. (PGU)


PG5
Supervision
Supervision
External masters:
PGU slave channel:
Serial-S-Bus, Profi-S-Bus,
Ether-S-Bus or modem line
Gateway Profi-S-Bus master channel
Profi-S-Bus PGU slave channel

The properties window corresponding to the S-Net communication slot enables a Profi-S-Bus slave or master gateway channel to be configured. Start by activating the desired configuration then add the active parameters.

3.6.1 Profi-S-Bus (slave)

Defines Profi-S-Bus channel as slave or PGU slave. This definition may be complemented by a master function by adding a SASI master instruction in the Fupla or IL program.



Profi-S-Bus	
Channel Number Profi-S-Bus	10
Profi-S-Bus Enabled	Yes
Full Protocol (PGU) Profi-S-Bus	No
Slave	Yes
FDL Address	0
Use S-Net Configuration	No
S-Net File Name	
Baud Rate Profi-S-Bus	1.5 MBd
Bus Profile	S-Net

Full Protocol PGU

PGU Slave (Yes)
Supports the exchange of data with master stations, supervision systems and terminals, but also supports the programming tool and tool for setting up PG5.

Slave (No)
Only supports the exchange of data with the master stations, supervision systems and terminals.

Address

Address of the station on the Profibus FDL network. In order to fully designate the Device with which telegram exchange takes place, two addresses are required, the Profibus FDL address and the S-Bus address defined in the device's properties.

Baud rate Profi-S-Bus

Speed of communication, must be identical on all stations in the network.

Bus Profile

The timings for transmission are grouped into three profiles:

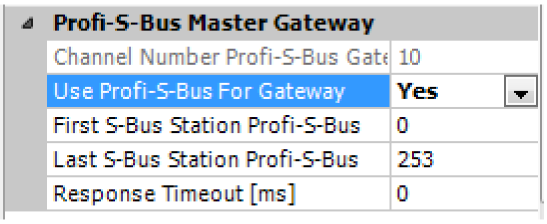
- *User-defined* : the parameters are defined by the user
- *S-Net* : uses the values which are most suitable for the Saia PG5 network Configurator.
- *DP* : uses the values which are most suitable for the Profibus DP network.

The Profile must be identical on all stations in the network.
The S-Net profile is required when RIO PCD3.T76x is used on the networks.

3.6.2 *Profi S-Bus Master Gateway.*

The *Gateway* function is commonly used to link two different communication networks, adapt a Saia PG5 programming tool, for VisiPlus supervision, a modem line on the Profi-S-Bus network.

All telegrams received from external masters and which are not meant for the *gateway* station are automatically redirected to the master *gateway* channel.



Profi-S-Bus Master Gateway	
Channel Number Profi-S-Bus Gate	10
Use Profi-S-Bus For Gateway	Yes
First S-Bus Station Profi-S-Bus	0
Last S-Bus Station Profi-S-Bus	253
Response Timeout [ms]	0

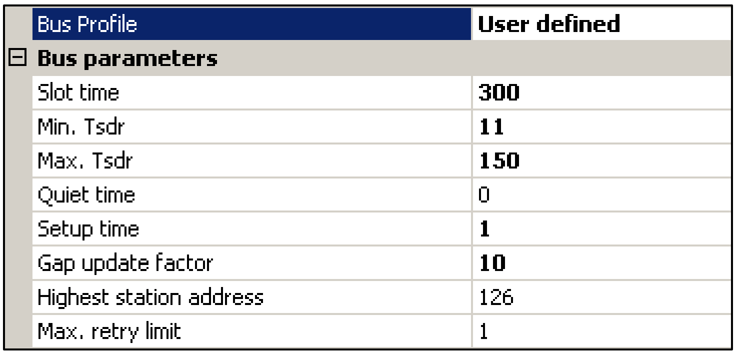
First/Last S-Bus Station

Enables filtration of telegrams to be sent on the *Gateway* according to the target station numbers.

Response Timeout

By default the value of the *Timeout* is zero, this means that the default timing is applied. In practice we only change it when the *Gateways* or modems are used: generally we restrict ourselves to stretching the *Timeout* on the external masters and never on the gateway channel.

3.6.3 Bus Parameters: user defined



Bus Profile	User defined
⊟ **Bus parameters**	
Slot time	**300**
Min. Tsdr	**11**
Max. Tsdr	**150**
Quiet time	0
Setup time	**1**
Gap update factor	**10**
Highest station address	126
Max. retry limit	1

The properties of the bus contain all of the Profi-S-Bus communication parameters. These values can only be edited if the *User-defined* bus profile is selected. The parameters must be the same for all stations on the network.

All timings are indicated in bit (number of bits).

Slot Time
Maximum amount of time the data or token emitter waits for the addressee's response.

Min. Tsdr
Minimum waiting time by a slave after having received a telegram until emission of the response to the master.

Max. Tsdr
Maximum waiting time by a slave after having received a telegram until emission of the response to the master.

Quiet Time
Waiting time by the emitter after the end of a frame before activating its reception.

Setup Time
Time elapsed between an event and the corresponding reaction.

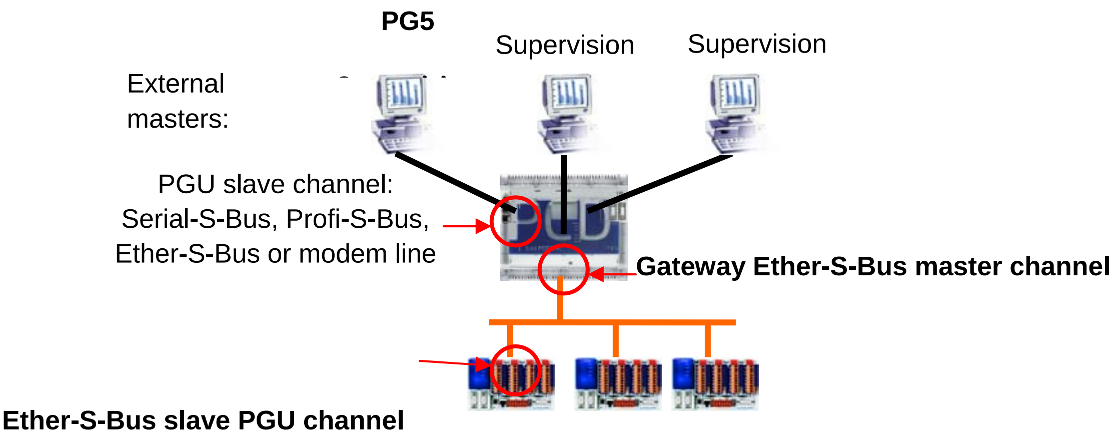
Gap Update Factor
Number of rotations by the token between two GAP (update) cycle maintenances.

Highest Station Address
The highest address (HSA) on the network

Max. Retry Limit
Number of repetitions without acknowledgement of receipt before sending a negative acknowledgement of receipt.

3.7 Ether-S-Bus communication properties

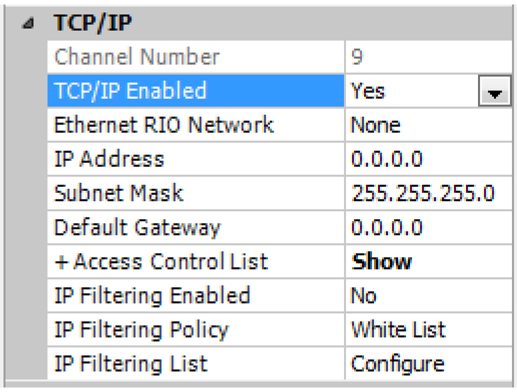
Ether-S-Bus is a multi-master network based on Ethernet standards and the SBC S-Bus protocol. It enables the Devices to be networked in order to exchange data between PCDs and supervise the process. It also supports all service functionalities by means of the Saia PG5 programming tool. (PGU)


PG5
Supervision
Supervision
External masters:
PGU slave channel:
Serial-S-Bus, Profi-S-Bus,
Ether-S-Bus or modem line
Gateway Ether-S-Bus master channel
Ether-S-Bus slave PGU channel

The properties window corresponding to the S-Net communication slot enables configuration of an Ether-S-Bus slave or master gateway channel. Start by activating the desired configuration then add the active parameters.

3.7.1 Ether-S-Bus (slave)

Defines Profi-S-Bus channel as slave or PGU slave. This definition may be complemented by the master function by adding a SASI master instruction in the Fupla or IL program.



TCP/IP	
Channel Number	9
TCP/IP Enabled	Yes
Ethernet RIO Network	None
IP Address	0.0.0.0
Subnet Mask	255.255.255.0
Default Gateway	0.0.0.0
+ Access Control List	**Show**
IP Filtering Enabled	No
IP Filtering Policy	White List
IP Filtering List	Configure

IP Node
Number of the TCP/IP node. The node is used in the Device's application program in order to reference the IP address of the slave station with which data is to be exchanged.

IP Address
Address of the station on the Ethernet network. In order to fully designate the Device with which telegram exchange takes place, two addresses are required, the Ethernet address and the S-Bus address defined in the device's properties.

Subnet mask
Defines the part of the IP address which belongs to identification on the network and identification of the host. All bits corresponding to the network are at 1 while the bits

corresponding to the host are at zero. The network identifier is the result of a logical AND combination between the IP address and the *subnet mask*. Each TCP/IP host requires a *subnet mask*, even on a network segment. The *subnet mask* by default is therefore 255.255.255.0 (ClassC)

Default Router.
Address of the default router*.*

PGU port

PGU slave (Yes)
Supports the exchange of data with master stations, supervision systems and terminals, but also supports the programming tool and tool for setting up PG5.

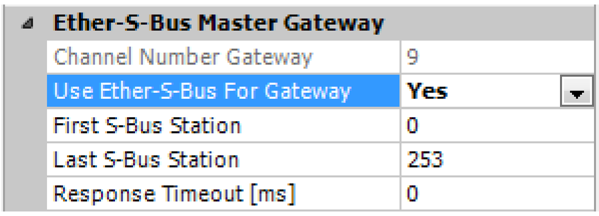
Slave (No)
Only supports the exchange of data with the master stations, supervision systems and terminals.

Network Groups
Displays the dialogue window in order to configure the Device as client or server on the network group.

3.7.2 Profi S-Bus Master Gateway.

The *Gateway* function is commonly used to link two different communication networks, adapt a Saia PG5 programming tool, for VisiPlus supervision, a modem line on the Ether-S-Bus network.

All telegrams received from external masters and which are not meant for the *gateway* station are automatically redirected to the master *gateway* channel.



Ether-S-Bus Master Gateway

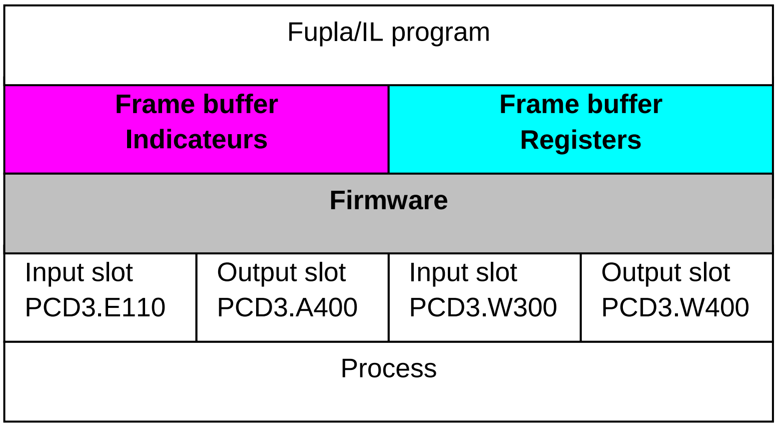
Channel Number Gateway	9
Use Ether-S-Bus For Gateway	Yes
First S-Bus Station	0
Last S-Bus Station	253
Response Timeout [ms]	0

First/Last S-Bus Station
Enables filtration of telegrams to be sent on the *Gateway* according to the target station numbers.

Response Timeout
By default the value of the *Timeout* is zero, this means that the default timing is applied. In practice we only change it when the *Gateways* or modems are used: generally we restrict ourselves to stretching the *Timeout* on the external masters and never on the gateway channel.

3.8 *On board slots properties,* configuration of the media mapping

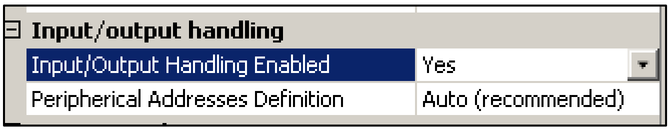
The Device's input/output handling can be managed with the assistance of media mapping made up of indicators/registers updated by the Device's firmware. The Fupla or IL program no longer directly accesses the inputs/outputs for the read/write operations but works with the media mapping.



The media mapping is configurable with PCD1.Mxxx0, PCD2.Mxxx0 and PCD3 devices.
However, it is still possible to access the inputs/outputs directly without configuring the media mapping. This makes it possible to guarantee compatibility with former projects by previous versions of PG5 and devices which do not yet support it: PCD1, PCD2.M1xx, PCD2.M480.

3.8.1 *Device properties,* necessary configurations.

If the Device's firmware supports the media mapping, I/O handling can be activated or deactivated by means of the parameters below.



⊟ **Input/output handling**	
Input/Output Handling Enabled	Yes
Peripherical Addresses Definition	Auto (recommended)

Input/Output Handling Enabled
Yes, all E/S parameters on the module are available to support configuration of the media mapping.

No, all of the parameters defined in *Onboard slots* are without influence on the user program.

Peripheral Address Definition
Automatic or manual definition of peripheral addresses for the media mapping of each module.

3.8.2 *Onboard slots,* configuration of the E/S modules.

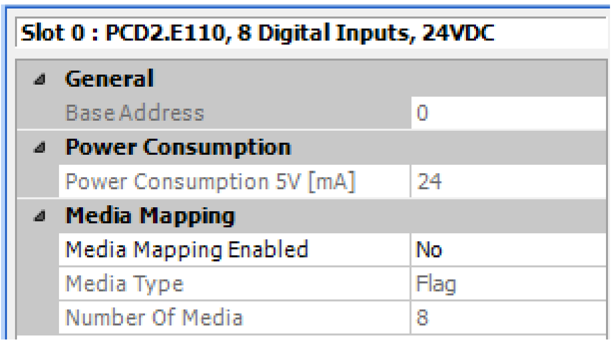
Enables configuration of the I/O modules present in the device by selecting them in the *E/S Selector* window in order to drag them to an I/O slot.

Selecting one of the I/O slots displays the relevant configuration parameters in a properties window.

Configuration of the I/O slots is not necessary if the media mapping is not supported by the PCD or not activated in the *Device's* properties.

3.8.3 Properties of binary I/O.

Enables definition of the configurations required to elaborate the media mapping.
If the *Media mapping* selection is not displayed, this means that the Device's firmware selected under *Device* does not support this functionality.



Slot 0 : PCD2.E110, 8 Digital Inputs, 24VDC

General	
Base Address	0
Power Consumption	
Power Consumption 5V [mA]	24
Media Mapping	
Media Mapping Enabled	No
Media Type	Flag
Number Of Media	8

Base Address
Base address of the module: 0, 16,32,etc.

Enabled Media Mapping
Cyclical update of the media mapping (register or indicators) with the input, output values present on the Device's slots.

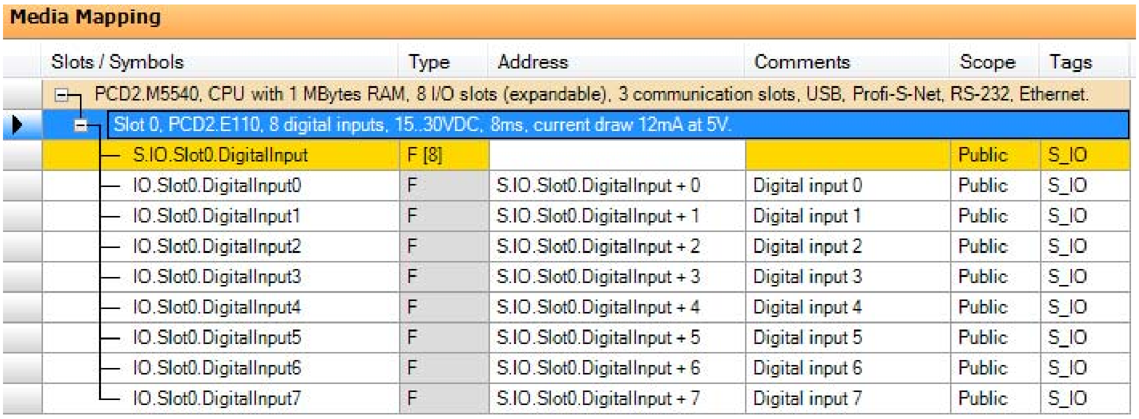
Media Type
Type of medium used to backup the input or output values. For analogue I/O, the type is always register. For binary I/O, the type is indicator by default but can also be register.

Number of Media
Number of media required to backup the values. For example, a PCD3.E110 digital input module requires 8 indicators.

Media Mapping
The new Media Mapping view shows the symbol names for all the I/Os which are mapped to media (Registers and Flags). This view can be shown or hidden using the "Media Mapping" command under the "View".

The addresses for the input and output symbols can be dynamic or absolute. It is no longer necessary to define consecutive addresses in an array of symbols (except for RIO media or Firmware compatibility).

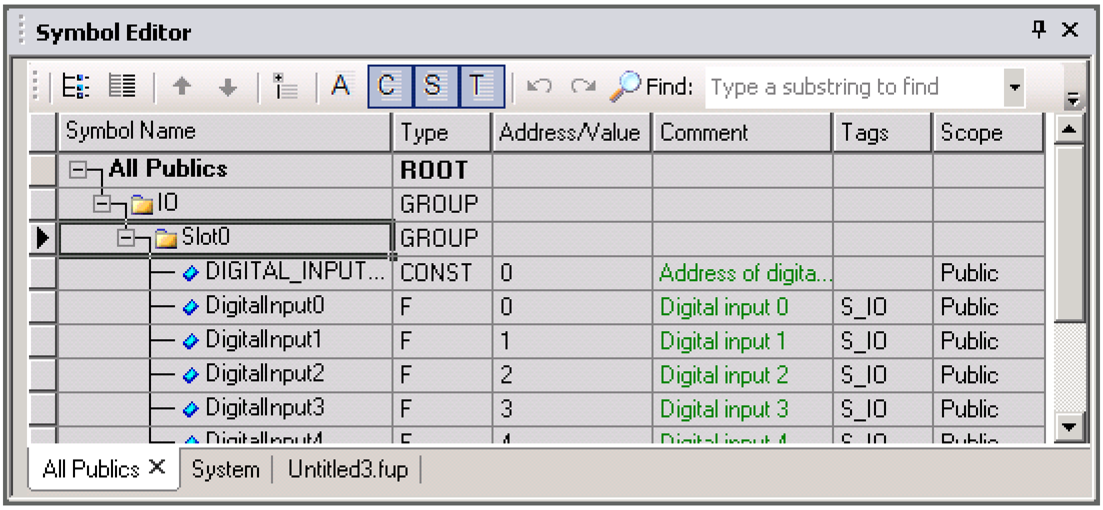
The media mapping supports external symbols which are defined in other files with Public scope (Fupla, IL or symbol files). These can be filled in quickly using drag-and-drop from the Symbol Editor. If you have defined a Fupla application where some public symbols need to be linked to an input or output, just drag-and-drop them into the Media Mapping view and onto the correct I/O.



Media Mapping

Slots / Symbols	Type	Address	Comments	Scope	Tags
PCD2.M5540, CPU with 1 MBytes RAM, 8 I/O slots (expandable), 3 communication slots, USB, Profi-S-Net, RS-232, Ethernet.					
Slot 0, PCD2.E110, 8 digital inputs, 15..30VDC, 8ms, current draw 12mA at 5V.					
S.IO.Slot0.DigitalInput	F [8]			Public	S_IO
IO.Slot0.DigitalInput0	F	S.IO.Slot0.DigitalInput + 0	Digital input 0	Public	S_IO
IO.Slot0.DigitalInput1	F	S.IO.Slot0.DigitalInput + 1	Digital input 1	Public	S_IO
IO.Slot0.DigitalInput2	F	S.IO.Slot0.DigitalInput + 2	Digital input 2	Public	S_IO
IO.Slot0.DigitalInput3	F	S.IO.Slot0.DigitalInput + 3	Digital input 3	Public	S_IO
IO.Slot0.DigitalInput4	F	S.IO.Slot0.DigitalInput + 4	Digital input 4	Public	S_IO
IO.Slot0.DigitalInput5	F	S.IO.Slot0.DigitalInput + 5	Digital input 5	Public	S_IO
IO.Slot0.DigitalInput6	F	S.IO.Slot0.DigitalInput + 6	Digital input 6	Public	S_IO
IO.Slot0.DigitalInput7	F	S.IO.Slot0.DigitalInput + 7	Digital input 7	Public	S_IO

According to the build of the program, these symbols are available in order to elaborate the Fupla et IL programs, we find them among the All Publics symbols under: *S.IO.Slot0, etc.*

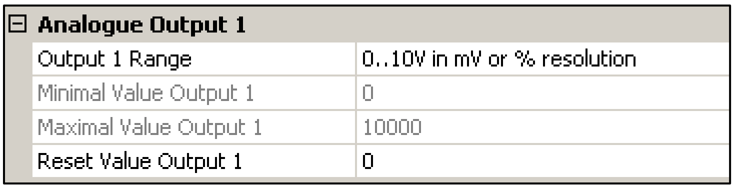


Symbol Editor

Symbol Name	Type	Address/Value	Comment	Tags	Scope
All Publics	ROOT				
IO	GROUP				
Slot0	GROUP				
DIGITAL_INPUT...	CONST	0	Address of digita...		Public
DigitalInput0	F	0	Digital input 0	S_IO	Public
DigitalInput1	F	1	Digital input 1	S_IO	Public
DigitalInput2	F	2	Digital input 2	S_IO	Public
DigitalInput3	F	3	Digital input 3	S_IO	Public
DigitalInput4	F	4	Digital input 4	S_IO	Public

3.8.4 Properties of analogue I/O.

Configured as for the binary I/O modules, we find the same parameters in order to define the *Media mapping* of the analogue module on registers.



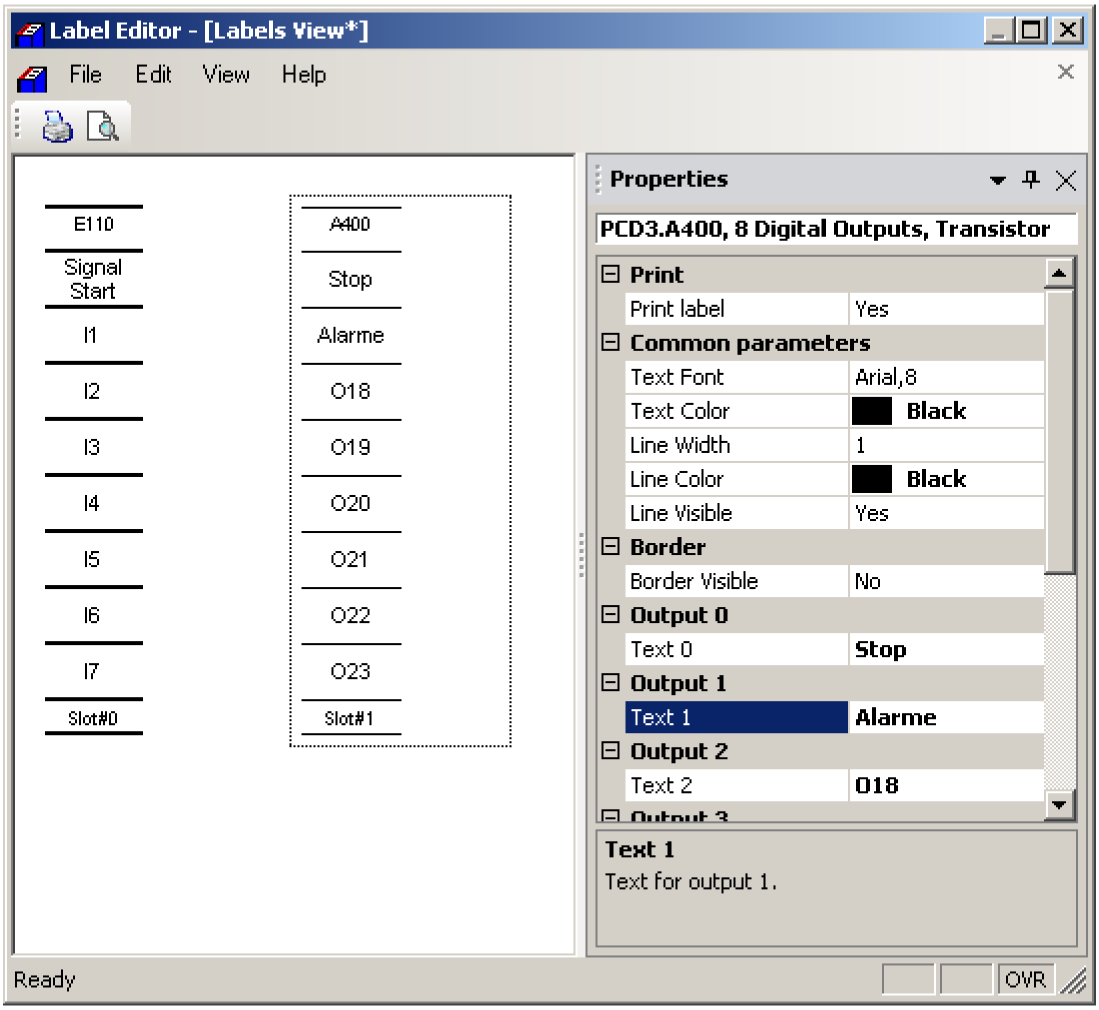
Analogue Output 1

Output 1 Range	0..10V in mV or % resolution
Minimal Value Output 1	0
Maximal Value Output 1	10000
Reset Value Output 1	0

On the other hand, a new section provides the parameters required for configuration of the I/O magnitudes of each channel.

3.9 Printing of labels for the I/O modules.

The *Tools, Label* menu enables display of the window below in order to prepare labels to be placed on the PCD3 I/O modules and in the PCD1.Mxxx0 and PCD2.Mxxx0 cover. Select the label and edit the properties window.



Slot#0	Slot#1
E110	A400
Signal Start	Stop
I1	Alarme
I2	O18
I3	O19
I4	O20
I5	O21
I6	O22
I7	O23

PCD3.A400, 8 Digital Outputs, Transistor

⊟ Print	
Print label	Yes
⊟ Common parameters	
Text Font	Arial,8
Text Color	■ **Black**
Line Width	1
Line Color	■ **Black**
Line Visible	Yes
⊟ Border	
Border Visible	No
⊟ Output 0	
Text 0	**Stop**
⊟ Output 1	
Text 1	**Alarme**
⊟ Output 2	
Text 2	**O18**
⊟ Output 3	

Text 1
Text for output 1.

Ready

Width and colour of lines printed on the labels.

Border Visible

Traces the edge of the label in order to facilitate cutting. Note, pre-cut sheets are available for printing the labels.

The size of the printed labels can appear twice the width because the intention is to fold them in two lengthwise. They are therefore more stable in their holders.

3.10 Extension of the Device Configurator by means of new *devices* and I/O modules

When new modules or devices become available, it is no longer necessary to install a new version of the Device Configurator or of PG5 in order to support them. It is sufficient to install the XML file which describes the new hardware in a PG5 installation sub-directory and restart the software.

C:\Program Files\SBC\PG5_21\DeviceTemplates

Contents

PCD Data

This section gives and overview of the types of data which can be used in the PCD programs (Inputs, Outputs, Flags, Registers, Counters, Timers etc.), their uses and address ranges.

4.1 Hardware Data

Programs contain many instructions to read, write and modify many different kinds if data. The data which allows the program to interact with the outside world is accessed via the controller's hardware.

4.1.1 Digital inputs and outputs

Inputs and outputs represent binary values (one bit) from the outside world. Inputs show the states of switches, pushbuttons, proximity detectors, sensors, etc. Outputs can activate valves, lamps, motors, etc.

Outputs can be written and read. Inputs can only be read. Inputs and outputs are fitted by plugging I/O cards into the PCD's module slots. The start address of the I/Os on the card is defined by its slot position.

Example

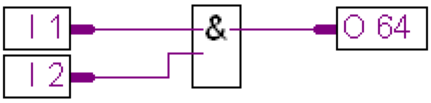
The following example turns on output `O 64` if inputs `I 1` and `I 2` are both high. Another way to show such functions is by using a boolean equation:

```
O 64 = I 1  AND  I 2
```

Instruction list program:

```
COB   0
      0
STH   I 1
ANH   I 2
OUT   O 64
ECOB
```

Fupla program:



Fbox: *Binary, And*

4.1.2 Date and time

A real-time clock (RTC) is built into the PCD. The date and time can be loaded into a Register with an IL instruction or an FBox.

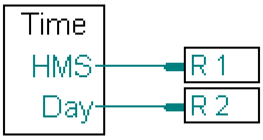
Example

The following example shows how to read the date/time.

Instruction list program:

```
COB    0
       0
RTIME R 1
ECOB
```

Fupla program:



Fbox: *Time Related, Read time*

This program reads the time from the clock and copies the value into registers R 1 and R 2 as decimal numbers, for example:

```
R 1 =   093510    hhmmss = 09:35 and 10 seconds
R 2 = 74081231    wdyymmdd = week 07, day 4 (Thursday), 31/12/08
```

4.1.3 Interrupt inputs

Some PCDs have two interrupt inputs called INB1 and INB2[2]. Whenever there is a rising edge on one of these inputs, the normal program cycle is interrupted and the PCD executes a special program block called XOB 20 or XOB 25 (XOB 20 for INB1 and XOB 25 for INB2). These inputs are capable of a frequency up to 1000 times per second.

Example

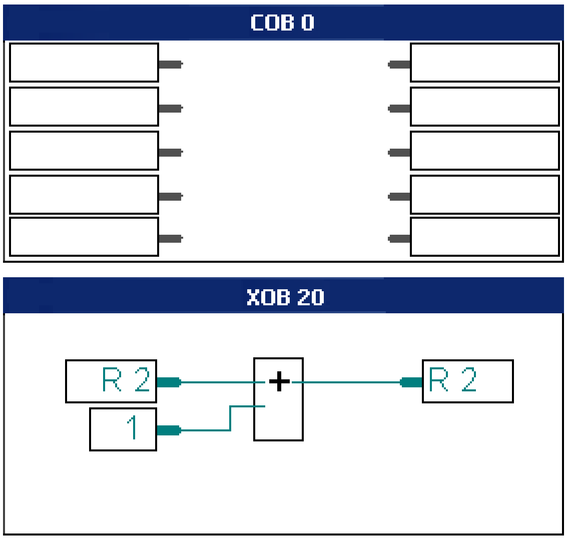
The example demonstrates how to count pulses from INB1.

Instruction list program:

```
COB  0   ;main program
     0
...
ECOB


XOB  20  ;interrupt INB1
INC  R 2 ;increments
         ;register R2
EXOB
```

M
1
2
0

Fupla program:



For more details, see the PCD hardware manuals

Limits imposed by the input filtering (protecting a normal digital input against interference and bounce from mechanical contacts) prevent the input from counting pulses with a frequency higher than 50 Hz. Interrupt inputs therefore represent an interesting alternative solution for this kind of application. They bypass the need to use PCD2/3.Hxxxx counting modules, which have a maximum counting frequency between 10 to 160 kHz, depending on the module type.

4.2 Internal Data

4.2.1 Flags

A flag contains a single binary bit of data, either 0 or 1. By default, all the flags are *no volatile*. This means that if you turn off the PCD when the flag is a 1, it will still be a 1 when you turn the PCD back on (assuming the RAM backup battery isn't flat). All *volatile* flags are reset to 0 when the PCD is turned off. The number of *nonvolatile* flags is defined from the device's *Build Options*, see below.

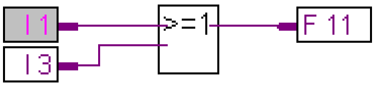
Example

The following example writes a high (1) to flag number 11 as soon as input 1 or input 3 is high. Boolean equation: `F 11 = I 1  OR  I 3`

Instruction list program:

```
COB   0
      0
STH   I 1   ;if I 1 is 1
ORH   I 3   ;and I 3 is 1
OUT   F 11  ;then set F 11
ECOB
```

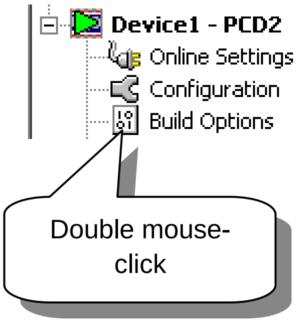
Fupla program:



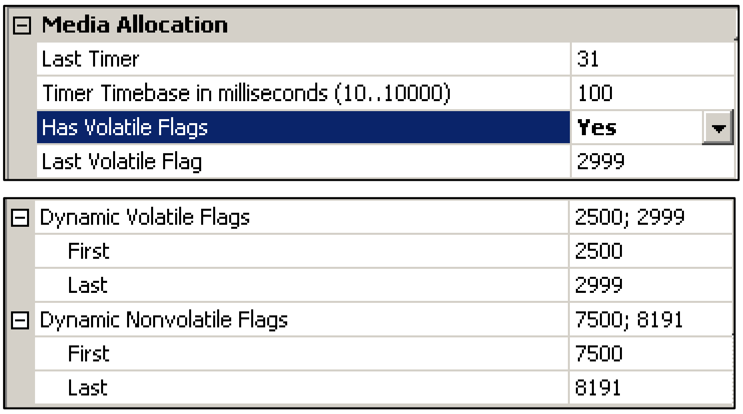
Fbox: *Binary, Or*

Configuring the number of no volatile flags

The partition between volatile and no volatile flags is defined in the device's *Build Options* in the Project Manager. The ranges for *dynamic addressing* can also be defined there. Dynamic addressing is described in the next section.



Double mouse-click



Media Allocation	
Last Timer	31
Timer Timebase in milliseconds (10..10000)	100
Has Volatile Flags	Yes
Last Volatile Flag	2999

Dynamic Volatile Flags	2500; 2999
First	2500
Last	2999
Dynamic Nonvolatile Flags	7500; 8191
First	7500
Last	8191

4.2.2 Registers

Registers can contain signed 32-bit integer or floating point values.

Registers are useful for arithmetic operations, such as processing analogue values, particularly in measurement and regulation applications.

.

All registers are non-volatile, which means that their values are not lost when the PCD is powered off.

In Fupla, the "wires" or lines connected to registers have different colours depending on the data type: yellow lines for a floating point values and green lines for integer values. An integer value cannot interact directly to a floating point value, one of the values must first be converted into the format of the other.

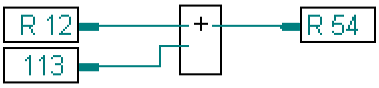
Example

The following example adds the integer 113 to the contents of register 12, and puts the result into workspace register 54: R 54 = R 12 + 113

Instruction list program:

```
 COB    0
        0
 ADD    R 12
        K 113
        R 54
 ECOB
```

Fupla program:

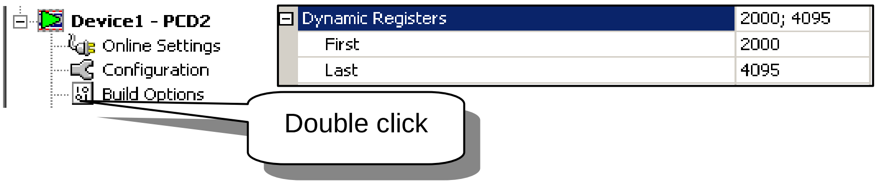


Fbox: *Integer, Addition*

The 'K' indicates that '113' is a constant, not another register. 'K' values are unsigned values from 0..16383. To use a negative or larger value, first load it into another register with the LD instruction or *Integer / Constant* FBox, and add the registers.

Dynamic register addressing

Dynamic address allocation is a powerful feature introduced to free you from having to specify a fixed address for every workspace register and flag in the program. Addresses are allocated if you define a symbol name and type, without specifying the address, this lets the *Build* assign an unused address for the symbol. The address range used for dynamic address allocation is configured from the device's *Build Options*.



Dynamic Registers	2000; 4095
First	2000
Last	4095

Double click

If a build error like this occurs: *Dynamic address overflow for type: R*, increase the number of dynamic addresses for that data type.

4.2.3 Constants

Constants are fixed values that can be used directly, or loaded into registers, timers or counters. Constants can be integer or floating point numbers, e.g. 100. 0.25, or Pi 3.1415. Timers and counters accept only unsigned integer values 0..2,147,483,647.

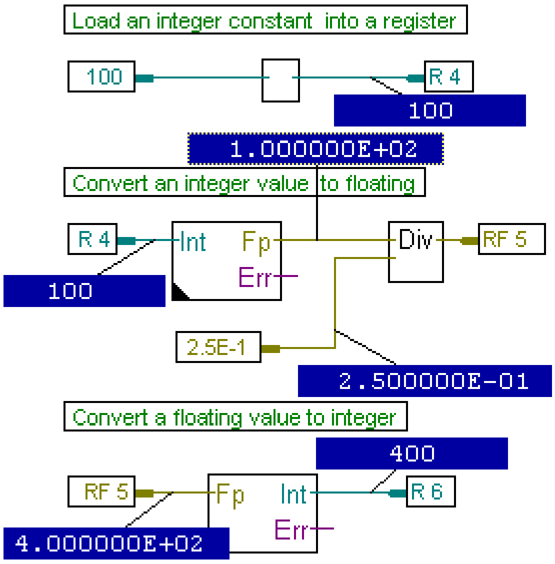
Example

The following example loads register R 4 with an integer value (100), which is divided by floating point value (0.25). Because register R 4 contains an integer and we want to divide it by a floating point value, R 4 must first be converted from integer to floating point. First, copy R 4 to R 35 (a work register which we know is not being used) and convert R 35 to a floating point value, then divide R 35 by 0.25 which has been loaded into R 36. The floating point result of the division is put in R 5. R 5 is then copied to R 6 to be converted back to an integer value (some of these steps are not really necessary, they could use the same workspace registers.)

Instruction list program:

```
COB   0      ;cyclic block
      0

LD    R 4    ;load 100 into R 4
      100

COPY  R 4    ;convert integer R 4
      R 35   ; to floating point
IFP   R 35   ; in R 35
      0      ; (0 = 10^0)

LD    R 36   ;Load 0.25 into R 36
      0.25
FDIV  R 35   ;divide R 35 by 0.25
      R 36
      R 5    ;put result in R5
COPY  R 5    ;convert result back
      R 6    ; to integer in R 6
FPI   R 6
      0

ECOB
```

Fupla program:


Load an integer constant into a register
100
R 4
100
1.000000E+02
Convert an integer value to floating
R 4
Int
Fp
Err
Div
RF 5
100
2.5E-1
2.500000E-01
Convert a floating value to integer
400
RF 5
Fp
Int
Err
R 6
4.000000E+02

FBox: *- Integer, Move*
- Converter, Int to float
- Floating point, Divide
- Converter, Float to Int

4.2.4 Timers and counters

Timers and counters can hold values between 0 and 2 147 483 648 (31 bits), and they share the same address range: 0 to 1599. The number of timers is defined by the device's *Build Options* , for example 0..31 are timers and 32 to 1499 are counters. Timers have a default "timebase" of 100ms, which means that the timer is decremented by 1 every 100ms, and so counts down 10 times a second.

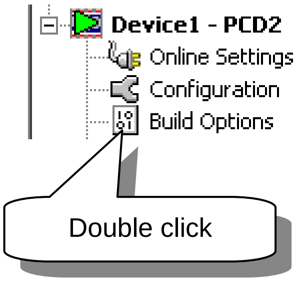
Usually addresses 0 to 31 are dedicated to the timers, and addresses 32 to 1599 are dedicated to the counters.
The user can, of course, configure personal settings. Timers have a default time-base of 100ms (i.e. the system decrements each timer by one every 100ms). The timebase can be changed in the *Build Options*., where timer / counter addresses can also be configured. Timers are volatile, counters are not.

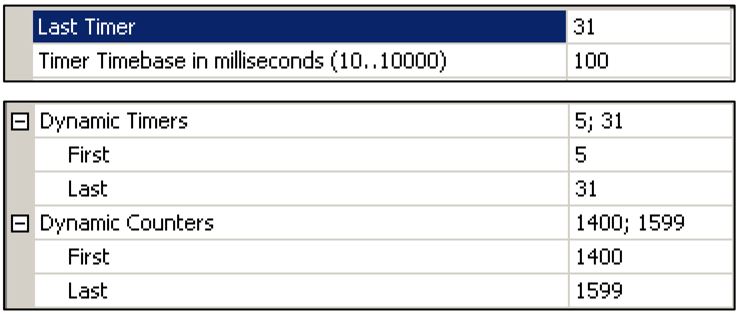
Timers and counters can only contain positive values. Their value can be changed by loading a new value with the LD instruction. Timer values decrease only. Counters can count up or down, using the INC/DEC instructions. (INC: ↑, DEC: ↓).

Timers and counters can also be used with binary instructions. When a timer or counter contains a non-zero value, its state is High (1). When its content is zero, its state is Low (0).

Configuring timers and counters

The distribution of the address range between timers and counters can be altered in the *Build Options*. This is also where you can change the time-base of 100 ms.





Last Timer	31
Timer Timebase in milliseconds (10..10000)	100

⊟ Dynamic Timers	5; 31
First	5
Last	31
⊟ Dynamic Counters	1400; 1599
First	1400
Last	1599

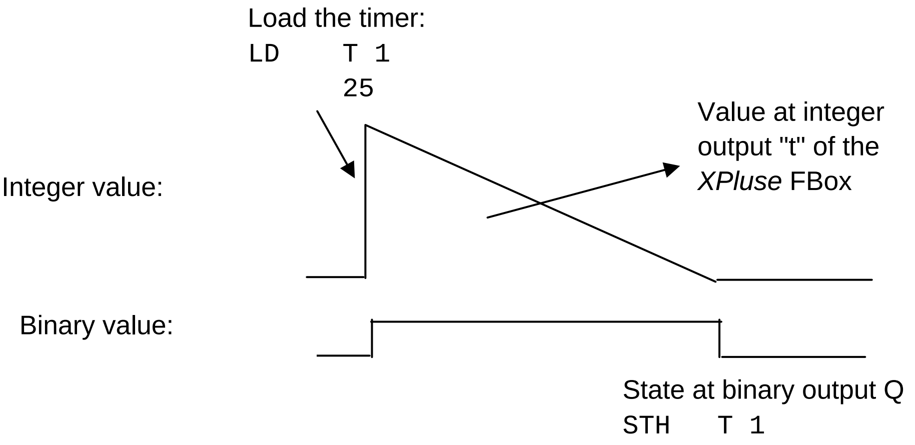
Technical information

The more timers you declare, the greater the load on the PCD. This is also true if you lower the time-base. Take this into consideration before you change the number of timers or lower the time-base.

Example: 100 timers will take about 2% of the PCD’s capacity.

Example: Timer

Input 4 goes to 1. On the rising edge of this input, Output 65 is also set to 1. It remains at 1 for duration of 2.5 seconds.



Load the timer:

```
LD    T 1
      25
```

Value at integer output "t" of the *XPluse* FBox

Integer value:

Binary value:

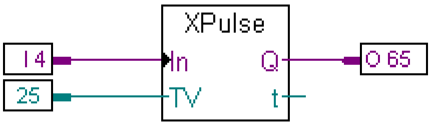
State at binary output Q

```
STH    T 1
```

Instruction list program:

Fupla program:

```
COB    0      ;Cyclic block 0
       0
STH    I 4    ;If input 4
DYN    F  12 ; sees a rising edge
LD     T 1    ;Load timer 1
       25     ; with 2.5 seconc
STH    T 1    ;Copy timer state
OUT    O 65   ; to output 65
ECOB
```

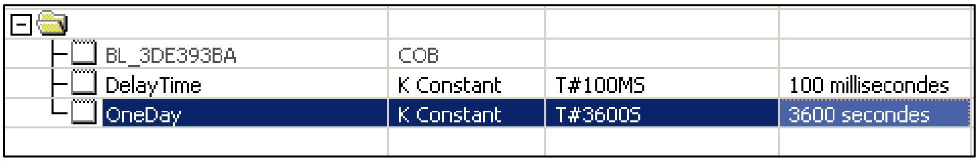


Fbox: *Time Related, Exclusive pulse (one-shot)*

Technical information

Timers in the Saia PCD are decremented at a rate defined by the *Build Options*, *Timer Timebase.* (normally 100ms). The actual time defined by a constant which is loaded into a timer changes if the time-base is changed. This means that if the time-base setting is changed, then all timer load values must also be changed. To overcome this problem, the time data type can be used to declare timer load values. If a time value is used, then the linker calculates the actual timer load value according to the time-base settings.

Format: **T#nnnS|MS**



⊟			
BL_3DE393BA	COB		
DelayTime	K Constant	T#100MS	100 millisecondes
OneDay	K Constant	T#3600S	3600 secondes

Example: Counter

A counter will be programmed to count up each time input 5 turns on, and down each time input 6 turns on. These counts will be activated on the rising edge of the input. The counter can be zeroed via input 2. The initial count will be loaded with 3.

Load the counter on input 1:

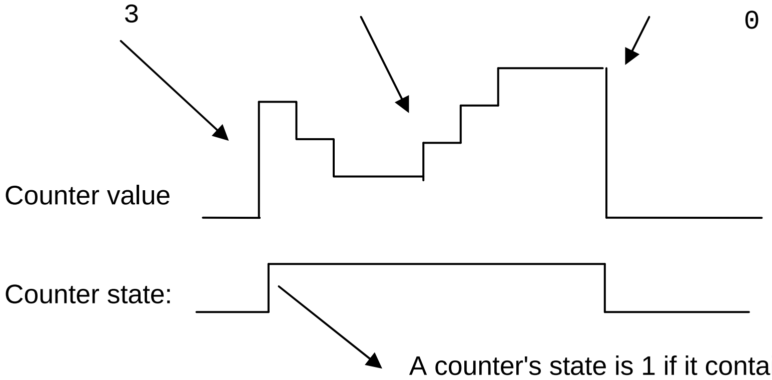
```
LD      C 35
        3
```

Increment the counter on input 5:

```
INC     C 35
```

On input 2, reset the counter:

```
LD      C 35
        0
```



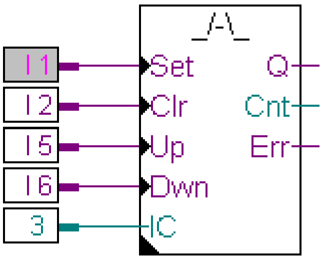
A counter's state is 1 if it contains a non-zero value:

```
STH     C 35
```

Instruction list program:

```
COB     0       ;Cyclic block
        0

STH     I 1     ;If input 1 is 1
LD      C 35    ;then load counter 35
        3       ; with 3
STH     I 2     ;If input 2 is 1
LD      C 35    ; then load counter 35
        0       ; with zero
STH     I 5     ;On rising edge of
DYN     F 13    ; input 5
INC     C 35    ;increment counter 35
STH     I 6     ;On rising edge of
DYN     F 14    ; input 6
DEC     C 35    ;decrement counter 35

ECOB
```

Fupla program:



FBox:
Counter, Up down with preset and clear

4.2.5 Texts and data blocks

Texts (character strings) and data blocks (DBs, arrays of 32-bit values) are non-volatile. Texts are used for: messages for displays, transmissions to pagers, command strings for modems, etc. DBs are used for data logging, tables etc.

Texts and DBs share the same addresses. If Text 1 is defined, the there cannot be a DB 1. Texts and DBs 0..3999 are in main program memory, which may be read-only. Texts and DBs 4000 and above are in extension memory, which is writable RAM.

The maximum number of Texts and DBs is 8191.

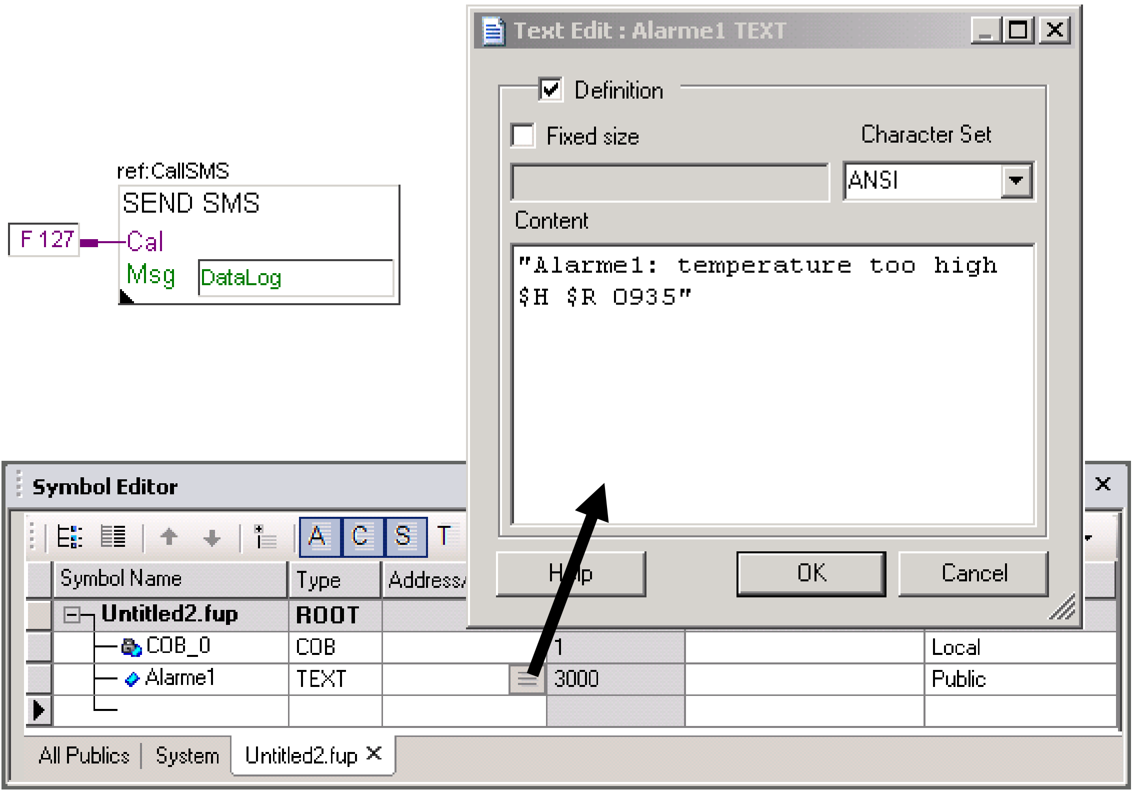
Technical information

Registers, flags, timers and counters are handled by the system and stored in separate RAM memory. DBs and Texts are stored in the main memory, together with the user program. If you want to use a Flash or EPROM for your main memory, your program can read from this memory but not write to it. Therefore you cannot alter the content of your DBs (for example your data logging). In most cases you will not bother with this, but if you know that you are going to read **and write** your DBs, then make sure to use DBs which are stored in the extension (data) memory => Texts/DBs 4000 and above. Extension (data) memory is always RAM, which means you can read and write to it.

Examples of Text and DB declarations

```
TEXT 10 "Bonjour!"  ;Text 10 contains the string Bonjour!

TEXT 11[7] "Hello"  ;Text 11 is 7 chars long, the first 5
                    ;are Hello and the last two are spaces

DB 12  45,46,78,999,0 ;DB 12 has the 5 integer values:
                      ;45,46,78,999,0

DB 13 [10]          ;DB 13 is 10 values, which are all zero

DB 14 [4] 2,3       ;DB 14 is four values, the first two are
                    ;2 and 3, the last two are 0
```

Text definition with the symbol editor



Text Edit : Alarme1 TEXT

☑ Definition

□ Fixed size

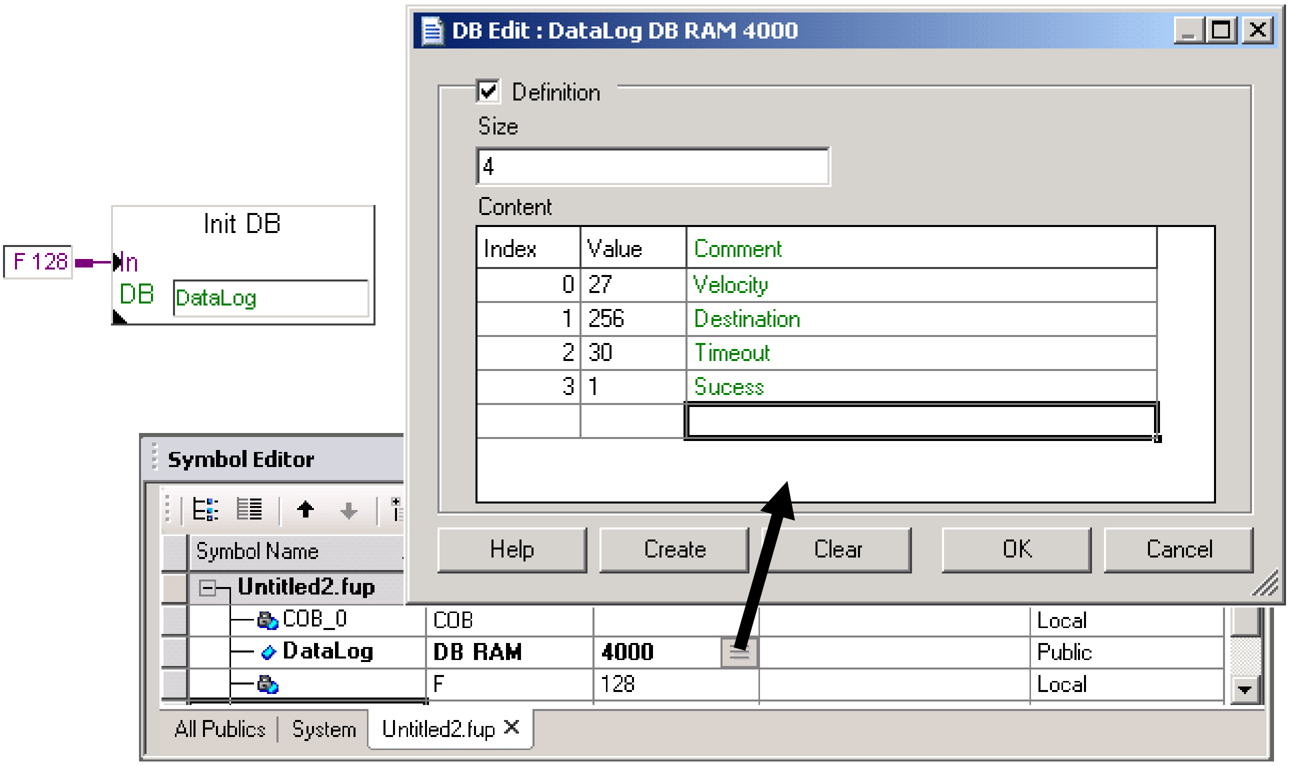
Character Set: ANSI

Content

```
"Alarme1: temperature too high
$H $R 0935"
```

Symbol Name	Type	Address/			
Untitled2.fup	ROOT				
COB_0	COB		1		Local
Alarme1	TEXT		3000		Public

Data bloc definition with the symbol editor



DB Edit : DataLog DB RAM 4000

☑ Definition

Size: 4

Content

Index	Value	Comment
0	27	Velocity
1	256	Destination
2	30	Timeout
3	1	Sucess

Symbol Name				
Untitled2.fup				
COB_0	COB			Local
DataLog	DB RAM	4000		Public
	F	128		Local

Summary table

Description	**Media**	**Operand**	**Binary**	**Numeric**	**Volatile**
Inputs	**I**	1) 0…8191	0,1		
Outputs	**O**	1) 0…8191	0,1		
Flags	**F**	0…16383	0,1		No
Registers	**R**	0…16383		-2 147 483 648…+2 147 483 647 -9.22337E+18…+9.22337E+18	No
Constantes	K			-2 147 483 648 à +2 147 483 647 -9.22337E+18 à +9.22337E+18	
Timers	**T**	2) 0…31	0,1	0 … 2 147 483 648	Yes
Counters	**C**	2) 32…1599	0,1	0 … 2 147 483 648	No
Texts	**X**	3) 0…3999 4) 4000 …		String of max. 3072 characters	No
Data Blocks	**DB**	3) 0…3999 4) 4000 …		Max. 382 values (slow access) Max.16 383 values (fast access)	No

1) Depends on PCD model and its fitted I/O cards

2) The actual number of timers is configured from the *Build Options*.

3) Texts/DBs 0..3999 are stored in program memory (RAM / EPROM / FLASH)

4) Texts/DBs 4000 and above are stored in extension (data) memory (RAM)

Contents

5 Symbol Editor

5.1 Introduction

This chapter provides an overview of the *Saia PG5 Symbol Editor* and use of symbols in programs.

5.2 Overview

A symbol is a Name that indicates the address of an input, output, flag, register etc. It is advisable to use symbol Names while editing a program, rather than direct address of a flag or register. Giving meaningful Names makes the program easier to read. For example you can assign Name *'Oil_Pump'* to *O 32* and then use *Oil_Pump* as an address in your program.

In addition using symbols allows correction of an address or data type from the *Symbol editor*. Instead of making correction at each place where the symbol is used in programs, it is only necessary to correct it in *Symbol editor*. The changes made to symbol definition are automatically propagated to all instances where this symbol is used in programs. There is no risk of forgetting to correct at few places in program and creating an error that is hard to find.

Before starting to write a program all symbols needed for the program can be defined and listed in a tool called *Saia PG5 Symbol Editor.* Once they are declared in symbol editor they are known to PG5. This is very helpful for finding elements inside program files, reporting programming errors, or it helps during the debugging process.

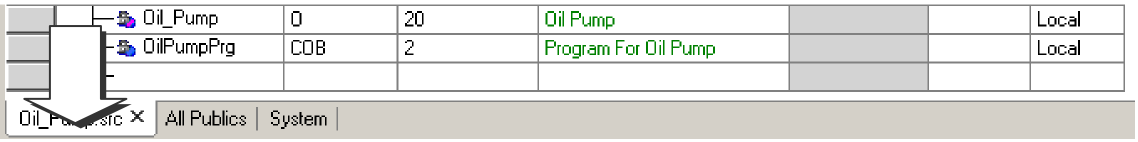
5.2.1 Components of Symbol Editor

Opening Symbol Editor:

Symbol Definitions are saved in program files (IL/Fupla etc.), As soon as a program file is opened in an editor, the symbol editor with the appropriate symbol list will also be opened.

Example:

Opening the program file named *Oil_Pump.src* automatically opens the symbol editor with the same Name.



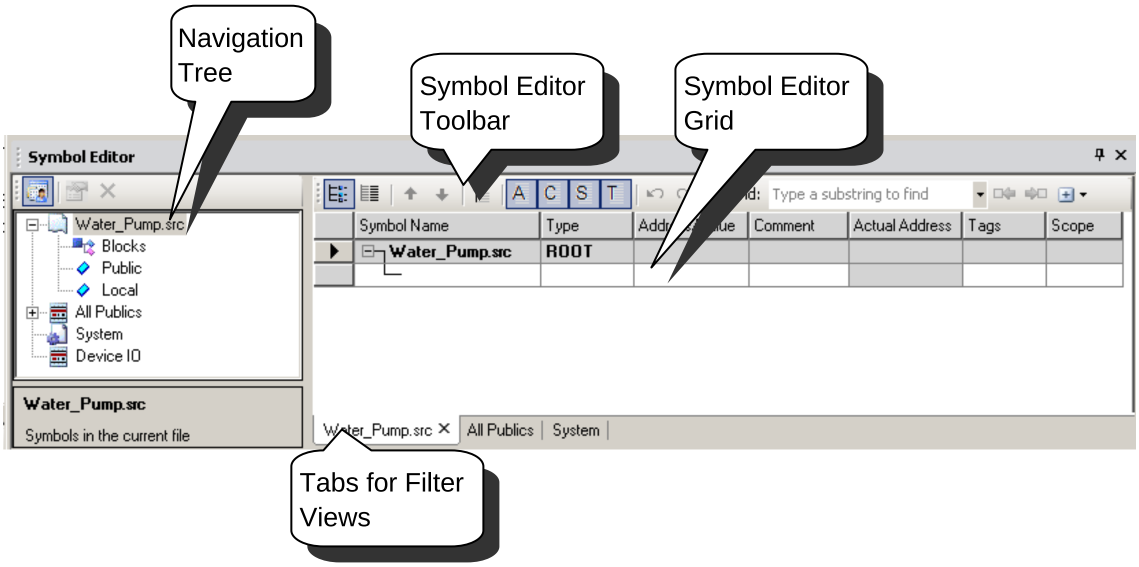
Oil_Pump	O	20	Oil Pump			Local
OilPumpPrg	COB	2	Program For Oil Pump			Local

Sym

Show Hide Symbols Editor

The *Symbol editor* window can be viewed with the *Show/Hide Symbol Editor* button, or via the menu command *View/Symbol Editor.*

Components of Symbol Editor:



Symbol Editor Grid:

It is a spreadsheet type editor to define symbols. An empty row is always present towards the end to define new symbol. Various actions can be performed form Right Click Context Menu.

Symbol Editor Tool bar

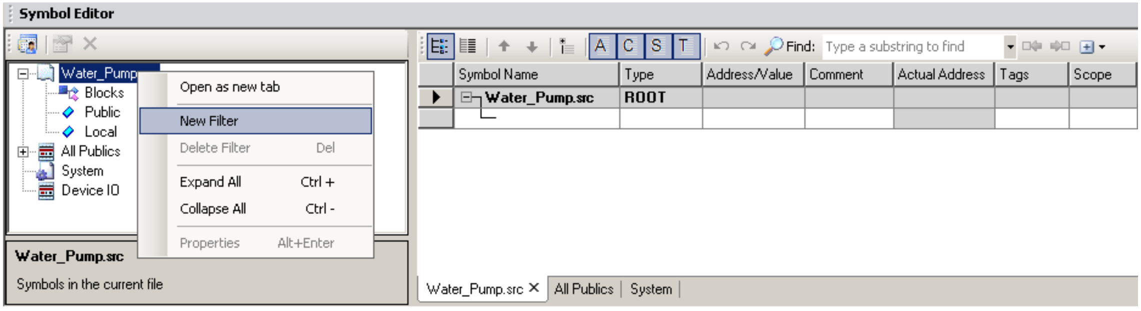
A set of buttons are present to perform actions in symbol editor. These include show/hide Navigator tree, List view/Group view, Move up/down symbols, Expand/collapse, Show/hide columns in grid, Undo/Redo, Find symbols etc.

Tabs for filter Views

Each filter view is opened in small window within symbol editor. These windows can be viewed in Tab view and it is possible to navigate between Tabs.

Navigation tree:

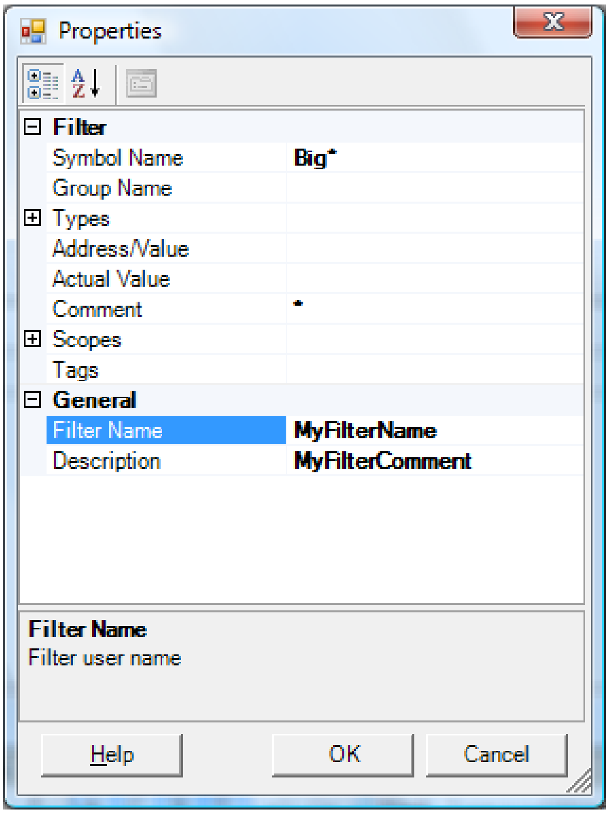
It contains the structure of predefined filters to view/display symbols in a grid according to filter selected. Navigation tree can be hide/open from symbol editor tool bar. It's also possible to add custom filters to Navigation tree and rules for the filter can be defined using filter properties. New filter can be added from Right Click context Menu.



Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Water_Pump.src	ROOT					

Filter Properties:

Symbols can be filtered according to any entry present in the symbol grid. Custom Symbol Filters can be stored with their Names. To change properties of existing filter, select *Properties* from Right Click context Menu.

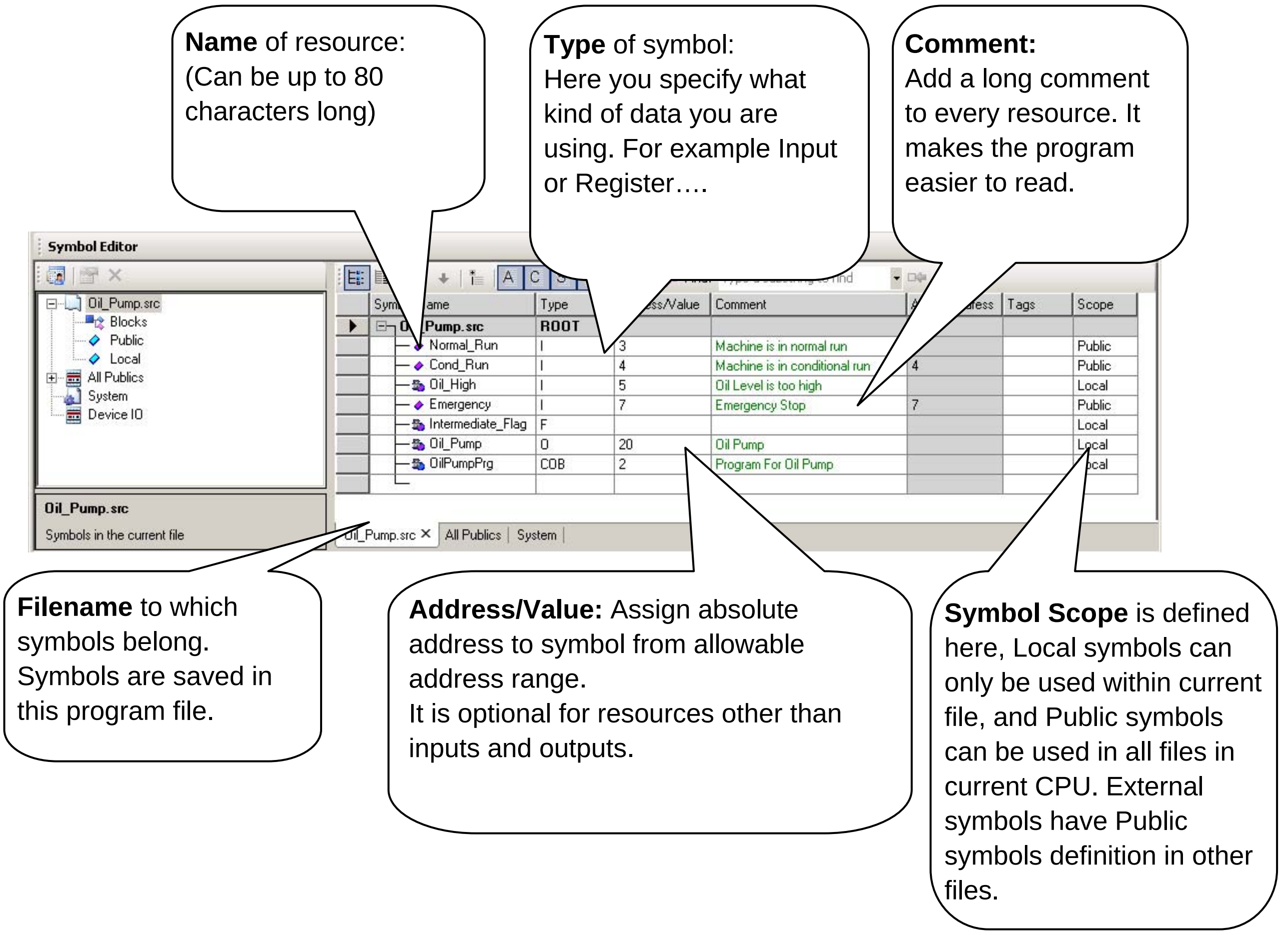


⊟ **Filter**	
Symbol Name	Big*
Group Name	
⊞ Types	
Address/Value	
Actual Value	
Comment	*
⊞ Scopes	
Tags	
⊟ **General**	
Filter Name	MyFilterName
Description	MyFilterComment

Filter Name
Filter user name

5.2.2 Elements of a Symbol

Symbols are defined in program files and symbol grid associated with program file can be viewed by selecting ‘Program file’ Tab. Symbols can be edited from this tab window.



Name of resource: (Can be up to 80 characters long)

Type of symbol: Here you specify what kind of data you are using. For example Input or Register….

Comment: Add a long comment to every resource. It makes the program easier to read.

Filename to which symbols belong. Symbols are saved in this program file.

Address/Value: Assign absolute address to symbol from allowable address range.
It is optional for resources other than inputs and outputs.

Symbol Scope is defined here, Local symbols can only be used within current file, and Public symbols can be used in all files in current CPU. External symbols have Public symbols definition in other files.

Symbol Editor

- Oil_Pump.src
  - Blocks
  - Public
  - Local
- All Publics
- System
- Device IO

Oil_Pump.src

Symbols in the current file

Sym ame	Type	ss/Value	Comment	A ess	Tags	Scope
O Pump.src	**ROOT**					
Normal_Run	I	3	Machine is in normal run			Public
Cond_Run	I	4	Machine is in conditional run	4		Public
Oil_High	I	5	Oil Level is too high			Local
Emergency	I	7	Emergency Stop	7		Public
Intermediate_Flag	F					Local
Oil_Pump	O	20	Oil Pump			Local
OilPumpPrg	COB	2	Program For Oil Pump			ocal

Symbol Name

The first character is always a letter, followed by other letters, numbers, or the underscore character. Symbols are not case-sensitive unless they contain accented characters. MotorOn is the same as MOTORON, but GRÜN is not the same as grün.

Reserved words cannot be used as symbol names, list of reserved words are present towards end of this chapter.

Type

Defines operand type like input (I), output (O), register (R), counter (C), timer (T), text (X), DB, etc.

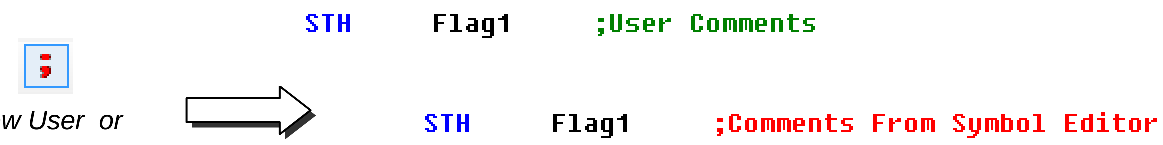
Address

Define absolute address of Operand here. For internal data like registers, flags etc If address is not entered, it is automatically assigned by the system during the build process. This is called auto allocation. It is compulsory to enter address for Inputs and Outputs.

Comment

The comment is linked to the symbol. In IL editor they can be viewed instead of the user comment linked to each line of program code.

Toggle with the button *View User* or *Auto Comment.*



```
STH     Flag1     ;User Comments
```

View User or Auto Comment

```
STH     Flag1     ;Comments From Symbol Editor
```

Actual Value

This is 'read only' column. It displays the dynamic address assigned by system to operand after build.

Tags

Tags can be used to mark Public symbols by common functionality like Network, HMI, and Supervision Symbols etc.

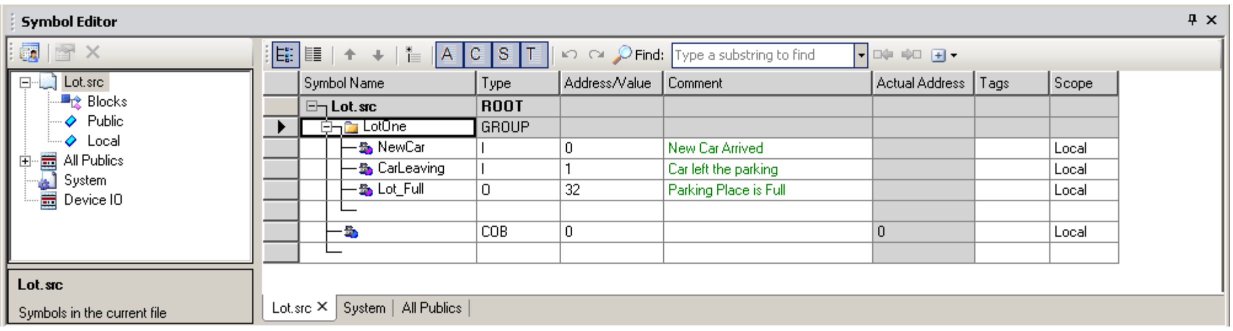
Scope

Local, *Public* or *external* scope can be selected form drop down list.

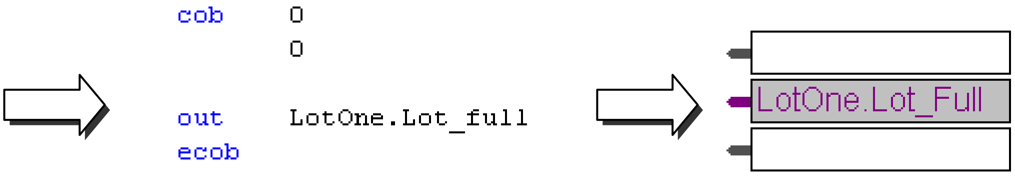
5.2.3 Grouping symbols together

If desired, symbols can be grouped together. This makes the program easier to read. Just use the right mouse button or *'CTRL+G'* to add a new group to the symbol editor and then define/drag-and-drop the symbols you want into the folder. Group names can be nested (up to 10 deep), e.g. *Group1.Group2.Group3.Symbol*.

Example: The Group named *LotOne* contains several symbols:



Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Lot.src	ROOT					
LotOne	GROUP					
NewCar	I	0	New Car Arrived			Local
CarLeaving	I	1	Car left the parking			Local
Lot_Full	O	32	Parking Place is Full			Local
	COB	0		0		Local



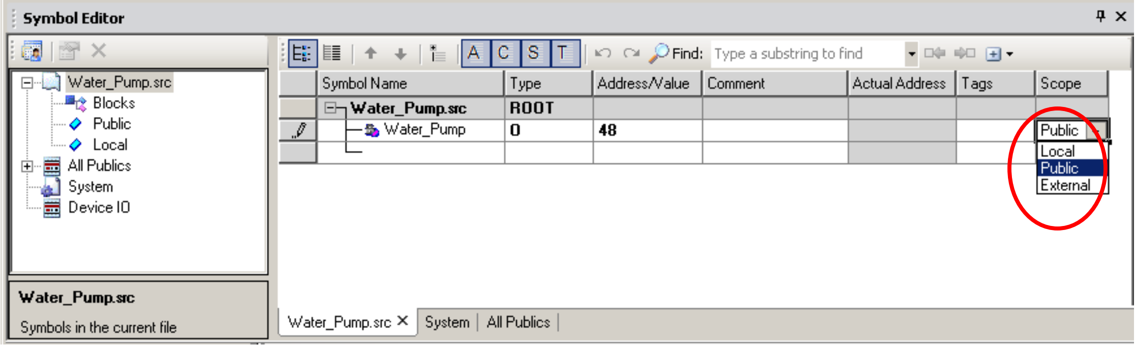
```
cob     0
        0

out     LotOne.Lot_full
ecob
```

In the program the group name *LotOne* precedes the symbol Name *Lot_full* and both are separated by a Dot.

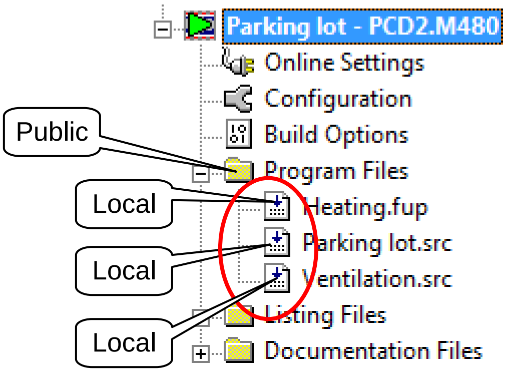
In very large programs you may have many symbols with similar Names, particularly if you have the same or similar pieces of code repeated several times. Instead of having many symbols with slightly different names, e.g. *Motor_A_Symbol1*, *Motor_B_Symbol1* etc., you can use the same symbol name, but put it in a different symbol 'group'. e.g. *MotorA.Symbol1*, *MotorB.Symbol1*.

5.2.4 Scope of symbols

Scope of the symbol can be selected from Scope column. There are three types of selection available *Local, Public* and *External* symbols.



Example: Device with three program files



Local symbols

Local symbols can be used only within same file where they have defined. For example symbol of scope local defined in *Parking_Lot.src* is valid for use in *Parking_Lot.src* only.

Public Symbols

Public symbols can be used in any file within same device. For Example Public symbols defined in *Parking_Lot.src* are valid for use in *Heating.fup* or *Ventilation.src* since all these files are present in same device.

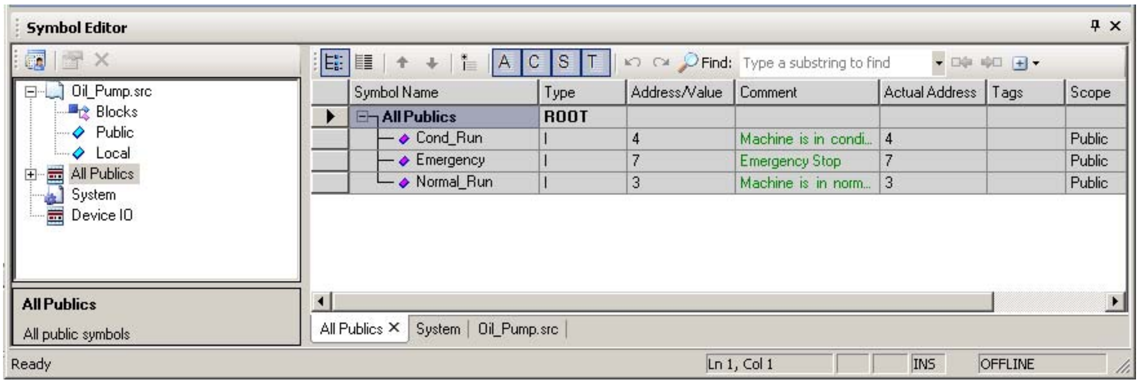
External Symbols

Symbol type external is a reference to Public symbol definition present in other program file. To use Public symbol defined in other program file, External symbol definition is needed in current program file. When Public symbol is Drag and drop from *'All Publics'* filter to program editor then External symbol definition is atomically added to current file. (More information on using Public symbols is in next section 'Working with Symbols')

5.2.5 Filter Views

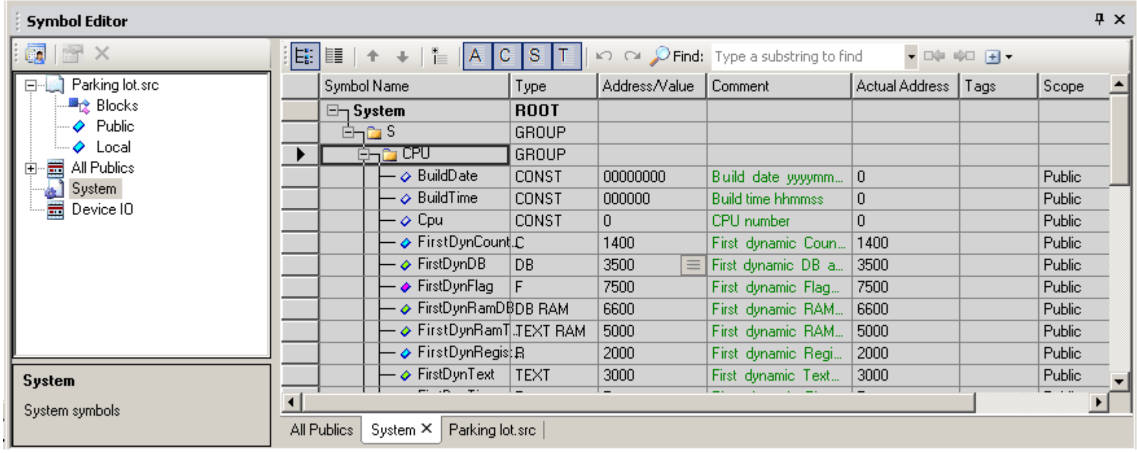
It is possible to navigate through filters in Navigator tree and also it is possible to open each filter view in new tab. Following pictures are the views for few predefined filters. Grey symbol grid indicates that symbols are read only in these views. Symbol definition can only be changed at the source file where actual symbol definition is present.

Predefined filter *‘All Publics”* displays the all Public symbols present in current device.



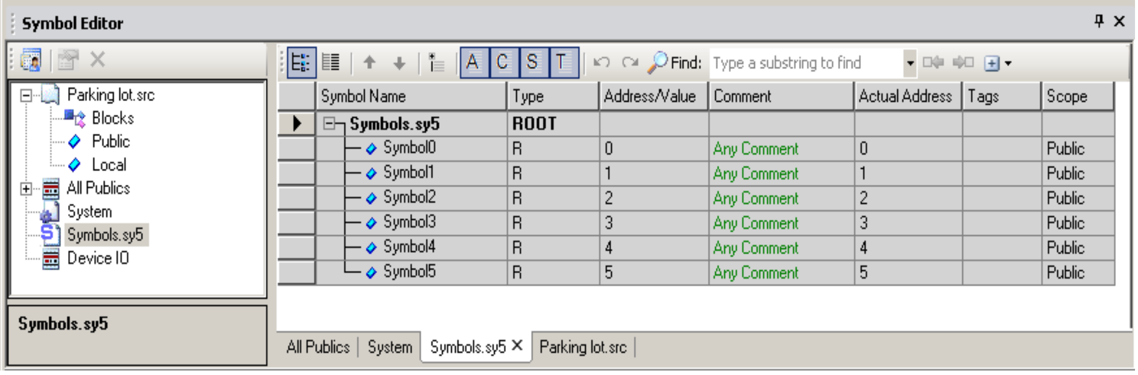
	Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
▶	All Publics	ROOT					
	Cond_Run	I	4	Machine is in condi...	4		Public
	Emergency	I	7	Emergency Stop	7		Public
	Normal_Run	I	3	Machine is in norm...	3		Public

Predefined filter *‘System’* displays the all system symbols present in current device.



	Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
	System	ROOT					
	S	GROUP					
▶	CPU	GROUP					
	BuildDate	CONST	00000000	Build date yyyymm...	0		Public
	BuildTime	CONST	000000	Build time hhmmss	0		Public
	Cpu	CONST	0	CPU number	0		Public
	FirstDynCount	C	1400	First dynamic Coun...	1400		Public
	FirstDynDB	DB	3500	First dynamic DB a...	3500		Public
	FirstDynFlag	F	7500	First dynamic Flag...	7500		Public
	FirstDynRamDB	DB RAM	6600	First dynamic RAM...	6600		Public
	FirstDynRamT	TEXT RAM	5000	First dynamic RAM...	5000		Public
	FirstDynRegis	R	2000	First dynamic Regi...	2000		Public
	FirstDynText	TEXT	3000	First dynamic Text...	3000		Public

If the device contains *.sy5* file, filter with *File Name* will appear in Navigation tree and all symbols in *.sy5* file will be displayed in the grid.



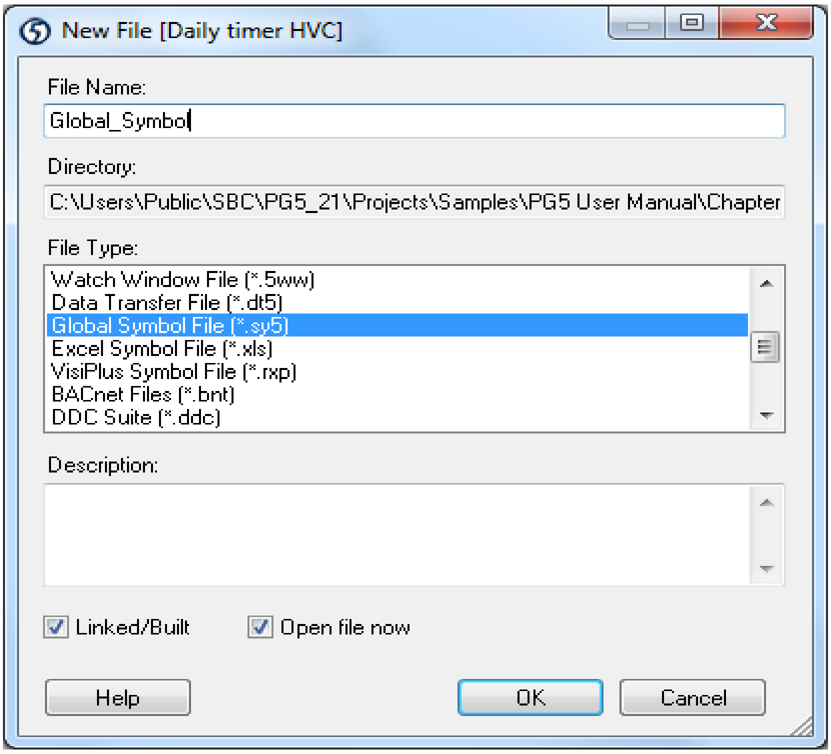
	Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
▶	Symbols.sy5	ROOT					
	Symbol0	R	0	Any Comment	0		Public
	Symbol1	R	1	Any Comment	1		Public
	Symbol2	R	2	Any Comment	2		Public
	Symbol3	R	3	Any Comment	3		Public
	Symbol4	R	4	Any Comment	4		Public
	Symbol5	R	5	Any Comment	5		Public

5.2.6 Symbols definition in .sy5 file

As we have seen in earlier sections that symbol definition are stored in program files (IL/Fupla etc.). Alternatively, it is possible to define Public Symbols at central location in *.sy5* file and use them in program files of current Device.

When Public symbols are defined in program files (IL/Fupla etc.), they are not lost when program files are copied from one device to another. It is therefore advantageous to define Public symbols in respective program files instead of defining them at one place in *.sy5* file.

New *.sy5* file can be created and added to the project by selecting file type as *.sy5*. Add *.sy5* file from Project manager similar to program file and *.sy5* file will be opened in Symbol Editor



New File [Daily timer HVC]

File Name: Global_Symbol

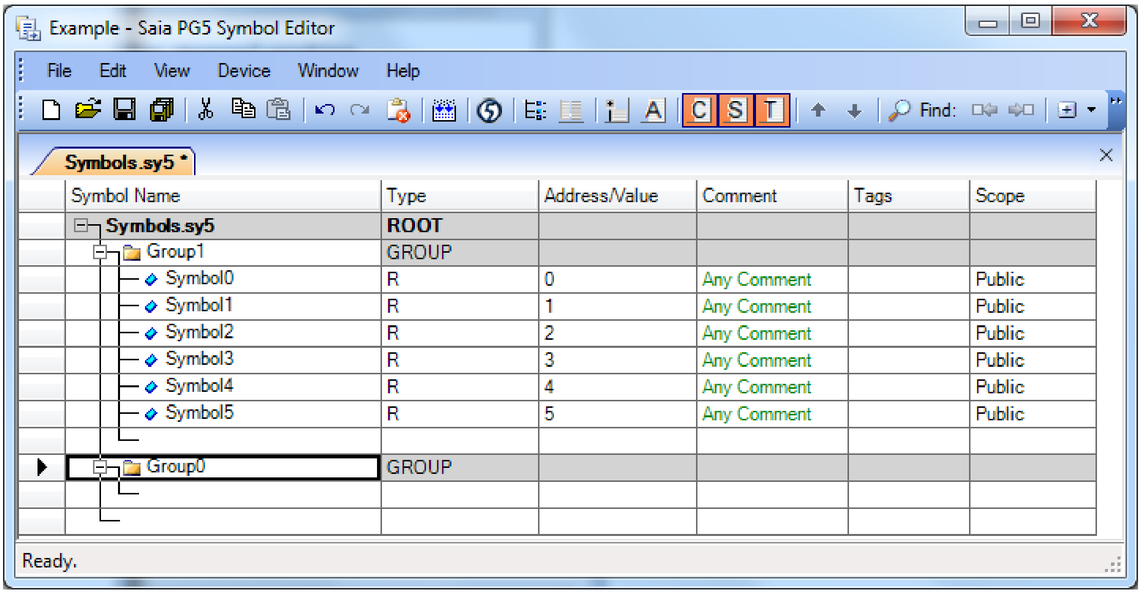
Directory: C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Chapter

File Type: Global Symbol File (*.sy5)

Watch Window File (*.5ww)
Data Transfer File (*.dt5)
Global Symbol File (*.sy5)
Excel Symbol File (*.xls)
VisiPlus Symbol File (*.rxp)
BACnet Files (*.bnt)
DDC Suite (*.ddc)
Description:
☑ Linked/Built
☑ Open file now
Help
OK
Cancel

.Sy5 File opened in symbol editor

This Public symbol definition file will be opened in Symbol editor and symbol definitions can be added to file.



Symbol Name	Type	Address/Value	Comment	Tags	Scope
Symbols.sy5	**ROOT**				
Group1	GROUP				
Symbol0	R	0	Any Comment		Public
Symbol1	R	1	Any Comment		Public
Symbol2	R	2	Any Comment		Public
Symbol3	R	3	Any Comment		Public
Symbol4	R	4	Any Comment		Public
Symbol5	R	5	Any Comment		Public
Group0	GROUP				

Public symbols from PG5 Ver. 1.4 and Older

When the PG5 Ver. 1.4 project is restored in PG5 Ver. 2.0, Public symbol definitions will be stored in *Globals.sy5* file and they can be viewed in symbol editor.

5.2.7 Symbols definition in .xls, .txt, .rxp files

Symbol definitions can be defined in other application files like *.xls, .txt* etc. and these files then can be added to device. After build symbols defined in these files are available in current device. In this way there is no more necessary to import and merge external symbols files with the internal symbols to the device program. We prefer to link the external files than to import them! This works better and easier. Also new versions of these files can easily be added.

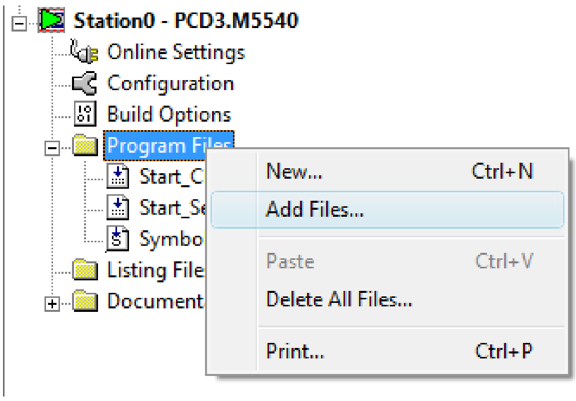
However, if symbols have still to be imported, this is always possible to copy symbols from original files like *.xls, .txt, .rxp, sy5* and paste them to symbol grid. (More information in section 5.3.16)

If the symbols file is already edited, it can be browse and added from right click menu on '*Program Files'* folder by selecting Add Files menu. It is also possible to create and add new symbol file (*.xls, .txt* etc.) from right click menu *'New'* on *Program files* and by selecting appropriate file type from New file dialog box.

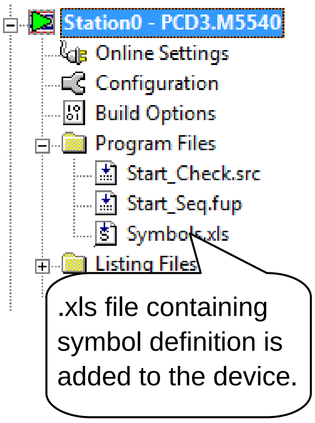
Note:-

Public symbol files with an extension *.sy5, .xls*, and *.rxp* are edited with the program corresponding to their extension and saved in the original file format.

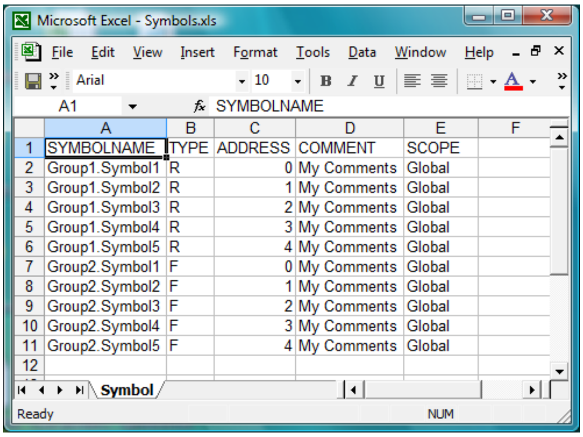
Add symbol definition file



Symbol definitions Excel file (*.xls) added.

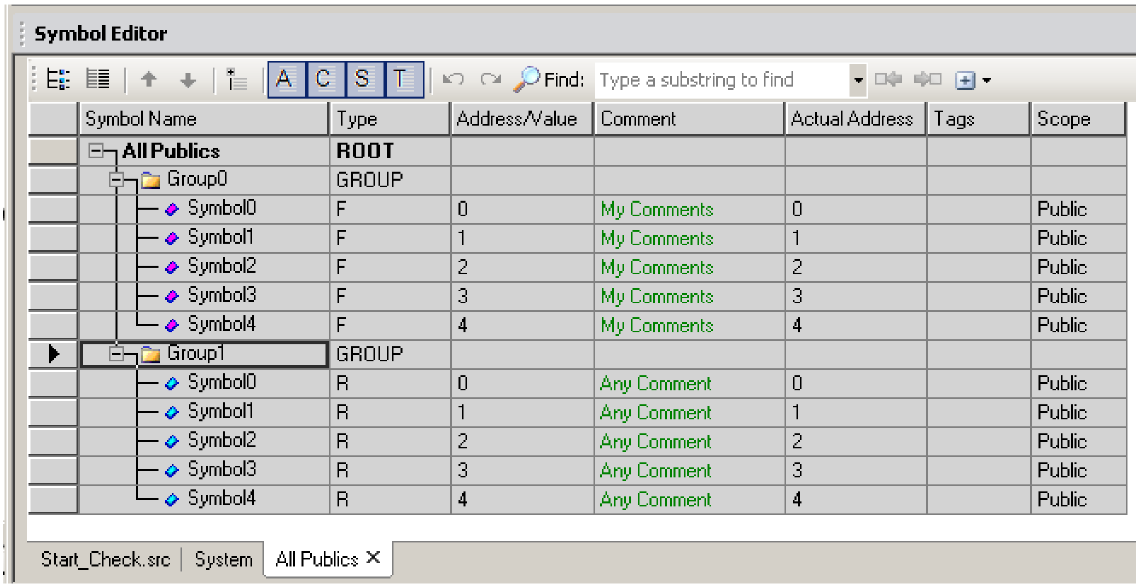


.xls file containing symbol definition is added to the device.


Microsoft Excel - Symbols.xls
File Edit View Insert Format Tools Data Window Help
Arial 10
A1 fx SYMBOLNAME
Symbol
Ready NUM

	A	B	C	D	E	F
1	SYMBOLNAME	TYPE	ADDRESS	COMMENT	SCOPE	
2	Group1.Symbol1	R	0	My Comments	Global	
3	Group1.Symbol2	R	1	My Comments	Global	
4	Group1.Symbol3	R	2	My Comments	Global	
5	Group1.Symbol4	R	3	My Comments	Global	
6	Group1.Symbol5	R	4	My Comments	Global	
7	Group2.Symbol1	F	0	My Comments	Global	
8	Group2.Symbol2	F	1	My Comments	Global	
9	Group2.Symbol3	F	2	My Comments	Global	
10	Group2.Symbol4	F	3	My Comments	Global	
11	Group2.Symbol5	F	4	My Comments	Global	
12						

After Build Public Symbols Defined in Excel file are available in project under *'All Publics'* Filter and they can be used in programs



Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
All Publics	ROOT					
Group0	GROUP					
Symbol0	F	0	My Comments	0		Public
Symbol1	F	1	My Comments	1		Public
Symbol2	F	2	My Comments	2		Public
Symbol3	F	3	My Comments	3		Public
Symbol4	F	4	My Comments	4		Public
Group1	GROUP					
Symbol0	R	0	Any Comment	0		Public
Symbol1	R	1	Any Comment	1		Public
Symbol2	R	2	Any Comment	2		Public
Symbol3	R	3	Any Comment	3		Public
Symbol4	R	4	Any Comment	4		Public

5.2.8 Define symbols for the communications networks

Sharing data between two different PCDs is more complicated than sharing information between files. Network connection is required between the two PCDs. This network connection can be designed in our network editor (which to date already supports SBus, Profibus DP and LON networks). Network symbols can be used in programs to transfer data from one PCD to another. These symbols appear as Public symbols.

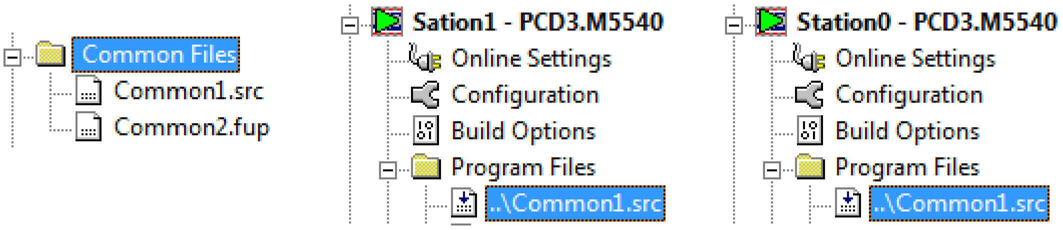
5.2.9 Symbols definition in Common file

When same file is needed to be used in many devices, it is added to Common Files folder in Project. These files can be program files like *.src, .fup, .sfc* or Public symbol files like *.sy5, .xls, .txt, .rxp* etc.

Public symbols defined in program files or Public symbol files which are placed in Project's *Common Files* Folder can be shared with several devices. Once the common file is referenced to current device, all Public symbols defined in common file are available to use in current device.

Example:

Common1.src is referenced in both Station0 as well as Station1. All Public Symbols defined in *Common1.src* will be available in both *Station0* as well as *Station1*.



5.3 Working with symbols

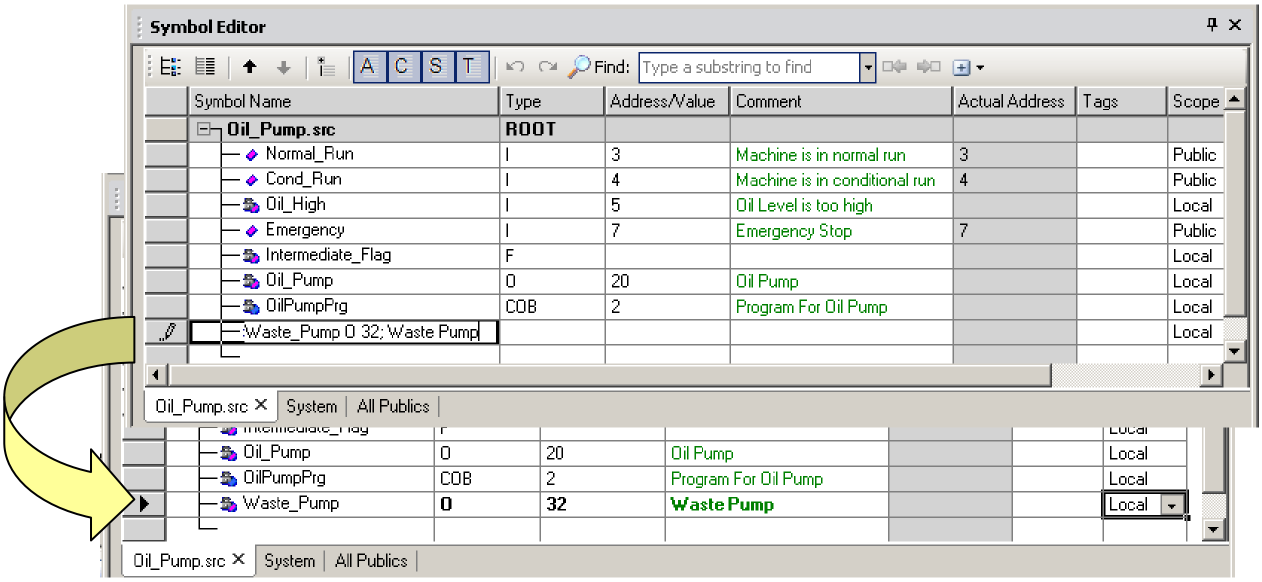
5.3.1 Adding symbols to symbol list

Simple Method

Open the file you are going to work with. This will also open the symbol editor. Symbol Editor always has empty row towards the end for new symbol entry. To add new symbol just start typing *Symbol Name* and Enter. Now select *Type*, Enter *Address/Value*, *comments* and select the *scope* of symbol. Once the symbol definition is added, empty row is automatically added towards the end for the next symbol definition.

Quick Method

It is also possible to enter variables for the different information fields from the Symbol Name field. This is more practical and quicker. See example below.



Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Oil_Pump.src	ROOT					
Normal_Run	I	3	Machine is in normal run	3		Public
Cond_Run	I	4	Machine is in conditional run	4		Public
Oil_High	I	5	Oil Level is too high			Local
Emergency	I	7	Emergency Stop	7		Public
Intermediate_Flag	F					Local
Oil_Pump	O	20	Oil Pump			Local
OilPumpPrg	COB	2	Program For Oil Pump			Local
Waste_Pump O 32; Waste Pump						Local

Oil_Pump.src | System | All Publics

Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Oil_Pump	O	20	Oil Pump			Local
OilPumpPrg	COB	2	Program For Oil Pump			Local
Waste_Pump	O	32	Waste Pump			Local

Oil_Pump.src | System | All Publics

Syntax to follow
symbol_name type address ;comment

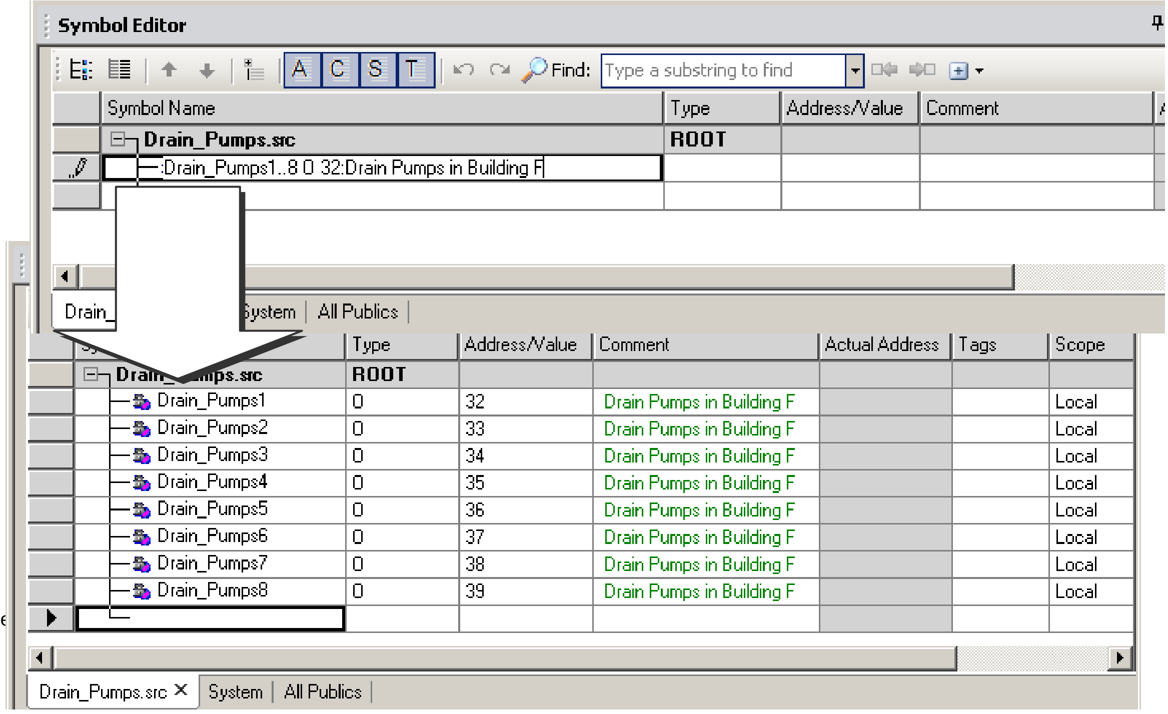
If the new symbol has been defined using the above syntax, pressing the enter key on the keyboard will automatically place information in the correct fields.

Entering partial symbol Definition

It is possible to save partial symbol definitions, which means for example you can enter symbol Names and type, stop working on symbol editor and enter addresses, comments and tags some other time. This enables possibility of stopping your work any time on symbol editor and save the intermediate result.

5.3.2 Adding several symbols to the symbol editor

You can add a range of symbols to your list if you want. Just enter the symbol name with the first and the last element number as shown, (Drainpumps1..8 O 32 ;Pumps in building F). 8 is the number of symbols, O is for output and 32 is the start address of the range you are entering. Press *Enter* and the symbol editor will complete the list. Up to 100 symbols can be added at time and if tried to add more it will add first 100 symbols.



Symbol Name	Type	Address/Value	Comment
Drain_Pumps.src	ROOT		
Drain_Pumps1..8 O 32:Drain Pumps in Building F			

Drain_ | System | All Publics

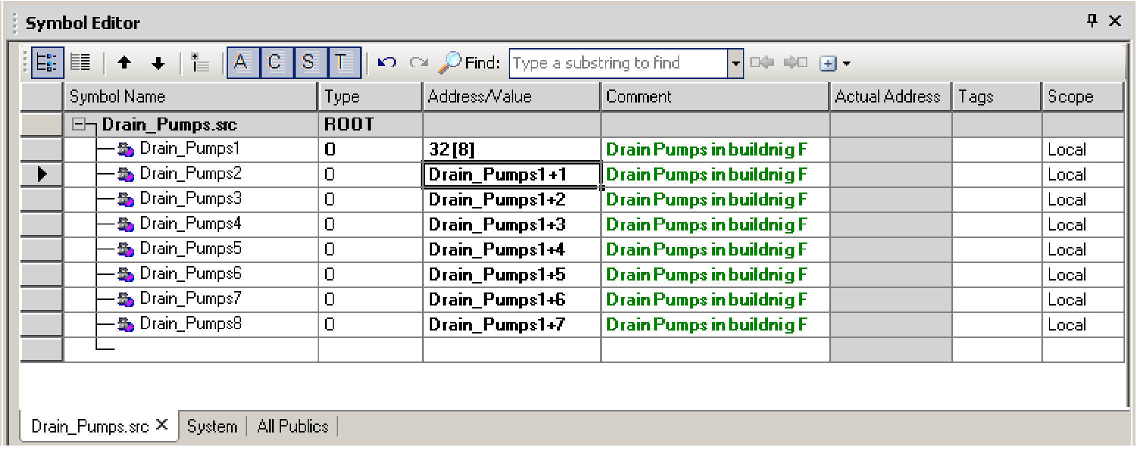
Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Drain_Pumps.src	ROOT					
Drain_Pumps1	O	32	Drain Pumps in Building F			Local
Drain_Pumps2	O	33	Drain Pumps in Building F			Local
Drain_Pumps3	O	34	Drain Pumps in Building F			Local
Drain_Pumps4	O	35	Drain Pumps in Building F			Local
Drain_Pumps5	O	36	Drain Pumps in Building F			Local
Drain_Pumps6	O	37	Drain Pumps in Building F			Local
Drain_Pumps7	O	38	Drain Pumps in Building F			Local
Drain_Pumps8	O	39	Drain Pumps in Building F			Local

Drain_Pumps.src | System | All Publics

5.3.3 Referenced symbols

It is possible to define a symbol with the reference to an other symbol instead of address value. If you have an array of symbols, this is helpful to refer the symbols address to the base address of the array. (The address of the symbol is defined by an other symbol of grid)

Also if you have a string of inputs or outputs and need to change their physical address location in the software, it’s easy to change with referenced symbols. You only have to change the first one and all the others will follow. In following example referenced symbols ‘*Drain_Pumps’2* to ‘*Drain_Pumps8’* are having address reference to first symbol *‘Drain_Pumps1’*.



Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Drain_Pumps.src	ROOT					
Drain_Pumps1	0	32 [8]	Drain Pumps in buildnig F			Local
Drain_Pumps2	0	Drain_Pumps1+1	Drain Pumps in buildnig F			Local
Drain_Pumps3	0	Drain_Pumps1+2	Drain Pumps in buildnig F			Local
Drain_Pumps4	0	Drain_Pumps1+3	Drain Pumps in buildnig F			Local
Drain_Pumps5	0	Drain_Pumps1+4	Drain Pumps in buildnig F			Local
Drain_Pumps6	0	Drain_Pumps1+5	Drain Pumps in buildnig F			Local
Drain_Pumps7	0	Drain_Pumps1+6	Drain Pumps in buildnig F			Local
Drain_Pumps8	0	Drain_Pumps1+7	Drain Pumps in buildnig F			Local

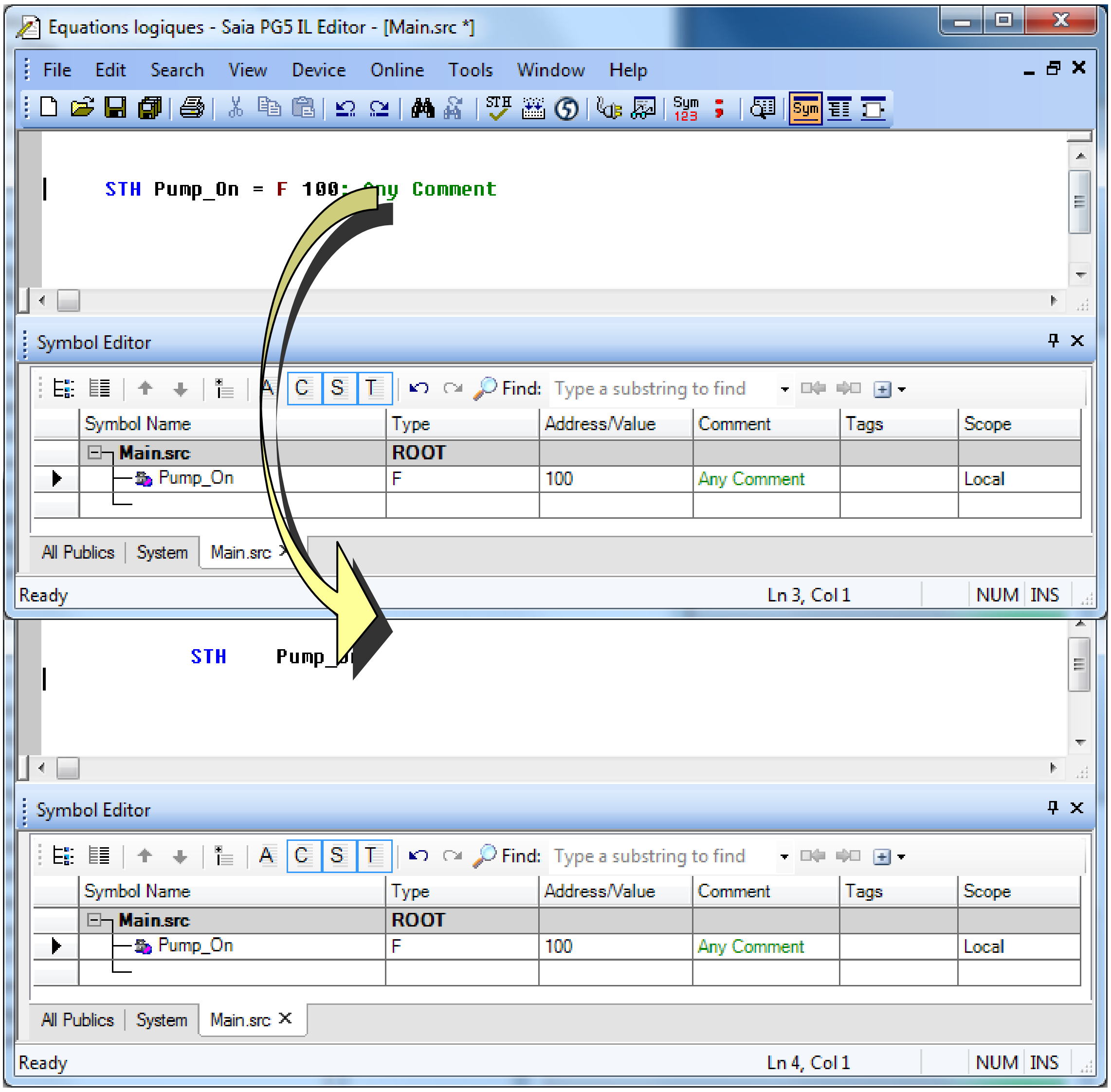
5.3.4 Adding a symbol while typing your IL Program

New symbols can also be added when editing the program. To do this, edit a line of program code with the mnemonic and its operand. For the operand, enter the symbol name and definition following the syntax below:
symbol_name = type address ;comment

Pressing the *enter* key on the keyboard with automatically place the new symbol on the *Symbols* list, but only if the symbol definition is correct, and only if the '*Automatically add entered type/value to the Symbol Table'* option has been selected (menu *Tools, Options* in the IL editor).

Note:
Any new symbol defined directly from the IL editor will be added as local symbol. If needed, Scope can be later changed from symbol editor.

Example:



```
STH Pump_On = F 100; Any Comment
```

Symbol Name	Type	Address/Value	Comment	Tags	Scope
Main.src	ROOT				
Pump_On	F	100	Any Comment		Local

Ready Ln 3, Col 1 NUM INS

```
STH     Pump_O
```

Symbol Name	Type	Address/Value	Comment	Tags	Scope
Main.src	ROOT				
Pump_On	F	100	Any Comment		Local

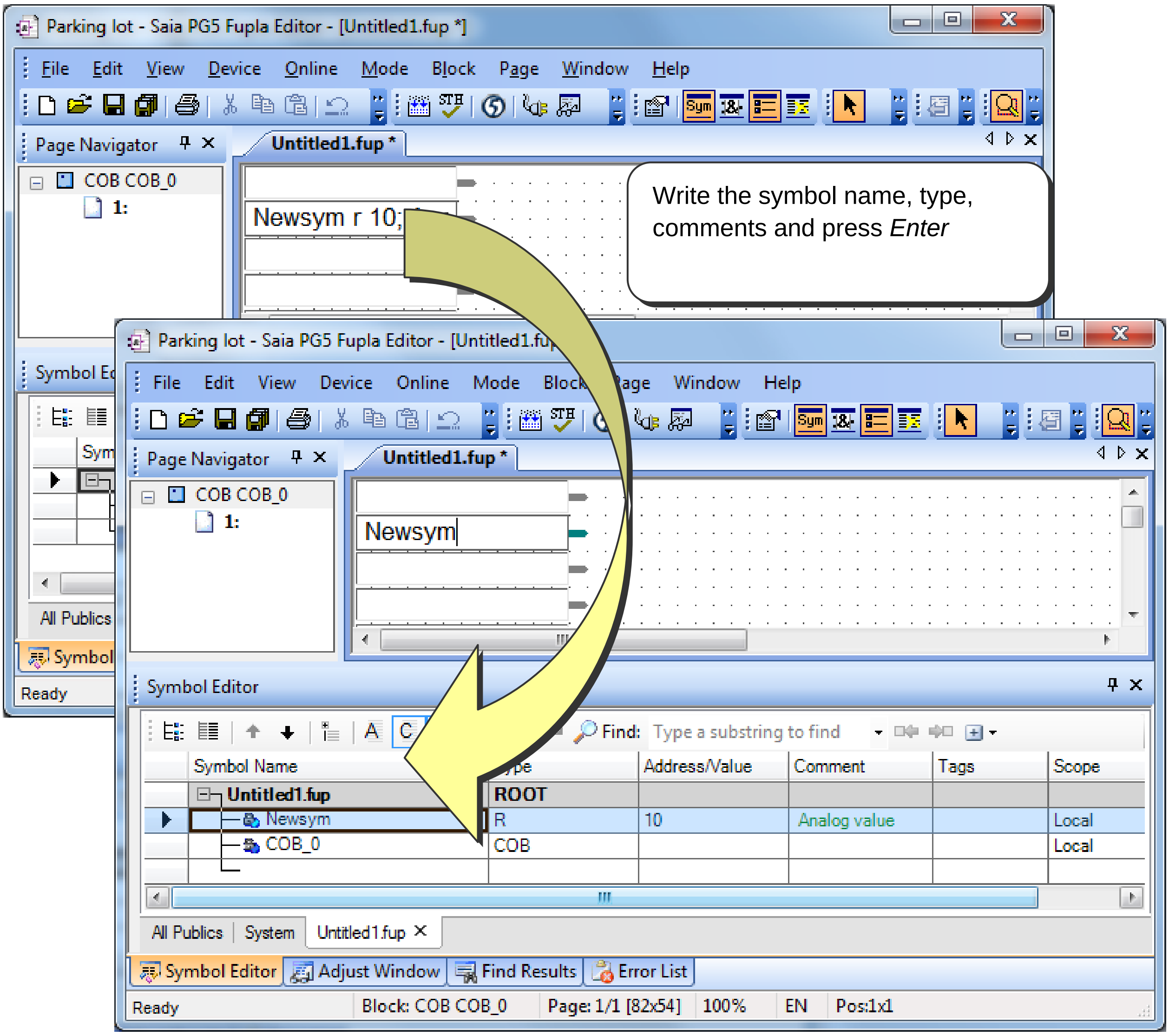
Ready Ln 4, Col 1 NUM INS

5.3.5 Adding a symbol while typing your program in Fupla

The Fupla editor works exactly the same way like IL editor. You can enter new symbols to the Symbol editor List directly from the Fupla input/output field.

Syntax: *Symbol Name symbol type [address] [; comment]*

Note:
Any new symbol defined directly from the Fupla editor will be added as local symbol. If needed, Scope can be later changed from symbol editor.



Write the symbol name, type, comments and press *Enter*

Parking lot - Saia PG5 Fupla Editor - [Untitled1.fup *]
File Edit View Device Online Mode Block Page Window Help
Page Navigator
Untitled1.fup *
COB COB_0
1:
Newsym r 10;
Symbol Editor
All Publics
Ready
Newsym
Find: Type a substring to find

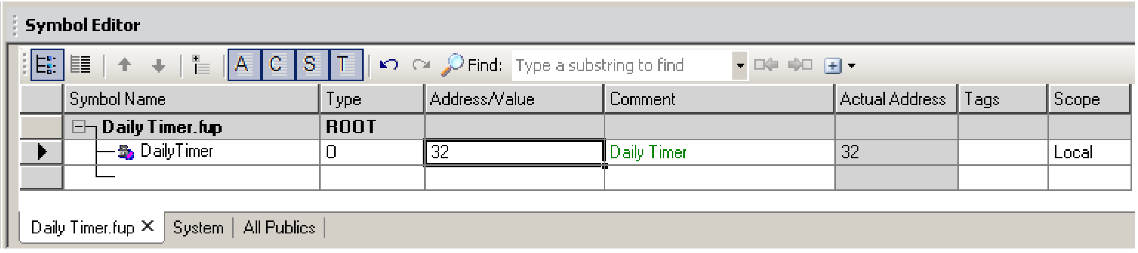
Symbol Name	Type	Address/Value	Comment	Tags	Scope
Untitled1.fup	ROOT				
Newsym	R	10	Analog value		Local
COB_0	COB				Local

All Publics | System | Untitled1.fup
Symbol Editor | Adjust Window | Find Results | Error List
Ready | Block: COB COB_0 | Page: 1/1 [82x54] | 100% | EN | Pos:1x1

5.3.6 Symbol Addressing Modes

A symbol definition does not necessarily include all the information presented below. We distinguish between three types of addressing:

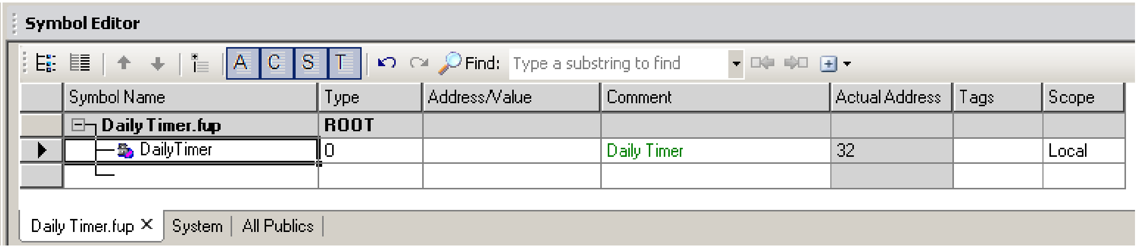
Symbol names



	Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
	⊟ Daily Timer.fup	ROOT					
▶	DailyTimer	0	32	Daily Timer	32		Local

The data is defined with a symbol name, type, address and optional comment. Correction of symbol, type or address is supported from the symbol list and each user program connector/line automatically updated if the symbol is changed.

Dynamic addressing

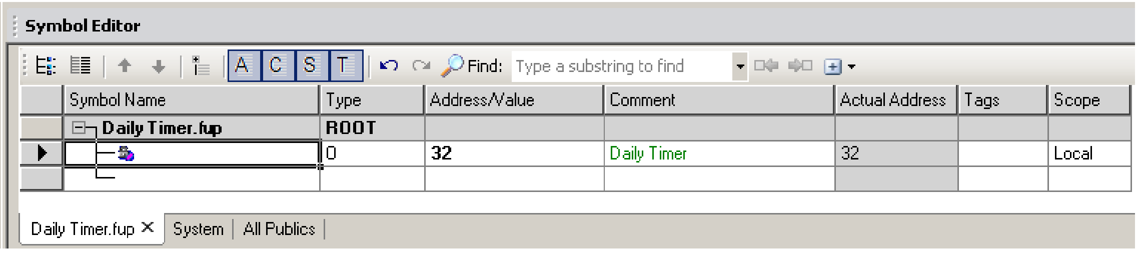


	Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
	⊟ Daily Timer.fup	ROOT					
▶	DailyTimer	0		Daily Timer	32		Local

This is a form of symbolic addressing in which the address is not defined. The address is assigned automatically during the program build. The address is taken from an address range defined by the Build Options. (See Project Manager.) After build dynamic address will be displayed in the Actual Value Column.

Note: Dynamic addressing is available with flags, counters, timers, registers, texts, DBs, COBs, PBs, FBs and SBs. However, absolute addresses must always be defined for inputs, outputs and XOBs.

Absolute addresses



	Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
	⊟ Daily Timer.fup	ROOT					
▶		0	32	Daily Timer	32		Local

The data is defined only with a type and address (e.g. 32), and an optional comment. Using absolute addressing directly in the program is a disadvantage when changing the type or address. The user program will not be updated by changes made in the symbol list. Changes must be made manually for connector/line of the program. It is therefore preferable to use symbol names, with optional dynamic addressing.

5.3.7 Using Symbols in Programs

When a program is being edited, symbols already defined in the *Symbols* editor may be used in different ways. All the methods described below can be used for both IL as well as fupla editor.

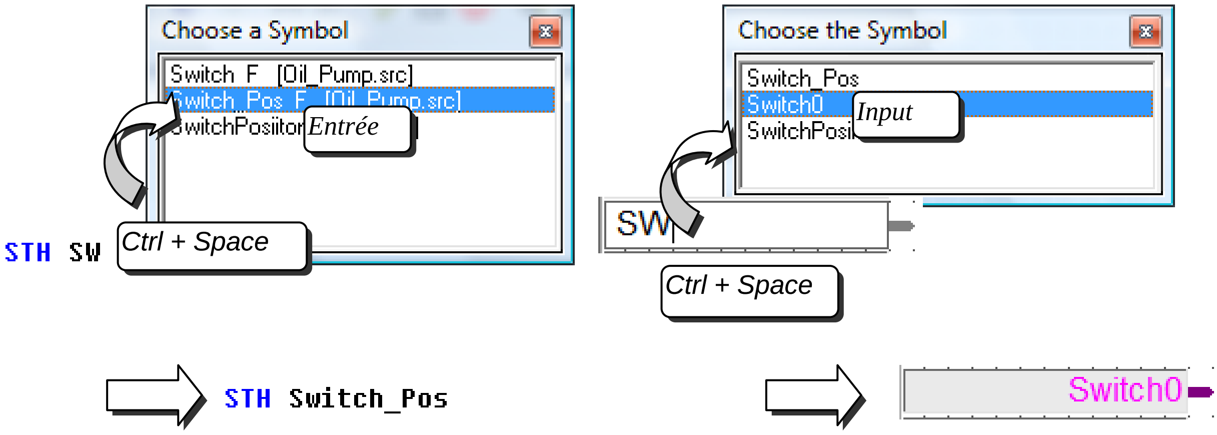
Symbol entry from the keyboard

The symbol name is entered in full from the keyboard for each instruction that uses it. This method might allow a symbol name to be edited with a typing error, which would only become evident when the program was built.

Symbol Entry by selective Searching

If you use long symbol names, your program will be easier to read. However, it would be annoying to have to re-enter a long symbol name every time you use it in the program. This can be avoided by simply entering the first letters of a symbol and then pressing the *Ctrl+Space* keys to look up all the symbols that match those letters. The required symbol can then be selected either with the mouse or the keyboard arrow keys (↑, ↓) and confirmed by pressing *Enter*.

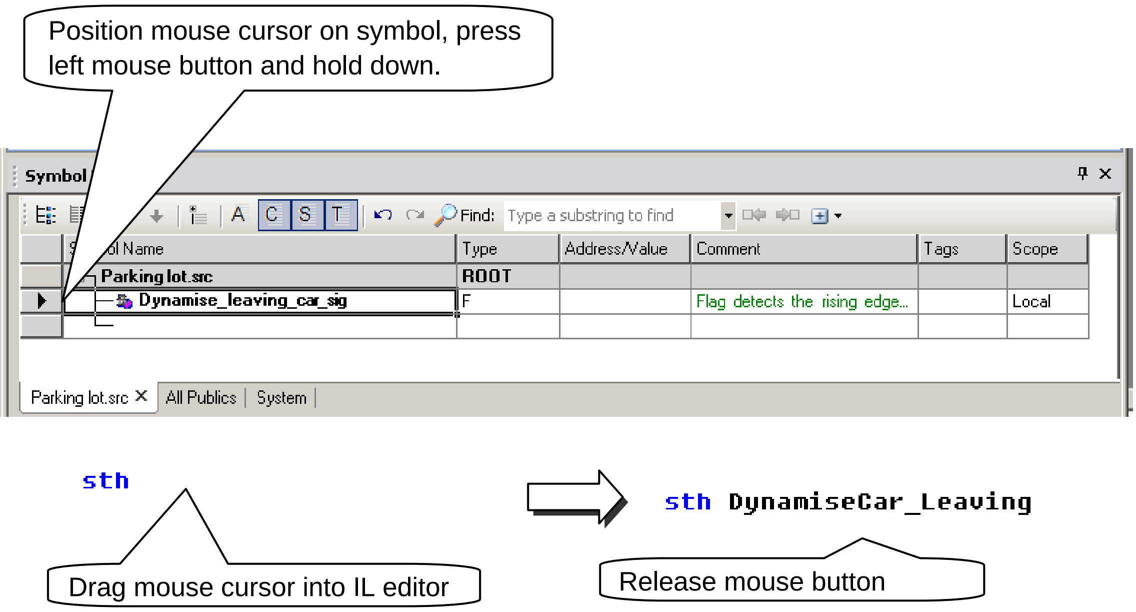
Example:



Drag and Drop Local Symbol

Once the symbols are defined in symbol editor, it is possible to drag and drop symbol to program editor and use it in program without actually typing the name of symbol. This way of using a symbol excludes any possibility of typing errors. In the *Symbols* window, position the mouse cursor on the definition line of a symbol, press the left mouse button and keep it down. Drag the mouse cursor into the Program editor and release the mouse button. The symbol chosen is automatically added at the place indicated by the mouse cursor.

Example 1



Position mouse cursor on symbol, press left mouse button and hold down.

S…ol Name	Type	Address/Value	Comment	Tags	Scope
Parking lot.src	ROOT				
Dynamise_leaving_car_sig	F		Flag detects the rising edge...		Local

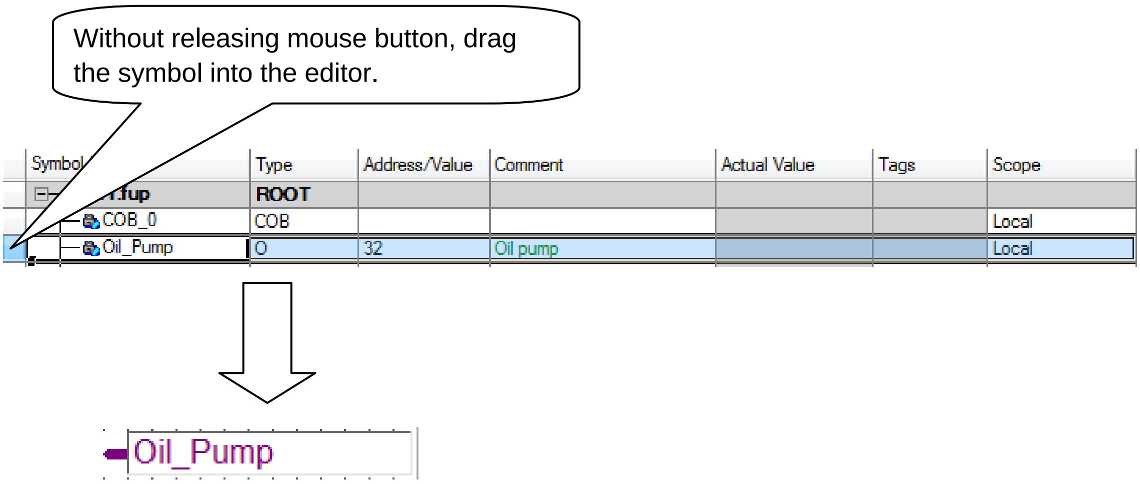
```
sth
```

Drag mouse cursor into IL editor

```
sth DynamiseCar_Leaving
```

Release mouse button

Example 2

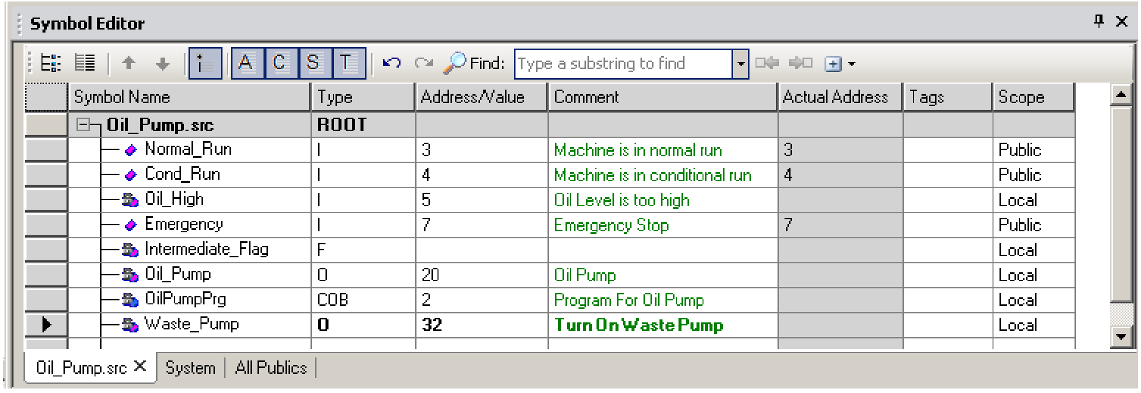


Without releasing mouse button, drag the symbol into the editor.

Symbol	Type	Address/Value	Comment	Actual Value	Tags	Scope
.fup	ROOT					
COB_0	COB					Local
Oil_Pump	O	32	Oil pump			Local

Drag and Drop Public symbol

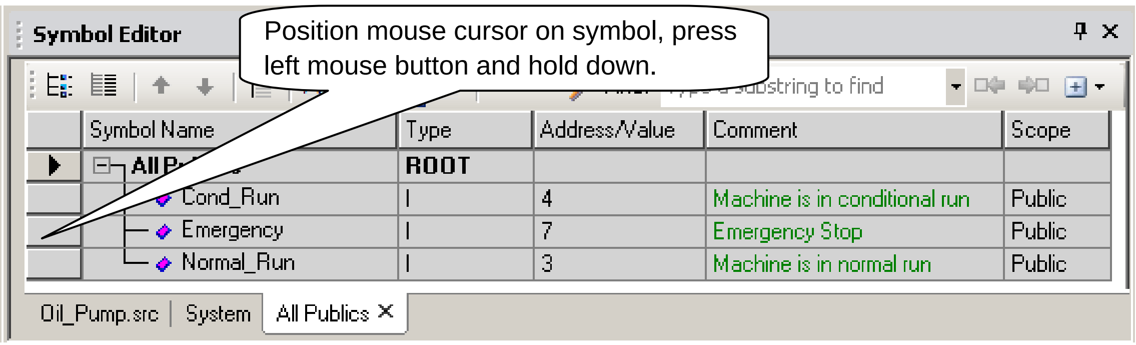
Public symbol ‘Emergency’ Defined in *Oil_Pump.src*



Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Oil_Pump.src	**ROOT**					
Normal_Run	I	3	Machine is in normal run	3		Public
Cond_Run	I	4	Machine is in conditional run	4		Public
Oil_High	I	5	Oil Level is too high			Local
Emergency	I	7	Emergency Stop	7		Public
Intermediate_Flag	F					Local
Oil_Pump	O	20	Oil Pump			Local
OilPumpPrg	COB	2	Program For Oil Pump			Local
Waste_Pump	**O**	**32**	**Turn On Waste Pump**			Local

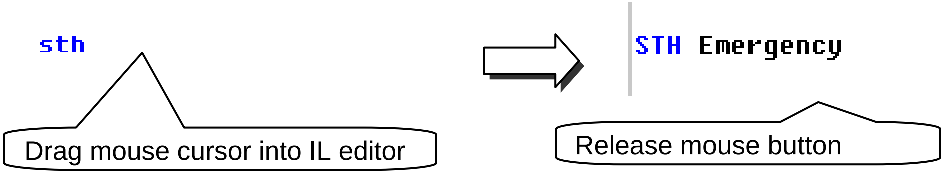
Public symbols defined in *Oil_Pump.src* will appear in *‘All Publics’* filter of files in current device for example *Parking_Lot.src*. To use Public symbol, it can be ***drag and drop*** from All Publics Filter Tab to Program editor. For example when Public Symbol *‘Emergency’* is drag and drop to program editor, External symbol is automatically added to *Pakring_Lot.src* file.

Display All Publics symbols in *Parking_Lot.src*


Symbol Editor
Position mouse cursor on symbol, press left mouse button and hold down.
substring to find

Symbol Name	Type	Address/Value	Comment	Scope
All P	**ROOT**			
Cond_Run	I	4	Machine is in conditional run	Public
Emergency	I	7	Emergency Stop	Public
Normal_Run	I	3	Machine is in normal run	Public

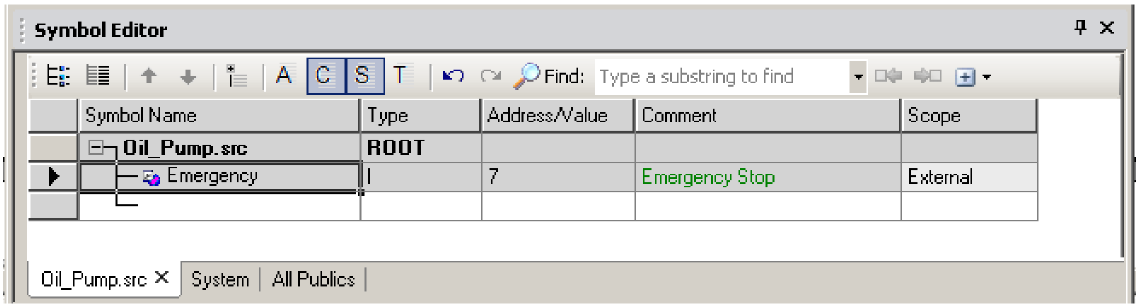
Oil_Pump.src | System | All Publics ✕



```
sth
```

```
STH Emergency
```

External symbol automatically added to Parking_Lot.src


Symbol Editor
A C S T
Find: Type a substring to find

Symbol Name	Type	Address/Value	Comment	Scope
Oil_Pump.src	**ROOT**			
Emergency	I	7	Emergency Stop	External

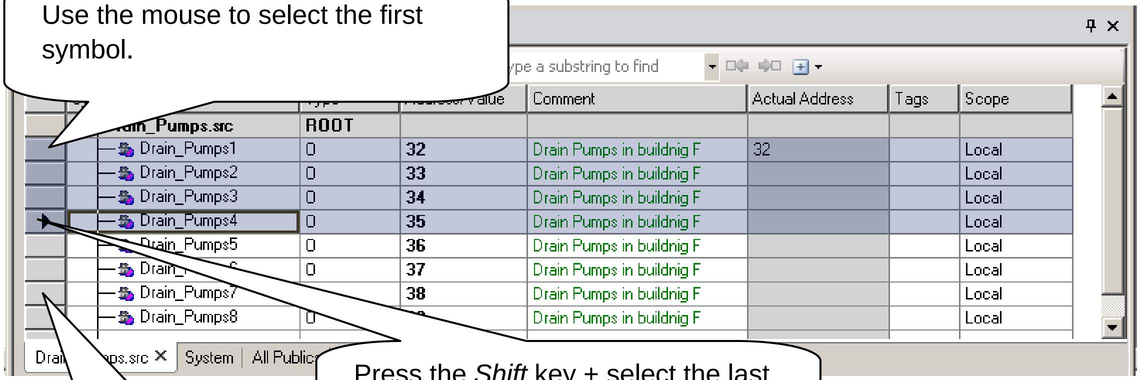
Oil_Pump.src ✕ | System | All Publics

Drag and Drop Multiple symbol

Drag and Drop Multiple Symbols

To avoid entering symbol names several times in one program (running the risk of typing errors) one or more symbols can be selected from the symbol editor and dragged into the Fupla or IL program.

Example: showing selection of several symbols



			Comment	Actual Address	Tags	Scope
rain_Pumps.src	ROOT					
Drain_Pumps1	0	32	Drain Pumps in buildnig F	32		Local
Drain_Pumps2	0	33	Drain Pumps in buildnig F			Local
Drain_Pumps3	0	34	Drain Pumps in buildnig F			Local
Drain_Pumps4	0	35	Drain Pumps in buildnig F			Local
Drain_Pumps5	0	36	Drain Pumps in buildnig F			Local
Drain_	0	37	Drain Pumps in buildnig F			Local
Drain_Pumps7		38	Drain Pumps in buildnig F			Local
Drain_Pumps8	0		Drain Pumps in buildnig F			Local

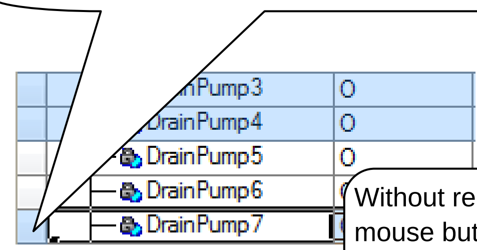
Use the mouse to select the first symbol.

Press the *Shift* key + select the last symbol.

Press the CTRl key + select an individual symbol.

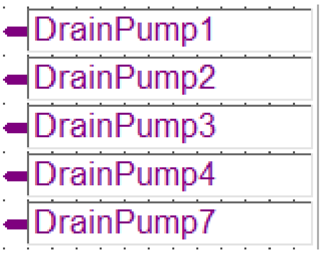
Example: showing symbol dragged into the Fupla or IL editor

Keep Ctrl/Shift Key Pressed adn Position mouse pointer as shown in figure. Press mouse button.



nPump3	O
DrainPump4	O
DrainPump5	O
DrainPump6	(
DrainPump7	

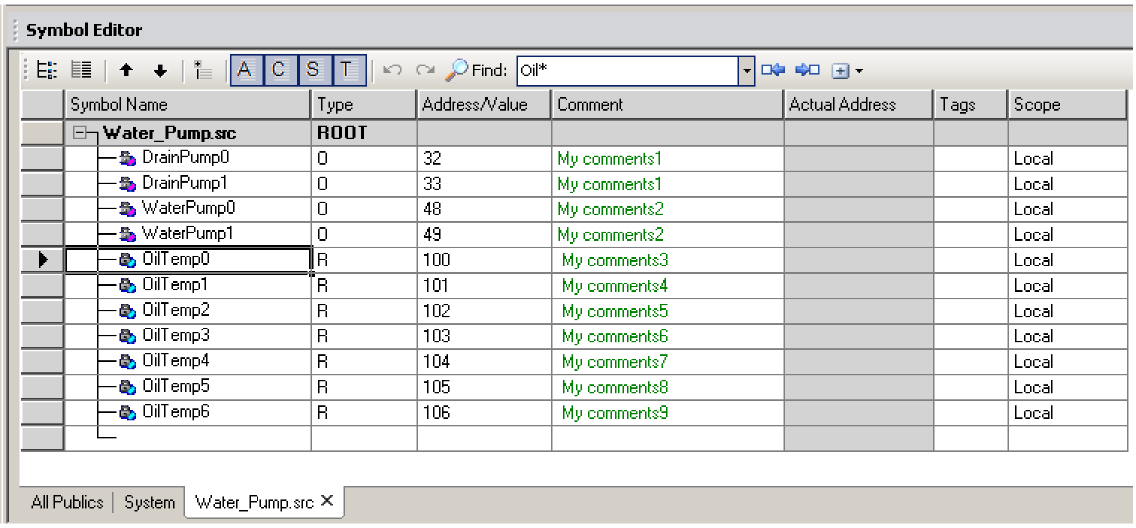
Without releasing mouse button, drag the symbol into the editor.



5.3.8 Search for a symbol

When large number of Public symbols present in the grid, Find tool can be used to locate the symbol in the grid. Once the symbol is found, it can be then drag and drop to program editor.

Find symbol toolbar allows finding symbols according to regular string. Find Next/Previous buttons are also available. It is possible to use joker characters like '*' or '?'.

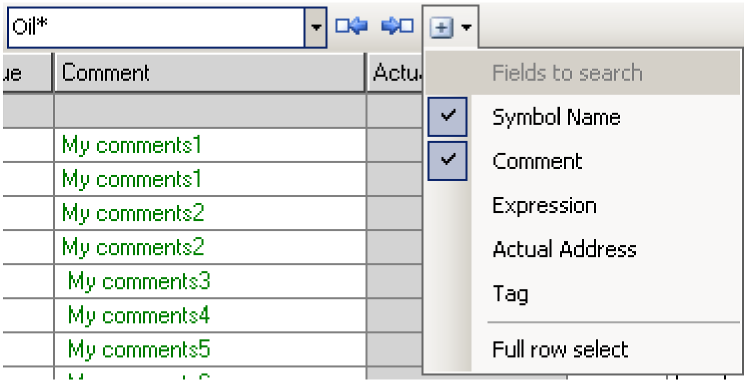


Symbol Editor

Find: Oil*

Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Water_Pump.src	**ROOT**					
DrainPump0	O	32	My comments1			Local
DrainPump1	O	33	My comments1			Local
WaterPump0	O	48	My comments2			Local
WaterPump1	O	49	My comments2			Local
OilTemp0	R	100	My comments3			Local
OilTemp1	R	101	My comments4			Local
OilTemp2	R	102	My comments5			Local
OilTemp3	R	103	My comments6			Local
OilTemp4	R	104	My comments7			Local
OilTemp5	R	105	My comments8			Local
OilTemp6	R	106	My comments9			Local

In advance options it's possible to select/deselect columns to look into. Search will include/exclude these columns based on selection.



Oil*

Fields to search

☑ Symbol Name
☑ Comment
☐ Expression
☐ Actual Address
☐ Tag

Full row select

5.3.9 Auto allocation

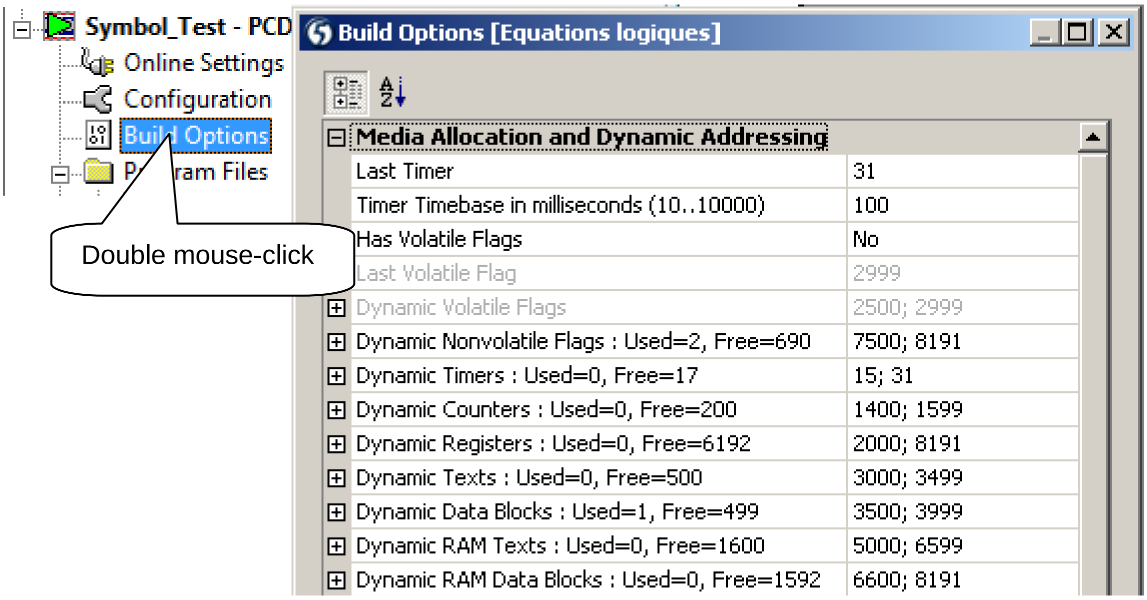
Until now we have always declared the elements like this:

	Symbol name	Type	Address	Comment
Example:	Pumpspeed	R	2000	;Speed in l/min

If you are entering any symbol type other than an input or an output, you do not have to enter an address for them. If you do not enter an address, the PG5 will assign an address to your element at build time. We call this automatic (or dynamic) allocation. The PG5 will look up the address range configured in the *Software Settings* for that element and assign an address during the build process.

Example:	Pumpspeed	R		;Speed in l/min

If you declare a register in your program without giving it an address:



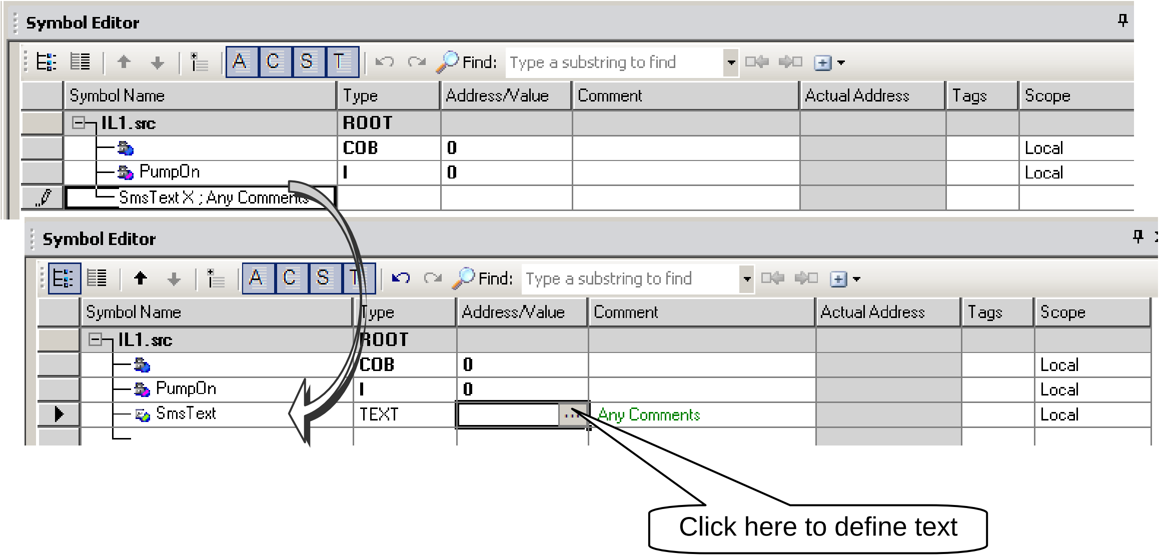
Media Allocation and Dynamic Addressing	
Last Timer	31
Timer Timebase in milliseconds (10..10000)	100
Has Volatile Flags	No
Last Volatile Flag	2999
⊞ Dynamic Volatile Flags	2500; 2999
⊞ Dynamic Nonvolatile Flags : Used=2, Free=690	7500; 8191
⊞ Dynamic Timers : Used=0, Free=17	15; 31
⊞ Dynamic Counters : Used=0, Free=200	1400; 1599
⊞ Dynamic Registers : Used=0, Free=6192	2000; 8191
⊞ Dynamic Texts : Used=0, Free=500	3000; 3499
⊞ Dynamic Data Blocks : Used=1, Free=499	3500; 3999
⊞ Dynamic RAM Texts : Used=0, Free=1600	5000; 6599
⊞ Dynamic RAM Data Blocks : Used=0, Free=1592	6600; 8191

The register will be allocated a number between 3500 and 4095 during the build process. This is because we declared the dynamic space between 3500 and 4095 for registers in the *Software Settings*. After build allocated address will be displayed in *'Actual Value'* Column in symbol editor.

5.3.10 Entering text

In order to add a text to your PCD the text must first be declared. This can be done by selecting symbol type as ‘TEXT’ in symbol editor. Also it can be declared by entering data type as X after the symbol name as shown in below example

Example:



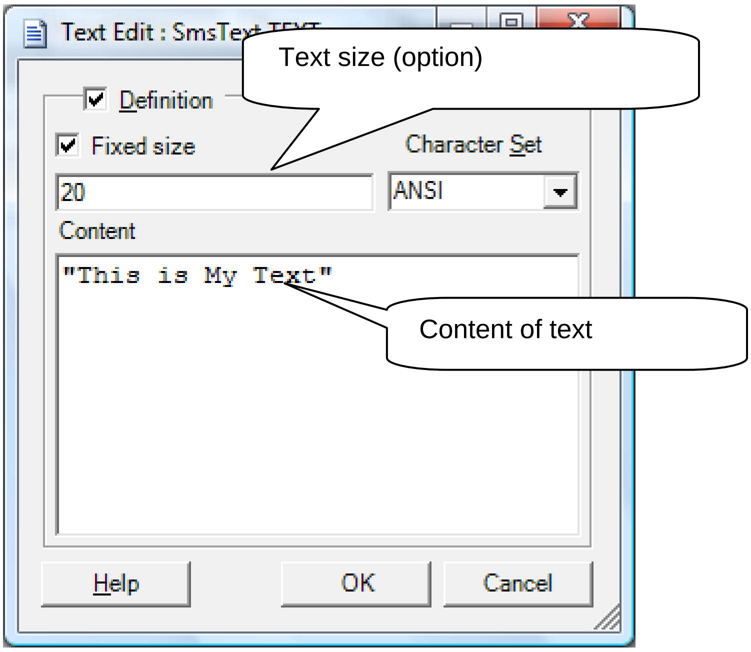
Symbol Editor

Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
IL1.src	ROOT					
	COB	0				Local
PumpOn	I	0				Local
SmsText X ; Any Comments						

Symbol Editor

Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
IL1.src	ROOT					
	COB	0				Local
PumpOn	I	0				Local
SmsText	TEXT		Any Comments			Local

Click here to define text



Text Edit : SmsText TEXT

☑ Definition

☑ Fixed size: 20

Character Set: ANSI

Content:

```
"This is My Text"
```

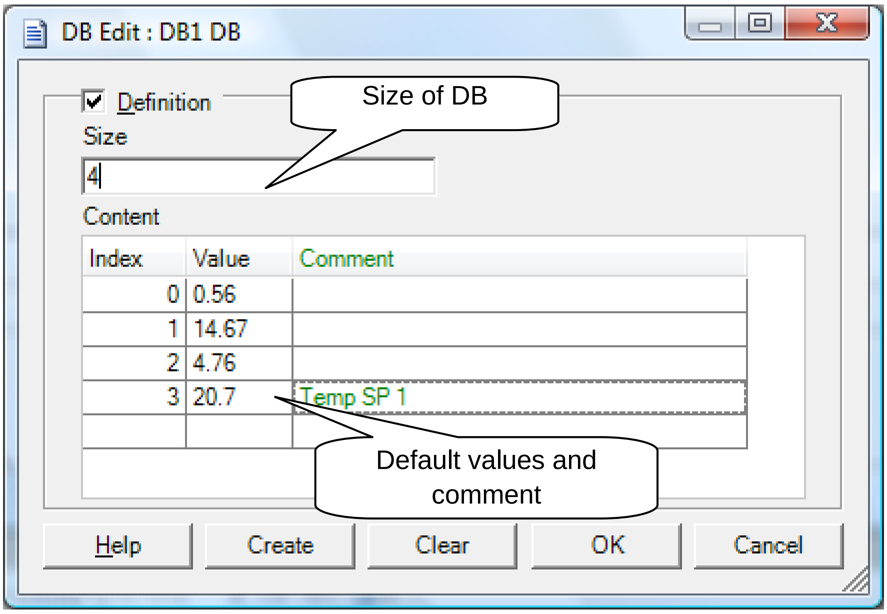
Text size (option)

Content of text

Do not forget to use " ", otherwise the text will not be valid.

5.3.11 Entering DBs

DBs have a special editor too. Define Symbol of type DB and Click on button in Address/Value Coulmn to display following editor. Enter size (Number of DB elements) and Click on Create button. Also Default Values and Comments can be added.



DB Edit : DB1 DB

☑ Definition

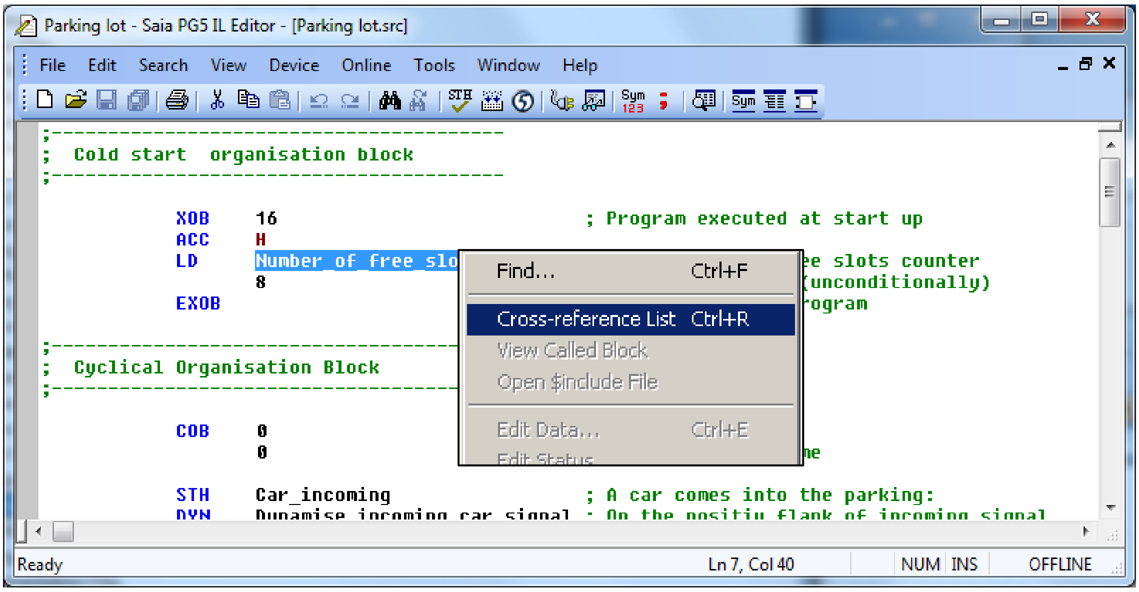
Size: 4

Content

Index	Value	Comment
0	0.56	
1	14.67	
2	4.76	
3	20.7	Temp SP 1

5.3.12 Symbol Cross Reference

Often a symbol will be used several times inside the program file or even in several different files. After saving files you can right-click with the mouse on any symbol and start the *Cross reference List* function. Cross Reference also available from Right click context menu of Symbol Editor.



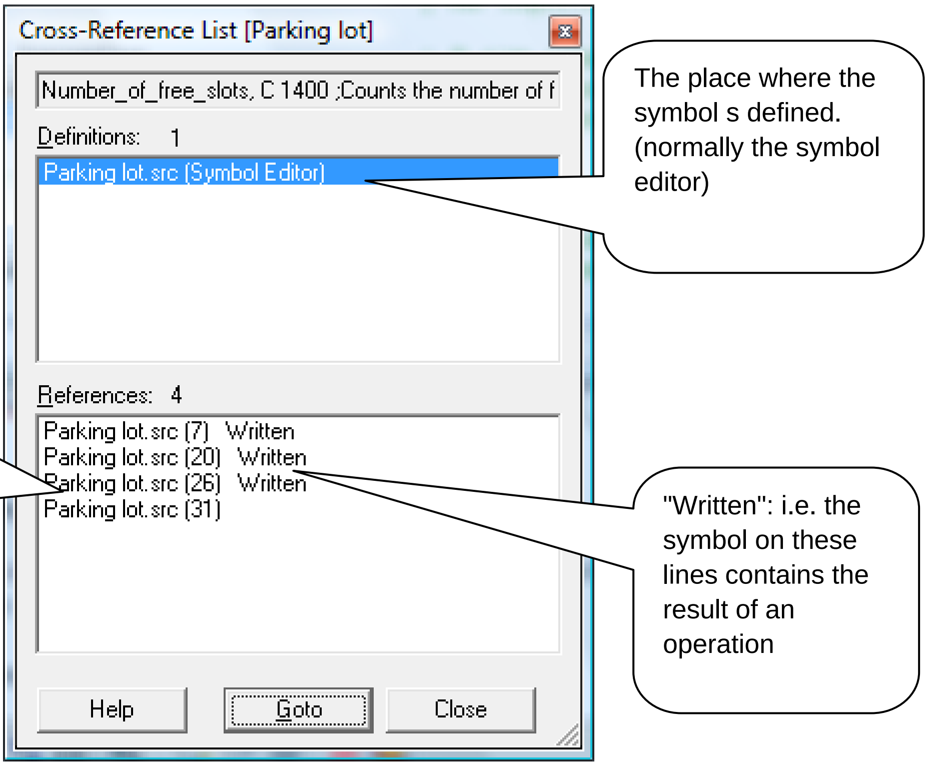
Parking lot - Saia PG5 IL Editor - [Parking lot.src]

```
;-----------------------------------------
;  Cold start  organisation block
;-----------------------------------------

            XOB     16                             ; Program executed at start up
            ACC     H
            LD      Number_of_free_slo             ee slots counter
                    8                              (unconditionally)
            EXOB                                   ogram

;---------------------------------------
;  Cyclical Organisation Block
;---------------------------------------

            COB     0
                    0                              ne

            STH     Car_incoming                   ; A car comes into the parking:
            DYN     Dynamise incoming car signal   ; On the positiv flank of incoming signal
```

Ready   Ln 7, Col 40   NUM INS   OFFLINE

File Edit Search View Device Online Tools Window Help
Find... Ctrl+F
Cross-reference List Ctrl+R
View Called Block
Open $include File
Edit Data... Ctrl+E
Edit Status

The cross-reference function displays the filename, line number and how many times a certain symbol was used. Double-click on any location in the reference list to open the program file with the cursor on the symbol concerned.



Cross-Reference List [Parking lot]

Number_of_free_slots, C 1400 ;Counts the number of f

Definitions: 1

Parking lot.src (Symbol Editor)

References: 4

```
Parking lot.src (7)   Written
Parking lot.src (20)  Written
Parking lot.src (26)  Written
Parking lot.src (31)
```

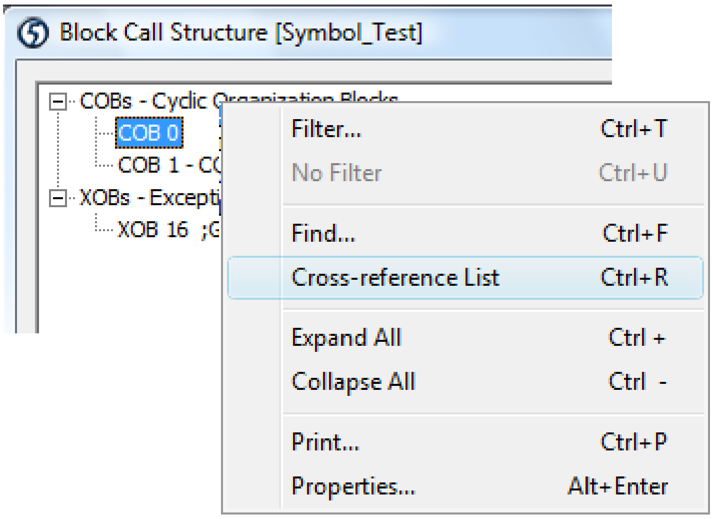
The place where the symbol s defined. (normally the symbol editor)

Program filename and line where the symbol '*Number_Of_Free_Slots* 'is used.

"Written": i.e. the symbol on these lines contains the result of an operation

The *cross-reference* tool not only works in S-Edit and Fupla but also in the different views which are available in the project manager.

Example: Block Structure view



Block Call Structure [Symbol_Test]

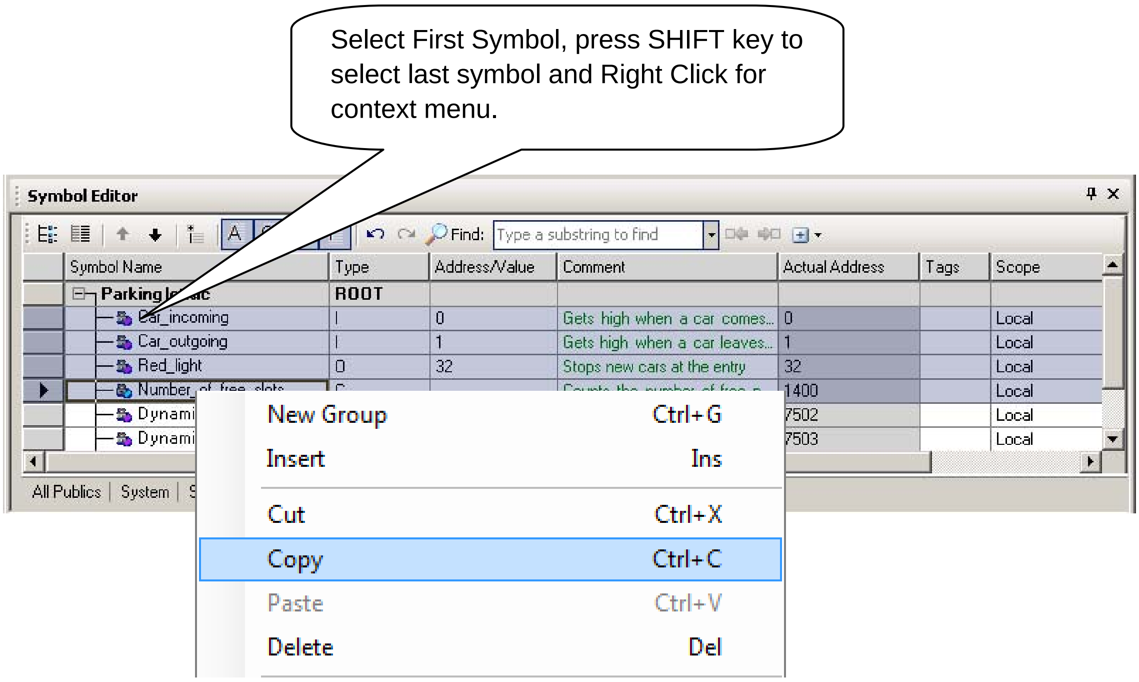
5.3.13 Editing Symbol Grid Areas

It is possible to select area in symbol grid and perform Edit actions like Copy/Paste Cut/Paste etc. Edit actions can be performed in same symbol grid or different symbol grid. This is useful to quickly transfer/duplicate symbols definitions from one file to another.

Few possible areas which can be selected in symbol grid for edit actions include:
-Symbol definitions (full row)
-Part of symbol definitions Example: - Only Symbol Names
-Several Symbol definitions
-Part of Grid Example: - Only Symbol Names and Types
-Symbol Groups etc.

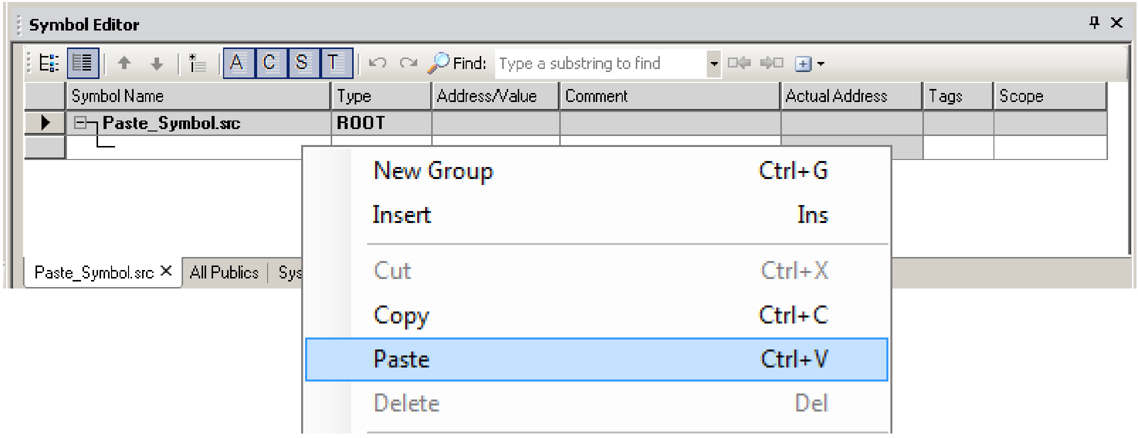
To proceed with symbol editing, select symbols/area and right click to perform action from context menu. Go to desired location in same grid or different file and right click to perform action from context menu.

Example Copy Paste Symbol Definitions:-



Select First Symbol, press SHIFT key to select last symbol and Right Click for context menu.

Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Parking l...ic	ROOT					
Car_incoming	I	0	Gets high when a car comes...	0		Local
Car_outgoing	I	1	Gets high when a car leaves...	1		Local
Red_light	O	32	Stops new cars at the entry	32		Local
Number_of_free_slots	C		Counts the number of free p...	1400		Local
Dynami				7502		Local
Dynami				7503		Local



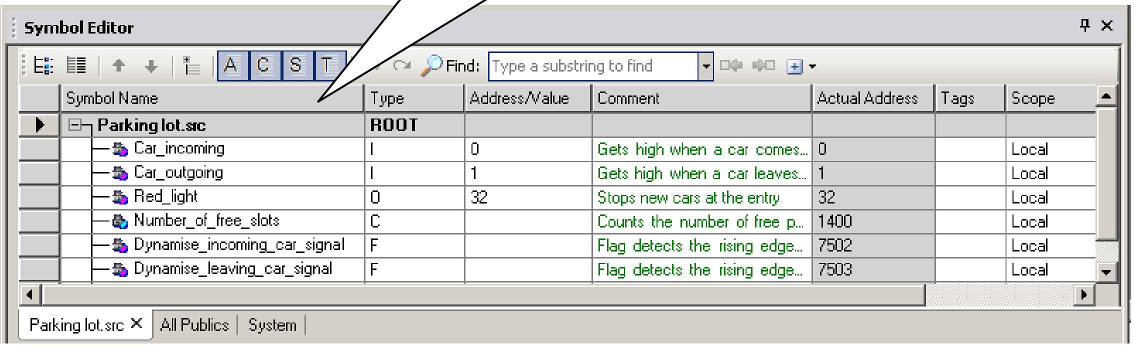
Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Paste_Symbol.src	ROOT					

5.3.14 Sorting Symbol List

Symbol list can be sorted in symbol grid with any column by clicking on column Name. This means symbols list can be sorted by Symbol Name, Type, Address, Comments, Actual Value, Tags or Scope.

Symbols Sorted with Symbol Name:-

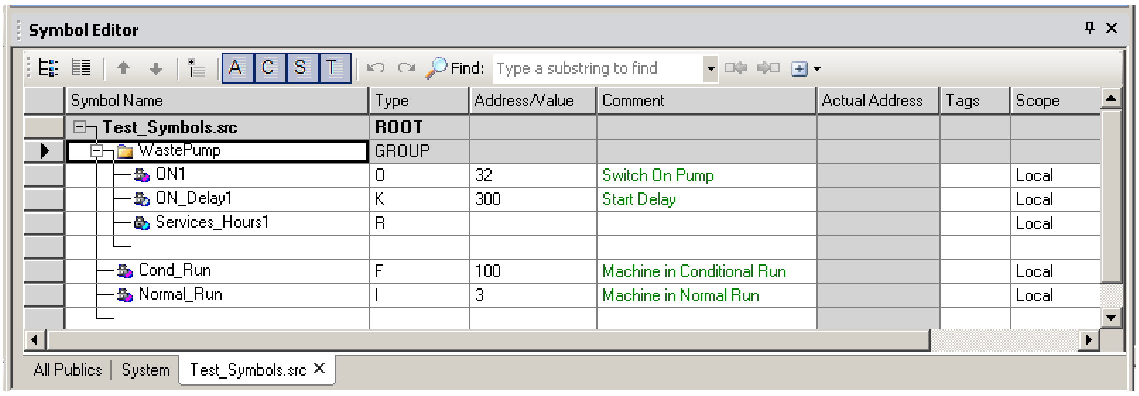
Click on any Column Name for sorting the symbols.



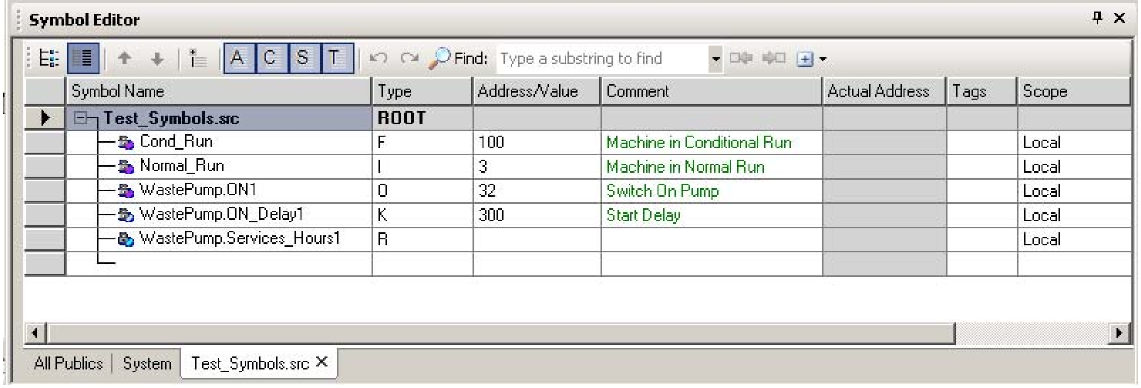
Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Parking lot.src	ROOT					
Car_incoming	I	0	Gets high when a car comes...	0		Local
Car_outgoing	I	1	Gets high when a car leaves...	1		Local
Red_light	O	32	Stops new cars at the entry	32		Local
Number_of_free_slots	C		Counts the number of free p...	1400		Local
Dynamise_incoming_car_signal	F		Flag detects the rising edge...	7502		Local
Dynamise_leaving_car_signal	F		Flag detects the rising edge...	7503		Local

You can also sort your symbols in *List view, Switch to List view and* click on one of the column in order to arrange them by: Name, Type, Address or Comment

Select Group/List View



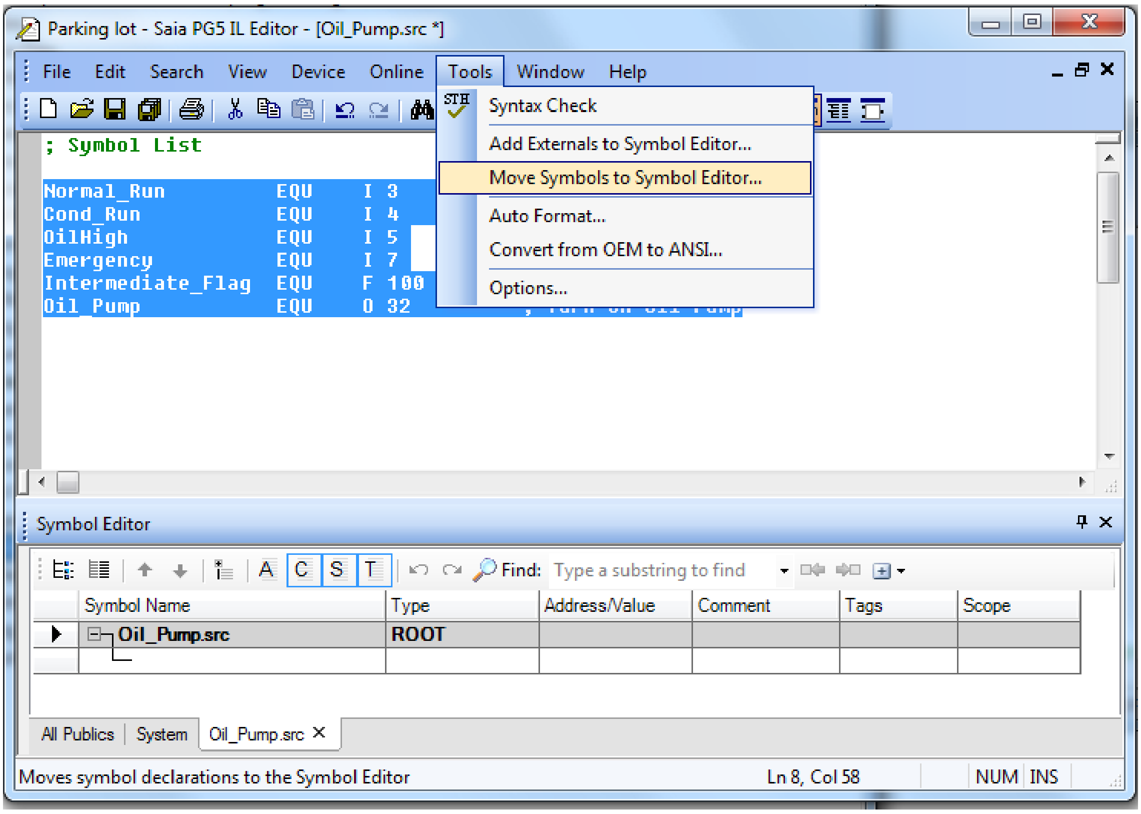
Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Test_Symbols.src	ROOT					
WastePump	GROUP					
ON1	O	32	Switch On Pump			Local
ON_Delay1	K	300	Start Delay			Local
Services_Hours1	R					Local
Cond_Run	F	100	Machine in Conditional Run			Local
Normal_Run	I	3	Machine in Normal Run			Local



Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Test_Symbols.src	ROOT					
Cond_Run	F	100	Machine in Conditional Run			Local
Normal_Run	I	3	Machine in Normal Run			Local
WastePump.ON1	O	32	Switch On Pump			Local
WastePump.ON_Delay1	K	300	Start Delay			Local
WastePump.Services_Hours1	R					Local

5.3.15 Importing symbols from “EQUATE” statements

If you have old PG4/3 Instruction List files containing EQU or DOC statements, then simply mark the statements and import the corresponding symbols with menu path: *Tools*, *Move Symbols to Symbol Editor*. The symbols are then moved from the program file into the symbol list.



Parking lot - Saia PG5 IL Editor - [Oil_Pump.src *]
File Edit Search View Device Online Tools Window Help
STH
Syntax Check
Add Externals to Symbol Editor...
Move Symbols to Symbol Editor...
Auto Format...
Convert from OEM to ANSI...
Options...
Symbol Editor
Find: Type a substring to find
All Publics System Oil_Pump.src

```
; Symbol List

Normal_Run          EQU     I 3
Cond_Run            EQU     I 4
OilHigh             EQU     I 5
Emergency           EQU     I 7
Intermediate_Flag   EQU     F 100
Oil_Pump            EQU     O 32          ; Turn on Oil Pump
```

Symbol Name	Type	Address/Value	Comment	Tags	Scope
Oil_Pump.src	ROOT				

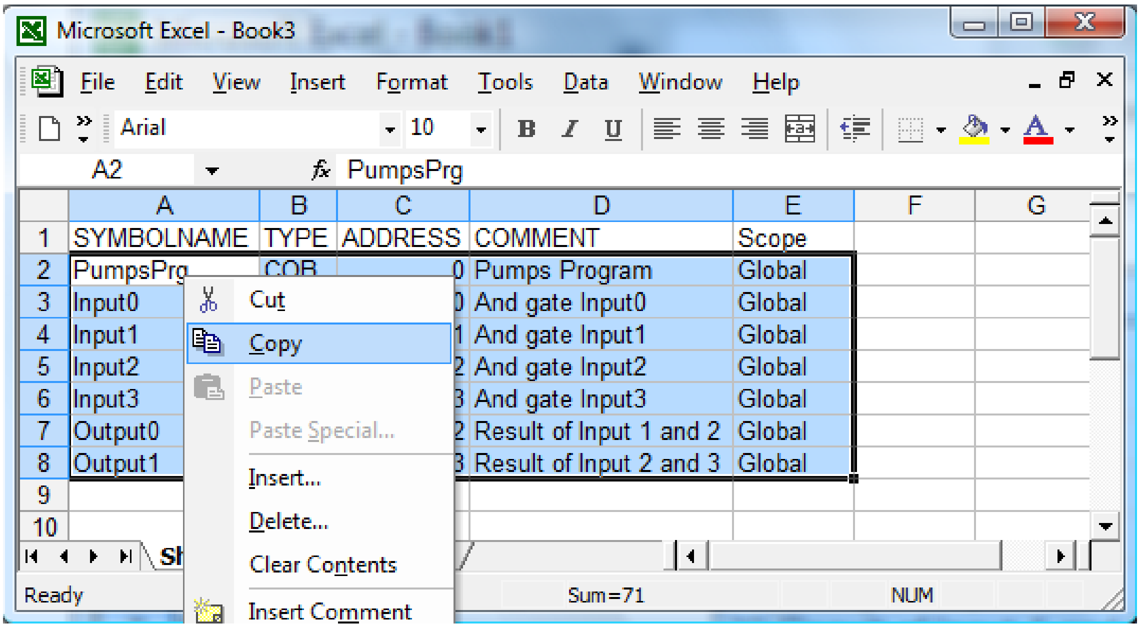
Moves symbol declarations to the Symbol Editor Ln 8, Col 58 NUM INS

5.3.16 Importing/Merging symbols

Symbols can be imported from another program (Electro CAD, VisiPlus,…) and used inside your project. This makes documentation consistent throughout the project and labels in your electrical drawings will be the same as in the program code. Simply use the export function in your CAD to export the symbols into a text file and then Copy/Paste symbols into symbol editor.

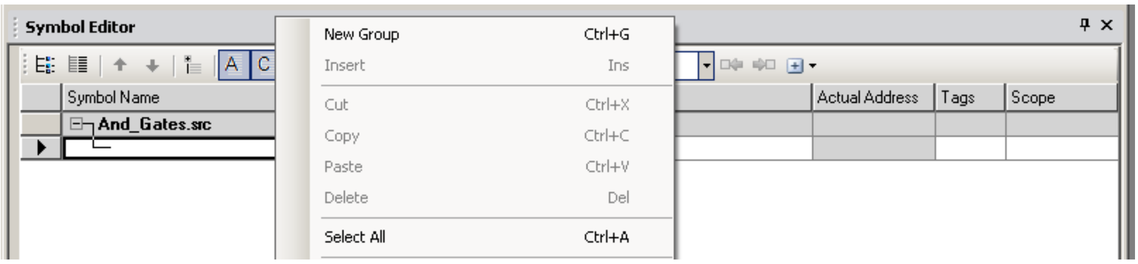
Copy/paste symbols from other editors like excel, word, etc. can be used to import/merge symbols. To do this, write a list of symbols in Excel, WinWord or any Text editor and Copy/Paste them into Symbol Editor directly. For example edit a symbol file as shown below and copy symbol definition from excel and Paste it in symbol editor. Also if symbol editor already contains symbol list then pasting symbols at the end of the grid does not disturb/overwrites the existing symbol definition.

Example Showing Copy/Paste symbol from Excel Sheet to Symbol Editor

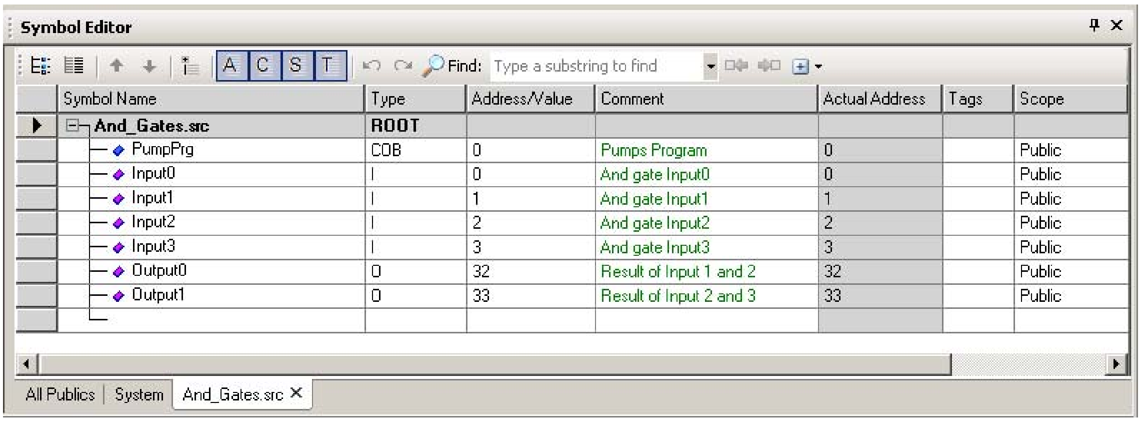


	A	B	C	D	E
1	SYMBOLNAME	TYPE	ADDRESS	COMMENT	Scope
2	PumpsPrg	COB	0	Pumps Program	Global
3	Input0		0	And gate Input0	Global
4	Input1		1	And gate Input1	Global
5	Input2		2	And gate Input2	Global
6	Input3		3	And gate Input3	Global
7	Output0		2	Result of Input 1 and 2	Global
8	Output1		3	Result of Input 2 and 3	Global

Use Right Click Context Menu to Paste Symbols



Symbols after Paste

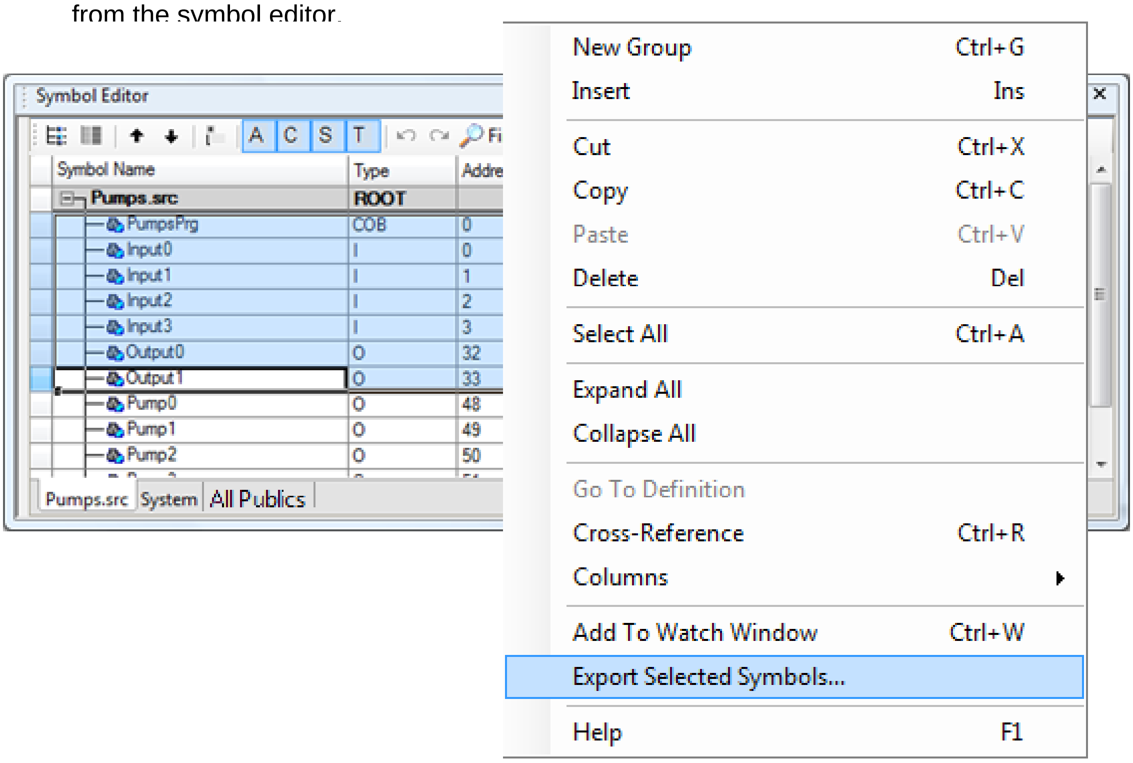


Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
And_Gates.src	ROOT					
PumpPrg	COB	0	Pumps Program	0		Public
Input0	I	0	And gate Input0	0		Public
Input1	I	1	And gate Input1	1		Public
Input2	I	2	And gate Input2	2		Public
Input3	I	3	And gate Input3	3		Public
Output0	O	32	Result of Input 1 and 2	32		Public
Output1	O	33	Result of Input 2 and 3	33		Public

5.3.17 Exporting symbols

A program's symbol list can be exported to other applications (such as Excel, VisiPlus or Word) for example, to produce your commissioning report. It also possible to Copy/Paste symbols from symbol editor to other application like Excel, Word, or Text editor.

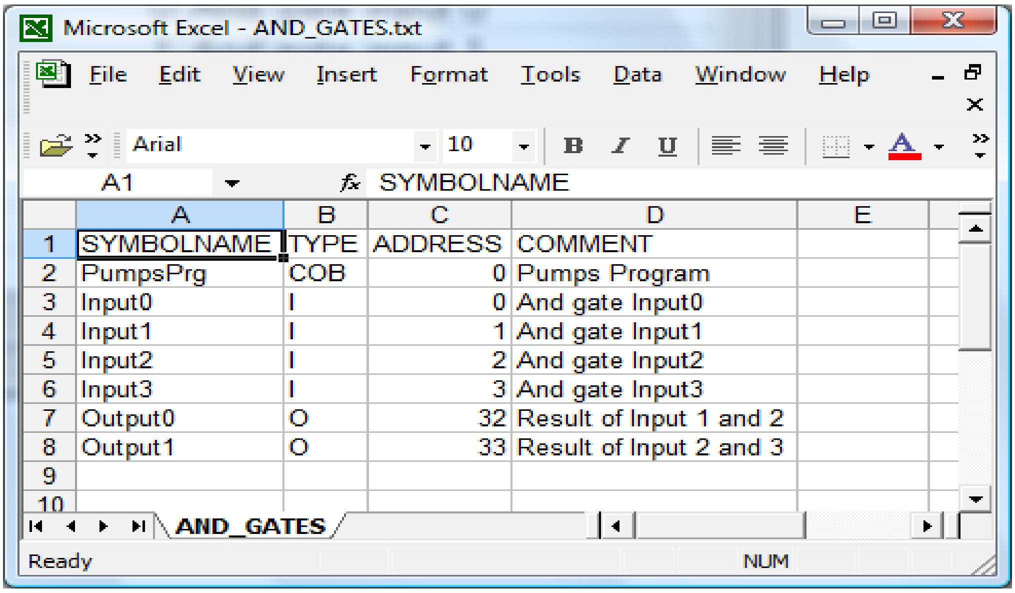
Example showing symbol export to Excel:
Select desired symbols to export and Select context menu *Export Selected Symbols* from the symbol editor.



Symbol Name	Type	Addre
Pumps.src	ROOT	
PumpsPrg	COB	0
Input0	I	0
Input1	I	1
Input2	I	2
Input3	I	3
Output0	O	32
Output1	O	33
Pump0	O	48
Pump1	O	49
Pump2	O	50

When exporting a symbol list to Excel, we strongly advise use of the *Tab separated Text file* format *(*.txt)*. You will obtain better results than if you use the *Excel* file format option *(*.xls).*

Start up Excel and open the text file with the exported symbols.

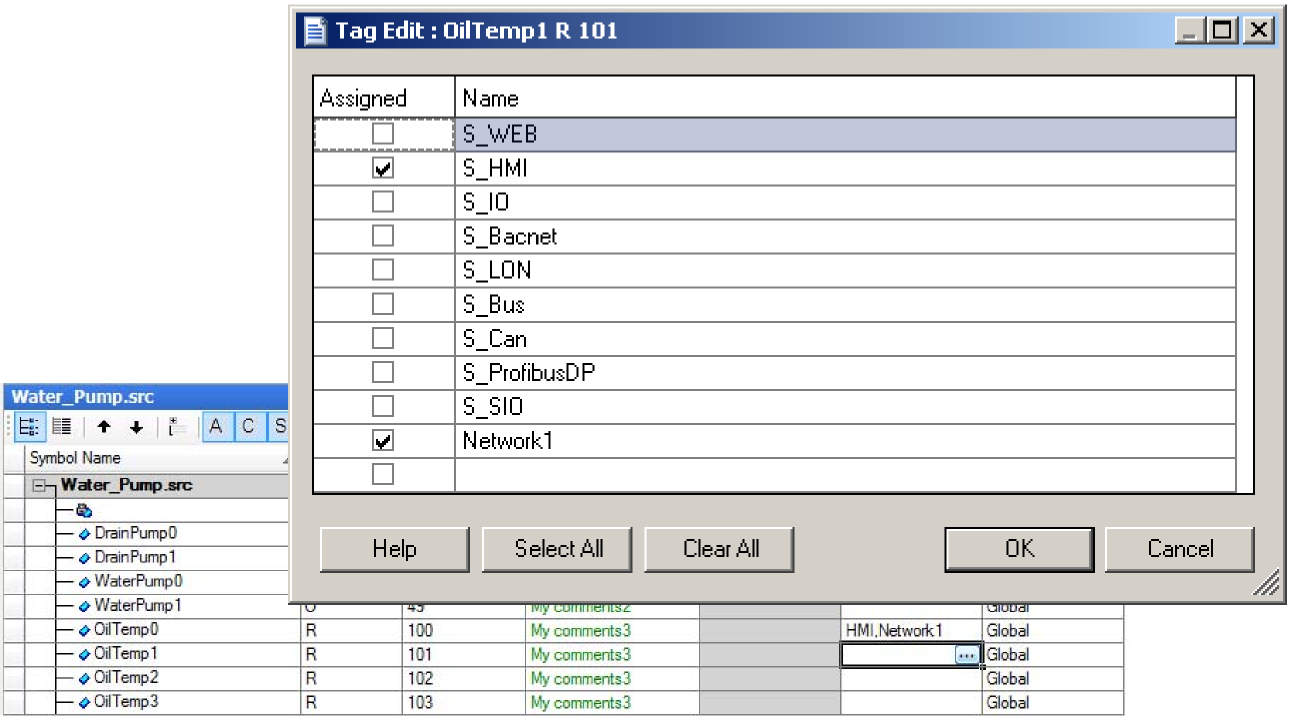


	A	B	C	D	E
1	SYMBOLNAME	TYPE	ADDRESS	COMMENT	
2	PumpsPrg	COB	0	Pumps Program	
3	Input0	I	0	And gate Input0	
4	Input1	I	1	And gate Input1	
5	Input2	I	2	And gate Input2	
6	Input3	I	3	And gate Input3	
7	Output0	O	32	Result of Input 1 and 2	
8	Output1	O	33	Result of Input 2 and 3	
9					
10					

5.3.18 Symbol Tags

Tags can be used to mark symbols by common functionality like Network, HMI, and Supervision Symbols etc. New tags are assigned to symbol from check list box. New tags can be added from tag cell. Tags can be used to filter common symbols in a same view. That makes them useful to export selected common symbols to other application like Excel or .rxp

Tags have no influence on the program; this is just a tool to manage the symbols. To edit tag select cell and enter one or several Names separated by comma or open the dialog box.



Tag Edit : OilTemp1 R 101

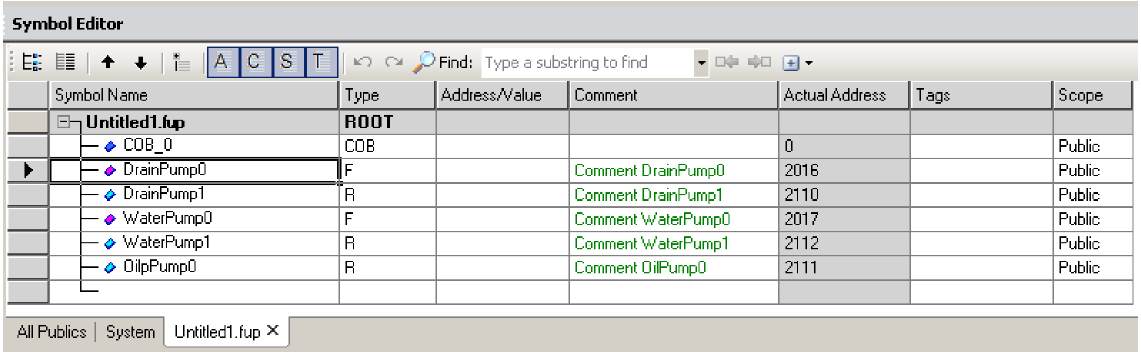
Assigned	Name
□	S_WEB
☑	S_HMI
□	S_IO
□	S_Bacnet
□	S_LON
□	S_Bus
□	S_Can
□	S_ProfibusDP
□	S_SIO
☑	Network1
□	

Water_Pump.src

Symbol Name						
Water_Pump.src						
DrainPump0						
DrainPump1						
WaterPump0						
WaterPump1						
OilTemp0	R	100	My comments3		HMI,Network1	Global
OilTemp1	R	101	My comments3			Global
OilTemp2	R	102	My comments3			Global
OilTemp3	R	103	My comments3			Global

5.3.19 Actual Address

After build Actual Address column displays the dynamic symbols addresses. Dynamic address space for each type of data is defined in *Build Options* of Project manager



Symbol Editor

Symbol Name	Type	Address/Value	Comment	Actual Address	Tags	Scope
Untitled1.fup	ROOT					
COB_0	COB			0		Public
DrainPump0	F		Comment DrainPump0	2016		Public
DrainPump1	R		Comment DrainPump1	2110		Public
WaterPump0	F		Comment WaterPump0	2017		Public
WaterPump1	R		Comment WaterPump1	2112		Public
OilpPump0	R		Comment OilPump0	2111		Public

5.3.20 Initialization of symbols

There are two ways to initialise symbols used by the PCD:

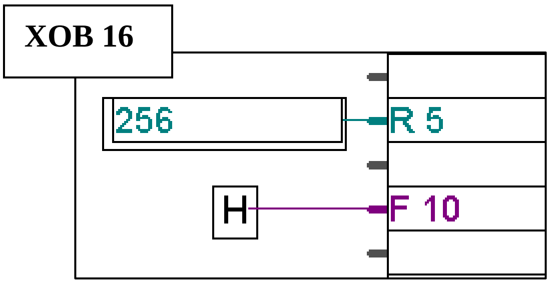
- initialization during a PLC coldstart (power-up)
- initialization when the program is downloaded into the PCD

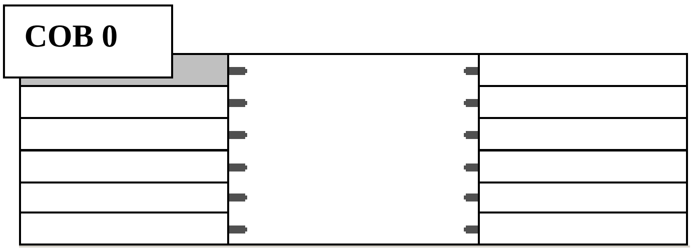
During coldstart
The initialization of symbols during a coldstart is done in XOB 16. This function block is processed only once, during a PCD coldstart. The user writes IL code to initialize symbols in XOB 16.

Example: initialisation of a flag and a register during a PCD coldstart

Program in IL **Program in Fupla**

```
XOB  16       ;Coldstart block
LD   R 5      ; R 5 = 256
     256
SET  F 10     ;F 10 = 1

EXOB

COB  0        ;Cyclic block
     0
…
;Your program
…
ECOB
```

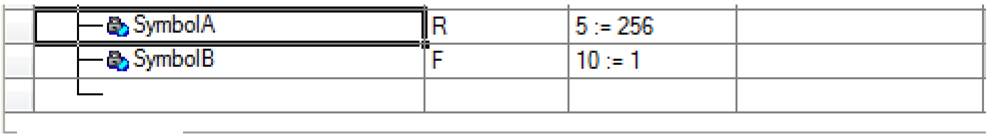




For more detailed information about COB and XOB blocks, please consult Chapter 7 of this document.

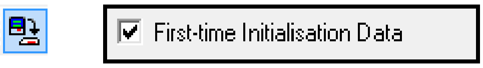
When downloading program
To initialise a symbol when the program is being downloaded to the PCD, the symbol address should be followed by **:=** (colon equals), which is in turn followed by the initialisation value.

Example:



SymbolA	R	5 := 256	
SymbolB	F	10 := 1	

Be careful
Remember to tick the following option when downloading the program:



☑ First-time Initialisation Data

5.3.21 Reserved words

The following words are reserved, and cannot be used as symbol names:

- Assembler instructions : PUBL, EXTN, EQU, DEF, LEQU, LDEF, MACRO, ENDM, EXITM…,
- Codes de commande et notations abrégées des différents types de données du PCD : I, O, F, R, C, T, K, M, COB, FB, TEXT, X, SEMA, DB,
- Special instructions MOV : N, Q, B, W, L, D,
- Conditional codes : H, L, P, N, Z, E,
- All instructions mnémonics,
- Symboles prédéfinis,
- Internal symbols reserved to the automatic resources allowance,begin with an underlined char. Example: ______TEXT, _________F
- Intern symbol __CSTART__, used with $$.

5.3.22 Errors and Warnings

Warnings and errors are displayed incase of non-acceptable entries are made to symbol editor. Following are couple of examples.

Too Short Symbol Name:

When only one character is entered as symbol Name, editor gives an error as ‘symbol Name too short (min. 2 Characters)’

Duplicate symbol Names:

When new Public symbol is added with the Name which is already used by another Public symbol then editor displays the error and both symbols goes red.

When new Local symbol is added with the Name which is already used by another Local symbol in same module/file then editor displays the error and both symbols goes red

When new Local symbol is added with the Name which is already used by Public symbol then editor displays a warning.

To eliminate these errors or warnings one of the symbols Name needs to be changed.

Contents

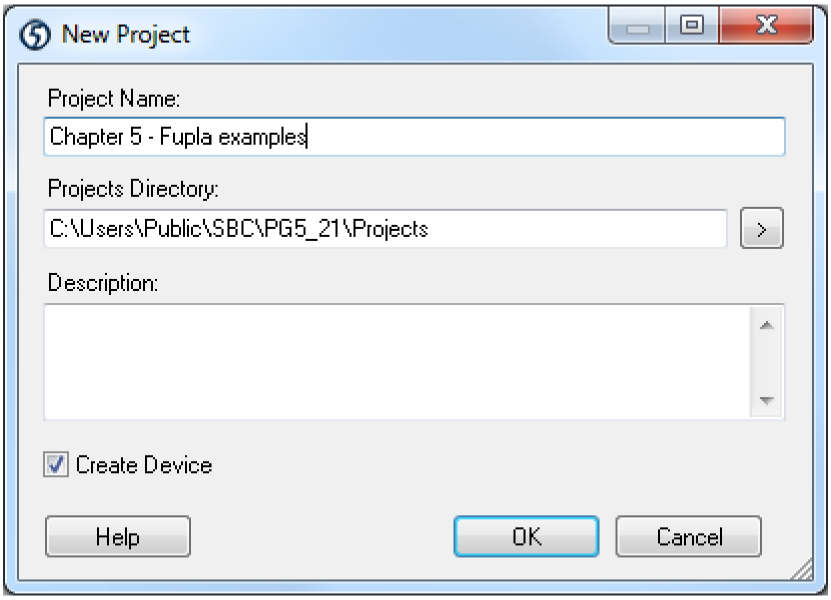
6 Programming with Fupla

The *Saia PG5 Fupla Editor* is the simplest, fastest introduction to programming Saia PCD controllers. The name "Fupla" means "*FUnction PLAn*", a graphical programming environment in which the user draws programs with the aid of hundreds of pre-programmed function boxes. These functions are organized into libraries covering the basic applications, through to more specialized functions for certain professional applications. The special libraries include: a HEAVAC library for heating, ventilation and air conditioning; a modem library for networking PLCs to exchange data via telephone lines (analog, ISDN, GSM, GPRS); SMS messaging; paging and DTMF.
Other libraries for communications networks LON, EIB and Belimo products are also available.

The great advantage of Fupla lies in the fact that the user can put a PCD into service without having to write a single line of code, and without any particular programming knowledge.

6.1 Preparing a Fupla project

In the *Saia PG5 Project Manager* window, select the menu command *Project, New…* and create a new project.



New Project

Project Name: Chapter 5 - Fupla examples

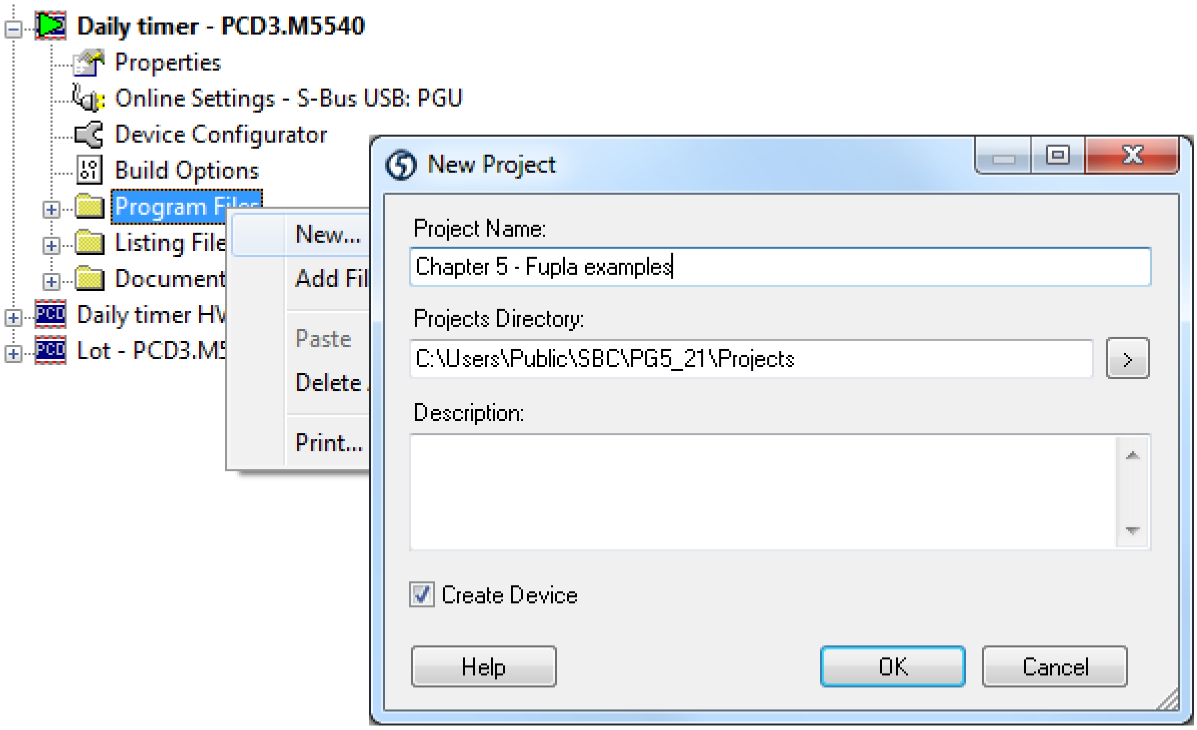
Projects Directory: C:\Users\Public\SBC\PG5_21\Projects

Description:

☑ Create Device

Next, create a new Fupla program file in the project by clicking on the *New File* button on the toolbar, or click the right-hand mouse button on the *Program Files* branch and use the *New File* command from the context menu:

New File



New Project

Project Name: Chapter 5 - Fupla examples

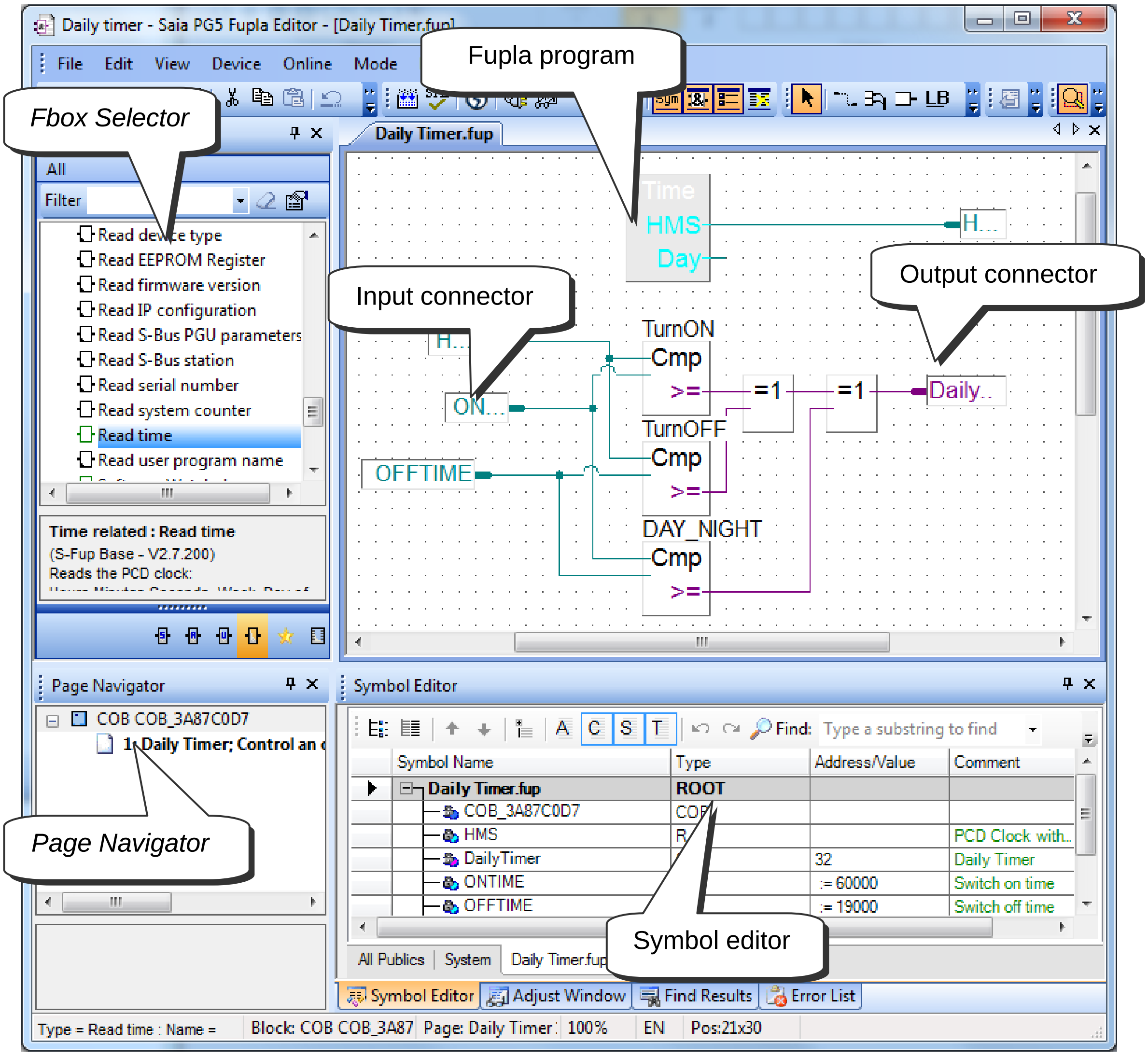
Projects Directory: C:\Users\Public\SBC\PG5_21\Projects

Description:

☑ Create Device

Select the file type *Fupla File*, and press OK to open the Fupla editor (S-Fup).

6.2 Layout of the Fupla window



Symbol Name	Type	Address/Value	Comment
Daily Timer.fup	ROOT		
COB_3A87C0D7	COB		
HMS	R		PCD Clock with..
DailyTimer		32	Daily Timer
ONTIME		:= 60000	Switch on time
OFFTIME		:= 19000	Switch off time

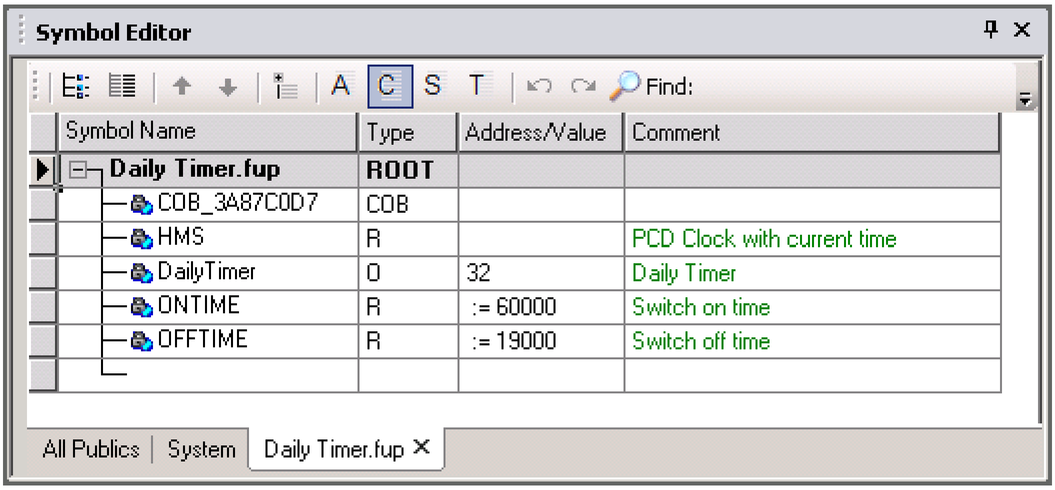
The PCD reads the data from the input connectors, evaluates it according to the program and writes the results to the output connectors. The symbols used by the program are all shown in the *Symbol Editor* window. Most data types are allowed in the input and output connectors, except *input* and *constant* types which cannot be used for outputs. Digital inputs and constants provide read-only data, and can therefore only be used at the input connectors.

In the middle of the page we have the program, made up of different graphical function boxes selected from the *FBox Selector* window. The "wires" represent the exchange of data between the different functions. The colour of these wires defines the type of data: purple for binary (Boolean) information, blue for integers and yellow for floating-point numbers. Data which is different in type or colour cannot be linked together without first being converted to a common type. (FBox family: *Converters*)

If the program uses several pages, the *Page Navigator* window allows pages to be deleted and helps you move around the program structure quickly.

6.3 Editing Symbols

Show Hide Symbol Editor



Symbol Name	Type	Address/Value	Comment
Daily Timer.fup	ROOT		
COB_3A87C0D7	COB		
HMS	R		PCD Clock with current time
DailyTimer	O	32	Daily Timer
ONTIME	R	:= 60000	Switch on time
OFFTIME	R	:= 19000	Switch off time

The *Symbol Editor* window contains a list of all the data used in the file. It can be viewed with the *Show/Hide Symbol Editor* button, or with the menu command *View, Symbol Editor*. The table has several columns:

Symbol Name

Each input, output, flag, register, etc. can be assigned a symbolic name. Names are easier to remember than numbers, and make it easier to understand what the data is for. Using descriptive symbol names makes program maintenance much easier.
The first character of a symbol name is always a letter, followed by other letters, numbers, or the underscore character. Avoid using accented characters (ö, è, ç etc). Differences of case (upper or lower) are not significant: MotorOn and MOTORON are the same symbol.

Type

The data type of the symbol: input (I), output (O), register (R), counter (C), timer (T), TEXT, DB, etc.

Address/Value

Each data type has its own range of valid addresses or values, for example:

Inputs/Outputs:	depends on I/O modules inserted in PCD	
Flags:	F	0…16383
Registers:	R	0…16383
Timers/Counters:	T/C	0…1599

…

Comment

The comment is linked to its symbol and can be displayed on the Fupla page. Place the mouse pointer over the connector to display its full symbol definition in a bubble.

```
STH    Flag                ;Copy the Flag state into the accu
⇨        STH    Flag                ;Control the incrementation
```

Scope

The *Scope* field defines the accessibility of the symbol. *Local* = the symbol is used only in the current file. *Public* = the symbol can be accessed from other files, where the symbol is declared as *Public*. *External* = the symbol is defined as *Public* in another file.

6.3.1 Adding a new symbol

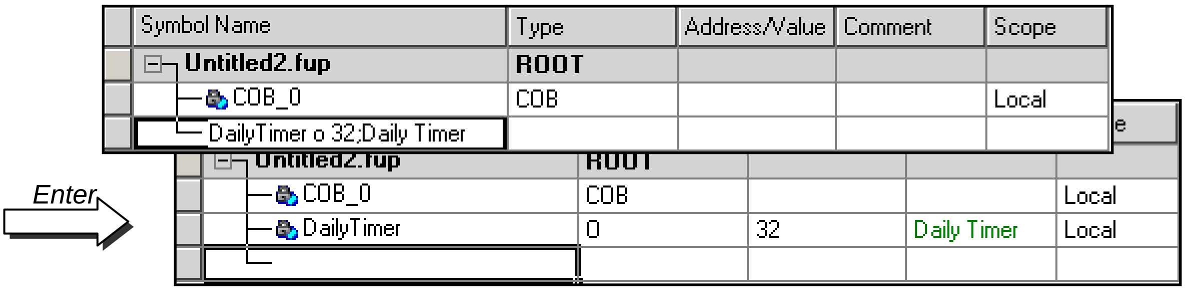
Simple method

To add a symbol to the list, open the *Symbol Editor* window. A free line is always available for entering new symbols. Select and complete each field *Symbol Name*, *Type*, *Address/Value, Comment and Scope*, press the *Tab* or *Enter* key to move to the next field.

Quick method 1

The entire definition can be entered in the *Symbol Name* field, which is much faster. Declare the symbol with this syntax the press Enter to automatically place the data in the correct fields:

symbol_name type address ***;****comment*

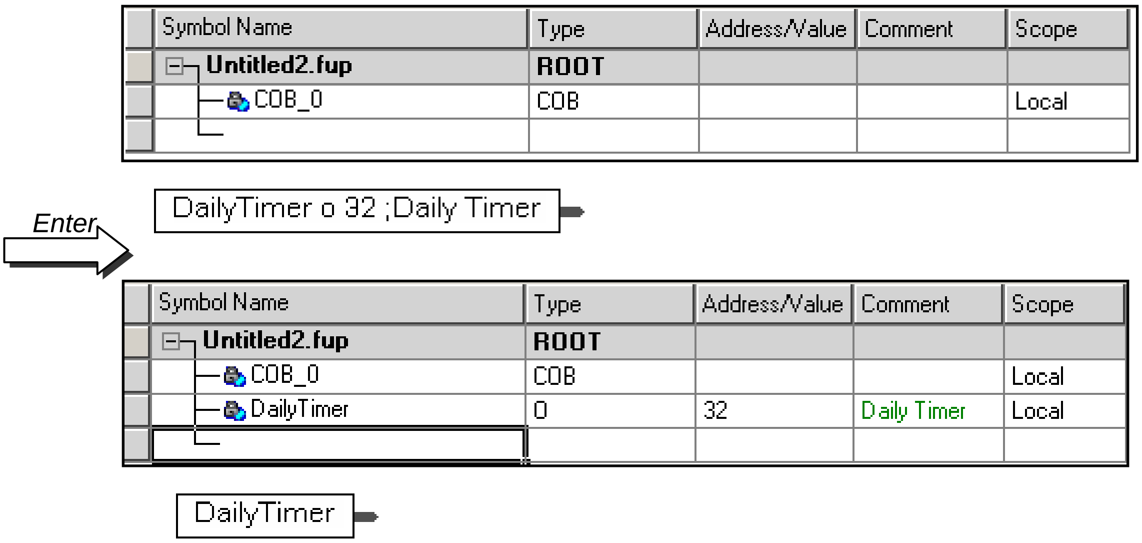


Symbol Name	Type	Address/Value	Comment	Scope
⊟ Untitled2.fup	ROOT			
COB_0	COB			Local
DailyTimer o 32;Daily Timer				

⊟ Untitled2.fup	ROOT			
COB_0	COB			Local
DailyTimer	0	32	Daily Timer	Local

Quick method 2

Use the same syntax when entering a symbol on the input or output connector of the Fupla page:



Symbol Name	Type	Address/Value	Comment	Scope
⊟ Untitled2.fup	ROOT			
COB_0	COB			Local

DailyTimer o 32 ;Daily Timer

Symbol Name	Type	Address/Value	Comment	Scope
⊟ Untitled2.fup	ROOT			
COB_0	COB			Local
DailyTimer	0	32	Daily Timer	Local

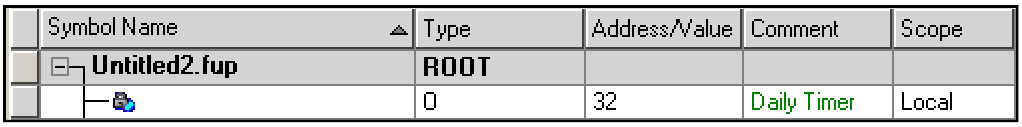
DailyTimer

If only the symbol name is entered in the Fupla page connector, it is added to the symbol table with a default type, and the details can be filled in later.

6.3.2 Symbol definitions

A symbol definition does not always need both a name and an address, but it must have a name and/or an address. This gives three types of symbol definition.

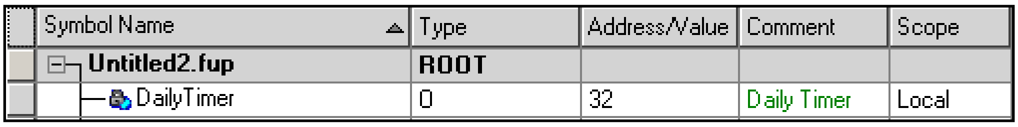
Absolute address only



Symbol Name	Type	Address/Value	Comment	Scope
Untitled2.fup	**ROOT**			
	0	32	Daily Timer	Local

The data is defined with only a *Type* and *Address* (e.g. 32), and an optional comment. Absolute addresses are OK for small test programs, or during development, but a final program should always have useful symbol names for all its data.

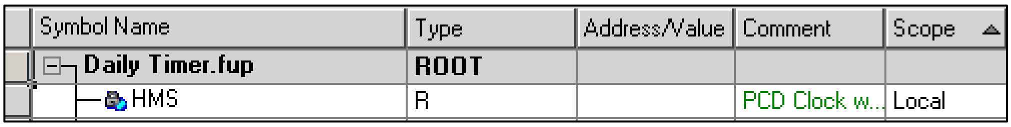
Full definition



Symbol Name	Type	Address/Value	Comment	Scope
Untitled2.fup	**ROOT**			
DailyTimer	0	32	Daily Timer	Local

The *Symbol Name*, *Type*, and *Address* are filled in, with an optional comment.

Dynamic addressing



Symbol Name	Type	Address/Value	Comment	Scope
Daily Timer.fup	**ROOT**			
HMS	R		PCD Clock w...	Local

If an actual address is not defined, the program *build* will assign an unused address from an address range defined from the device's *Build Options*, see Project Manager. The *Type* must always be defined.

Dynamic addressing can be used for flags, counters, timers, registers, texts, DBs, COBs, PBs, FBs and SBs. Inputs, outputs, XOBs and constants must always have a fixed address.

6.3.3 Using a symbol from the *Symbols* list in an Fupla program

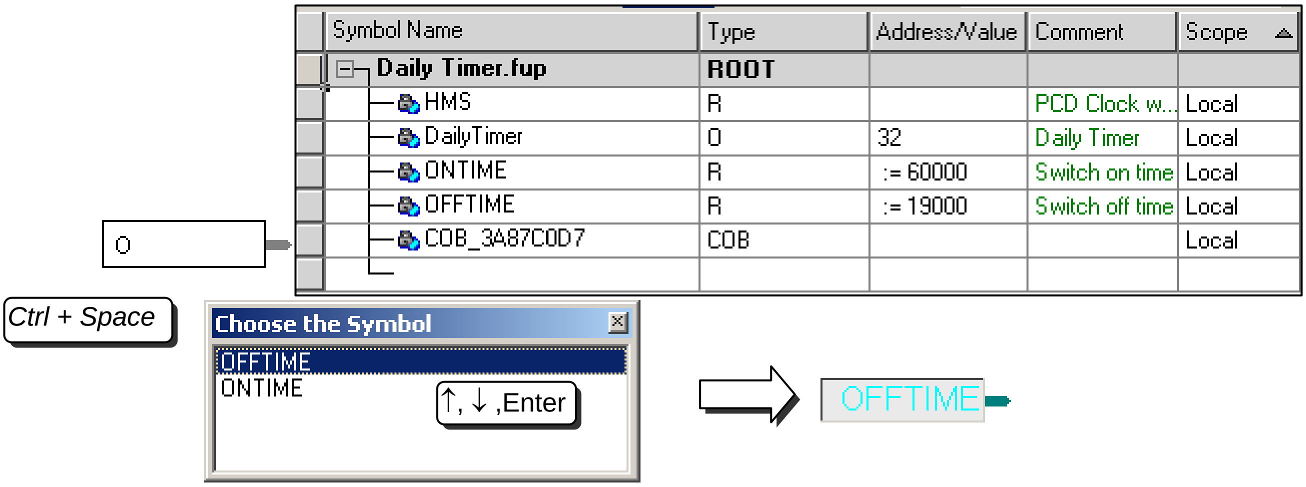
When a program is edited, symbols already defined in the *Symbol Editor* window can be used in different ways:

Symbol entry from the keyboard

The symbol name is entered into the page connector in full, using the keyboard. This method might allow a symbol name to be entered with a typing error, causinh a new symbol to be added to the symbol table.

Symbol entry by selective searching

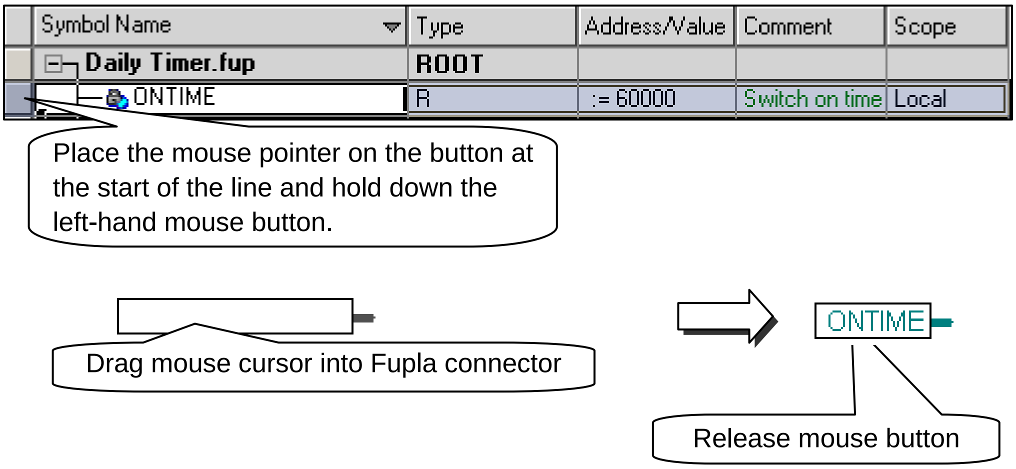
If only the first few characters of the symbol name are typed, the pressing the *Ctrl+Space* keys at the same time displays a window showing a list of all the symbols which start with the letters which have been typed. The required symbol can then be selected either with the mouse or the keyboard arrow keys (↑, ↓) and confirmed by pressing *Enter*.



Symbol Name	Type	Address/Value	Comment	Scope
Daily Timer.fup	ROOT			
HMS	R		PCD Clock w...	Local
DailyTimer	O	32	Daily Timer	Local
ONTIME	R	:= 60000	Switch on time	Local
OFFTIME	R	:= 19000	Switch off time	Local
COB_3A87C0D7	COB			Local

Symbol entry by drag-and-drop

This way of using a symbol excludes any possibility of typing errors. In the *Symbol Editor* window, place the mouse cursor over the button at the start of the symbol line, press the left mouse button and keep it down. Drag the mouse cursor over the empty connector and release the mouse button. The symbol name, or type/address, is copied into the connector under the mouse cursor.
You can also drag a symbol onto a free space on the Fupla page, and the connector and symbol are added automatically in a single operation.



Symbol Name	Type	Address/Value	Comment	Scope
Daily Timer.fup	ROOT			
ONTIME	R	:= 60000	Switch on time	Local

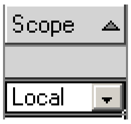
Place the mouse pointer on the button at the start of the line and hold down the left-hand mouse button.

Drag mouse cursor into Fupla connector

Release mouse button

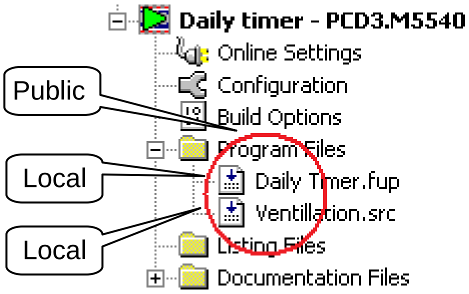
6.3.4 Local, Public and External symbols

The view with the symbols definition includes a Scope cell to define the option: *Local*, *Public* or *External*.



Scope

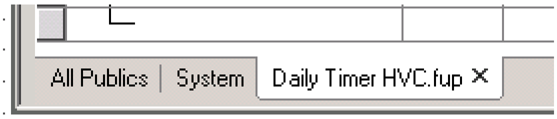
Local



A symbol's scope defines the accessibility of the symbol:

Local symbols are accessible only within the file which contains the symbol definition. For example, only inside *Daily timer.fup*.

Public symbols are accessible from all files in the *device*. For example, publics symbols are shared by both the files *Parking lot.fup* and *Ventilation.src* in device *Daily timer*, regardless of which file defines the symbol.



The Symbol Editor typically shows three views: a view with the name of the open Fupla file, two views called *ALL Publics* and *System*:

The view with the name of the open file allows the definition of all the locals and publics symbols used by the program of this file.

New symbols created in the Symbol Editor or the Fupla editor are by default either *Local* or *Public* depending on an option defined by Fupla's *View, Options, Symbols, Add symbols with Public scope.*

The *ALL Publics* view shows all publics symbols in the device. The *System* view shows all the system symbols. The symbols on the *ALL Publics* and *System* pages are updated when a file is saved or when a *Build* is done.

These pages use the results of the *Build* to gather all the publics and system symbols from all the files in the device's program and show them in a single view.

To place a public or system symbol into the program, select the symbol on the Public or System view and do a drag-and-drop of the symbol onto the Fupla page. The reference to the public symbol is placed into the file's symbols page with the scope *External*. This shows that the symbol is defined in another file.

The symbols on the *ALL Publics* page are not editable. Public symbol definitions can only be edited from the file which defines them. You can use the context menu's *Goto Definition* command to open the file which defines the symbol. The *File* column shows the name of the file which defines the symbol, this is the file which must be opened to modify the symbols.

6.4 Editing connectors

Input and output connectors can be placed anywhere on Fupla pages, and used to hold the necessary symbols for program functions described by FBoxes.

As a default, each new page may already provide margins with connectors on the left and right. If you prefer new pages not to appear with these connectors, so that you can place them yourself at your own convenience, please deactivate the corresponding option with menu: *View, Options…, Workspace, New pages with side connectors.*

To remove any connectors present on the left or right of the page, select menu: *Page, Remove Unused Connectors.*

To restore connectors to a blank page use: *Page, Add Side Connectors*.

6.4.1 Placing connectors

Add Connector

To add a connector and its symbol to a Fupla page, select the toolbar button *Add Connector* and position the mouse on the Fupla page. A ‘read’ input connector is added by clicking with the left-hand mouse button. A ‘write’ output connector is added by pressing the *Shift* key while clicking the left-hand mouse button. The connector you have just added is ready for entering a symbol, and a cursor is displayed inside the connector. If you don't want to edit the symbol inside the connector straight away, press the *Esc* key and place the next connector.

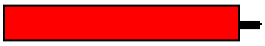
6.4.2 Editing a symbol inside connector

To edit or modify a connector symbol already present on the Fupla page, click on the connector once to select it, and a second time to open the field for editing. A cursor is displayed inside the connector, and it's now possible to enter the symbol definition.
Note that newly entered symbols are automatically added to the *Symbol Editor* window if they are not already there.

6.4.3 Quick way to place a symbol and its connector

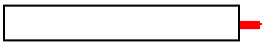
Symbols already present in the *Symbol Editor* window can be dragged onto a free space on the Fupla page. This will create a new connector containing the symbol.
If the symbol is dragged onto an FBox input or output, an input or output connector will be created and linked directly to the FBox.

6.4.4 Drag, Copy/Paste, Delete symbol



Selecting the area shown in red will only affect the symbol. It is possible to select the symbol with the mouse and drag, copy/paste it to another connector, or delete it. The right-hand mouse button will display a context menu with all available operations.

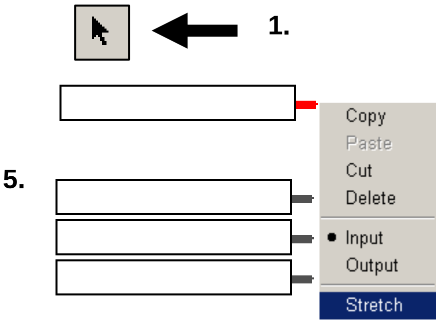
6.4.5 Copy/Paste, Delete connector



Selecting the area shown in white affects the connector and the symbol it contains. The right-hand mouse button will display a context menu with all available operations.

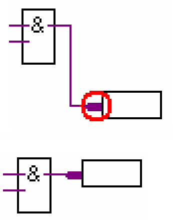
6.4.6 Stretch connectors

Connectors are stretchable. This means that the number of connectors can be defined by vertical movement of the mouse.



Press toolbar button: *Select Mode*
Select connector on area shown in red.
Display context menu by right-clicking mouse.
Selection menu: *Stretch*
Move the mouse vertically to create the
Desired number of connectors
Press the left-hand mouse button.

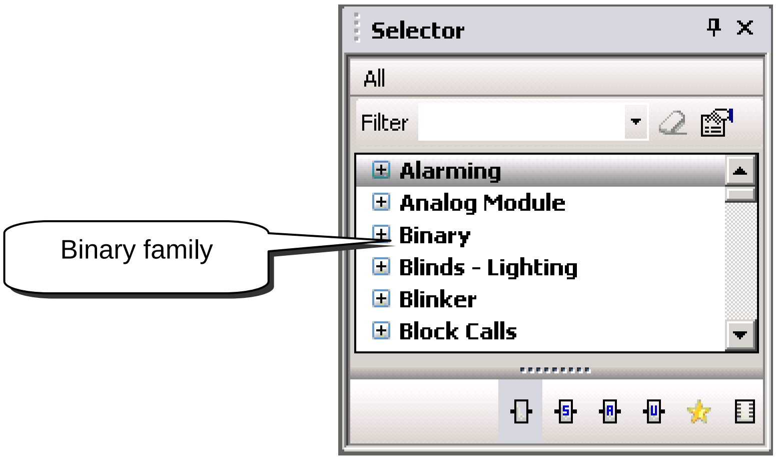
6.4.7 Move connector vertically



To move the connector, place the mouse in the red circle.
Press and hold down the shift-key.
Press and hold down the left-hand mouse button.
Drag the mouse vertically onto a free space on the page.
Release mouse button and shift-key.

6.5 Placing a Fupla function box

6.5.1 FBox selector



Show/Hide Selector Window

The FBox *Selector* window shows all FBoxes defined in the available FBox libraries. They are orginized into *Familes* with similar application domains. For example, here are some of the main families:

Binary	FBoxes for solving logical equations
Integer	Arithmetic with integer numbers
Floating Point	Floating point arithmetic
Counter	Counting tasks
Time related	Time-related tasks
Analogue Module	Controlling analogue modules
Communication	Exchanging data on S-Bus or Ethernet networks
Converter	Converting binary to integer, integer to floating point, etc.

…

The FBox libraries provide almost all the operations ever needed by a program. There are a many *Families* and *FBoxes*, and it may be difficult to find the right one. Various search facilities have been provided to help you.

If an FBox family is selected, pressing a letter key scrolls to the next family name which begins with that letter. If a family branch is open, pressing a letter key scrolls to the next FBox name in that family which begins with that letter.

The *Selector* window's toolbar has a *Filter* field where a filter string can be entered. For example, type ADD and press the *Enter* key, the *Selector* window will now show only the FBoxes which contain the ADD keyword, which is Floating Point and Integer. To see all the FBoxes again, press the *Clear Filter* button.

Libraries

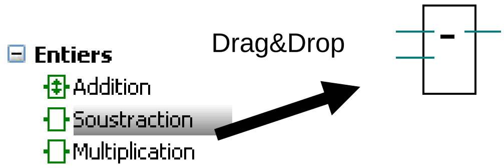
Project Manager's *Libraries* branch shows all the PG5's installed libraries, and libraries local to the current Project. Libraries which you don't want to use can be unchecked, which reduces the number of libraries shown in the *Selector* window.

Favorites

FBoxes which are regularly used can be added to a *Favorites* list. Select the FBox, open the context menu and use the *Add To Favorites* command.

To show the *Favorites*, press the ☆ button at the bottom ot the *Selector* window.

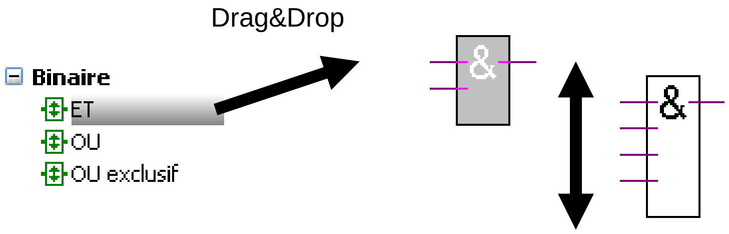
6.5.2 Adding an FBox



The functions needed for writing a program are selected from the FBox Selector, then inserted into the Fupla program using Drag&Drop.

6.5.3 Edit stretchable FBox

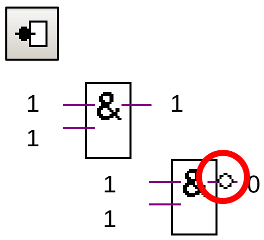
Some FBoxes are stretchable, which means that the number of links can be defined by dragging vertically with the mouse.



Select a stretchable FBox.
Drag&Drop onto the Fupla page.
Drag the mouse vertically until the correct number of inputs or outputs is shown.
Press the left mose button to finish

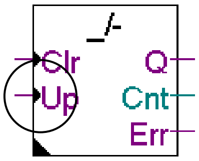
6.5.4 Edit logical inversion

Click on the *Invert Connector* button.
Position the mouse pointer on the input or output link of a logic function and press the left mouse button.



6.5.5 Triggering on a rising edge

The inputs of some binary FBoxes have been 'dynamized'. They only trigger on the rising edge of the signal. These are indicated by a little black triangle.

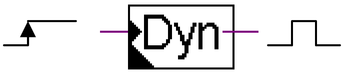


FBox: *Counter, Up with clear*

For example, a pulse counter cannot be incremented when its *Up* input is one.

Otherwise, what would happen if the *Up* signal remained at one for any amount of time? The counter would be continuously incrementing itself for as long as the *Up* signal remained one. It is for this type of application that certain digital inputs have been dynamized. Therefore, only the positive edge of a *Up* signal will increment the counter.

It is sometimes necessary to add dynamization to the input or output of an FBox. We then use the *Binary, Dynamize* function



6.5.6 Comments

Comments can be inserted anywhere on the page:

1. Click on the *Place comment* button
2. Position the comment field on the Fupla page, then press the left mouse button.
3. Write the comment.
4. Press the *Enter* key.

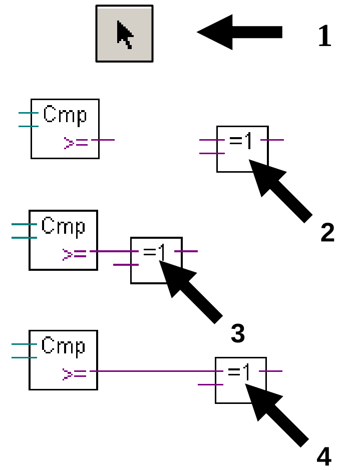
6.5.7 FBox Help

To obtain a full description of any function, select the FBox in the *Selector* window or on the Fupla page and then press the F1 key.

For rapid identification of an unknown FBox found in a program, open the *Selector* window, position the mouse pointer on the unknown FBox and single-click on the left mouse button. The *Selector* window will select the FBox.

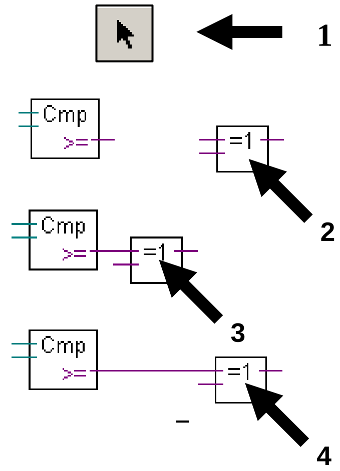
6.6 Links between FBoxes and connectors

6.6.1 Link by shifting FBox



1. Click on the *Select Mode* button on the toolbar.
2. Point onto the FBox, then press the left mouse button.
3. Keep pressing the mouse button as you drag the FBox towards a neighbouring FBox.
4. The FBoxes are linked as soon as the two connections touch.

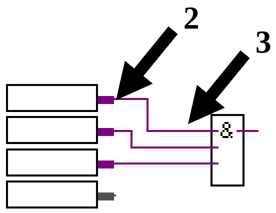
6.6.2 Link with automatic routing



1 Click on the *Line Mode* button on the toolbar.
2 Position the mouse pointer at the depart and click on the left mouse button.
3 Position mouse pointer on destination point and click the left-hand mouse button.

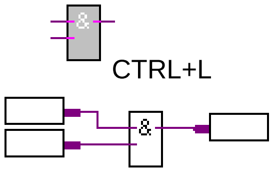
Note:
Intermediate points of passage can also be selected.
To interrupt link editing, press the right-hand mouse button.

6.6.3 Multiple link with automatic routing



1 Select menu *Mode, Connect Bus* or (CTRL+B).
2 Select a starting point with the mouse.
3 Then select the destination point

6.6.4 Link all inputs/outputs on an FBox to connectors



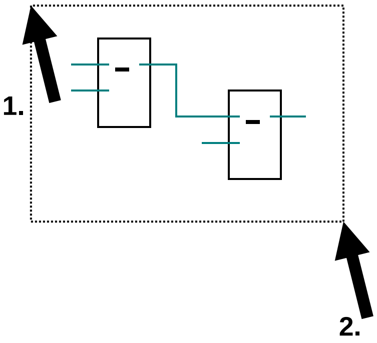
Place the mouse pointer over an FBox. Right-click to display the context menu: *Connections, Connect to Side Connectors.*

6.6.5 Delete lines, FBoxes, connectors or symbols

Select the *Delete Object* button on the toolbar, then select the links, FBoxes or symbols to delete.

Another, faster solution is to mark a space and delete it.

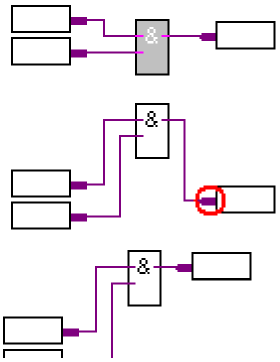
1 Press the mouse button.
2 Without releasing the button, drag the mouse.
3 Release the mouse button.
4 Select menu *Edit, Delete*



6.6.6 Move FBox/connector vertically without undoing links

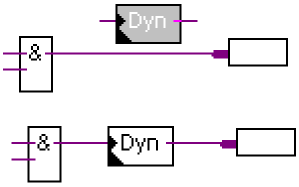
Position the mouse pointer over the FBox.
Press and hold down the shift-key.
Press and hold down the left-hand mouse button.
Drag the mouse vertically onto a free area on the page.
Release mouse button and shift-key.

To move the connector, position the mouse pointer in the red circle and repeat the sequence.



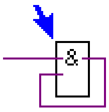
6.6.7 Insert FBox without undoing link

Select the FBox to insert in the window *Selector.*
Place it above the link.

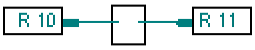


6.6.8 Rules to follow

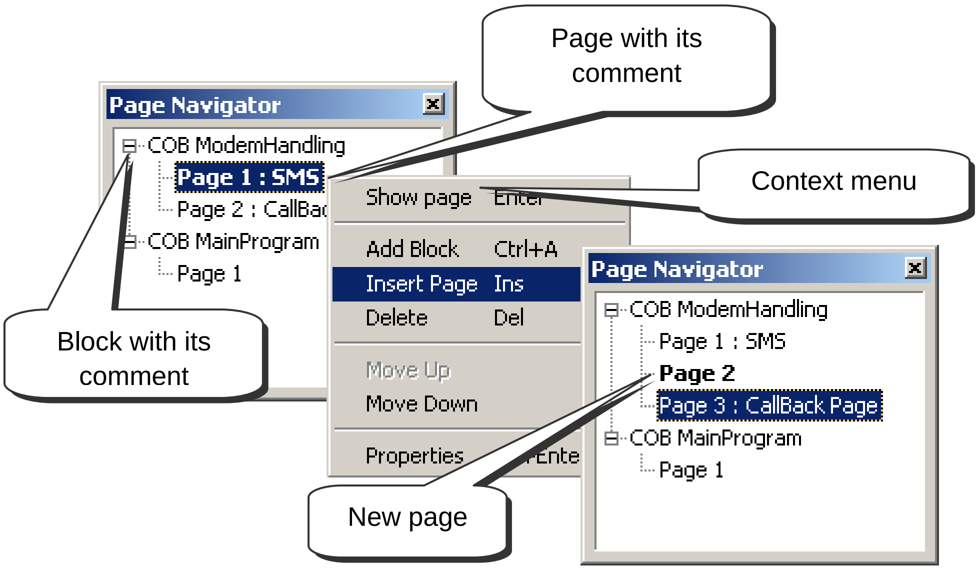
Loops are not allowed. If a loop is created, an error message will be displayed: *Page 1: Error 55: Loop back detected*



No direct links are allowed between input connectors and outputs connectors. An FBox must be used: *Binary, Direct transfer* or *Integer, Direct transfer.*



6.7 Editing Fupla pages



Show/Hide Page Navigator

The *Page Navigator* window shows the program's blocks and pages. Each Fupla file can hold up to 200 pages grouped into blocks: COBs, PBs, FBs, or SBs. But Fupla is faster if you don't have too many pages in a single file. By default, pages are put into a COB type block. For more detailed information about blocks and their use, please refer to the Program Structure section in this document.

6.7.1 Insert page

Insert Page

Open the *Page Navigator* window, mark the reference page and select *Insert Page* from the context menu*.*

It is also possible to insert a page after the current page with the *Insert Page* button or the menu item: *Page Insert After (Page Insert Before)*

6.7.2 Delete a page

Open the *Page Navigator* window, mark the page to be deleted and select *Delete* from the context menu.

6.7.3 Page navigation

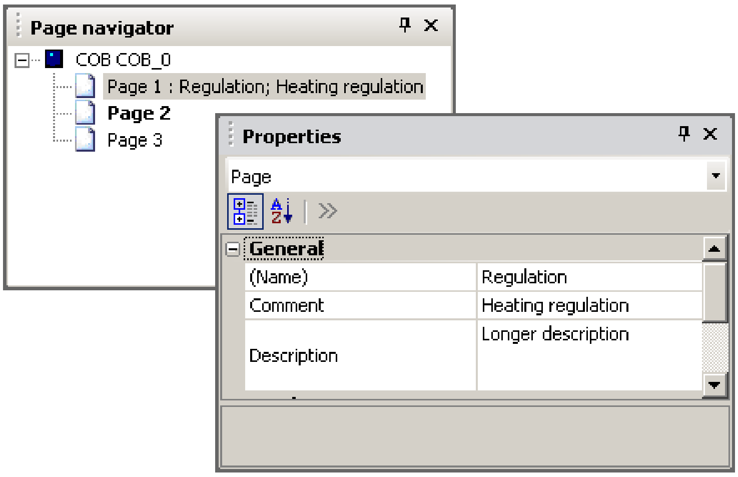
It is also possible to navigate with the *Go to Previous Page* and *Go to Next Page* buttons, allowing movement from page to page in a Fupla block. If either of the buttons is grey, you are already on the first or last page of the block.

Goto Next Page

6.7.4 Page documentation

You are strongly advised to document each of your Fupla pages. This is very useful when navigating through the pages of your program, because page names and comments will be displayed in the *Page Navigator* window. The description is a way of leaving some useful information about the program that will make it easier to maintain.

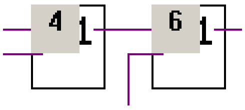
To display the *Properties* page, select the page in the *Page Navigator*, open the context menu and use the *Properties* command.



(Name)	Regulation
Comment	Heating regulation
Description	Longer description

6.7.5 Processing of program by the PCD

The PCD processes the pages of each block from the top left of the first page to the bottom right of the last page. For more precise details on the order in which FBoxes are processed by the PCD, select menu path: *Page, Show FBox priorities*

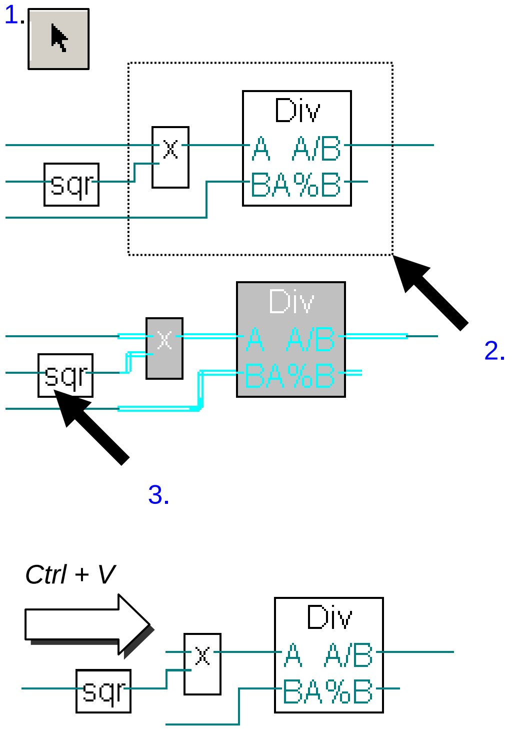


6.8 Copy and paste

Certain parts of a program may be repetitive. It is not necessary to edit them again in full. It is much faster to duplicate them by copying and pasting, and then adapt them as required.

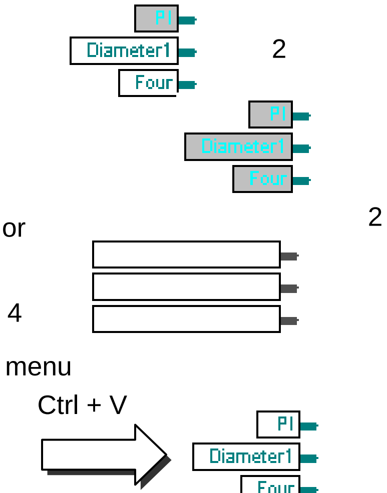
6.8.1 Copy/paste part of a program

1. Click on the Select Mode button.
2. Mark the area to be copied:
   - Press the left mouse button.
   - With button still pressed, slide mouse.
   - Release left mouse button.
3. Add an FBox or connection to the selection:
   - Press the *Ctrl* key.
   - Keeping the *Ctrl* key down, select the connectors and FBoxes to add.
4. Copy the selection with the *Edit Copy* menu path, or with the *Ctrl+C* keys.
5. Paste a copy of the selection with the *Edit Paste* menu path, or the *Ctrl+V* keys.
6. Position the copy on the Fupla page:
   - Position mouse pointer in middle of copy.
   - Press left mouse button.
   - With button still pressed, slide mouse.



6.8.2 Copy and paste symbols

1. Click on the *Select Mode* button.
2. Mark a list of symbols:
   - Position mouse pointer on first symbol.
   - Left-click with mouse.
   - Position mouse pointer on last symbol.
   - Press *Shift* key. *⁾
   - Keeping *Shift* key down, left-click with mouse.
3. Copy the selection with the *Edit Copy* menu path, or with the *Ctrl+C* keys.
4. Position the mouse pointer on a free part of the margin.
5. Paste a copy of the selection using the *Edit Paste* menu path or the *Ctrl+V* keys..

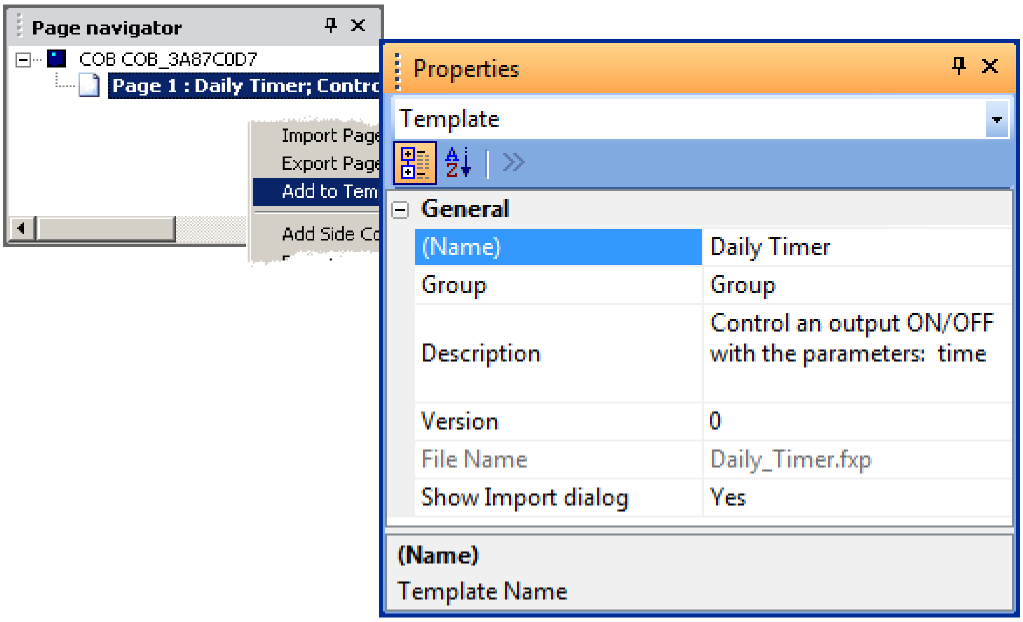


*⁾ The *Ctrl* key allows non-consecutive symbols to be selected.

6.9 Templates

Fupla pages can be saved as a *Template* which can be used like a library of pages.

6.9.1 Creating a template

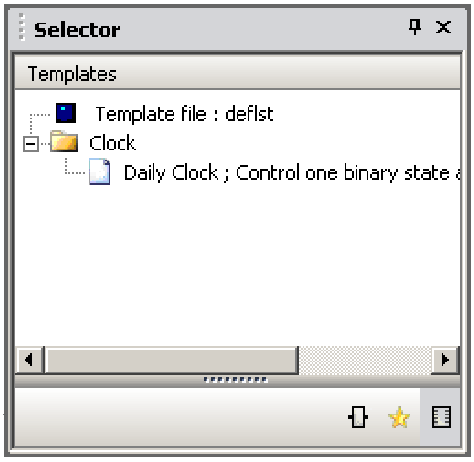


(Name)	Daily Timer
Group	Group
Description	Control an output ON/OFF with the parameters: time
Version	0
File Name	Daily_Timer.fxp
Show Import dialog	Yes

(Name)
Template Name

It is easy to create a *template*. Use the *Page Navigator* window to select one or more pages, the execute the context menu command *Add To Templates*. A dialog box will ask for a group, a name and a comment for the *template*.

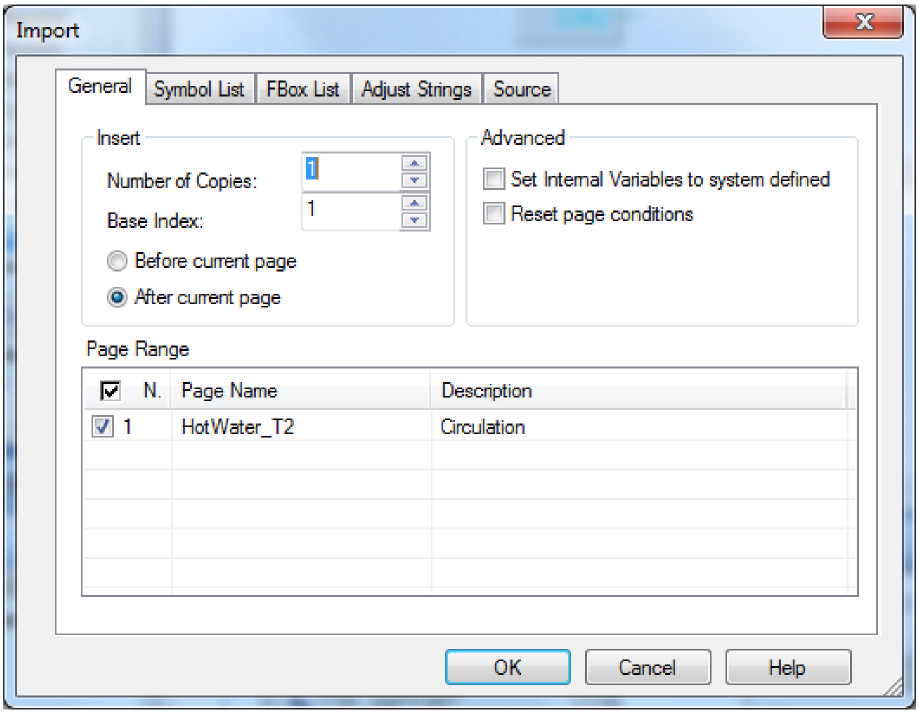
The *template's* Group is similar to the FBox *Family*. The group organizes the templates according to the classification defined by the author. The group name defines the tree structure of the *Templates* selector window.



6.9.2 Importing templates

Templates can be re-used in any projects. Select the template in the *Template Selector* window and drag it onto a Fupla page to insert the sequence of pages with their FBoxes, links, symbols, adjust parameters etc., into the file.

A dialog box is displayed which allows the changing of names and addresses of imported symbols and other parameters. This functionality is similar to a macro or



Number of Copies: 1

Base Index: 1

○ Before current page

● After current page

□ Set Internal Variables to system defined

□ Reset page conditions

☑	N.	Page Name	Description
☑	1	HotWater_T2	Circulation

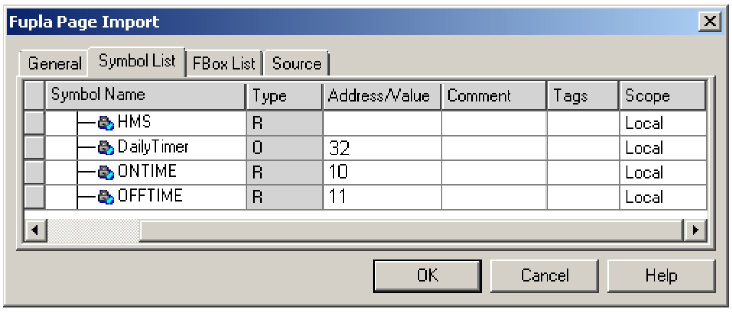
Number of Copies, Base Index
If several copies of the same template are needed, define the number of times the template will be inserted and the base index which will be appended to the symbol and group names.

Before/After current page
Imports the sequence before or after the page currently active in Fupla.

Set Internal Variables to system defined
Some FBoxes have *Adjust Variables* whose name is defined by the user or by the system (*Static symbols*). This setting allows you to keep the addresses and static symbols defined by the author, or to restore dynamic addressing and internal symbols by default.

Reset page conditions
A Fupla page's *Properties* window allows the definition of an execution *Condition* for each page. This setting allows the conditions to be removed when the pages are imported.

Page Range
Allows the selection of individual pages to be imported, or all pages in the template.

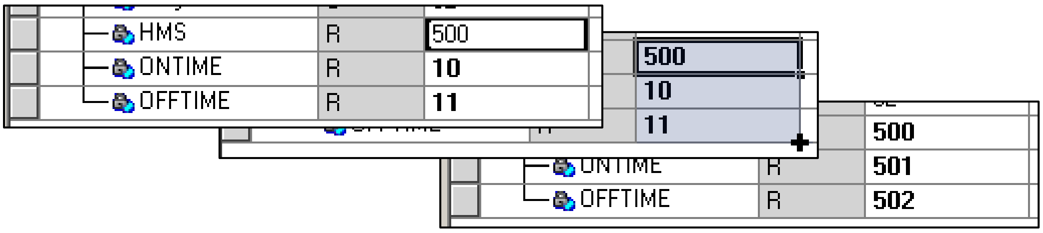


Symbol Name	Type	Address/Value	Comment	Tags	Scope
HMS	R				Local
DailyTimer	O	32			Local
ONTIME	R	10			Local
OFFTIME	R	11			Local

The *Symbol List* page shows all the symbol definitions and references which are imported with the template. It allows the symbols to be redefined with new names, addresses, comments and scopes.

Marking symbols for putting in a group is the fastest way to change the names of all the imported symbols. The context menu command *Insert Pre-group* puts the selected symbols into a group with the chosen name.

To change the addresses of symbols, sort them by type by pressing the column's header button *Type*. Select and edit the first address, and then drag the tiny square at the bottom right of the selected cell downwards until all the desired addresses are selected and release the mouse button. All selected addresses are renumbered starting from the first address.



If importing several copies of the same template, examine the parameters on the *General* page. It is useful to insert an index into the names of symbols or groups using the # character. This character is automatically replaced by the base index incremented by 1 for each copy of the template. It is also possible to select the symbols using the context menu command *Indexing*.

The *FBox List* page shows a list of all the FBoxes whose symbols are defined with a name. These names can also be modified using the # character.

6.10 Editing your first Fupla program

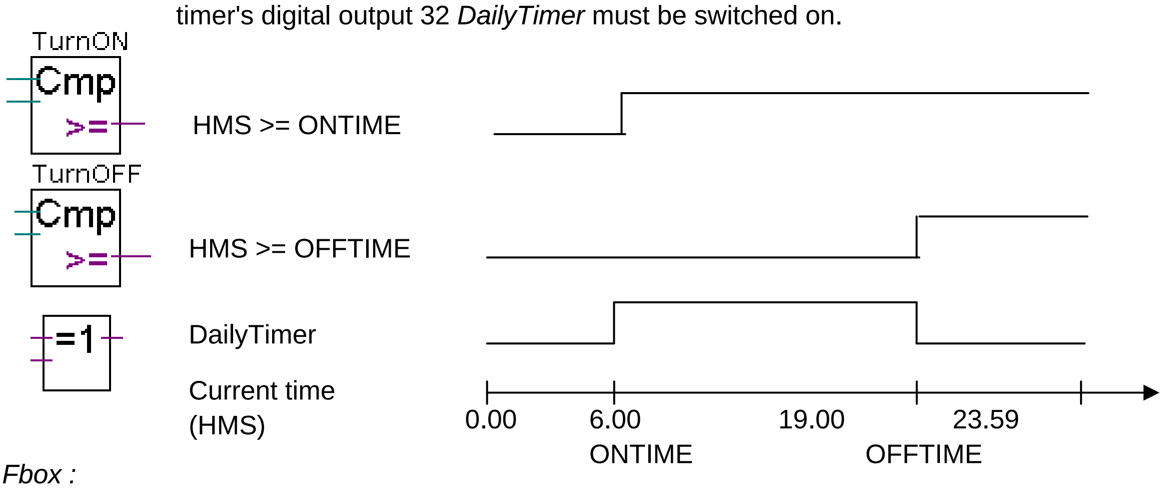
6.10.1 Objectives

Now that the working environment is known, the next step is to create a more complex program than the logic structures presented up to this point. We propose creating a daily timer to control a digital output (O 32) that comes on at 06.00 hrs and goes off at 19.00 hrs. Although this function is available with the HEAVAC library, we are going to reproduce it ourselves using standard FBoxes.

6.10.2 Solution

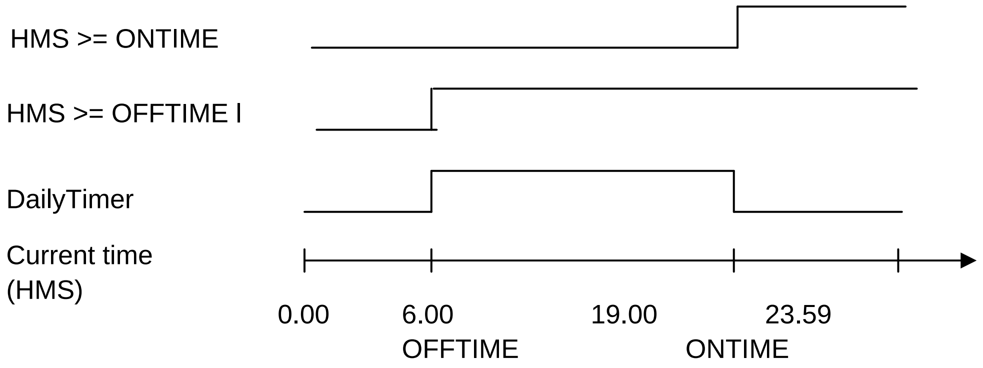
Before starting to program, a method must be found that will behave according to our specification document and that can be implemented with the most elementary functions possible.

For this timer example, we propose making two comparisons. The first will determine whether the current time in *HMS* (i.e. the time by our watches or PCD time) is greater than or equal to the turn-on time: *ONTIME*. The second will determine whether current time is smaller than or equal to the turn-off time: *OFFTIME*. If both comparisons are verified by an expression – an exclusive OR logic function – the timer's digital output 32 *DailyTimer* must be switched on.



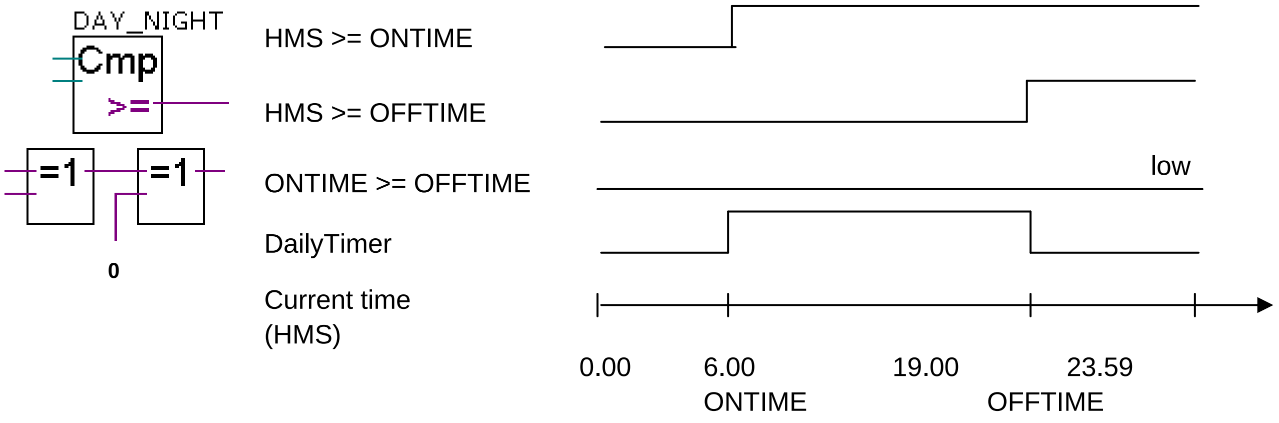
Fbox :
- Integer, Is greater or equal to
- Binary, Xor

This algorithm offers one solution, but it may leave some gaps. What happens if the turn-on and turn-off time instructions overlap? The following drawing demonstrates that the PCD output will be in the opposite state to that desired.

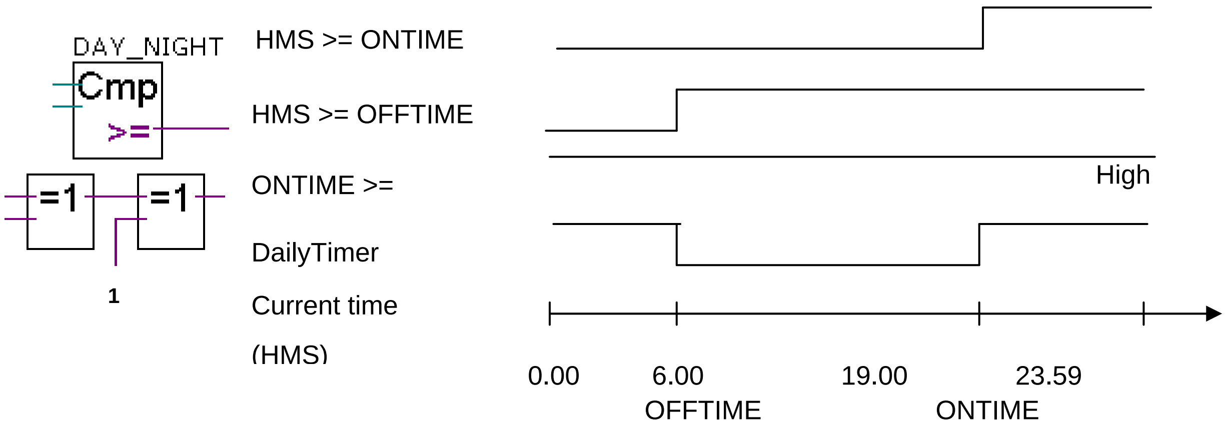


It is therefore necessary to complete our algorithm by adding a third comparison to determine whether the turn-on time is greater than or equal to the turn-off time. The final solution is therefore as follows.

Outputs active by day:

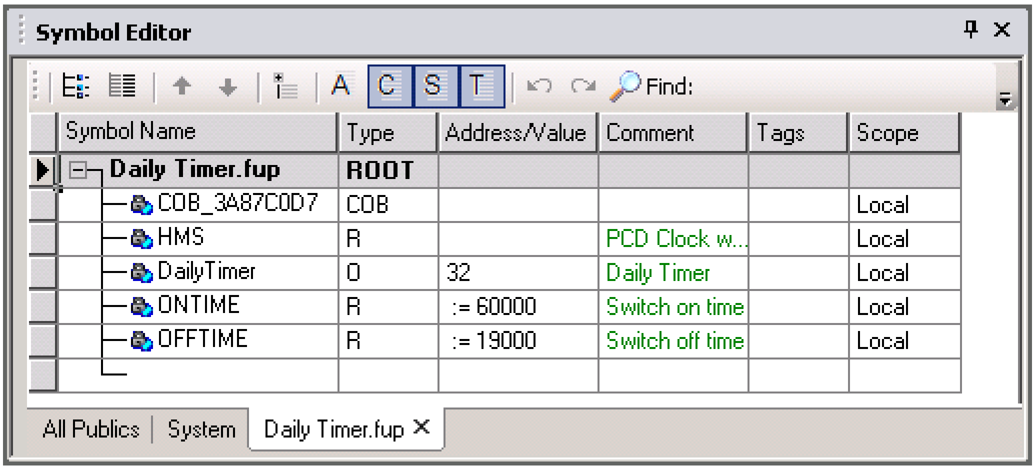


Outputs active by night:



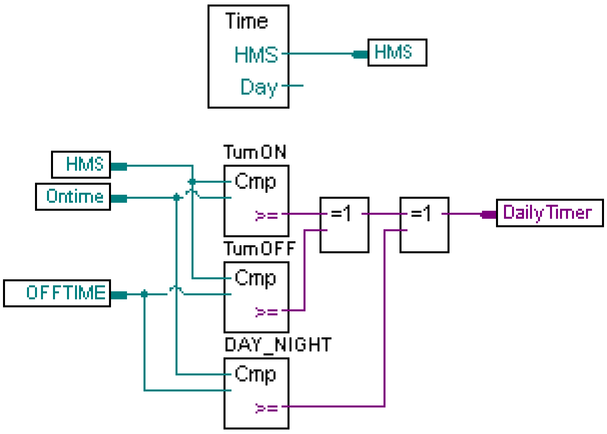
6.10.3 Programming

It is now time to move on to programming. At the beginning of this chapter we created a project with a file in it called: *DailyTimer.fup*. This is the file to which you will now write the present programming example.



Symbol Name	Type	Address/Value	Comment	Tags	Scope
Daily Timer.fup	**ROOT**				
COB_3A87C0D7	COB				Local
HMS	R		PCD Clock w...		Local
DailyTimer	O	32	Daily Timer		Local
ONTIME	R	:= 60000	Switch on time		Local
OFFTIME	R	:= 19000	Switch off time		Local

Start by creating the symbol list. Note that the current PCD time is saved in a dynamic HMS register. The address of this register has not been defined. The PG5 will automatically assign its address when the program is built.
The same applies for the turn-on and turn-off times (*ONTIME, OFFTIME)*, except that «:=60000» is not a register address, but the value with which it will be initialised when the program is downloaded to the PCD (:=60000 means 6 hours 00 minutes 00 seconds).
N.B.: A PCD cold start will not reinitialise these registers. They can only be reinitialised by downloading the program!



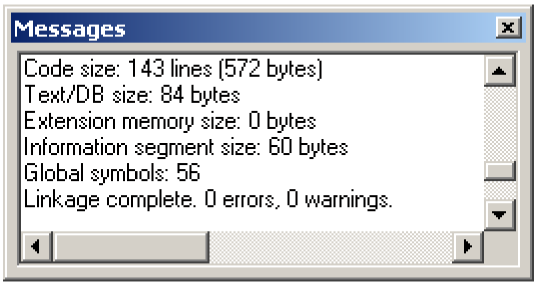
All the necessary FBoxes can be found in the *Selector* window:
- Time related, Read time
- Integer, Is greater or equal to
- Binary, Xor

6.11 Building the program

Build All

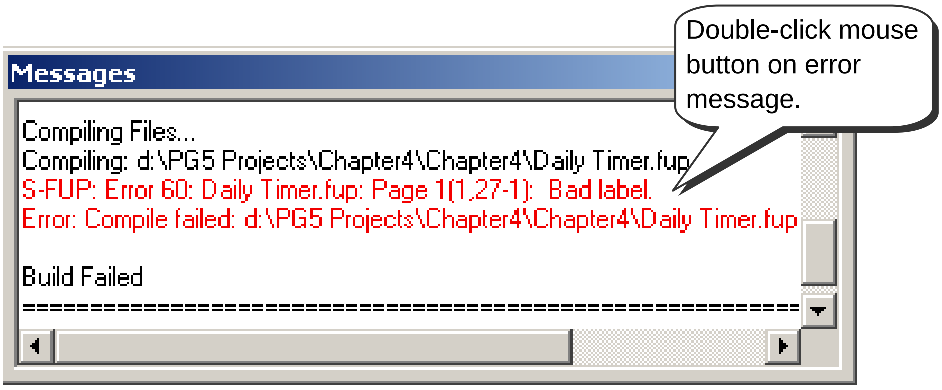
Before the fully edited program can be read and executed by the PCD, it must be "built" (or converted) using the command *Device, Build Changed Files* or *Rebuild All Files* from in the Project Manager or the Fupla editor.

The *Messages* window shows the results of various stages of the program build (Compiling, Assembling, Linking etc.). If the program has been correctly edited, the build function concludes with the message:
Build successful. Total errors: 0 Total warnings: 0



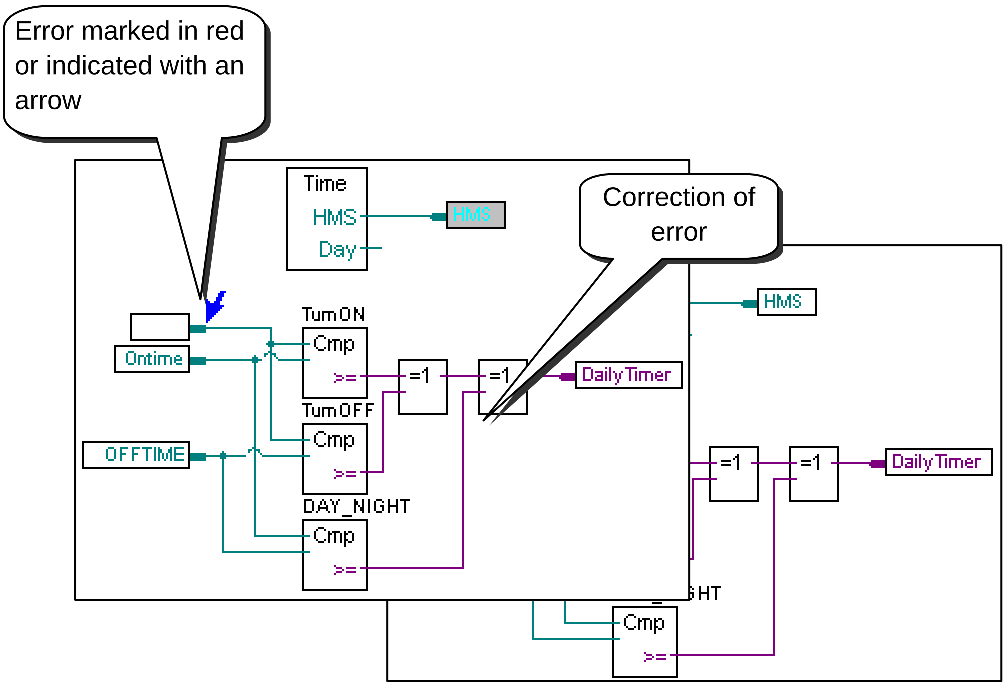
```
Code size: 143 lines (572 bytes)
Text/DB size: 84 bytes
Extension memory size: 0 bytes
Information segment size: 60 bytes
Global symbols: 56
Linkage complete. 0 errors, 0 warnings.
```

Any errors are indicated with an error message in red. By double-clicking the mouse button, the error can easily be located in the user program.



```
Compiling Files...
Compiling: d:\PG5 Projects\Chapter4\Chapter4\Daily Timer.fup
S-FUP: Error 60: Daily Timer.fup: Page 1(1,27-1):  Bad label.
Error: Compile failed: d:\PG5 Projects\Chapter4\Chapter4\Daily Timer.fup

Build Failed
================================================================
```

Double-click mouse button on error message.



Error marked in red or indicated with an arrow

Correction of error

6.12 Downloading the program into the PCD

Download Program

The user program is now ready. All that remains is to download it from the PC into the PCD. This is done with Project Manager's *Download Program* toolbar button or with menu command *Online, Download Program*.

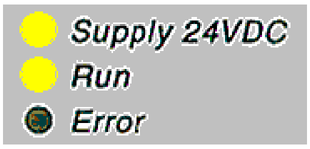
If any communications problems arise, check the *Online Settings*, and the PCD8.K111 or USB cable connection between PC and PCD, and make sure the PCD is powered up.

6.13 Finding and correcting errors (Debugging)

The first version of a program is not always perfect. A stringent test is always needed. The program can be tested using the same editor that was used to write the program.

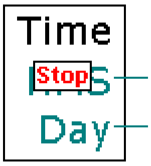
6.13.1 Go On/Offline – Run – Stop - Step-by-step

1. Press the *Go On /Offline* button
2. Start program with the *Run* button



At the same time, observe the Rum lamp on the front-panel of the PCD. The *Run* command turns on the Run LED and PCD starts executing the program.

3. When the *Stop* button is clicked, the *Run* lamp goes off and the PCD stops execution of the user program.
4. The PCD executes one FBox each time the *Step-by-step* button or *F11* key is pressed.



Observe the Stop marker which indicates the step-by-step progress of the program.

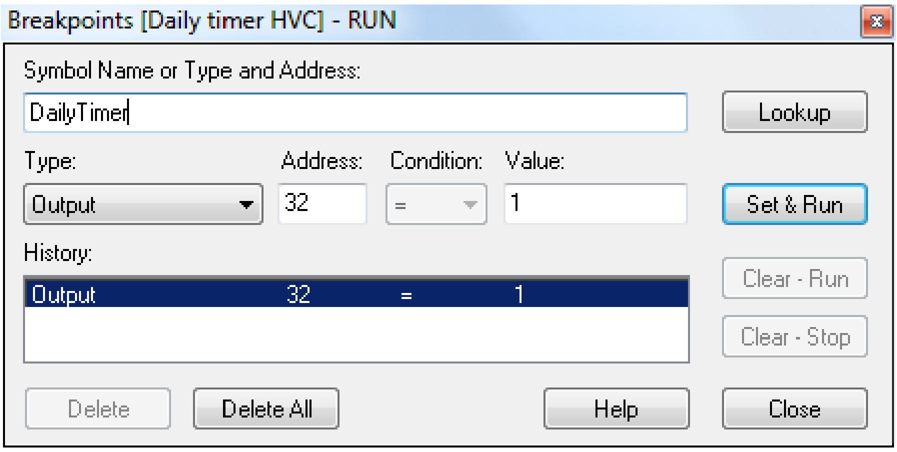
6.13.2 Breakpoints

Breakpoints let you stop a program at an event linked to one of its FBoxes, or to a symbol:
Low or high state of input, output, flag or status flag
Value in a register or counter

Breakpoint on a symbol's value

The stop condition can be defined via the menu *Online Breakpoints*.

Set or Clear Breakpoints



Breakpoints [Daily timer HVC] - RUN

Symbol Name or Type and Address: DailyTimer

Type: Output | Address: 32 | Condition: = | Value: 1

History:

Output	32	=	1

The above window is used to define symbol type and address/number. A symbol can simply be dragged from the Symbol Editor into the *Symbol Name* field, then the breakpoint condition and status/value are defined.

Pressing the *Set & Run* button will put the PCD into Conditional Run mode. The PCD’s *Run* LED will flash and its *Run* toolbar button alternates between green and red.

The PCD will automatically put itself in stop mode when the breakpoint condition is reached. For example, when an instruction modifies the output value, the status of 32 is high. The last FBox processed by the PCD is shown in red. It is possible to continue processing the program in step-by-step mode, or with another breakpoint condition.

If necessary, conditional Run mode can be interrupted:
The *Clear-Run* button forces the PCD into RUN mode. The PCD’s *Run* LED will come on the its *Run* button will be green.
The *Clear-Stop* button forces the PCD into Stop mode. The PCD’s *Run* LED will go out and its *Run* button will be red.

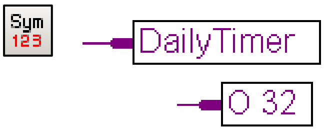
If a number of conditional breakpoints are defined, they will all be recorded in the *History* field. Any of them can then be selected with the mouse and activated with the *Set & Run* button.

Breakpoint on a program FBox

Select any FBox within the program, followed by the menu or button *Online, Run to, Fbox*, to make the program stop at the chosen FBox, and then continue in step-by-step mode.

6.13.3 Display symbols or addresses

The *Change Symbol/Resource view* button allows information from the connectors to be displayed with their symbols or addresses. If pressing it does not replace a symbol with its corresponding address, that symbol's address is assigned by the build.



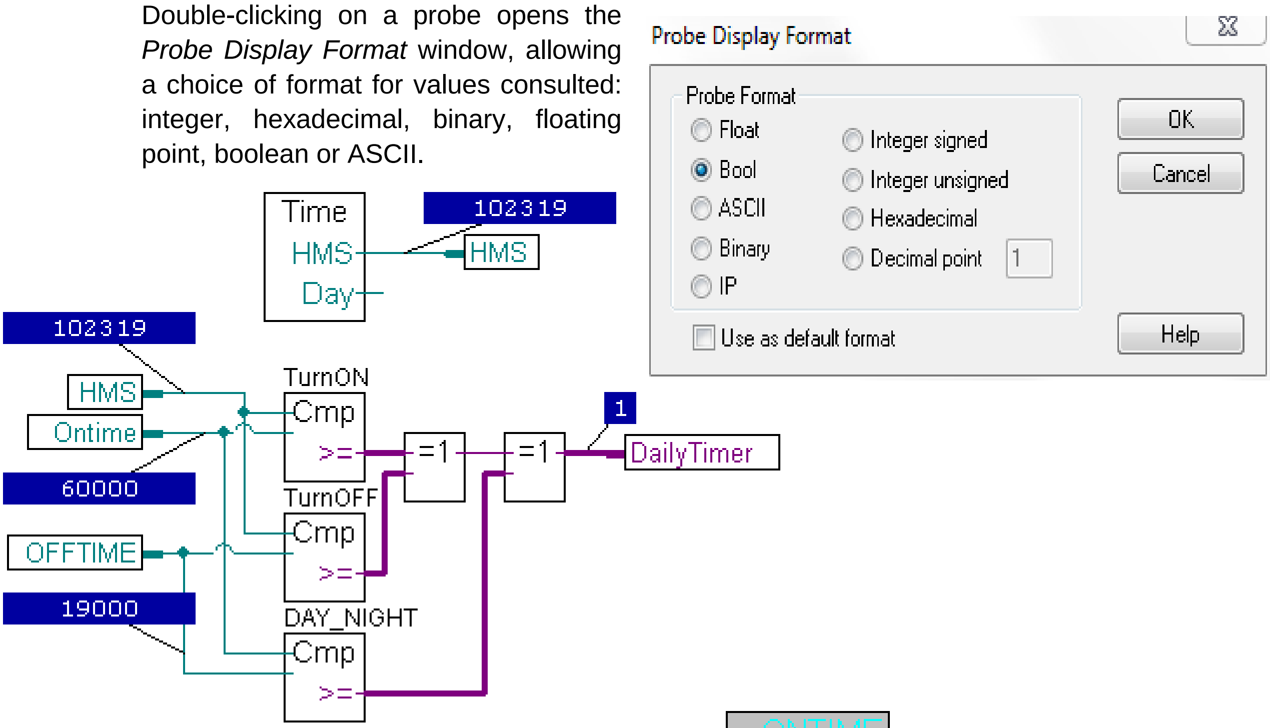
6.13.4 Display symbol state with Fupla

When the editor is Online and the PCD is in *Run* mode, each individual symbol used by the program can be displayed:

Add Probe

The logical state of a binary value is shown with a heavy or fine line (heavy = 1 and fine = 0). Other data values can be seen by pressing the *Add Probe* button to connect a probe to a line.

Double-clicking on a probe opens the *Probe Display Format* window, allowing a choice of format for values consulted: integer, hexadecimal, binary, floating point, boolean or ASCII.


Probe Display Format

Probe Format

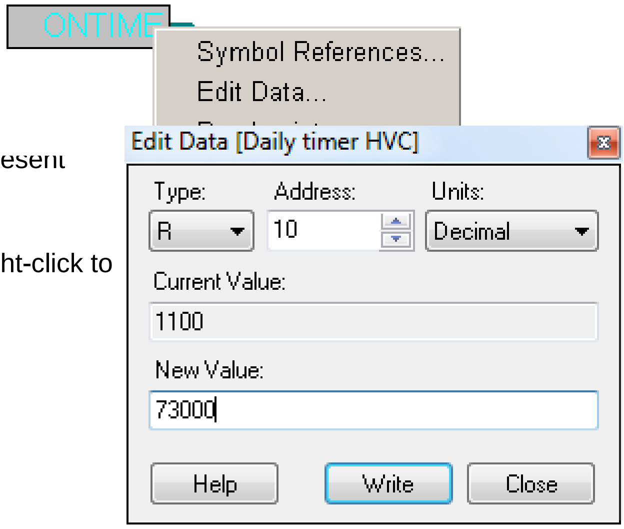
○ Float ○ Integer signed
● Bool ○ Integer unsigned
○ ASCII ○ Hexadecimal
○ Binary ○ Decimal point 1
○ IP

□ Use as default format

6.13.5 Editing symbols online

When checking program behaviour under certai helpful to change the states/values of symbols presen in the input connectors.

Select an input connector with the mouse and right-click to display the context menu.
The *Edit Data* context menu lets you modify the state/value of a symbol inside a connector or the *Symbol Editor.*

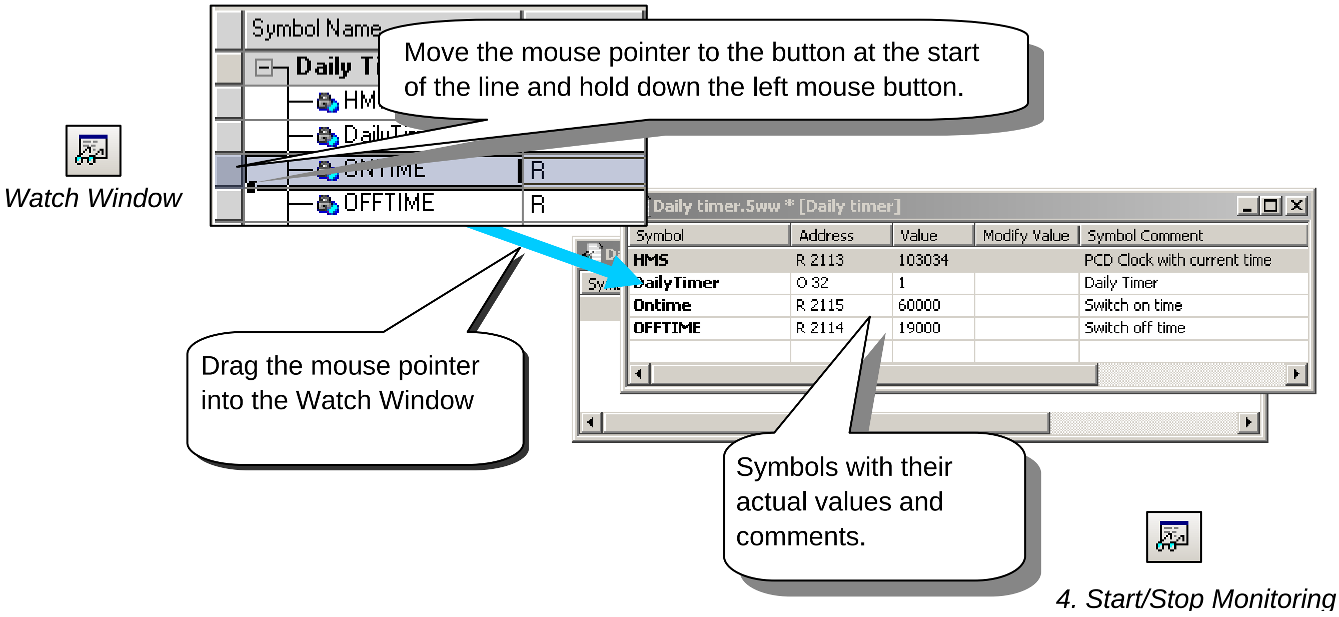


Edit Data [Daily timer HVC]

Type: R
Address: 10
Units: Decimal
Current Value: 1100
New Value: 73000

6.13.6 Display symbol state with *Watch window*

Another useful way to test and display the symbol states in our example is in the *Watch Window.* Press the *Watch Window* button. Then drag symbols from the symbol editor to the *Watch Window:*



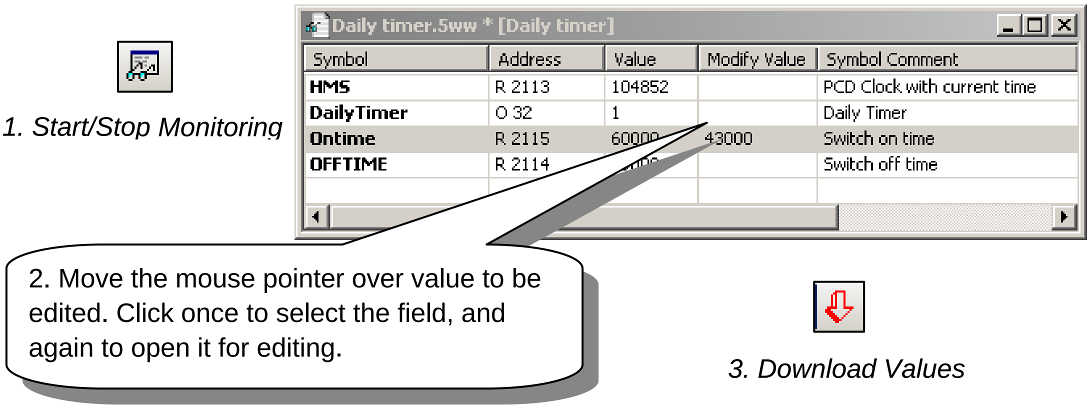
Symbol	Address	Value	Modify Value	Symbol Comment
HMS	R 2113	103034		PCD Clock with current time
DailyTimer	O 32	1		Daily Timer
Ontime	R 2115	60000		Switch on time
OFFTIME	R 2114	19000		Switch off time

Move the mouse pointer to the button at the start of the line and hold down the left mouse button.

Drag the mouse pointer into the Watch Window

Symbols with their actual values and comments.

To test the proper functioning of our daily clock example, we will now modify the turn-on/off instructions (*ONTIME* and *OFFTIME)* and observe the state of the *DailyTimer* output. To edit an instruction, proceed as follows:



Symbol	Address	Value	Modify Value	Symbol Comment
HMS	R 2113	104852		PCD Clock with current time
DailyTimer	O 32	1		Daily Timer
Ontime	R 2115	60000	43000	Switch on time
OFFTIME	R 2114	[illegible]		Switch off time

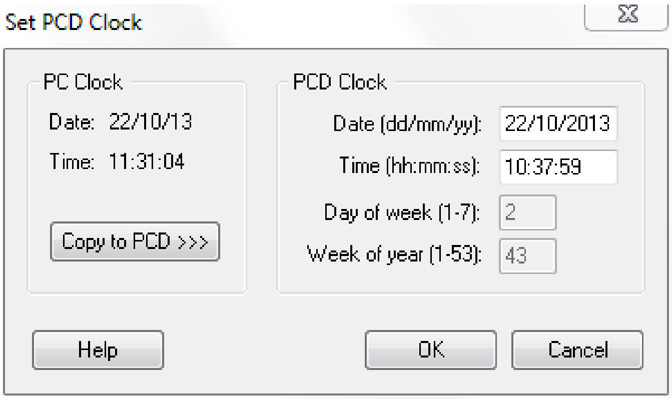
2. Move the mouse pointer over value to be edited. Click once to select the field, and again to open it for editing.

6.13.7 Setting the PCD's clock

When a PCD is commissioned, its internal clock may not have the correct time. To adjust it, proceed as follows:

1. Press the *Online Configurator* button on the *Project Manager* window. Then press *Clock*.

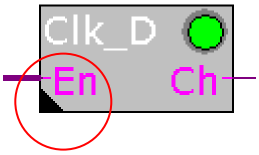
2. Copy the PC's time to the PCD with the *Copy to PCD >>>* button, or enter clock settings in the *Saia PCD Clock* fields and press OK.


Set PCD Clock

PC Clock
Date: 22/10/13
Time: 11:31:04

PCD Clock
Date (dd/mm/yy): 22/10/2013
Time (hh:mm:ss): 10:37:59
Day of week (1-7): 2
Week of year (1-53): 43

6.14 Adjust parameters

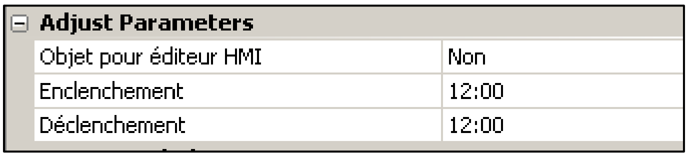


FBox: HEAVAC clocks, daily clock

Some FBoxes, which are indicated by a black triangle in the bottom left-hand corner, have additional *Adjust Parameters*. These parameters configure particular features of the FBox, and they can also be modified online.

If the *Properties* window is already open, just click on the FBox to see its properties, which shows the *Adjust Parameters*. If not open, right-click on the FBox to display the context menu, and select the *Properties* command.

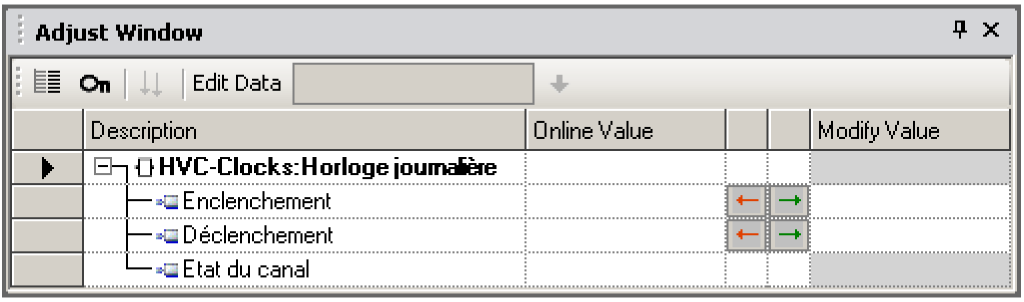
Editing Adjust Parameters when offline



⊟ Adjust Parameters	
Objet pour éditeur HMI	Non
Enclenchement	12:00
Déclenchement	12:00

The offline editing of adjust parameters is supported by the *Properties* window. The parameter's values are saved in the Fupla file. The program must be built and downloaded for the new parameter values to be used by the PCD.

Editing Adjust parameters when online


Adjust Window

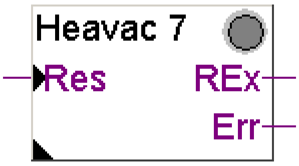
Description	Online Value			Modify Value
⊟ HVC-Clocks:Horloge journalière				
Enclenchement		←	→	
Déclenchement		←	→	
Etat du canal				

The online editing of adjust parameters is supported by the *View, Adjust Window* command which opens the online Adjust Window showing both the actual online values and the modified values. The modified values are written directly into the PCD's memory and are not updated in the original Fupla source file.

The online *Adjust Window* is automatically displayed instead of the *Properties* window when Fupla is online.

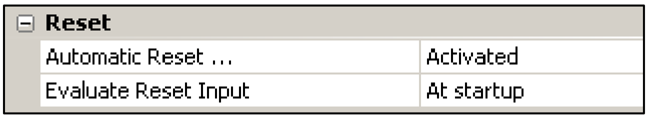
6.14.1 Initialization of HEAVAC FBoxes

When using certain FBox libraries, such as the HEAVAC library, an initialization FBox must always be positioned on the first page of the Fupla file. It allows some of the library's common tasks to be managed, such as initialisation of the library after the program has been downloaded or after a PCD cold start (power-up).



Fbox: CVC Init,
Initialization CVC 7

After any program download and PCD cold start, the *Res* input of this FBox and the adjust parameters shown below have an important influence on initialisation of the adjust parameters for all the other HEAVAC FBoxes in the program.



⊟ Reset	
Automatic Reset ...	Activated
Evaluate Reset Input	At startup

Downloading the program and the automatic Reset parameter
With the Active option, the adjust parameters of all HEAVAC FBoxes will be initialised with the values defined by the program.
With the Not active option, all existing parameters in the PCD will be preserved.

Res input and the Evaluate Reset input parameter
If the status of the reset input is high, the adjust parameters of all HEAVAC FBoxes will be initialised with values defined during programming.

Depending on the option selected for the Evaluate Reset input parameter, the Res input will only be taken into account in case of a PCD coldstart or during runtime (always).

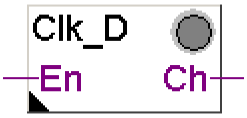
Green/red LED
Some FBoxes have a simulated LED that can display three different colours: grey when the controller is off-line, green or red when the controller is on-line. Green signifies that everything is functioning properly, red indicates an error (generally caused by information at FBox inputs or by the selection of unsuitable adjust parameters. For more detailed information, please consult the guides regarding FBox errors).

Note:

Within the HEAVAC library you will find different versions of the initialisation function (Initialisation HEAVAC 4, …7). Version 7 is the most recent. We recommend the use of function 6 for all new applications.

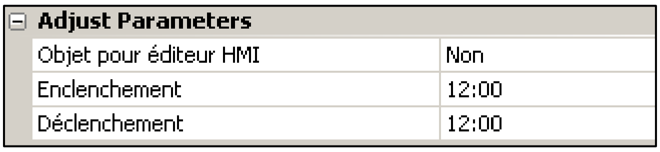
6.14.2 HEAVAC FBox with adjust parameters

The *ClK_D* FBox allows a daily clock to be produced just like the one created earlier in this chapter, but with a single FBox available in the HEAVAC library.
The FBox output can be switched on or off according to times defined in the adjust window.



FBox: HEAVAC clocks, Daily clock

The parameter *Objet pour HMI editor* is only used in the presence of HMI terminals. If this option is not used, keep the proposed standard parameter. Input *En* allows the clock function to be disabled. If *En* is low, output *Ch* will remain inactive.



⊟ **Adjust Parameters**	
Objet pour éditeur HMI	Non
Enclenchement	12:00
Déclenchement	12:00

6.14.3 Mini HEAVAC application

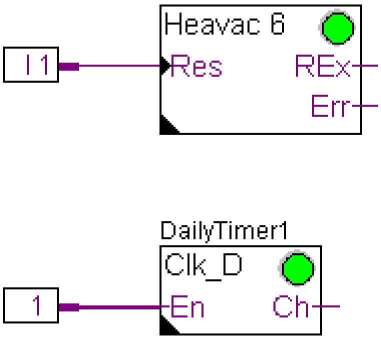
To try out the operation of adjust window parameters we can once again use the daily clock program presented at the beginning of this chapter. However, this time we will achieve it with the help of the HEAVAC library.

The two FBoxes described above are the only ones we need. Create the program as set out below, then execute *Build All*, *Download Program* and *Go Online.*

Rebuild All Files

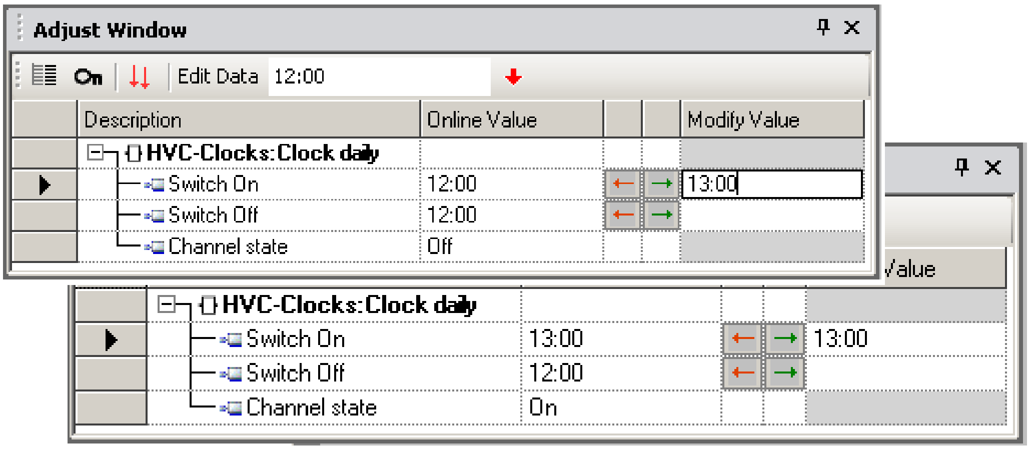
Download Program

Go Online



If the program is extended with several other HEAVAC FBoxes, the *Initialisation HEAVAC 7* FBox must be positioned once only at the top of the first Fupla page.

6.14.4 Modifying Adjust Parameters when online



Adjust Window

Edit Data 12:00

Description	Online Value			Modify Value
HVC-Clocks:Clock daily				
Switch On	12:00	←	→	13:00
Switch Off	12:00	←	→	
Channel state	Off			

Description	Online Value			Modify Value
HVC-Clocks:Clock daily				
Switch On	13:00	←	→	13:00
Switch Off	12:00	←	→	
Channel state	On			

The online modification of Adjust Parameters is supported by the *View, Adjust Parameters* window. It shows the parameters of the selected FBox in a window which works a bit like the *Watch Window*.

The *Description* column describes the adjust parameter. The *Online Value* column shows the value of the parameter read from the memory of the PCD. The *Modify Value* column allows new values to be entered and written individually or simultaneously into the PCD.

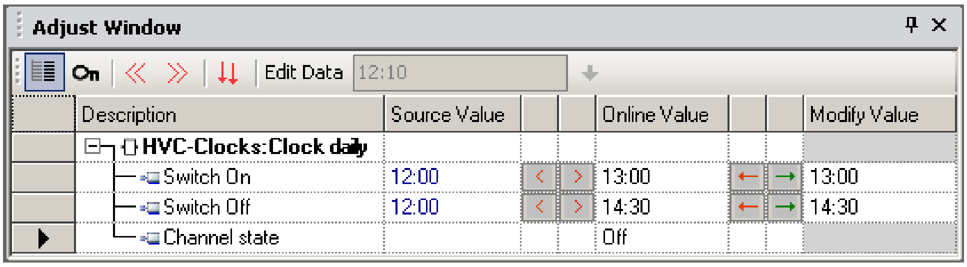
← Writes a single parameter to the PCD.

↓↓ Writes all changed parameters simultaneously.

It's also possible to select a parameter and modify it in the *Edit Data* field on the tool bar.

The values of modified parameters are written directly into the PCD's memory, they do not change the contents of the original Fupla file.

6.14.5 Restoring the original parameters from the Fupla file



Adjust Window

Edit Data 12:10

Description	Source Value			Online Value			Modify Value
HVC-Clocks:Clock daily							
Switch On	12:00	‹	›	13:00	←	→	13:00
Switch Off	12:00	‹	›	14:30	←	→	14:30
Channel state				Off			

After online changes to the adjust parameters, it's possible to restore the original values from the Fupla file. The ***Show Source Value*** button fills the *Source Value* column with the original values from the Fupla file. See the FBox *Properties* window.

› Restores a single parameter

» Restores all the parameters for the current FBox from the Fupla file

You can also use the menu command *Online, Write FBox Adjust Parameters* download Adjust Parameters from the Fupla file.

6.14.6 Saving the online parameters into the Fupla file

If the parameters which have been changed online are suitable, they can also be saved into the Fupla file.

‹ Save a single parameter

« Save all the parameters the current FBox

You can also use the menu command *Online, Read FBox Adjust Parameters* to upload *Adjust Parameters* from the PCD and save them in the Fupla file.

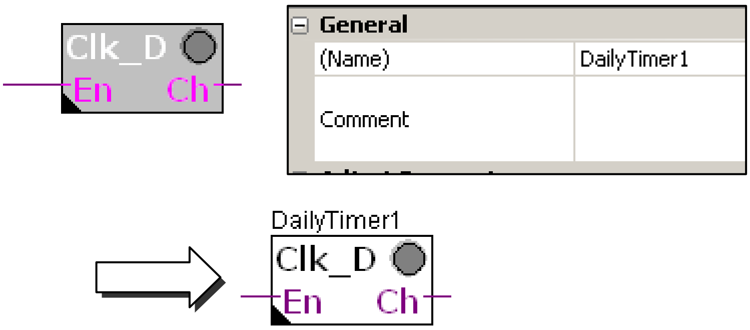
6.14.7 Defining symbol names for Adjust Parameters

Sometimes it is necessary to read or write adjust window parameters from the Fupla program, the communications network, or the supervisory system.

This is possible if symbols have been defined for flags or registers corresponding to parameters displayed in the FBox adjust window.

To define these symbols, right-click on the FBox to display the context menu. Select menu item *FBox Properties*… Define a symbol name for a group of parameters linked to the selected FBox.

To define these symbols, open the FBox's *Properties* window and fill in the *Name* in the *General* section.



General

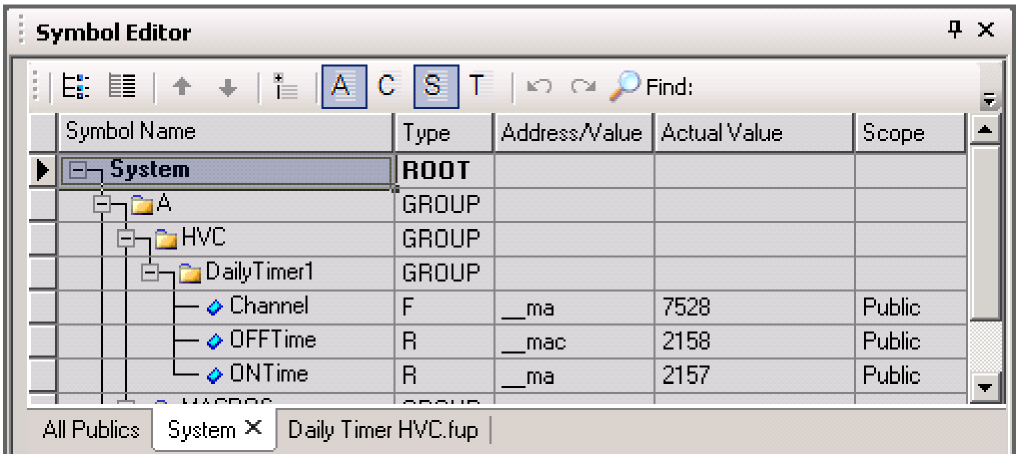
(Name)	DailyTimer1
Comment	

Rebuild All Files

Build the program and open the Symbol Editor. Open the *System* symbols page.

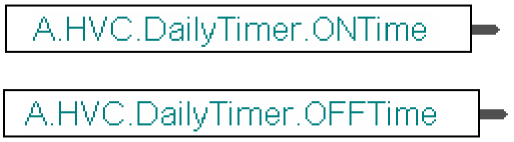
With the HEAVAC library, all system symbols corresponding to adjust window parameters are grouped under A.HVC.*name* (where *name* is the symbol name of the FBox).

Show or Hide Symbol Editor



Symbol Name	Type	Address/Value	Actual Value	Scope
System	ROOT			
A	GROUP			
HVC	GROUP			
DailyTimer1	GROUP			
Channel	F	__ma	7528	Public
OFFTime	R	__mac	2158	Public
ONTime	R	__ma	2157	Public

Now it is just a question of using these new symbols in the Fupla program.

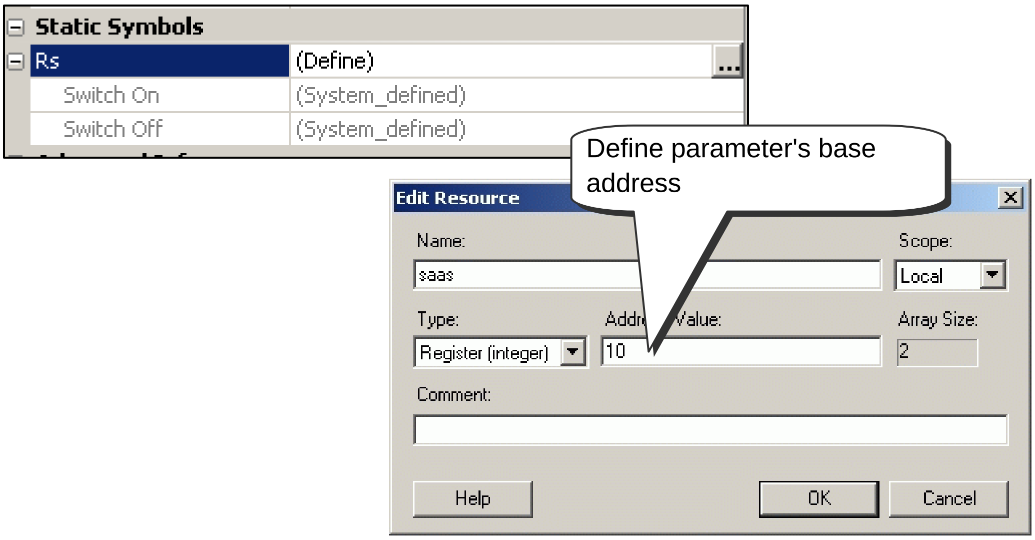


A.HVC.DailyTimer.ONTime

A.HVC.DailyTimer.OFFTime

6.14.8 Defining Adjust Parameter addresses

Define the system symbol for the Adjust Parameters as described above, and add the address from the FBox *Properties*. Select the *(Define)* line and press the **...** button at the end of the line.



Static Symbols	
Rs	(Define) ...
Switch On	(System_defined)
Switch Off	(System_defined)

Edit Resource

Name: saas

Scope: Local

Type: Register (integer)

Address/Value: 10

Array Size: 2

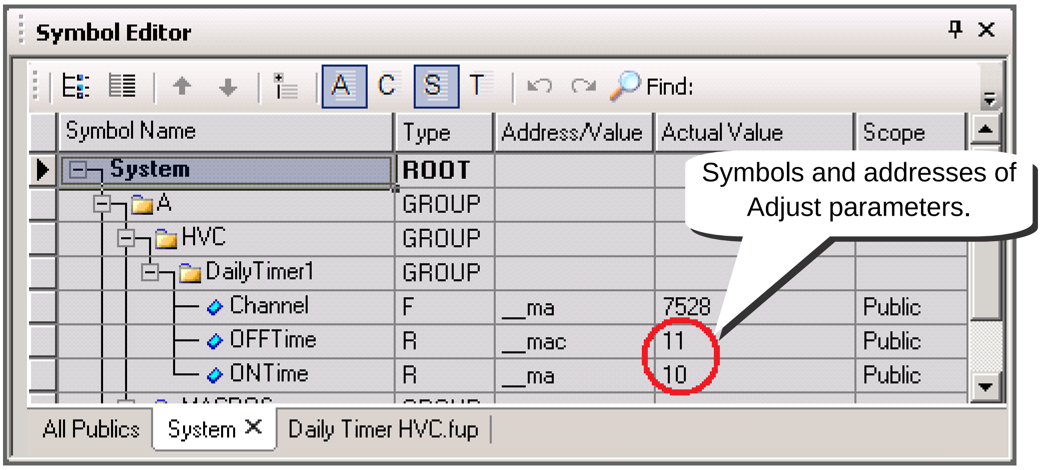
Comment:

Define parameter's base address

Build the program and open the Symbol Editor. System symbols have been assigned the register addresses shown below.

Rebuild All Files

Show or Hide Symbol Editor



Symbol Editor

Symbol Name	Type	Address/Value	Actual Value	Scope
System	ROOT			
A	GROUP			
HVC	GROUP			
DailyTimer1	GROUP			
Channel	F	__ma	7528	Public
OFFTime	R	__mac	11	Public
ONTime	R	__ma	10	Public

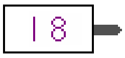
Symbols and addresses of Adjust parameters.

6.15 Commissioning an analogue module

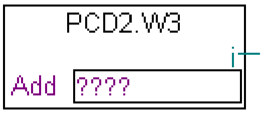
The reading or writing of an analogue value requires a small program for each analogue module. This controls the multiplexing of channels and the A/D or D/A conversion. This program is provided either by an FBox or by the media mapping created by the *Device Configurator*.

6.15.1 Acquisition of an analogue measurements

The sample programs presented up until now make use of digital inputs and outputs, putting their addresses or symbols in the margin of the FUPLA editor.



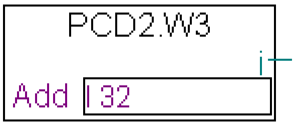
With analogue input or output modules, an FBox must be used to acquire the analogue value. These FBoxes are available with libraries: *Analogue modules, or HEAVAC-Analogue* .



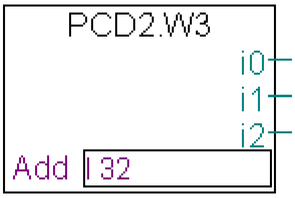
These libraries offer a wide variety of FBoxes, each corresponding to an analogue module. The name that appears in the *FBox Selector* matches the module item number.

Analogue FBoxes are expandable. The user can define the number of measurement channels required by an application. If some measurement channels are not used, or if an extra channel is added, the context menu *Resize FBox* can be used to adjust its dimensions. However, an FBox can also be defined with the maximum number of channels, even if they are not all used.

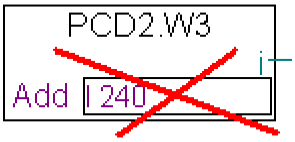
The *Add* field allows the base address of the analogue module to be defined This address indicates where the module has been inserted in the PCD: 0, 16, 32, …



Analogue measurements are available at FBox inputs I 0 to I 7. They can be connected directly to other FBoxes, or the values can be saved to a register. Saving a value to a register is a good solution, particularly when the value is used on several different pages of the program or by Graftec Steps and Transitions.

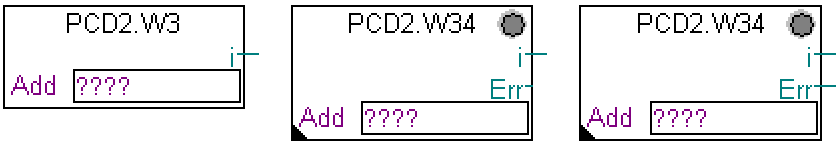


Attention:
Be careful never to define more than one FBox per analogue module, and never to insert the analogue module at the PCD watchdog address (255). Otherwise the value supplied by the module may be incorrect.



6.15.2 Example for PCD2.W340 analogue input modules

If the PCD is equipped with a PCD2.W340 module, which has 8 universal input channels, the user can take one of the following FUPLA FBoxes and define the required number of measurement channels.



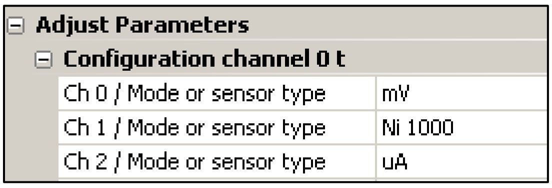
FBoxes: PCD2.W3, PCD2.W34, PCD2.W34 with error

Units of measurement depend on the module, FBox, and adjust parameters selected.

The PCD2.W340 is a universal module. It supports measurement of ranges 0..10V, 0..2.5V, 0..20mA and Pt/Ni 1000 temperature sensors. A bridge must be selected on the module to define the measurement range. Resolution is 12 bits, equating to 4096 distinct measured states. (For more detailed information about these modules, please refer to your PCD hardware manual.)

The *PCD2.W3* FBox supplies a raw measurement. For this module with a resolution of 12 bits, that corresponds to a measured value between 0 and 4095. The user then has the task of converting the measurement into a standard physical unit.

The *PCD2.W34* FBox is more elaborate. An adjust window allows units of measurement to be defined for each channel. The FBox LED turns red if one of the measurements exceeds the valid range: short-circuit or break in sensor cable. The error can be acknowledged with the *Acknowledge* button in the adjust window.

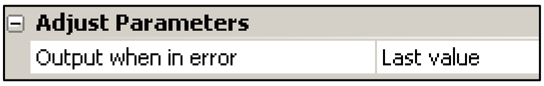


⊟ **Adjust Parameters**

⊟ **Configuration channel 0 t**

Ch 0 / Mode or sensor type	mV
Ch 1 / Mode or sensor type	Ni 1000
Ch 2 / Mode or sensor type	uA

The *PCD2.W34 with error* FBox offers the same services for converting units, but also has an error output indicating which channel has the error, plus an additional adjust parameter to define a default value in case of error.



⊟ **Adjust Parameters**

Output when in error	Last value

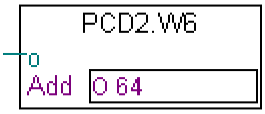
6.15.3 Example for PCD2.W610 analogue output modules

The same principle applies as for inputs: the user puts an FBox corresponding to the analogue output module on the FUPLA page, drags it to select the number of output channels and defines the module base address.

Unlike input FBoxes, the setpoints of analogue outputs are displayed on the left side of the FBox.

These inputs can be linked directly to other FBoxes, or to registers defined in the left margin of the FUPLA page.

If the PCD is equipped with a PCD2.W610 module, which has 4 universal analogue outputs, the FBox below may be used to output a current of 0..20mA, or a voltage of 0..10V.

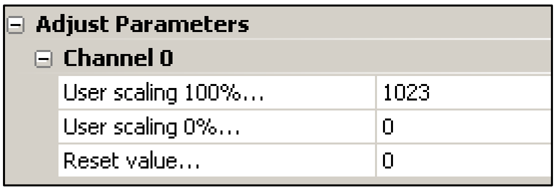


FBox: PCD2.W6

A bridge must be selected on the module to define the output range. The resolution of this module is 12 bits, equating to 4096 distinct setpoint states. The integer value at the FBox input determines the output voltage or current of the channel:

Input value at FBox	Output voltage [V]	Output current [mA]
0	0	0
2047	5	10
4095	10	20

Other FBoxes have an adjust window for adapting the range of setpoint values applied to the FBox input (e.g. the FBox for the PCD2.W605 module, which has 6 electrically isolated outputs of 0..10V:



⊟ Adjust Parameters

⊟ Channel 0

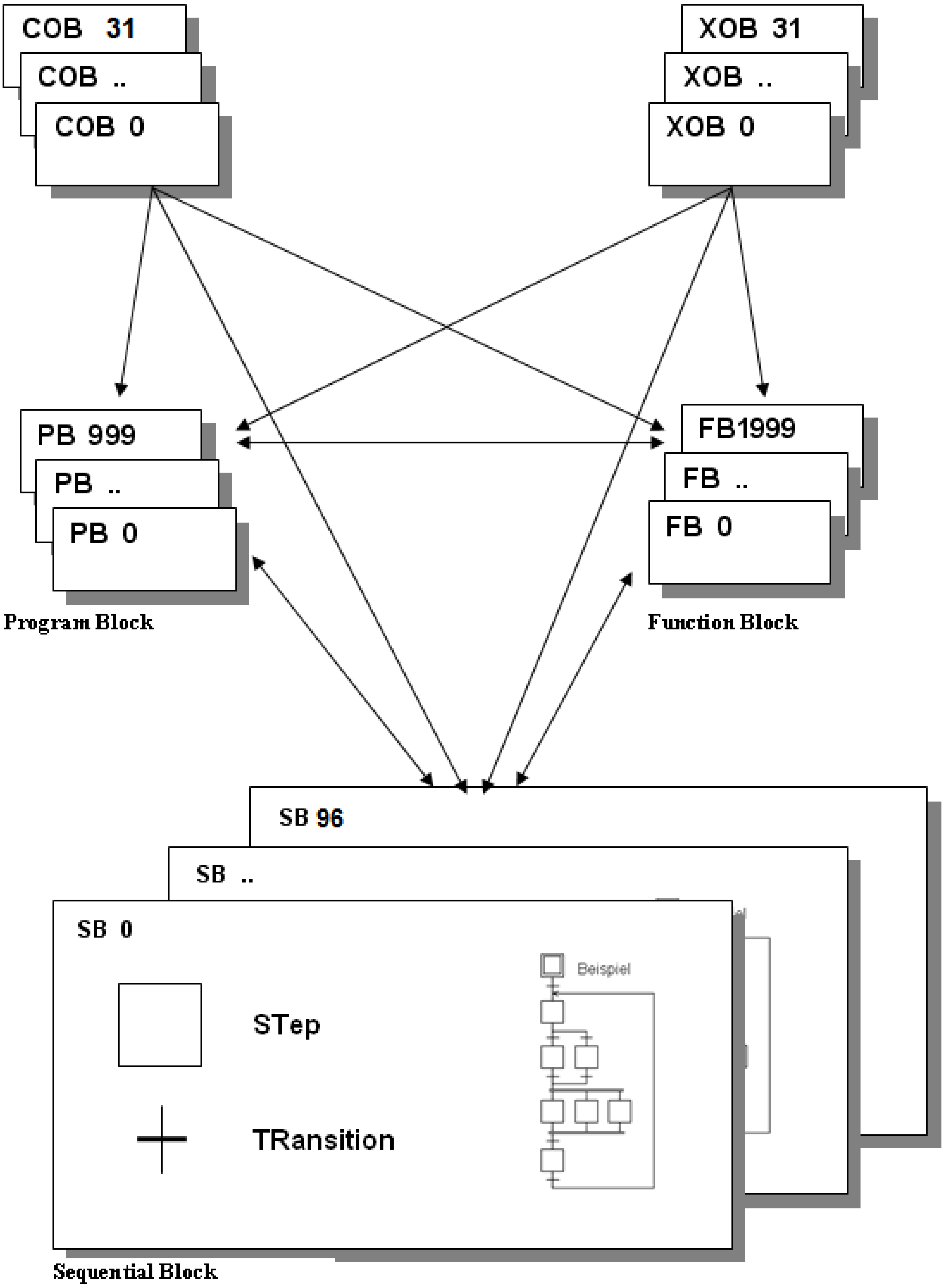
User scaling 100%...	1023
User scaling 0%...	0
Reset value...	0

The parameters *User scaling 0 and 100%* allow values to be defined for the minimum and maximum channel voltages applied to the FBox input.
The *Reset value* parameter corresponds to the value applied to the channel when the PCD is powered up.

Contents

7 Program structure

A good program needs a well-designed structure. It simplifies the program and makes it easier to develop and maintain. The Saia PCD programming language is a language which uses "organisation blocks" to structure the program. Each block encapsulates a task, program or function. These are the block types: Cyclic Organisation Blocks (COBs), Program Blocks (PB), Function Blocks (FB), Exception Organisation Blocks (XOB) and Sequential Blocks (SB).



Each block type is described in the following chapters.

7.1 Cyclic Organisation Blocks (COB 0 to 31)

Cyclic Organisation Blocks (COBs) are the program's "tasks", which run continuously, without program loops or waiting for events. When the PCD starts up, it executes the instructions in each COB in turn in a continuous loop. A program must have at least one COB. Because each COB is executed cyclically, it can regularly check for significant events, such as input signals, end-stop switches, emergency stop buttons, etc.

It is important to understand the concept of COBs. Since all COBs must run continuously, they should not contain wait loops or delays because these would prevent the regular handling of events.

If you use the Fupla editor (S-Fup), it creates a COB by default. Fupla programs are "continuous function chart" programs, which are executed cyclically and are therefore well-suited to COBs.

If the program is written in the Instruction List language, the block begins with a COB instruction and ends with ECOB (End COB). The block's code is written between theses two instructions. At the start of every COB, the Accumulator (ACCU) is always High (1), you will see that this is very important for cyclic programs.

The COB instruction has two operands. The first is the COB number, the second is the COB's *supervision time*. If the supervision time is 0, then the COB's execution time is not monitored. If the supervision time is not 0, then it represents a timeout in 10ths of a second (e.g. 10 = 100ms, 100 = 1s). If the COB has not finished within that time, the Exception Organization Block XOB 11 is called. At the end of XOB 11, the COB which timed out is resumed from where it was interrupted, and the supervision time is restarted. The Error LED is not lit because the error has been handled by the program.

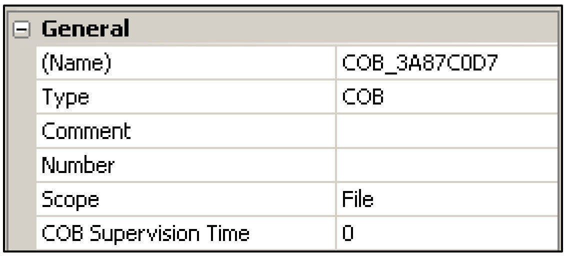
If XOB 11 is not programmed, the PCD's Error LED is lit, and execution continues with the next COB, which starts its own supervision time. On the next cycle of the program, the COB which timed out continued from where is was interrupted, and the supervision time is restarted.

In Fupla programs, the supervision time is configured using the *Block, Properties* command.

Note:
Each COB has its own *Index Register*.

7.1.1 Creating a block

A Fupla file can contain several blocks which can be added, deleted or edited using the *Block* menu.



⊟ General	
(Name)	COB_3A87C0D7
Type	COB
Comment	
Number	
Scope	File
COB Supervision Time	0

The *Block, Properties* command opens the window on the left,

Name — Symbol name of the block

Type — Block's type: COB, PB, FB, XOB

Comment — Free comment text

Number — The block's number. For example, COBs are numbered 0..31, PBs are 0..999. By default the block's number is empty (dynamically allocated), except for XOBs. If the block's number is dynamically allocated, then the actual block number is assigned by the build.

Scope — Scope of the symbol (Local or Global). Global means that the symbol is accessible for other files.

COB Supervision Time — COB timeout period, in 100ths of a second.

7.1.2 Example

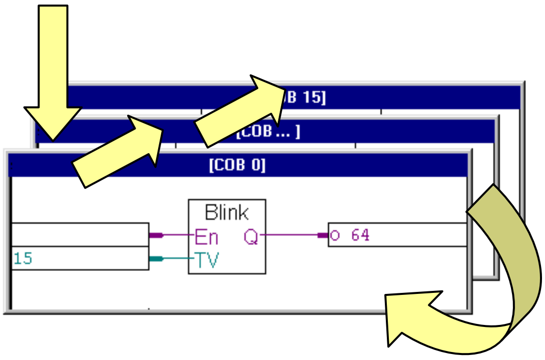
This example, in both IL and FUPLA, makes Output 64 blink at a rate of 1.5 seconds. The program is written in COB 0. Other COBs, if present, are executed consecutively.

IL program

```
COB    0    ;start COB 0
       0    ;supervision time=0
STL    T 1  ;if Timer 1 = 0,
LD     T 1  ; load it with 1.5s
       15
COM    O 64 ; and toggle O 64
ECOB        ;end of COB 0

COB    1    ;next COB
       0
...
ECOB
```

Fupla program

START UP



FBox: *Blinker, Blink delay T*

7.2 Program Blocks (PB) and Function Blocks (FB)

The programming language also allows working with Program Blocks (PB 0..999), and Function Blocks (FB 0..1999). These provide a good way to organize the structure and hierarchy of the program.

The only difference between PBs and FBs is that an FB can be called with parameters, and a PB cannot.

FBs provide an ideal solution for developing libraries which are usable in many projects. They help to reduce the development time.

PBs and FBs must be called from other blocks (COB, PB, FB, SB or XOB).

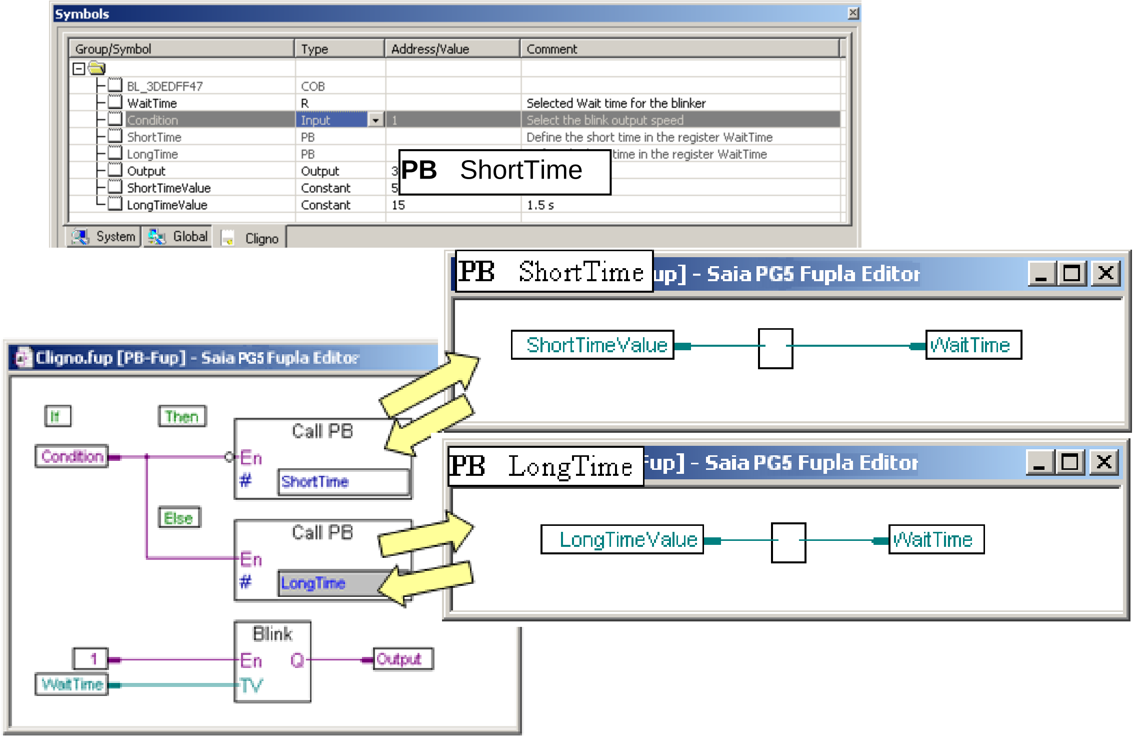
There are two type of call, conditional and unconditional. The first depends on the result of a logical operation; the second does not depend on a condition. It is possible to call the same PBs and FBs several times in a program.

A PB/FB can also call another PB/FB, and another, up to a maximum call depth of 31. If the maximum call depth is exceeded, then Exception Organization Block XOB 10 is called, if programmed.

7.2.1 Program Block with conditional call

Example of a two-speed blinker controlled by the state of input *Condition*.

Fupla program



Symbols

Group/Symbol	Type	Address/Value	Comment
BL_3DEDFF47	COB		
WaitTime	R		Selected Wait time for the blinker
Condition	Input	1	Select the blink output speed
ShortTime	PB		Define the short time in the register WaitTime
LongTime	PB		time in the register WaitTime
Output	Output	3	
ShortTimeValue	Constant	5	
LongTimeValue	Constant	15	1.5 s

If the state of digital input *Condition* is low (0), then PB *ShortTime* is called, which loads timer *WaitTime* with constant *ShortTimeValue* (5). If input *Condition* is high (1), then PB *LongTime* is called, which loads timer *WaitTime* with the constant *LongTimeValue* (15). The *WaitTime* timer defines the length of the delay between the changes of the blinker state (FBox "*Blink*"). To ensure that the *WaitTime* timer is initialised after a cold start, the *Blink* FBox must be positioned after both the PB calls.

If the program is edited with the Fupla editor, create a new block with the menu command *Block, New* and enter the block name from the block's *Properties* window. The *Call PB* FBoxes can be found in the *Block Call* family in the FBox *Selector* window.

IL program

```
;Two-speed Blinker
LongTime           EQU    PB 1
ShortTime          EQU    PB 2
ShortTimeValue     EQU    K 5       ;0,5s
LongTimeValue      EQU    K 15      ;1,5s
Condition          EQU    I 1
Output             EQU    O 32
WaitTime           EQU    T

            COB    0
                   0
            STH    Condition     ;IF Condition = High)
            CPB    L ShortTime   ;  THEN Call PB ShortTime
            CPB    H LongTime    ;  ELSE Call PB LongTime
            ECOB

            PB     ShortTime
            STL    WaitTime      ;IF WaitTime = Low
            LD     WaitTime      ;  load it with a short value
                   ShortTimeValue
            COM    Output        ;  Invert the output
            EPB

            PB     LongTime
            STL    WaitTime      ;IF WaitTime = Low
            LD     WaitTime      ;  load it with a long value
                   LongTimeValue
            COM    Output        ;  Invert the output
            EPB
```

If the program is written in Instruction List, the start of a block is begins with the instruction PB or FB. with the block name or number as the operand. The end of the block is defined with EPB or EFB. The program code is inserted between the two instructions.

At the start of every block, the *ACCU* is always *High*. When a PB or FB is called, the contents of the *ACCU* is saved, set High as the start of the called block, and is restored when the call returns. This allows the programming of logical IF..THEN..ELSE structures where the blocks are called conditionally.

Notes:
The status flags (Error, Negative, Positive and Zero) are not saved and restored when a PB of FB is called, only the *ACCU* state is saved. If the status flags need to be saved, they must be copied into normal Flags.
As with COBs, PBs and FBs should not contain wait loops and delays, and jumps to out of the block are not allowed. As a general rule, backward jumps should not be used.

7.2.2 Function Block with parameters

The following example shows an FB that makes an output flash. The FB is called twice. Its first call makes output 64 flash at a rate of 1.5 seconds. Its second call makes output 65 flash at a rate of 3 seconds.

```
;Blinker FB
        FB    1        ;start of FB

        ;FB parameters
tempo   LDEF  =1       ;[T] timer
delay   LDEF  =2       ;[W] delay between flashes
blinker LDEF  =3       ;[O|F] output or flag to be controlled

        STL   = tempo   ;if timer is 0
        LDL   = tempo   ;initialise timer with parameter 'delay'
              = delay
        COM   = blinker ;toggle parameter 3
        EFB             ;end of FB


        COB   0
              0

        CFB   1        ;call the FB for the first time
              T 1
              15
              O 64

        CFB   1        ;call the FB for the second time
              T 2
              30
              O 65
        ECOB
```

As already stated, the only difference between PBs and FBs is that FBs can be called with parameters. The CFB instruction is followed by the list of parameters, numbered from 1 to a maximum of 255. Inside the black, parameter numbers can optionally be defined with symbol names, which are local to the block.

Symbols for FB parameters are indicated by '=' followed by the parameter number. For example, `STL = 1`. Or you can define a symbol with a value "`= 1`", as shown in the example above.

Note: Fupla programs do not support calling FBs with parameters.

Almost all instructions can reference FB parameters. One exception is the LD (Load) instruction, because is needs a 32-bit operand, and FB parameters are 16 bits. A 32-bit value can be transferred using two instructions LDH and LDL (Load High Word and Load Low Word), which each transfer 16 bits.

When making nested FB calls, it is possible to pass directly from one call to the next:

```
COB   1
      0
CFB   1
      R 1  ;parameter 1 = R 1
EFB
```

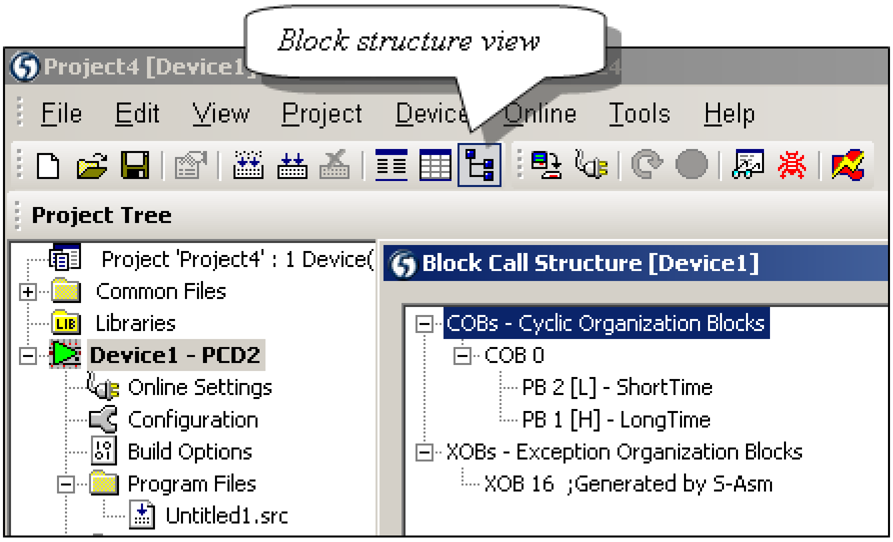
```
FB    1
CFB   2
      =1 ;call FB 2 with FB 1's parameter 1
EFB
```

```
FB    2
INC   =1  ;FB 1's parameter 1
CFB   3
      =1  ;call FB 3 with FB 1's parameter 1
EFB
```

```
FB    3
DEC   =1  ;FB 1's parameter 1 = R 1
EFB
```

7.3 View Block Call Structure

Once you have built your program, you can view its block structure. Click on the toolbar button called *Block Call Structure*. This displays a window showing which COB calls which PB, FB, SB etc. The display below is for the PB example in chapter 7.2.1. It shows that COB 0 calls PB 2 and PB 1.

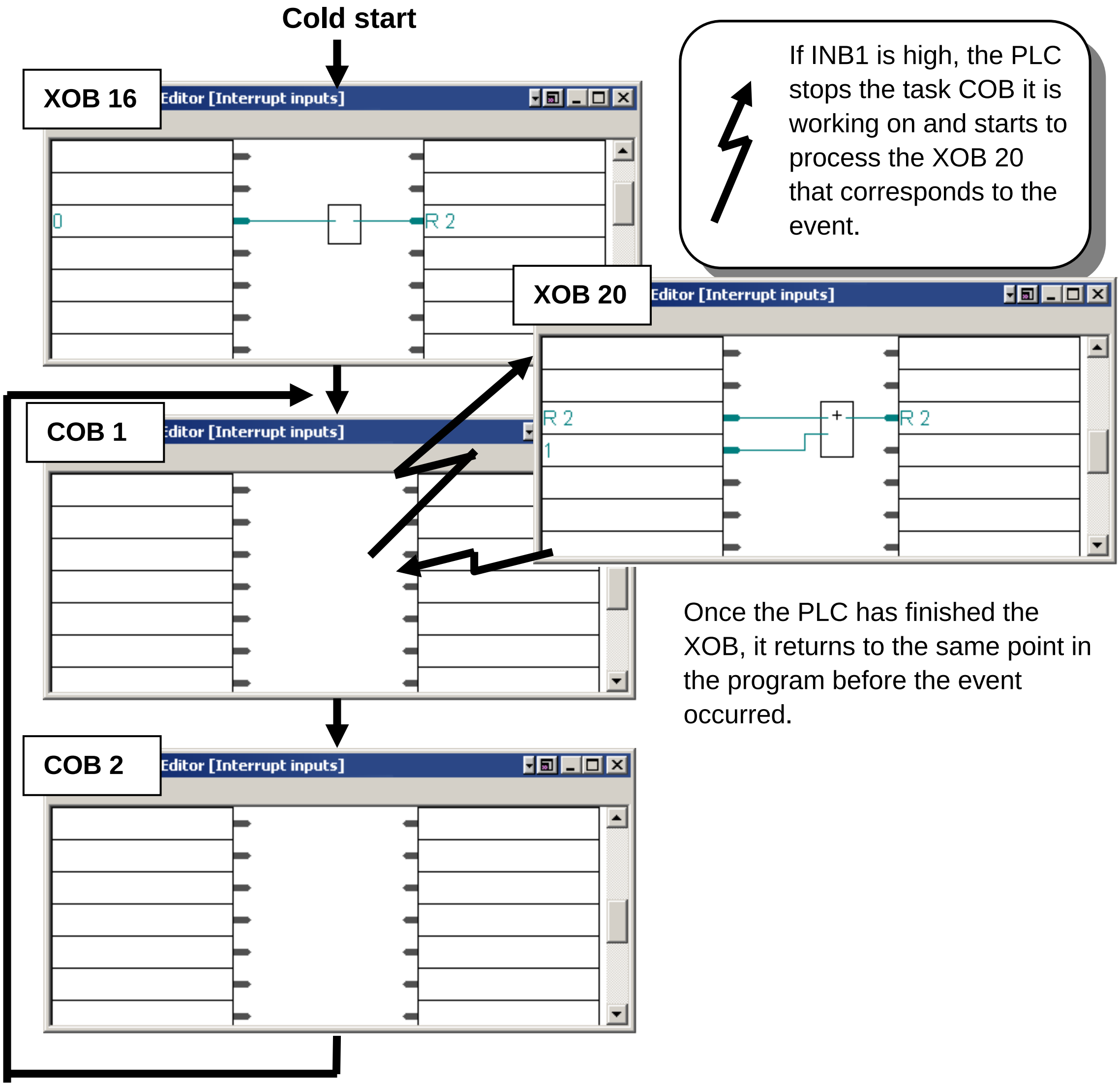


COBs - Cyclic Organization Blocks
COB 0
PB 2 [L] - ShortTime
PB 1 [H] - LongTime
XOBs - Exception Organization Blocks
XOB 16 ;Generated by S-Asm

7.4 Exception Organization Blocks (XOB)

Exception Organization blocks are called automatically when a particular event or error occurs. Some hardware and software events are handled by XOBs. The events themselves cannot be modified by the user, but the code inside the XOB, which handles the event, can be programmed.

Example 1:
When the PCD is powered, it zeros a register which is used to count pulses INB1 at a maximum frequency of 1kHz. XOB 20 is called whenever INB1 goes from low to high.


Cold start
XOB 16
Editor [Interrupt inputs]
0
R 2
XOB 20
Editor [Interrupt inputs]
R 2
1
+
R 2
COB 1
Editor [Interrupt inputs]
COB 2
Editor [Interrupt inputs]

If INB1 is high, the PLC stops the task COB it is working on and starts to process the XOB 20 that corresponds to the event.

Once the PLC has finished the XOB, it returns to the same point in the program before the event occurred.

Example 2:
Turn on the PCD and take out the battery, the Error LED will light up. If your program contained XOB 2 (see table), the LED would not have come on and XOB 2 would have been executed instead.

7.4.1 XOB numbers and descriptions

XOB	Description	Priority
0	Power problem in the main rack (PCD6) or Watchdog (PCD1/2)	4
1	Power problem in the extension rack (PCD 6)	2
2	Battery low	2
4	Parity error on the I/O bus (PCD6)	1
5	No response on a module I/O (PCD4/6)	1
7	Overload of the system due to multiple events.	3
8	Instruction not valid	4
9	To many active tasks (Graftec)	1
10	To many PB/FB levels	1
11	Watchdog COB	3
12	To many index registers used	1
13	Error flag is set	1
14	Interruption cyclic	3
15	Interruption cyclic	3
16	PCD cold start	4
17	S-Bus telegram	3
18	S-Bus telegram	3
19	S-Bus telegram	3
20	Interrupt input INB1	3
21	Interrupt input	3
22	Interrupt input	3
23	Interrupt input	3
25	Interrupt input INB2	3
26	Cyclic interrupt	2
27	Cyclic interrupt	2
28	Cyclic interrupt	2
29	Cyclic interrupt	2
30	RIO connection lost	1

If an error occurs and the handler XOB has not been programmed, the Error LED on the front-panel of the PCD is lit, and the program keeps running.

If an error occurs and the handler XOB has been programmed, the Error LED stays off, and the XOB is called. After executing the XOB, the program returns to where it was when the XPB was called.

XOBs have different priorities to ensure that the most important XOBs are processed first. Priority 4 is the highest. Only XOBs 0 and 8 can interrupt the execution of another XOB. If an XOB event occurs during the execution of an XOB with a lower priority, it will be handled as soon as the current XOB is finished.

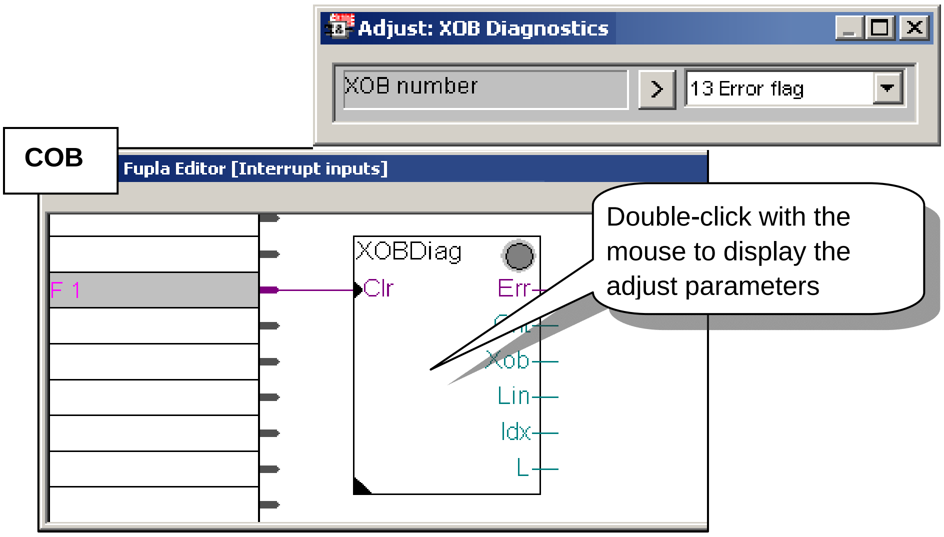
Error diagnostic XOBs and their programming is described in the following chapters. XOBs cannot be called directly by the user program.

7.4.2 Use of XOBs

XOBs detect the following types of error:

- Incorrect hardware configuration
- Invalid jump addresses
- More then 7 (or 31) program call levels
- More then 32 active transitions in a Graftec structure
- Never-ending loops (COB supervision timeout)
- Mathematical errors (overflow, divide by 0)
- Communications errors

Fupla example:
Using features to detect to location of programming errors.
With Fupla it is easy to use XOBs. They are added automatically by the Fbox: *Special, Diagnostic XOB*
Diagnostic information is available on the function outputs, error counter, XOB number, program line number,…


Adjust: XOB Diagnostics

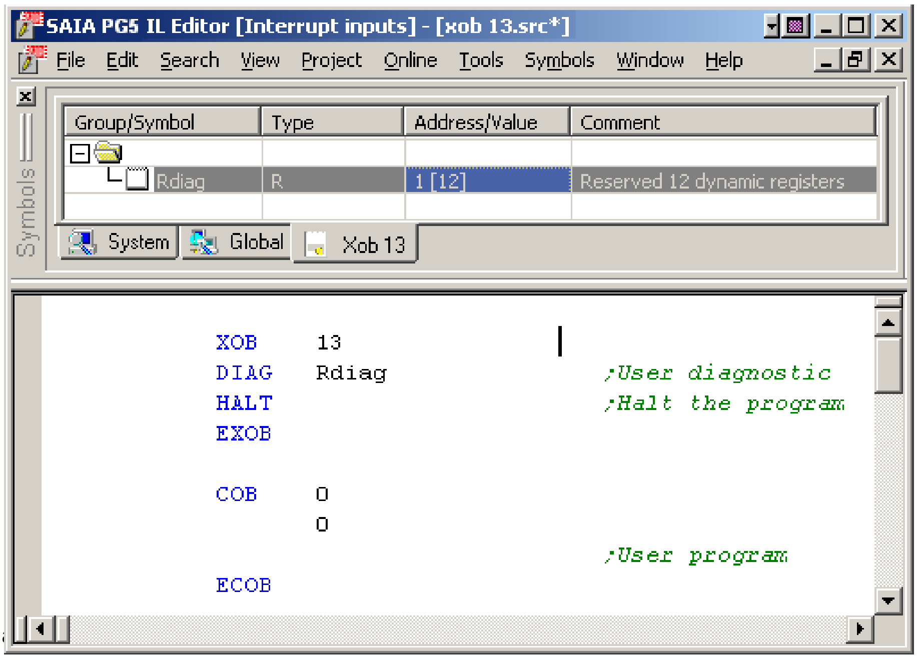
XOB number > 13 Error flag

COB

Double-click with the mouse to display the adjust parameters

IL example:

The IL program's diagnostics supply the same information as above in registers Rdiag + 0 … +12.


SAIA PG5 IL Editor [Interrupt inputs] - [xob 13.src*]

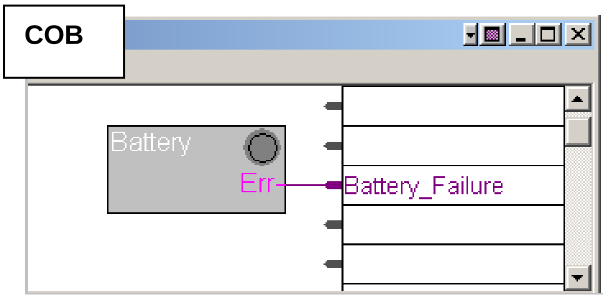
Group/Symbol	Type	Address/Value	Comment
Rdiag	R	1 [12]	Reserved 12 dynamic registers

```
XOB     13
DIAG    Rdiag              ;User diagnostic
HALT                       ;Halt the program
EXOB

COB     0
        0
                           ;User program
ECOB
```

File Edit Search View Project Online Tools Symbols Window Help
Symbols
System
Global
Xob 13

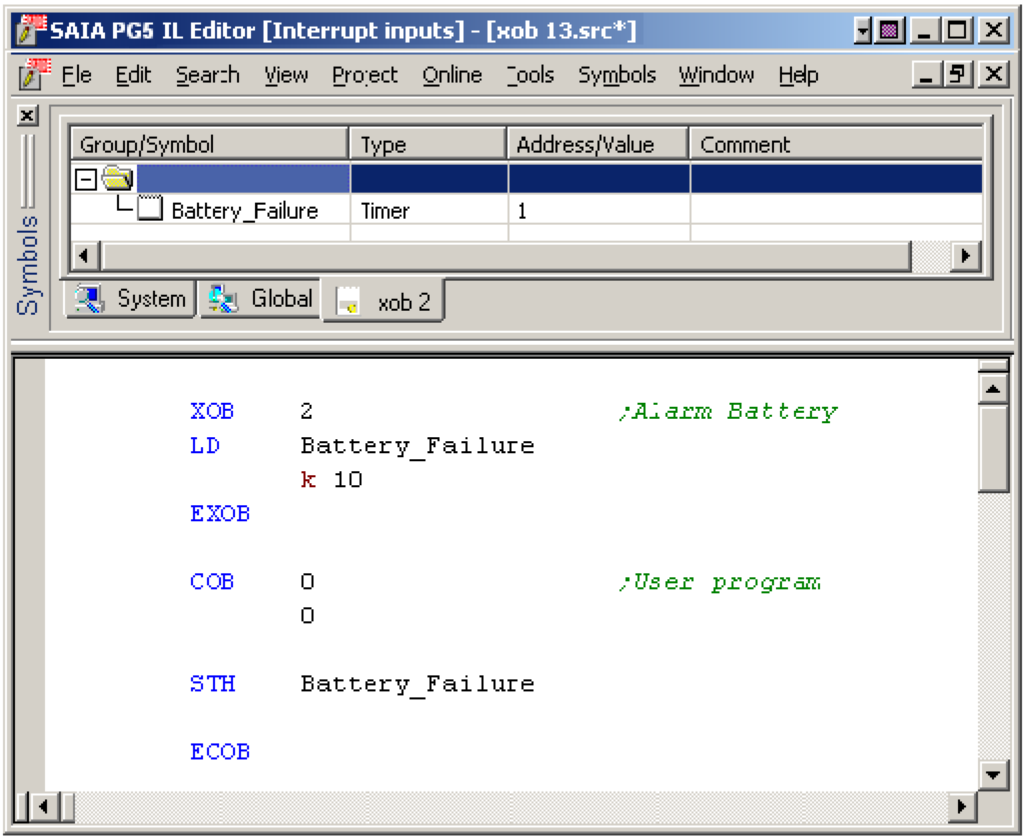
Maintenance of your PLC:
Monitoring of batteries (need to be changed every 3 to 4 years)

Fupla example:
XOB 2 Battery Failure also has its own FBox, *Special, Battery*. The Err output, which is connected to symbol Battery_Failure goes high if the battery needs replacing.



IL Example:
If there is a PCD battery failure, the *Batt* LED on the front-panel of the PCD is turned on and XOB 2 will then be called at regular intervals.

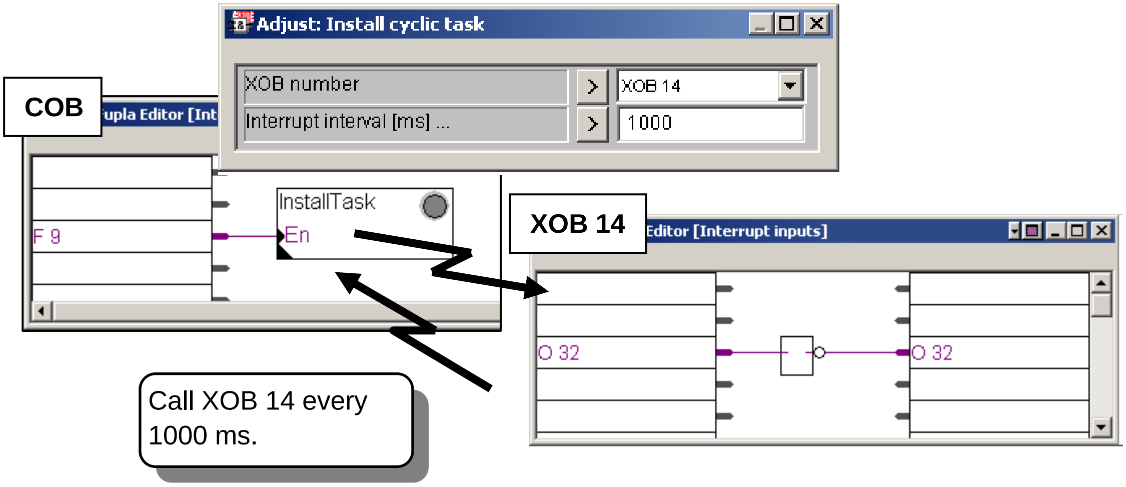
In the example below, XOB 2 loads a timer with a delay of 1 second. As the exception block is called regularly, the timer will be initialised frequently and will not have the chance to count down to zero. The binary state of this timer will therefore be high for a battery failure, and going low approximately 1 second after the battery has been replaced.


SAIA PG5 IL Editor [Interrupt inputs] - [xob 13.src*]
File Edit Search View Project Online Tools Symbols Window Help
Symbols
System
Global
xob 2

Group/Symbol	Type	Address/Value	Comment
Battery_Failure	Timer	1	

```
XOB     2                   ;Alarm Battery
LD      Battery_Failure
        k 10
EXOB

COB     0                   ;User program
        0

STH     Battery_Failure

ECOB
```

Fupla example:
Output pulses to a digital output. Use functions *Special* , *Install cyclic task* and *Binary, Direct transfer.*



XOB number > XOB 14
Interrupt interval [ms] ... > 1000

Call XOB 14 every 1000 ms.

IL example:

```
;Start-up XOB 16
XOB     16
SYSWR   4014        ;Initialise XOB 14
        1000        ;with a 1000ms interrupt
EXOB

COB     0
        0
...                 ;user program goes here
ECOB

;Cyclic Interrupt
XOB     14
COM     O 32        ;toggles output O 32
EXOB
```

7.4.3 History

The History window shows all the hardware or software errors which have occurred while the PCD was operating. History messages are always added to this list, even if the associated XOB handler is programmed. Examine this list if the PCD's *Error* lamp is lit. To see the history table, start the *Online Configurator* and press the *History…* button.

Online Configurator

7.4.4 Description of XOBs

XOB 0: Power failure in main rack
The voltage monitor in the supply module of the main rack has detected an excessive drop in voltage. All outputs are reset, XOB 0 is called and the PCD is put into the Halt state.
From the moment when XOB 0 is invoked until CPU HALT is an interval of approx. 5 ms. During this time, XOB 0 continues processing, so that data can still be saved.

XOB 1: Power failure in extension rack
The voltage monitor in the supply module of an extension rack detected an excessive drop in voltage. In this case all outputs of the extension rack are set low within 2ms and XOB 1 is called.
If outputs from this "dead" extension rack continue to be handled (set, reset or polled) by the user program, XOB 4 and/or XOB 5 are also called.

XOB 2: Battery failure or low battery
The battery is low, has failed or is missing. Information in non-volatile flags, registers or the user program in RAM as well as the hardware clock may be altered. The battery can fail even if the PCD is not in use for a long time. Even a new PCD which has never been used can show the same symptoms.

XOB 4: Parity error on address bus
XOB 4 can only be called if the PCD has extension modules. The monitor circuit of the address bus has noticed a parity error. This can either arise from a faulty extension cable, a defective extension rack or a bus extension module, or else it is simply because the extension rack addressed is not present. If there is a fault, the wrong element could be addressed.

XOB 5: No response from I/O module
The PCD’s input and output modules return a signal when they are accessed. If this signal is not returned, XOB 5 is called. Generally occurs if the module is not present, but it can also happen in case of faulty address decoding on the module.
On the PCD1/2/3, this mechanism is not implemented.

XOB 7: System overload

The waiting mechanism for XOBs with priority levels 2 or 3 is overloaded.

If a level 2 or 3 XOB is processed at the same instant as an XOB with a higher priority (level 4), the lower priority XOB is put on hold until the XOB with priority has finished. XOB 7 is called when the queue is full.

XOB 8: Invalid opcode

The PCD tried to execute an invalid instruction code. This can occur if the firmware is old and does not support the instruction, or if the program has been incorrectly edited using the debugger S-Bug.

Other errors are: calling non-existent blocks; missing end of block instructions; program jumps to the second line of multi-line instructions; jumps from one block into another, etc.

XOB 9: Too many active Graftec branches

More than 32 Graftec branches were simultaneously activate in a Sequential Block (SB). More than 32 parallel branches can be programmed in a single SB, however, only a maximum of 32 are allowed to run simultaneously.

XOB 10: More than 7 (31) nested PB/FB calls

PBs and FBs can be nested to a depth of 7 (or 31) levels. An additional call (calling the 8th or 32nd level) causes XOB 10 to be called. The 8th/32nd level call is not executed.

XOB 11: COB monitoring time exceeded

If the second line of the COB instruction is a non-zero supervision time (in 1/100ths of a second), and if COB processing time exceeds this duration, XOB 11 is called. COB processing time is the time which elapses between the COB and ECOB instructions. The original purpose of this monitoring time was the immediate discovery and subsequent eradication of any long delays in the user program resulting from bad programming (wait loops, over-long count loops). It is in fact, a "software watchdog". As already mentioned, wait and count loops (program jumps) are not encouraged. This minimizes the possibility of blocking user programs. However, even in properly structured programs, one or more COBs may be programmed with very lengthy mathematical calculations etc. which cause a long execution time, and other COBs with only monitoring and control functions may be delayed.

If a monitoring time defined for this lengthy calculation program elapses, the COB will be abandoned to continue from the start of the next COB. The "release point" is automatically stored in memory together with the ACCU status.

When the original COB is next invoked, it will continue from the release address+1. If this technique is used, XOB 11 should not be programmed as otherwise time is wasted calling XOB 11 when the timeout is not actually an error.

A further programming technique (timeslice) is explained in "Other programming techniques".

XOB 12: Index Register overflow

The size of the Index Register is 13 bits (0 to 8191). This is sufficient to reference all element addresses. If a program contains an indexed element which falls outside its address range, then XOB 12 is called.
For example, the indexed Flag 8000 is referenced and the Index Register contains 500, such that flag 8500 would be referenced, which lies outside the Flag’s address range of 0..8191.

XOB 13: Error flag set

Many instructions can set the Error flag, see the "Reference Guide", status flags.
If an error occurs, the Error flag is set and XOB 13 is called. so that error can be handled (alarm, error message to a printer, etc). XOB 13 is always called when the Error flag is set, irrespective of whether the cause is a calculation, data transfer or communications error.
If a more detailed diagnostics is needed for the Error flag, a PB (or FB) can be conditionally called after every instruction which could set the Error flag.

Example:

```
...
DIV     R 500    ;value 1
        R 520    ;value 2
        R 550    ;result
        R 551    ;remainder
CPB     E 73     ;if error then call PB 73 ....
...
PB      73       ;divide by zero
SET     O 99
INC     C 1591
EPB
...
```

PB 73 is called after a divide by zero, which turns on Output 99. Counter C 1591 counts how often this event occurs. An overflow from multiplication could, for example, activate output 98 and increment counter 1590.

XOB 13 should also be programmed, but can be empty.
If it is not programmed, the Error LED on the PCD's front-panel is turned on when the Error flag is set, which may not be satisfactory.

IMPORTANT:
The Error flag and other arithmetic status flags (Positive, Negative, Zero) are set in case of a particular event or state, and, if they are of interest, must be processed immediately, as these status flags always refer to the last executed instruction which can affect them.
For example, if a correct addition had followed the division by zero example above, the Error flag would be reset.

XOB 14, 15: Cyclic interrupt XOBs
XOBs 14 and 15 are called periodically with a frequency of between10ms and 1000s. This frequency is defined by the SYSWR instruction.

XOB 16: Coldstart
XOB 16 is a strat-up block. It is processed when the PCD is powered up or when a "restart cold" command is received from a programming tool. XOB 16 is used to initialise data before starting the program. Once XOB 16 is finished, the program will process COBs in ascending number order, but will never return to XOB 16.
XOB 16 cannot be restarted by the user program. If a particular action has to be executable both by a COB and during initialisation, this action must be written in a PB or FB which can be called from XOB 16 and from the COB.
XOB 16 has its own *Index* register which is separate from the Index registers used by the COBs

XOB 17, 18, 19: Request to call an XOB via S-Bus
These three XOBs can be used as interrupt routines. They can be called when a particular S-Bus message is received. The SYSWR instruction or Fupla FBox *Special, Execute XOB* can also be used to call them.

XOB 20, 21, 22, 23 ,25: Interrupt input change detected
XOB 20,…25 is called when interrupt input INB1 or INB2 of the PCD has detected a rising edge (see Saia PCD hardware manual for further details).

XOB 25, 26, 27, 28, 29 : Cyclic interrupt XOBs
XOBs 25,…,29 can be called periodically with a period between 10ms and 1000s. The period is defined by the SYSWR instruction.

XOB 30: Loss of master slave connection with RIOs
The connection is tested after each message sent by the master station to the slave station. If the test is negative, the master PCD calls XOB 30. This occurs, for example, when an online station is disconnected from the network or is powered off.

7.5 Sequential Blocks (SB 0 to 96)

Sequential blocks SB are a collection of Steps and Transitions. In each step you execute a part of your program and in each transition you wait for a condition to occur in order to continue with the following step. This is known as a Graftec program.

Graftec programs are created using the S-Graf editor, and the files have the extension ".sfc". The Graftec editor is explained in the next chapter. It is an excellent tool if you have to solve programming tasks, where your installation must deal with a situation in a sequential manner.

SBs can be called from any other block.

7.6 Summary

Service	Média	Opérand	Notices
Cyclic Organization Block	COB	0…31	Minimum 1 COB by program
Programme Block	PB	0…999	Under programs called by a COB, PB,FB,SB or XOB
Function Block	FB	0…1999	Function with parameters called by a COB, PB,FB,SB or XOB
Sequential Block	SB	0…95	Sequential under programs called by a COB, PB or FB (SB, XOB)
Step	ST	0…5999	
Transition	TR	0…5999	

Contents

8 Graftec Programming

Saia PG5 Graftec is based on the French Grafcet standard NF C-03-190 and IEC 848, but it contains a few differences and improvements. It is also known as "Sequential Function Chart" (SFC).

Grafcet is independent of the technology used for its implementation. It standardises the representation of sequential processes using a small number of graphical symbols governed by a few simple rules. A Grafcet diagram is composed of *steps* which define actions, and *transitions* which check for events.

A *sequence* consists of a succession of alternating *steps* and *transitions*. A *step* is not executed until the preceding *transition* allows it.

The Saia PG5 Graftec editor creates all the instructions necessary to generate the diagram within a Sequential Block (SB).

A Graftec application is programmed in two stages:
- The creation of the step/transition diagram which describes the sequential process.
- The coding of the steps and transitions with the Fupla or IL editors, S-Fup or S-Edit.

After the *Build* and *Download* of the program into the PCD, the functioning of the program can be observed while it's running. This is a great help when testing and commissioning.

Graftec also allows you to subdivide a large structure into smaller *pages*. The pages are like a zoom which allows the representation of the process in the desired level of detail.

The execution of a Graftec program is purely sequential and follows the Grafcet rules. The result is an optimal speed of execution with a very fast reaction time. Even if the program contains many *steps* and *transitions* , only the active transitions are executed. The execution times of other cyclic parts of the program are not influenced, even by a large Graftec program.

8.1 Sequential Blocks (SB 0 to 95)

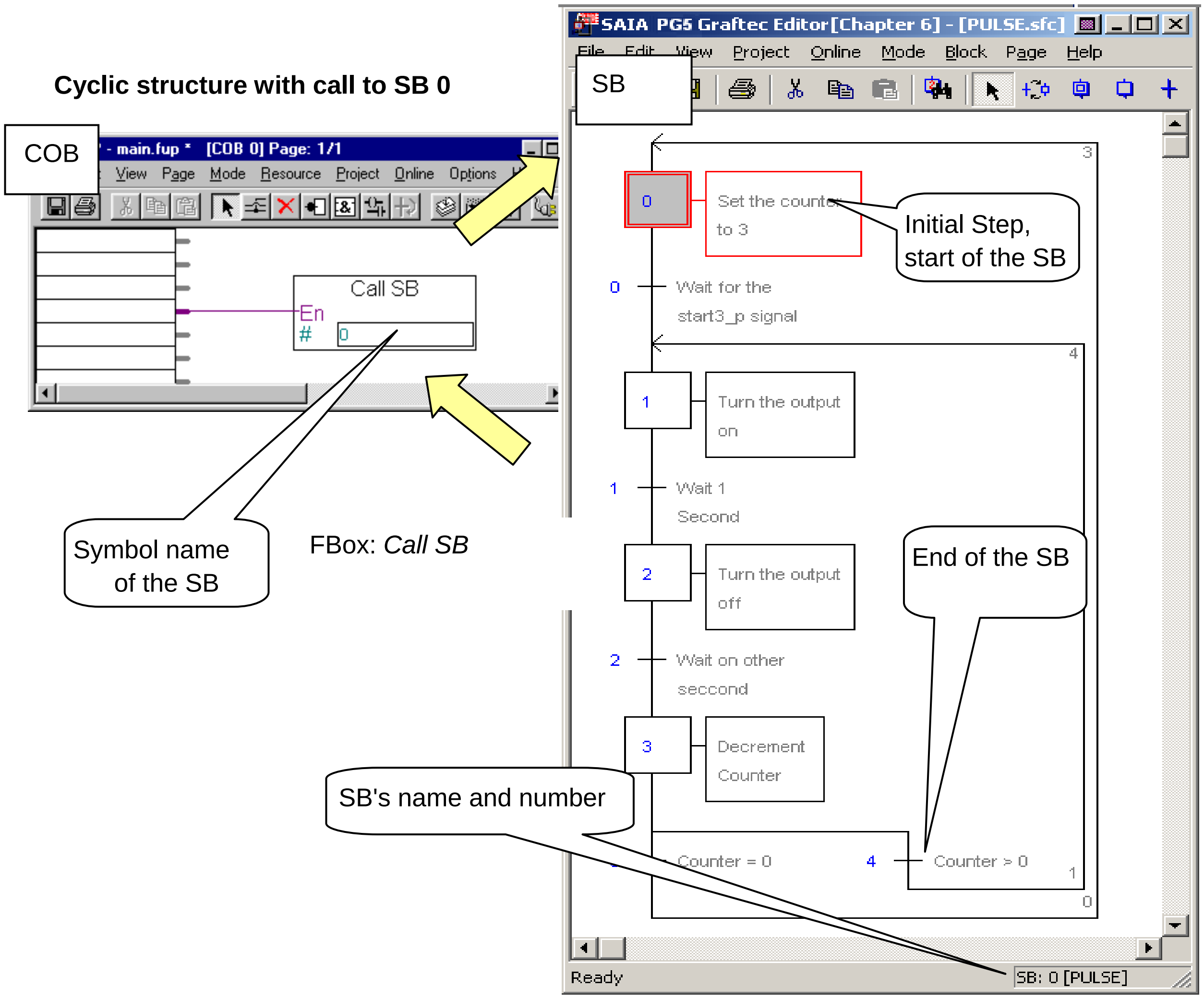
Because the timing of events is indeterminate, we cannot estimate the cycle time of a sequential program. This makes it important to separate the cyclic programs from the sequential programs.

A wait on a sequential event will never block the execution of a cyclic program. To satisfy this condition, sequential programs are placed inside one of the SB structures which are called on every cycle of the program.

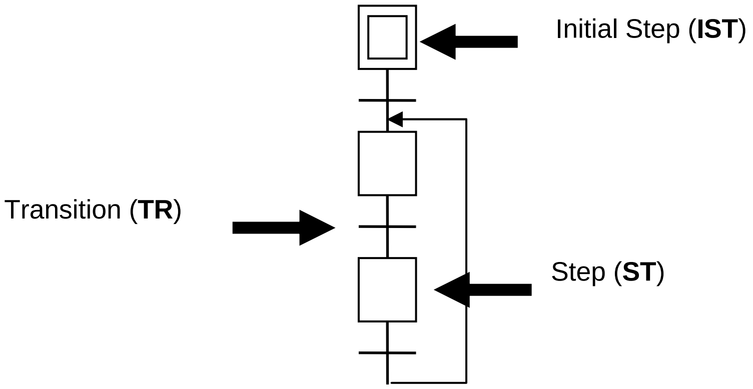
If the sequential program in an SB is waiting for an event, the PCD stops processing the SB and continues with the cyclic programs. The SB is called again on the next cycle of the program.

Sequential Block

8.2 Cyclic structure with call to SB 0



Structure of a Sequential Block (SB)



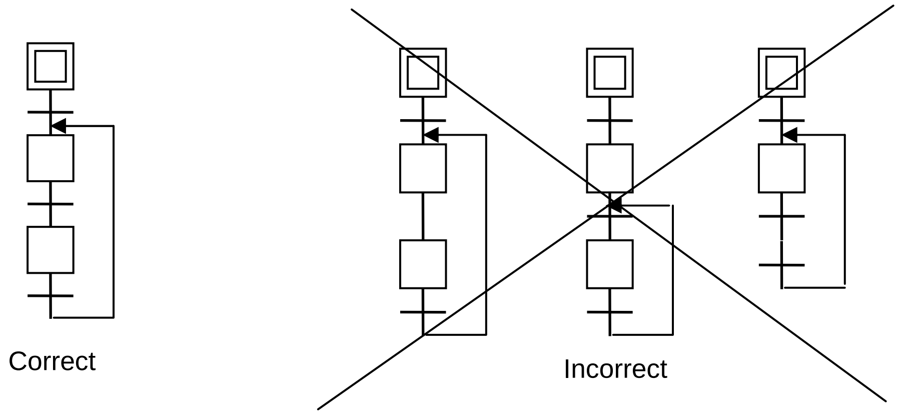
The Graftec editor (S-Graf) allows an SB to created using steps and transitions which contain Instruction List or graphical Fupla code.

The Sequential Block starts with an Initial Step, represented by a square drawn with a double line. This is the start of the sequential process which is executed the first time the SB is called (cold start).

The structure must always be closed in a loop.

8.2.1 Rules for connecting Steps and Transitions

The structure of an SB has a simple but strict syntax. As you know, the block starts with the Initial Step, and then alternates between Transitions and Steps. Two Steps or two Transitions can never be directly connected.



8.2.2 Transitions (TR 0..5999)

:1
Was the Info button touch?

The Graftec process is controlled by the code inside the transitions, which are active until an event is detected, such as the change of state of an input, output, indicator, or evaluation of a logical expression.

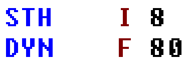
If the program is written in IL, the transition executes the next step only if the *accumulator* (*ACCU*) is high (1) at the end of the transition.

If the program is written in Fupla, the transition executes the next step only if the input to the FBox *ETR* is 1.

If these cases are not fulfilled at the end of the transition then it remains active and the same transition is evaluated repeatedly until the awaited condition occurs.

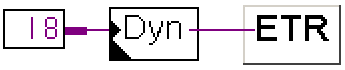
Example: Detecting the rising edge of an input signal

IL program



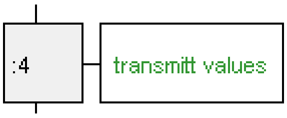
```
STH     I  8
DYN     F  80
```

Fupla program



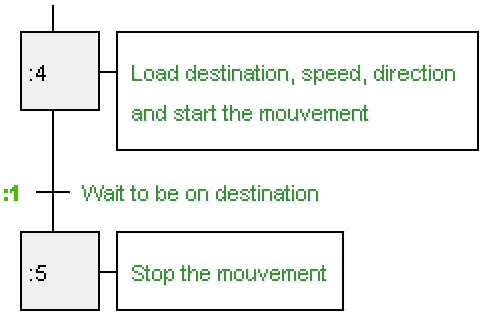
Note:
For transitions in instruction list, the ACCU is always high (1) at the start of a transition or a step. Therefore all ACCU dependent instructions are always executed, and empty transitions are always fulfilled.

8.2.3 Steps (ST 0..5999)



Steps contain the programs that are the actions of the process: turn on/off the outputs, flags, calculations, loading counter values, etc.

Example: Controlling the axis of a machine with a motor.

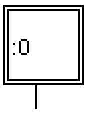

:4
Load destination, speed, direction and start the mouvement
:1
Wait to be on destination
:5
Stop the mouvement

We define the destination position, the speed and the direction of the movement, then start the movement. These tasks are executed once, so they are placed in a step.

Next we monitor the movement, and wait for it to reach the destination position. The actual position is compared with the destination position. This task must be done repeatedly, so it is placed in a transition. When the destination is reached, the transition exits with the ACCU or the ETR FBox high, so the transition is fulfilled and the next step is executed.

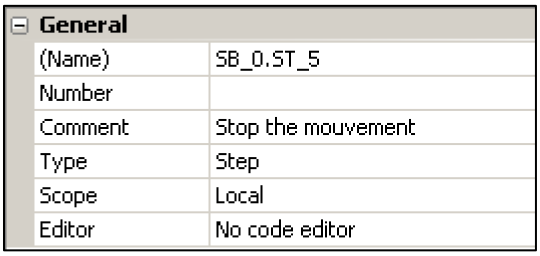
The next step stops the motor at the destination position. This task is also executed once, so it's placed in a step.

Note:
A step without a program passes control directly to the next transition. A step is executed only once, it is not executed periodically like the transitions.
The entire Graftec structure starts with an Initial Step, represented by a square drawn with a double line. This is the start of the sequential process which is executed the first time the SB is called, after a cold start or power up.



8.2.4 Properties of steps and transitions

Selecting a step or transition in the Graftec structure with the mouse displays the following information in a window, if it has been opened with the *Block, Properties* command.



⊟ **General**	
(Name)	SB_0.ST_5
Number	
Comment	Stop the mouvement
Type	Step
Scope	Local
Editor	No code editor

Name: Symbol name for the step or transition.

Number: Number of the step or transition. By default this number is empty, which means it is dynamic and is assigned by the *Build*. If necessary a number can be defined, either 2000 or 6000 steps and transitions are available according to the PCD type.

Comment: Free test comment which is shown on the right of the step or transition.

Type: Step or Transition.

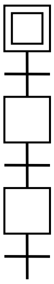
Scope: Scope of the symbol (Local or Public). If Public then the symbol name can be accessed from other files, but that's not normally necessary for steps or transitions.

Editor: IL Instruction List or Function Block Diagram.

8.2.5 Typical Graftec sequences

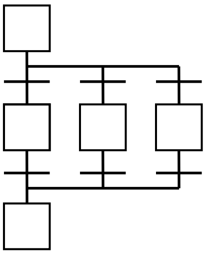
Simple sequence

Alternate steps and transitions.
Note that two steps or transitions cannot be connected together.



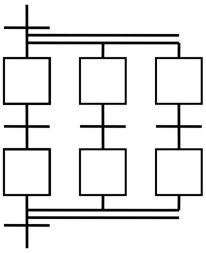
Alternate branching (OU)

A branch with a choice of sequences. The transitions are evaluated from left to right. The first transition to be active determines which sequence is executed.
An alternate branch always starts from a step, which is connected to several transitions, and is terminated by transitions which converge into a single step. The Graftec editor supports up to 32 branches. If there are more than 32 branches, XOB 9 in called.



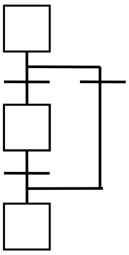
Simultaneous branching (ET)

A simultaneous branch contains several sequences which are executed in parallel at the same time. The simultaneous branch always starts with a transition which is connected to several steps, and terminated by a single synchronising transition. The Graftec editor supports up to 32 parallel branches. If there are more than 32 branches, XOB 9 is called.



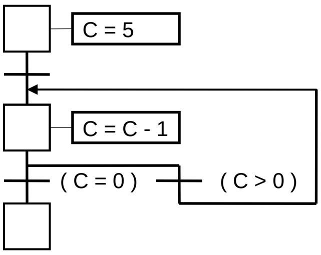
Jump sequence

The jump sequence is like an alternate branch which allows a sequence to be processed in a conditional manner.



Repeat sequence

The repeat sequence is also like an alternate branch, but it is connected to a preceding step. In the example, a counter is initialised with the number of loops, then follows a simple sequence of any length, the last step decrements the counter, and if the counter is not zero then it repeats the loop.



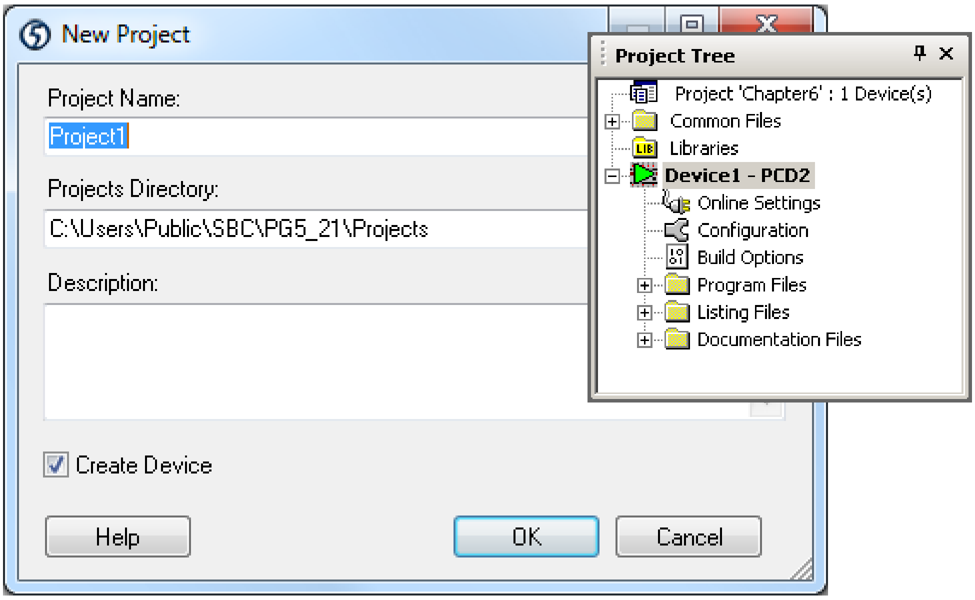
8.3 Creating a Graftec project

For this example, we will create a new Project to contain the files for the Graftec program.

- For graphical programming, prepare a Graftec file and a Fupla file.
- For IL programming, prepare a Graftec file and an IL ".src" file.

8.3.1 Create a new project

From *Project Manager*, use the *Project, New* menu command to create the new project.



New Project

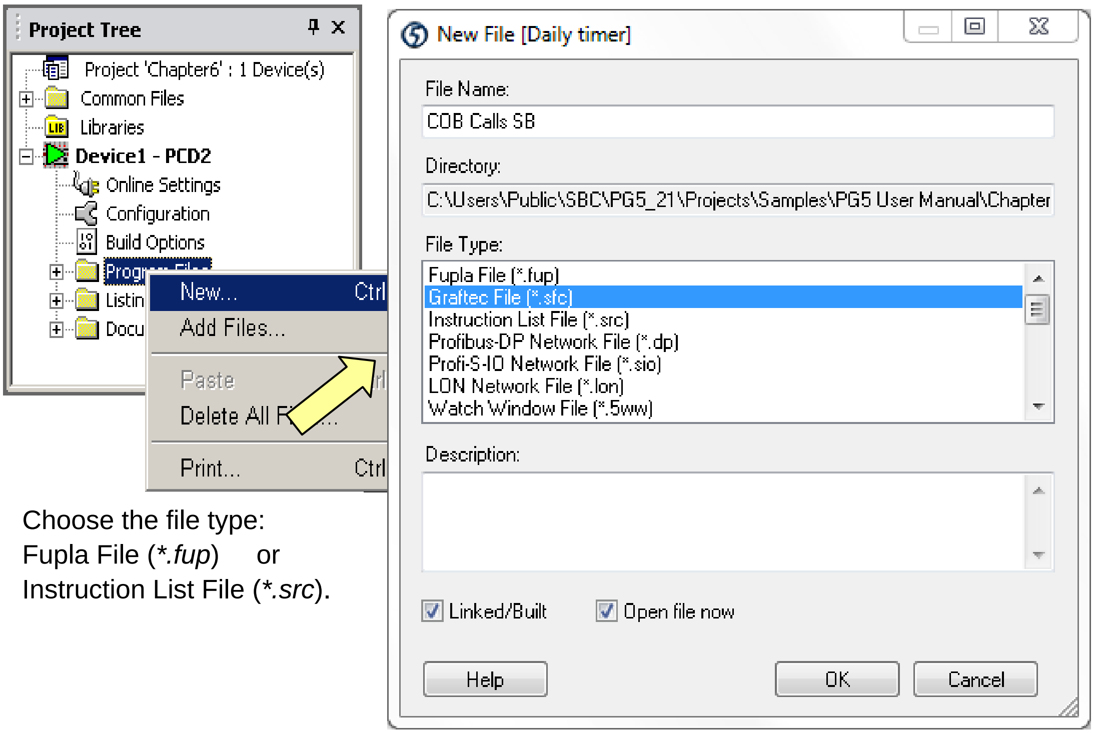
Project Name: Project1

Projects Directory: C:\Users\Public\SBC\PG5_21\Projects

Description:

☑ Create Device

8.3.2 Add a Fupla or IL file



New File [Daily timer]

File Name: COB Calls SB

Directory: C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Chapter

File Type:

Fupla File (*.fup)
Graftec File (*.sfc)
Instruction List File (*.src)
Profibus-DP Network File (*.dp)
Profi-S-IO Network File (*.sio)
LON Network File (*.lon)
Watch Window File (*.5ww)

Description:

☑ Linked/Built ☑ Open file now

Choose the file type:
Fupla File (*.*fup*) or
Instruction List File (*.*src*).

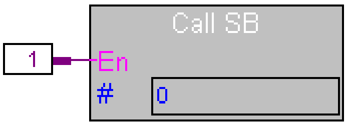
8.3.3 Calling the SB from a COB

Depending on the choice of language (IL or Fupla), either call the SB with a CSB instruction or a *Call SB* FBox. Open the new file and write the program as shown below.

IL Program:

```
COB    1   ;start of COB
       0

CSB    0   ;call SB 0

ECOB       ;end of COB
```

Fupla Program:

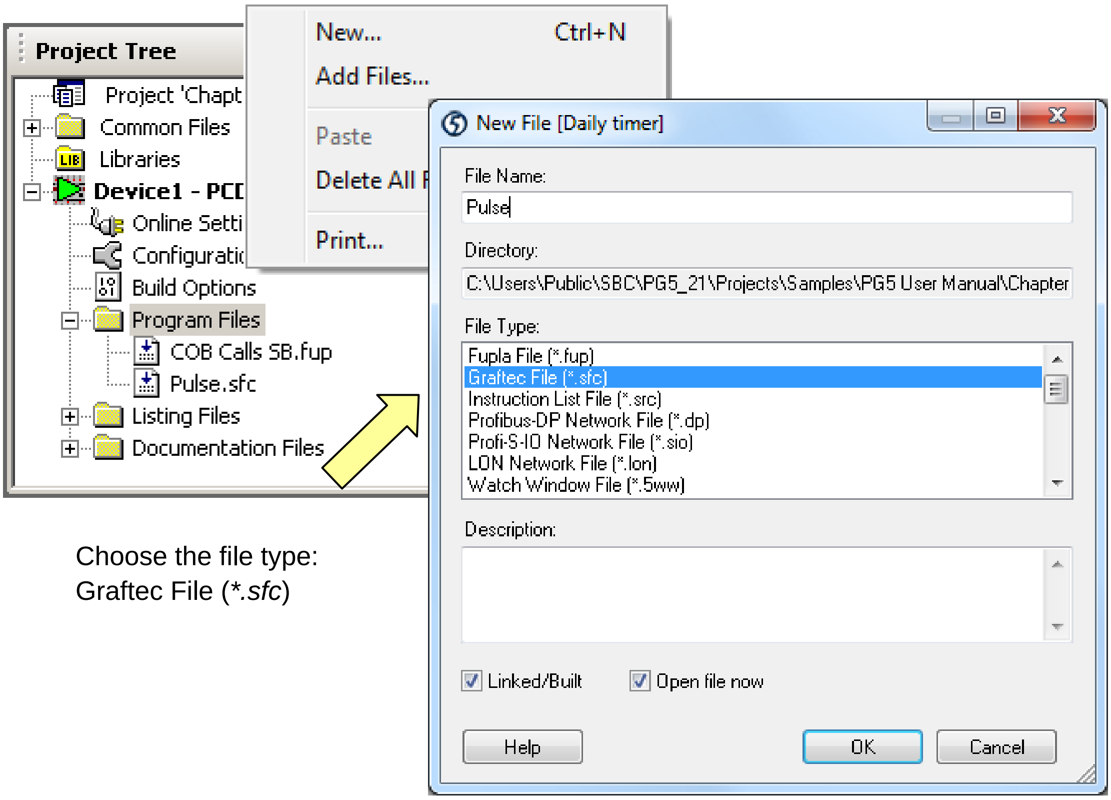


FBox: *Block Calls, Call SB*

The SB can be called as in the examples above. But there's an even easier way. The PG5 can automatically create a COB containing the CSB instruction to call the SB. This is enabled by an option on the *Build Options* dialog box, *Advanced* group, set *Generate SB calls* to *Yes*. (This option is set to *Yes* by default.)

You can create the SB first, as described below, and then add the call afterwards so you can use the symbol name of the SB instead of the number.

8.3.4 Add a Graftec file



File Name: Pulse

Directory: C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Chapter

File Type:
- Fupla File (*.fup)
- Graftec File (*.sfc)
- Instruction List File (*.src)
- Profibus-DP Network File (*.dp)
- Profi-S-IO Network File (*.sio)
- LON Network File (*.lon)
- Watch Window File (*.5ww)

Description:

☑ Linked/Built ☑ Open file now

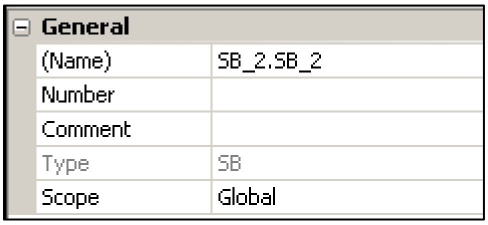
Choose the file type:
Graftec File (*.*sfc*)

8.3.5 Page Navigator, adding an SB

When a new Graftec file is created, the editor automatically creates a sequential block containing the initial step.

Several SBs can be created inside a single Graftec file. The *Page Navigator* and *Block Symbols* windows show the list of SBs in the file.

If necessary, another SB can be added to the file using the *Block, New* menu command, then modify the block's details from the *Properties* window. This window is also used to modify the properties of the SB which is created when a new file is created.



⊟ General	
(Name)	SB_2.SB_2
Number	
Comment	
Type	SB
Scope	Global

Name: The symbol name of the block. Assigning meaningful names to the blocks it makes the program easier to understand and maintain.

Comment: Free comment which can describe some details about the block.

Number: Block's number. By default the block's number is blank, so it is assigned dynamically by the *Build*. If necessary, you can assign a number yourself.

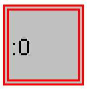
Scope: Scope of the SB's symbol name (Local or Public).
Use Public if the symbol needs to be accessed from other files. For example, if it is called from a COB defined in another file.

To display the Graftec structure of an SB, right-click on the *Page Navigator* window and select the *Open Block* command from the context menu.

Next, we will structure the SB with the steps and transitions.

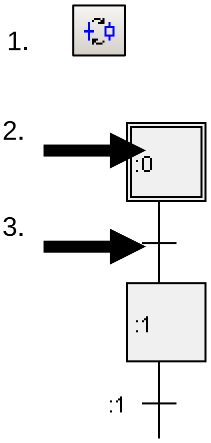
8.4 Editing the Graftec structure

A new Graftec file always contains the initial step, which is executed the first time the SB is run. Additional steps and transitions are added using keyboard or toolbar commands.



8.4.1 Editing a simple sequence

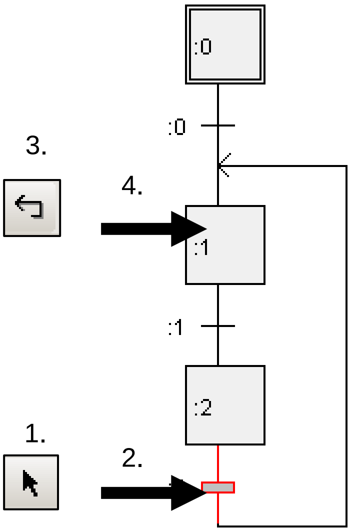
1. Press the *Transition Mode* toolbar button.
2. Place the mouse pointer on the initial step and click the left-hand mouse button.
3. Press the *Step Mode* toolbar button.
4. Move the mouse over the new transition and click again.
5. Continue in the same way.



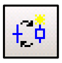
8.4.2 Creating a loop

When the sequence ends, the SB also ends. To repeat the sequence, a loop must be added.
Remember that it's illegal to directly connect two steps or two transitions, a loop always starts after a transition, and connects above a step.

1. Press the *Select Mode* toolbar button
2. Click on the transition before the jump
3. Press the *Link Mode* toolbar button
4. Click on the step to be jumped to

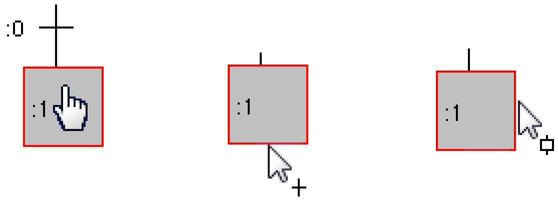


8.4.3 Smart cursor option



Smart Mode

Sequences can also be edited using the button *Smart Mode*.This mode automatically changes the cursor mode according to the mouse pointer's location.



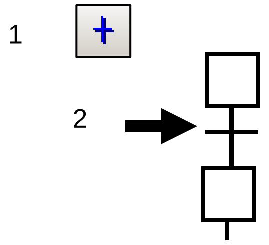
If the mouse pointer is over a step or transition, then *Select Mode* is activated and the mouse pointer becomes a hand. Double-clicking opens the program editor to edit the element's code.

Moving the mouse pointer to the bottom of a step or transition changes the mouse pointer to represent the transition or step which would be inserted below if the left-hand mouse button is pressed.

If the mouse pointer is moved over the right hand side of the step or transition, the mouse pointer changes to indicate that an alternate or simultaneous branch will be created if the left-hand mouse button is pressed.

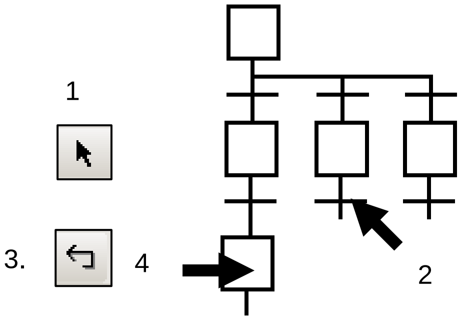
8.4.4 Creating an alternate branch (OU)

1. Activate *Transition Mode*
2. Select a transition which us already followed by a state
3. Each time the left-hand mouse button is pressed, a new transition as added to the right



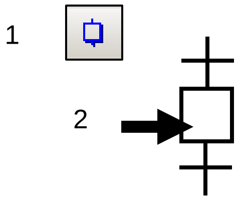
8.4.5 Connecting alternate branches

1. Activate *Select Mode*
2. Select a transition to connect
3. Press the *Link mode* button
4. Click on the step, the transition is connected after this step



8.4.6 Creating a simultaneous branch (ET)

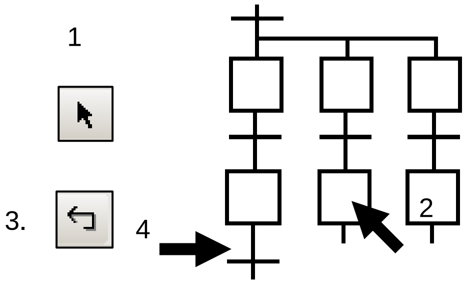
1. Activate *Step Mode*
2. Click on the first step to connect a new step on the right
3. Each click of the mouse on a step connects a new step on the right



8.4.7 Connecting simultaneous branches

To synchronize simultaneous branches:

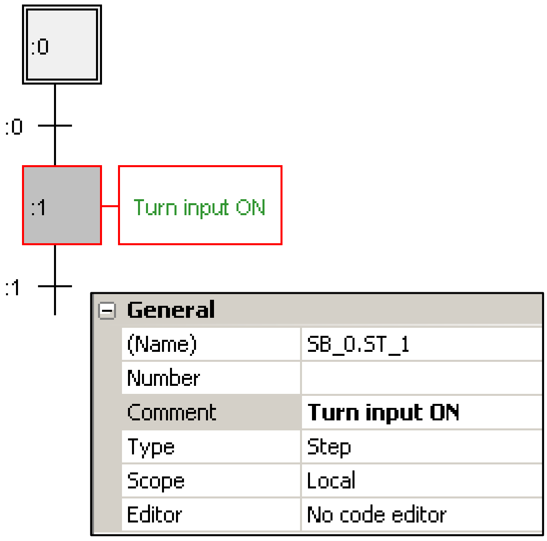
1. Activate *Select Mode*
2. Select the step to be connected
3. Activate *Link Mode*
4. Click on the destination transition



8.4.8 Adding a comment

1. Activate *Select mode*
2. Right-click with the mouse on the step or transition to display the *Properties* window
3. Enter the comment in the *Comment* field of the *Properties* window

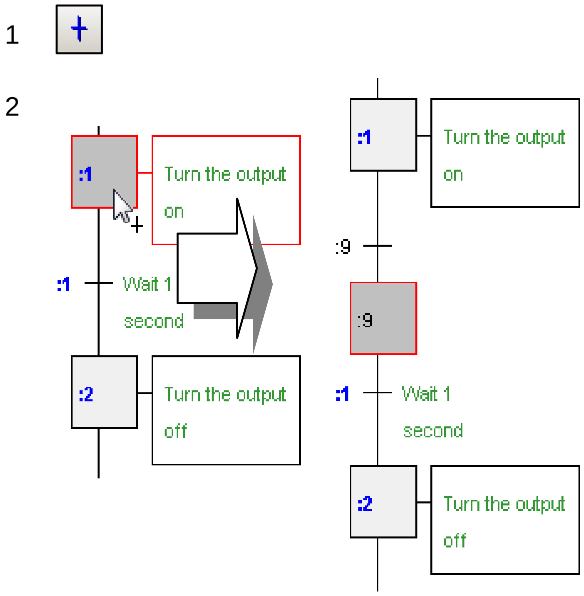
Tip: To create a comment on two lines, enter '\n', for example:
Line 1\nLine 2



General	
(Name)	SB_0.ST_1
Number	
Comment	**Turn input ON**
Type	Step
Scope	Local
Editor	No code editor

8.4.9 Inserting a sequence

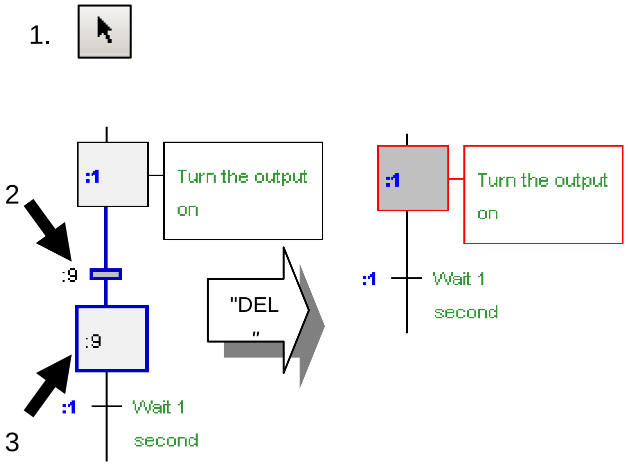
1. Activate *Transition Mode*
2. Click on a step which already has a transition
3. A new step and transition are inserted



8.4.10 Deleting a sequence

1. Activate *Select mode*.
2. Click on the first step or transition of the sequence to be deleted
3. Hold down the *Shift* key and click on the last transition or step. The marked sequence in highlighted.
4. Press the *Del* key

The marked sequence cannot be deleted if it would result in an invalid structure.



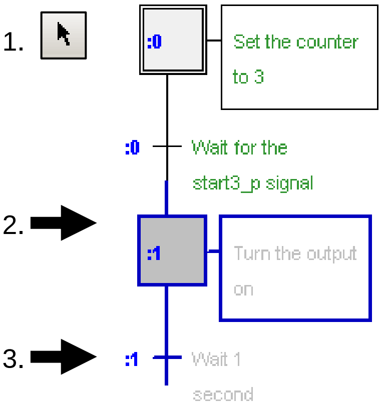
8.4.11 Copy/pasting a sequence

To copy a sequence to the clipboard:

1. Activate *Select Mode*
2. Click on the first element of the sequence
3. Hold down the *Shift* key and click on the last element of the sequence
4. Copy the sequence to the clipboard with the menu command *Edit*, *Copy* or press *Ctrl+C*

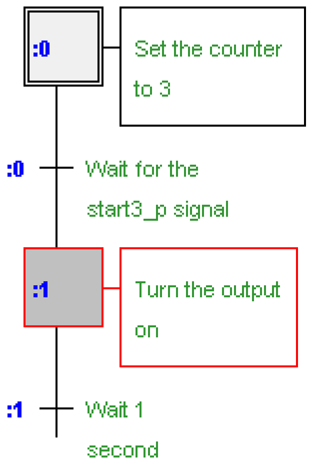
To paste the sequence from the clipboard:

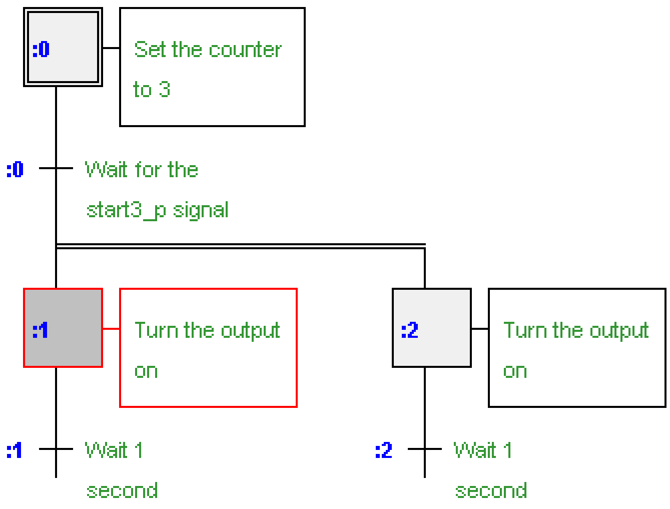
5. Activate *Select Mode*
6. Click on the element before the sequence to be inserted
7. Use the menu command *Edit*, *Paste* or press *Ctrl+V*



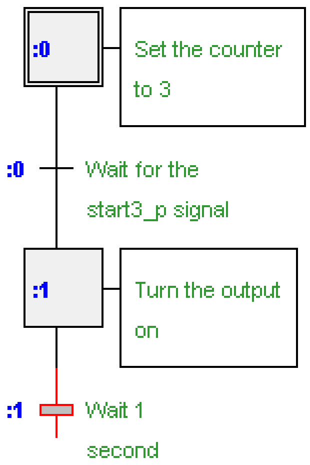
Note:
Depending on the destination element's type (step or transition) and the elements to be inserted, the sequence will be added below (simple sequence), or to the left (alternate sequence) of the selected element.

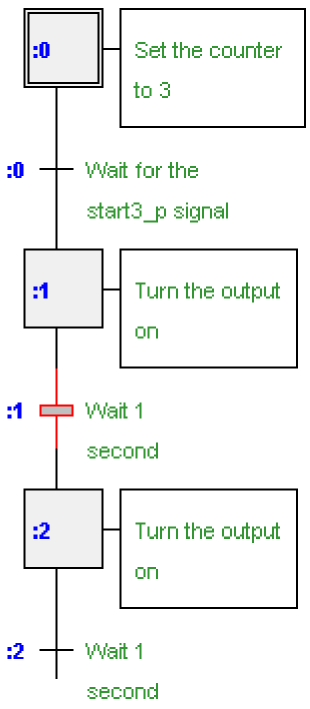
Inserting on a step





Inserting on a transition

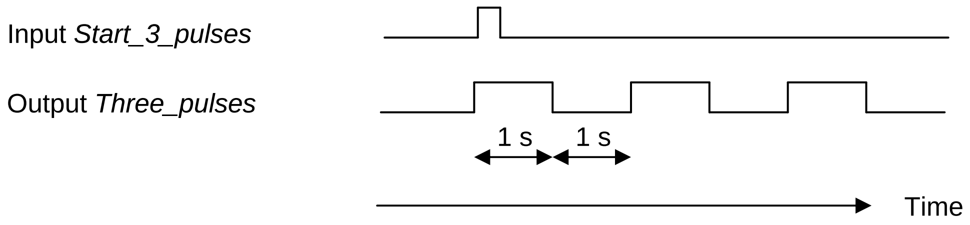




8.5 Writing a first sequential block

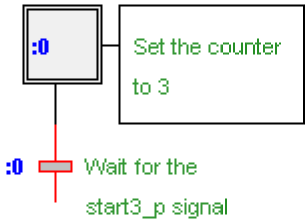
Objective:
Write a program which blinks output O 33 (*Three_pulses*) three times whenever input I 2 (*Start_3_pulses*) is activated.

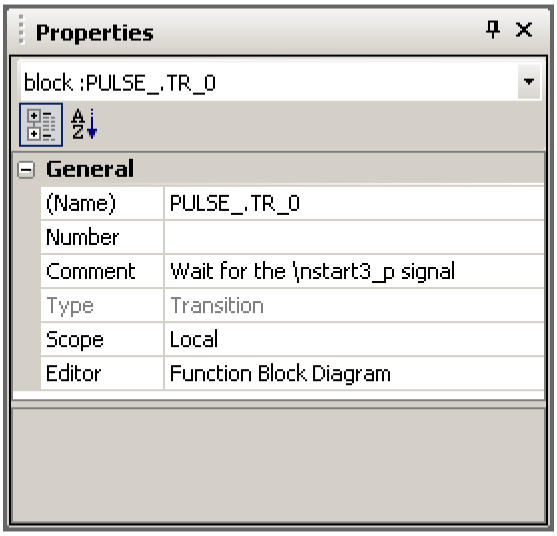
Timing diagram



8.5.1 Creating the Graftec structure

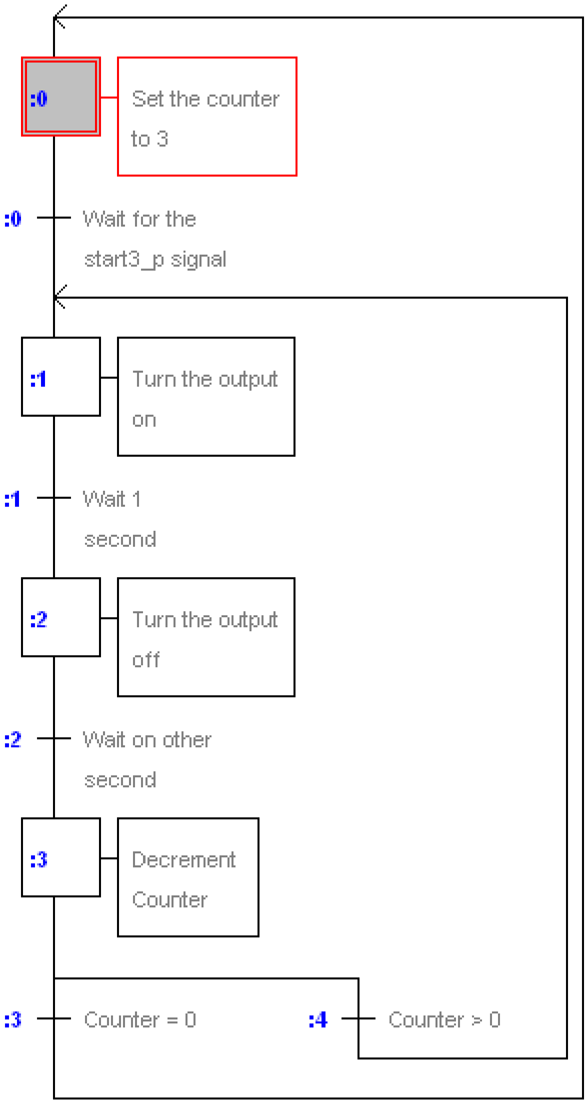
We always start with the initial step which is the start-up entry point. It will initialise the counter. (If it is not used, it can remain empty, without code or a comment.) Next, we wait for the signal *Start_3_Pulses*. Edit the transition as below and enter a comment in the *Properties* window.





(Name)	PULSE_.TR_0
Number	
Comment	Wait for the \nstart3_p signal
Type	Transition
Scope	Local
Editor	Function Block Diagram

At the start of the sequence, set the output *Three_pulses* to the high state for 1 second, then set it low for 1 second. Repeat this operation three times, then repeat the entire sequence including the initial step.

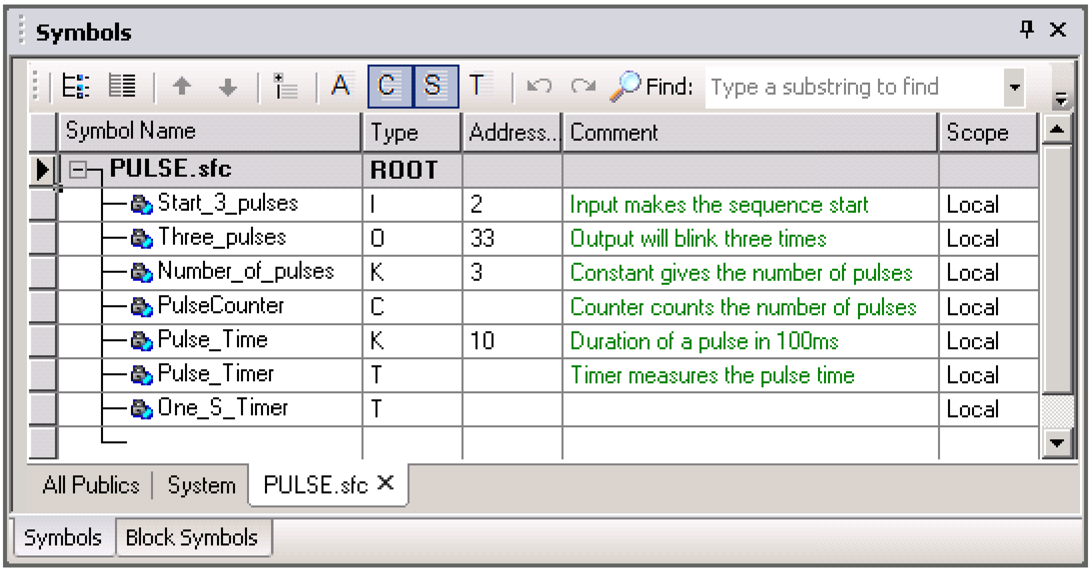


8.5.2 Choosing the editor: IL or Fupla (S-Edit or S-Fup)

Now that the Graftec structure has been created, it remains to write the code for each step and transition, using the *Instruction List* editor (S-Edit) or the *Function Block Diagram* editor (S-Fup). The default choice of editor is defined from the *Options* dialog box, *Code Editor*, *Default editor*.

8.5.3 Editing the symbols

First declare all the data using the Symbol Editor, assigning symbol names, types, addresses and comments, as shown in the window below.

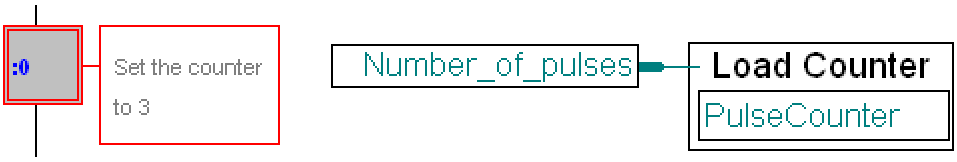


Symbol Name	Type	Address...	Comment	Scope
PULSE.sfc	ROOT			
Start_3_pulses	I	2	Input makes the sequence start	Local
Three_pulses	O	33	Output will blink three times	Local
Number_of_pulses	K	3	Constant gives the number of pulses	Local
PulseCounter	C		Counter counts the number of pulses	Local
Pulse_Time	K	10	Duration of a pulse in 100ms	Local
Pulse_Timer	T		Timer measures the pulse time	Local
One_S_Timer	T			Local

8.5.4 Programming an initial step, loading a counter

Open the initial step to add the code which loads counter *PulseCounter* with the constant *Number_of_pulses* (3). Double-click on the element to be edited and choose the editor *IL Instruction List* or *Function Block Diagram* (Fupla)

Fupla Program:
Use the FBox: *Graftec*, *Load Counter*
Important: Do not use timers or counters from other families which are reserved for cyclic programs.



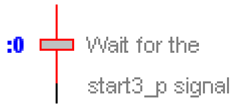
IL Program:

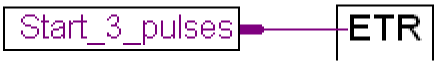
```
    LD     PulseCounter        ;initialise the counter
           Number_of_pulses
```

8.5.5 Programming a transition, waiting for the start signal

A transition is reprocessed repeatedly until the ETR FBox input is high (Fupla), or the ACCU is high (IL), at the end of the transition. Transition 0 waits for the input *Start_3_pulses* to go high.

Fupla program:





Add the FBox: *Graftec, End of transition*

IL program:

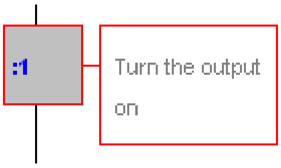
```
;Start High – set the ACCU to the state of input Start_3_pulses
STH    Start_3_pulses
```

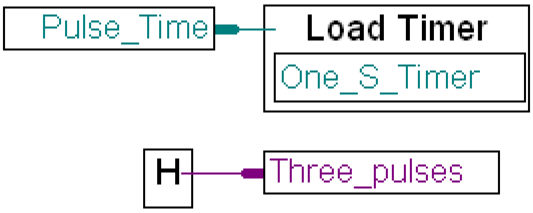
8.5.6 Programming a step, turning on an output and starting a timer

This step turns on the output and loads the timer, then continues to the next transition to wait for the timer to reach 0.

Fupla program:

The timers and counters in the Fupla standard library are not designed for SBs, they are designed for COBs which are executed cyclically. Instead, you must use the functions in the *Graftec* family which are specially designed for SBs. These can be loaded in a step, and interrogated later in a transition.





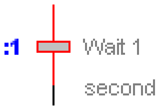
FBox:
- *Graftec: Load Timer*
- *Binary: High*

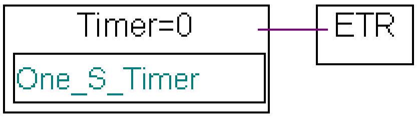
IL program:

```
SET    Three_pulses     ;turn on the output
LD     One_S_Timer      ;start the timer
       Pulse_Time
```

8.5.7 Waiting for a timer

Fupla program:





Fbox:
- *Graftec, Tempo écoulé*
- *Graftec, Fin TR*

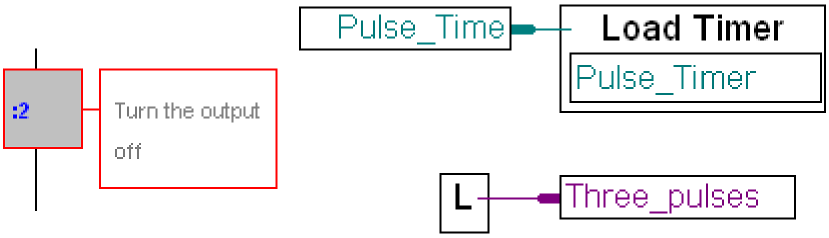
IL program:

```
;Set the ACCU high if the timer has reached 0
STL    One_S_Timer
```

8.5.8 Turning off an output when a timer reaches 0

Step and transition 2 are similar to step and transition 1, except that output *Three_pulses* is set low, and a different timer is started.

Fupla program:



FBox:
- *Graftec: Load timer*
- *Binary: Low*

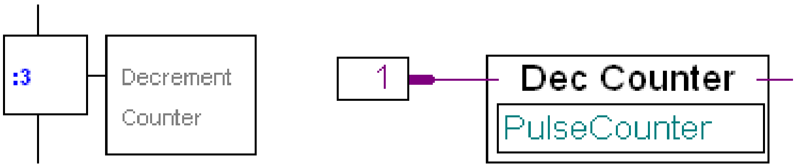
IL program:

```
RES    Three_pulses     ;turn on the output
LD     Pulse_Timer      ;load the timer
       Pulse_Time
```

Note: For steps and transitions 1 and 2 we have used two different timers (*One_S_Timer* and *Pulse_Timer*), but to economise on the number of timers used we could have used one, by using the same timer twice, because they are not used at the same time.

8.5.9 Decrementing a counter

Fupla program:
The counter is decremented each time the step is executed, because the FBox input is high (1).



FBox: *Graftec, Decrement counter*

IL program:

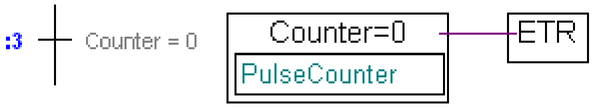
```
;if the ACCU is high, dexcrement the counter
DEC    PulseCounter
```

Remember that the ACCU is always high (1) at the start of an ST or TR, so the ACCU-dependent instructions are always executed.

8.5.10 Alternate branching

The next two transitions make a choice.

Fupla program:



FBox: *Graftec, Counter is zero*

IL program:

```
STL  PulseCounter
```

Transition 3: The input to FBox ETR is 1 if the counter is 0.
Transition 4: The input to FBox ETR is 1 if the counter is not zero.

Invert Binary Connector

Place an inverter at the input of the ETR FBox with the toolbar button *Invert Binary Connector*.

8.6 Building and debugging the program

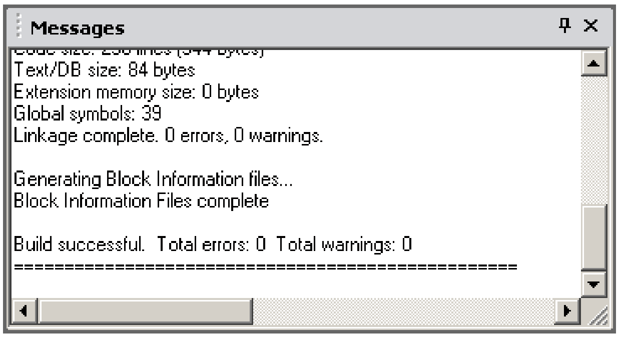
Build All

Once the programming is complete, press the *Build* button on the toolbar to compile, assemble and link the entire program.

8.6.1 Messages window

Project Manager's *Messages* window indicates the results of the build. If the program was created without errors, the last line in the window will show:

Build successful. Total errors: 0 Total warnings: 0



```
Text/DB size: 84 bytes
Extension memory size: 0 bytes
Global symbols: 39
Linkage complete. 0 errors, 0 warnings.

Generating Block Information files...
Block Information Files complete

Build successful.  Total errors: 0  Total warnings: 0
==================================================
```

Error messages are shown in red. Double-clicking on an error message will usually take you to the part of the program which contains the error.

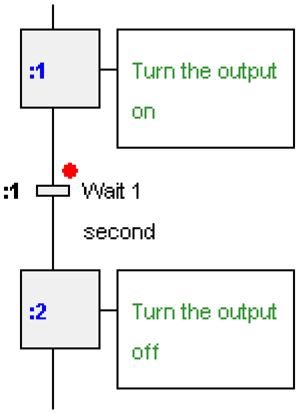
Project Manager also has an Error List window which shows only the error and warning messages.

8.6.2 Online tools

Download Program

It remains to download the program and go into online mode.

Using the Graftec editor, the execution of the sequential block can be visualised when online. A red dot indicates the active transition, so the sequential operation can be viewed.



We can stop the program at any time by pressing the *Stop* button, and then continue the program step-by-step.

Each time the *Step By Step* button is pressed, a step or transition executed.

The *Step In* button opens the step or transition with the Fupla or IL editor, so that the code inside the step or transition can be stepped through.

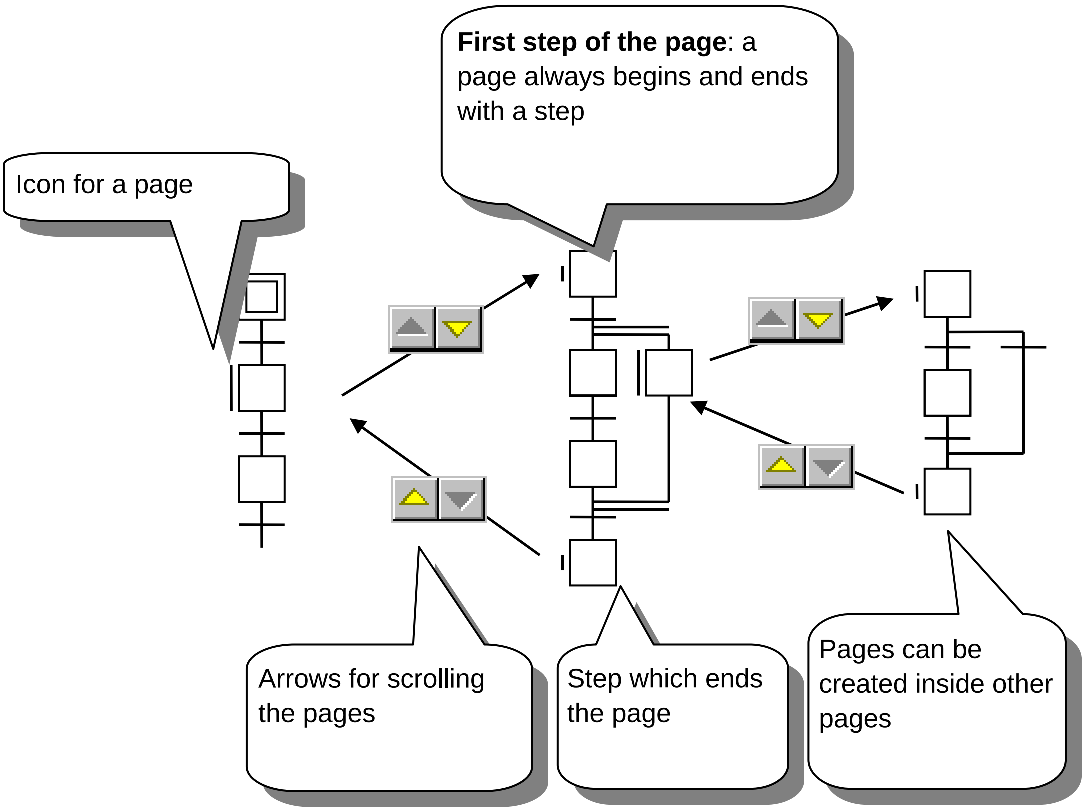
The *Run to Element* button processes all the Graftec steps and transitions and stops when the selected element is reached. If the program is already running, it will stop at the selected element.

8.7 Grouping a Graftec program into pages

Graftec allows a sequence of steps and transitions to be grouped into a new element called a *Page*. The element looks like a step, and can have its own comment, but is distinguished by an additional vertical line on the left hand side.

Pages allow the Graftec structure to represent the process from a higher level, and each page can be opened to display the next level of detail, which is composed of more pages, steps and transitions.

Pages can themselves contain pages, without any nesting depth limitations. The nesting of pages is bit like a zoom function which permits the representation of the program to several levels of detail.


First step of the page: a page always begins and ends with a step
Icon for a page
Arrows for scrolling the pages
Step which ends the page
Pages can be created inside other pages

8.7.1 Rules for editing pages

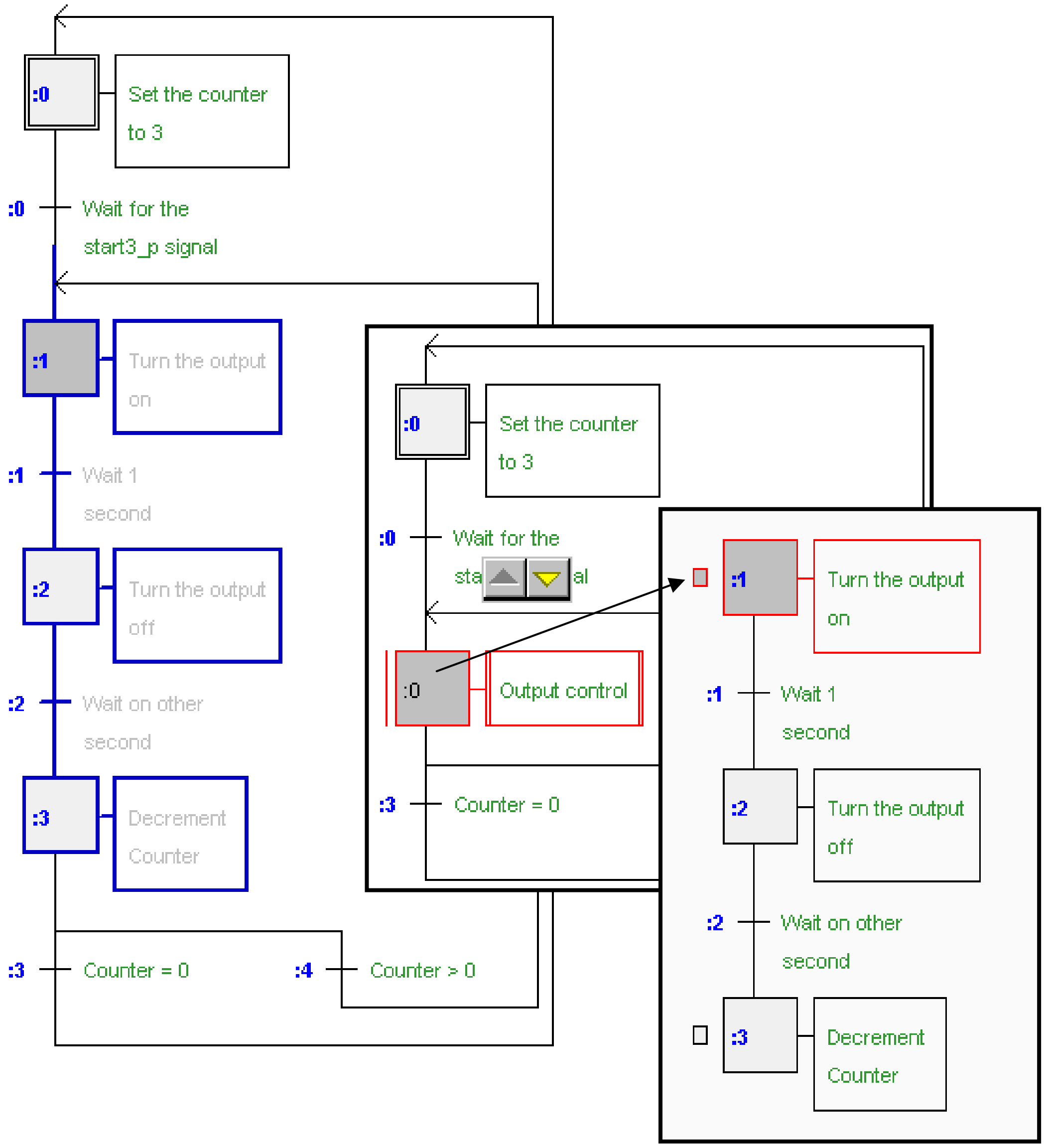
Graftec sequences to be made into pages must respect a few rules:

- A page must always start and end with a step.
- The sequence cannot be only one step.
- The entry and exit steps cannot be deleted.

8.7.2 Creating a new page

To create a new page, proceed as follows:

- Activate *Select mode*
- Select the first step for the page
- Hold down the *Shift* key and select the last page of the sequence
- Use the menu command *Page*, *Create*



8.7.3 Opening pages

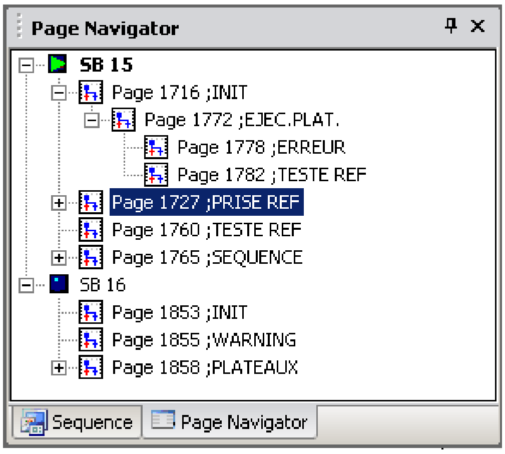
To view the contents of a page, select the page and use the *Page, Subpage* menu command or toolbar button.

The command *Page, Calling* collapses the page to view the level above. The top level page is shown by the command *Go To Main*

8.7.4 Expanding a page

To replace a page with its original sequence, select the page and use the *Page, Expand* command.

8.7.5 Block Navigator



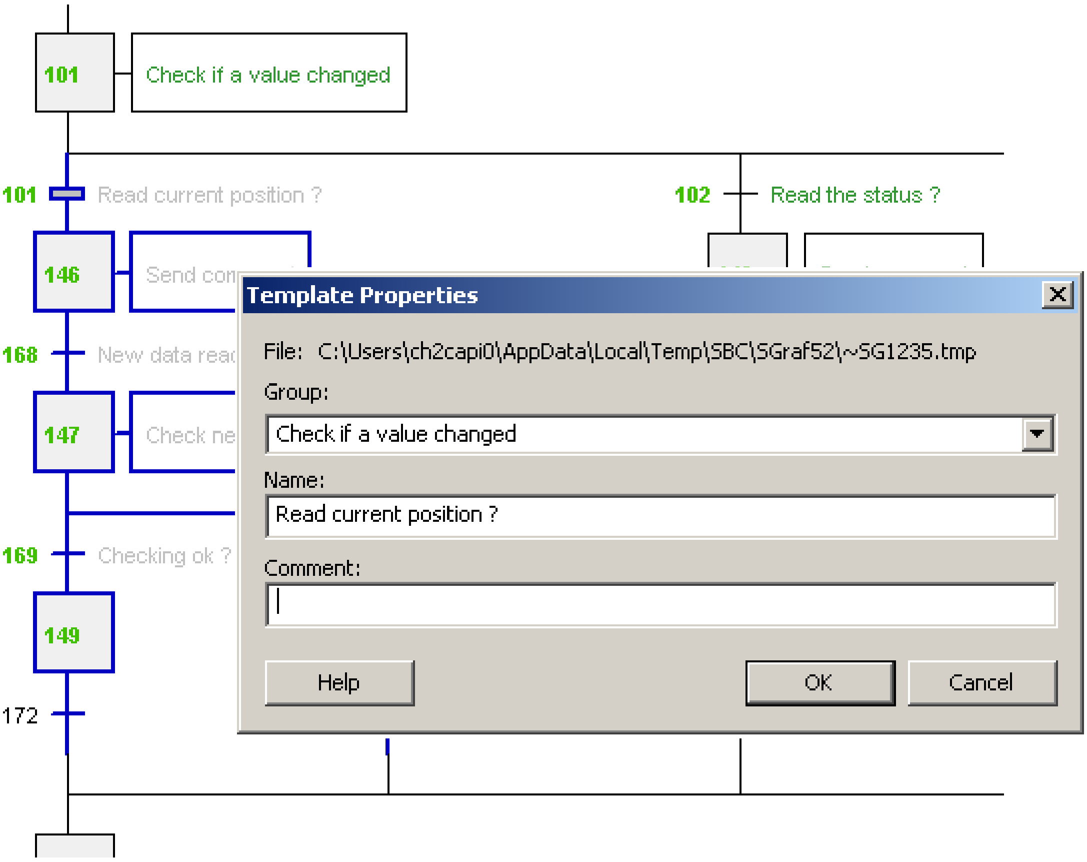
It is strongly recommended to reduce the size of a large Graftec structure by using *pages*. This makes it easier to read the program and to navigate between the high level functionality represented by the pages.

The *Block Navigator* provides a global view of all the SBs and pages in the file. The selection of a block or a page in this view displays the corresponding block or page without having to search for it in the Graftec structure.

8.8 Graftec templates

Sequences of steps and transitions can be grouped into *templates* which can be used like a library of sequences in other programs.

8.1.1 Creating a template



Template Properties

File: C:\Users\ch2capi0\AppData\Local\Temp\SBC\SGraf52\~SG1235.tmp

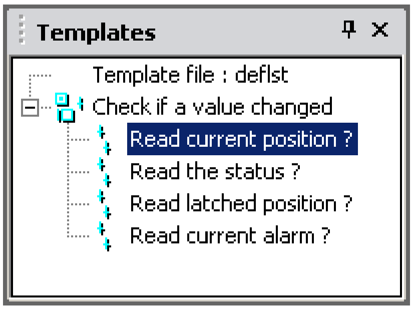
Group: Check if a value changed

Name: Read current position ?

Comment:

It is very easy to create a template. Select a sequence of steps and transitions, and use the *Edit, Add to templates* command. The command is also on the context menu. A dialog box is displayed which prompts for a group name, template name and comment.

Templates are organised into *Groups* which are comparable to FBox *Families*. The groups classify the templates according to the criteria defined by the author. Templates are listed below their group names in the *Templates* window.



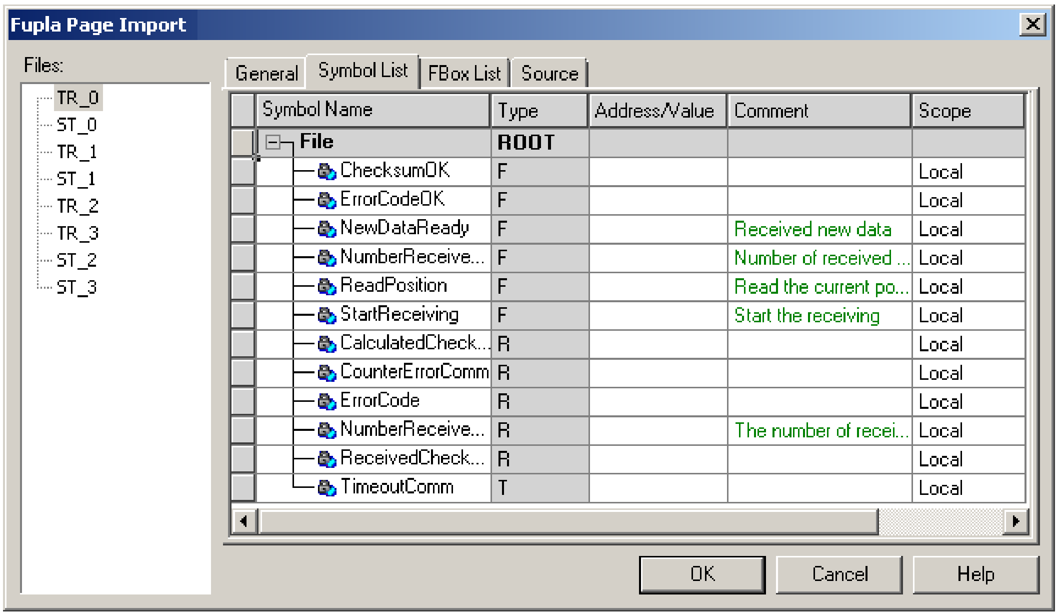
Template file : deflst
Check if a value changed
Read current position ?
Read the status ?
Read latched position ?
Read current alarm ?

The icons show how the template starts and ends. Any sequence can be made into a template, they can contain pages, branches, etc, and be coded in Fupla or IL.

8.1.2 Importing templates

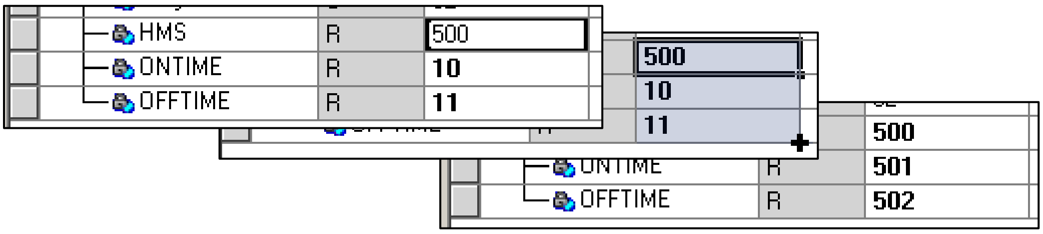
The templates can be used in any projects. Open the *Templates* window using *View, Templates*, and drag-and-drop the template into the Graftec structure. All the steps, transitions, branches, symbols, comments and associated Fupla or IL code are inserted.

A dialog box is displayed which allows the modification of the names, addresses, comments and scopes of symbols imported by the template, and changes to various other data. This functionality can be compared to a *Macro* or *Function Box* with parameters.



Symbol Name	Type	Address/Value	Comment	Scope
File	ROOT			
ChecksumOK	F			Local
ErrorCodeOK	F			Local
NewDataReady	F		Received new data	Local
NumberReceive...	F		Number of received ...	Local
ReadPosition	F		Read the current po...	Local
StartReceiving	F		Start the receiving	Local
CalculatedCheck...	R			Local
CounterErrorComm	R			Local
ErrorCode	R			Local
NumberReceive...	R		The number of recei...	Local
ReceivedCheck...	R			Local
TimeoutComm	T			Local

The *Symbol List* tab shows all the symbols contained in the template. The fastest way to rename the symbols and prevent duplication of symbol names is to put all the symbols into a symbol Group. The context menu command *Insert Pre-group* will place the symbols below into a group with the name of your choice.



HMS	R	500
ONTIME	R	10
OFFTIME	R	11

500
10
11

		500
ONTIME	R	501
OFFTIME	R	502

To update the addresses of symbols, they can be sorted by type by pressing the column header button *Type*, edit the address of the first element, then drag the tiny square on the bottom right of the cell downwards to select all the addresses to be renumbered.

To import the same template several times, see the parameters on the *General* tab. It allows an index to be inserted into the symbol names or groups using the # character. This character is automatically replaced by the index number, incremented by one for each copy of the template. The context menu command *Indexing* can also be used.

Contents

9 Programming in IL (Instruction List)

The Saia PG5 IL editor (S-Edit) can be used to create the fastest and most efficient programs for Saia PCD controllers. IL stands for Instruction List, which is a low level non-graphical language using the PCD's native instruction set. All PCD models share the same instruction set, thereby guaranteeing portability of programs from one PCD to another.

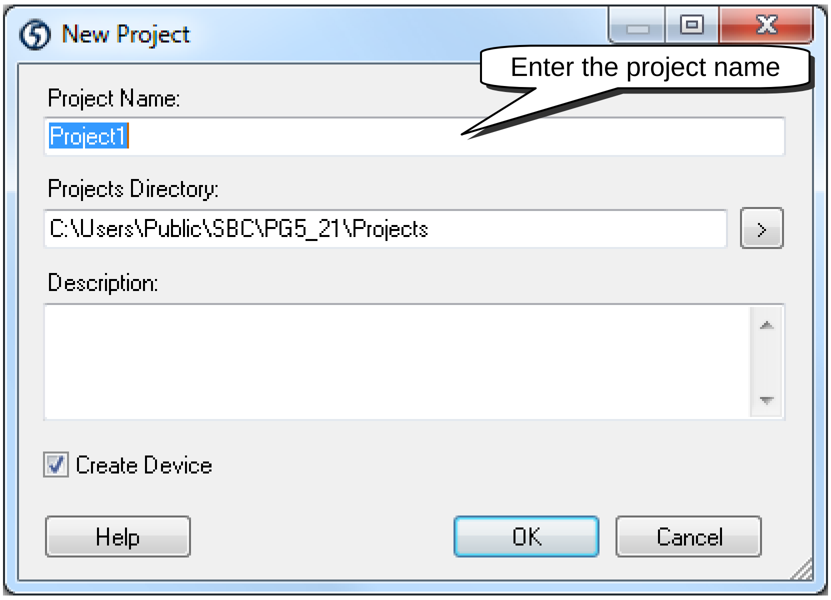
The IL editor is more than just a valuable aid to program editing, it is also a diagnostic and on-line testing tool.

9.1 Preparing an IL project

First, prepare a new project and file in which to edit the IL program.

9.1.1 Create new project

In the *Saia PG5 Project Manager* window, select menu *File, Project, New…* and create the new project.



Enter the project name

New Project

Project Name: Project1

Projects Directory: C:\Users\Public\SBC\PG5_21\Projects

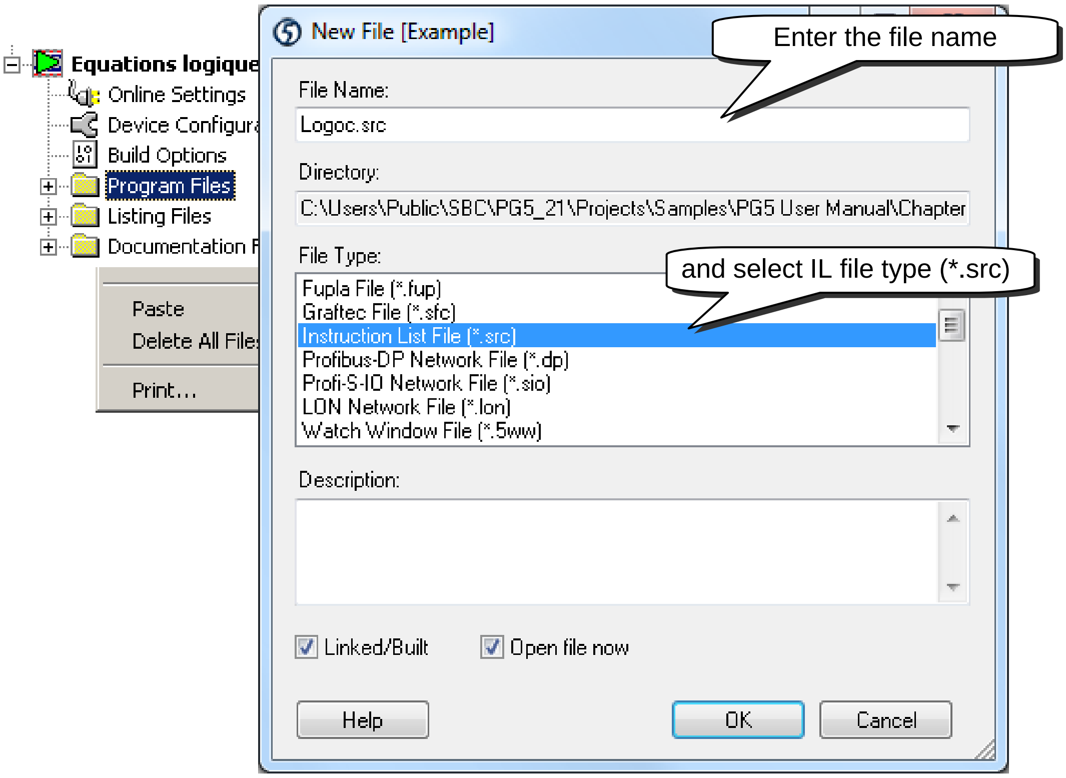
Description:

☑ Create Device

9.1.2 Create new IL file

New File

To add a new program file to the project, select the folder *Program Files*, right-click with the mouse, and select menu *New…* (or press the *New File* button on the toolbar):



Enter the file name

and select IL file type (*.src)

New File [Example]

File Name: Logoc.src

Directory: C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Chapter

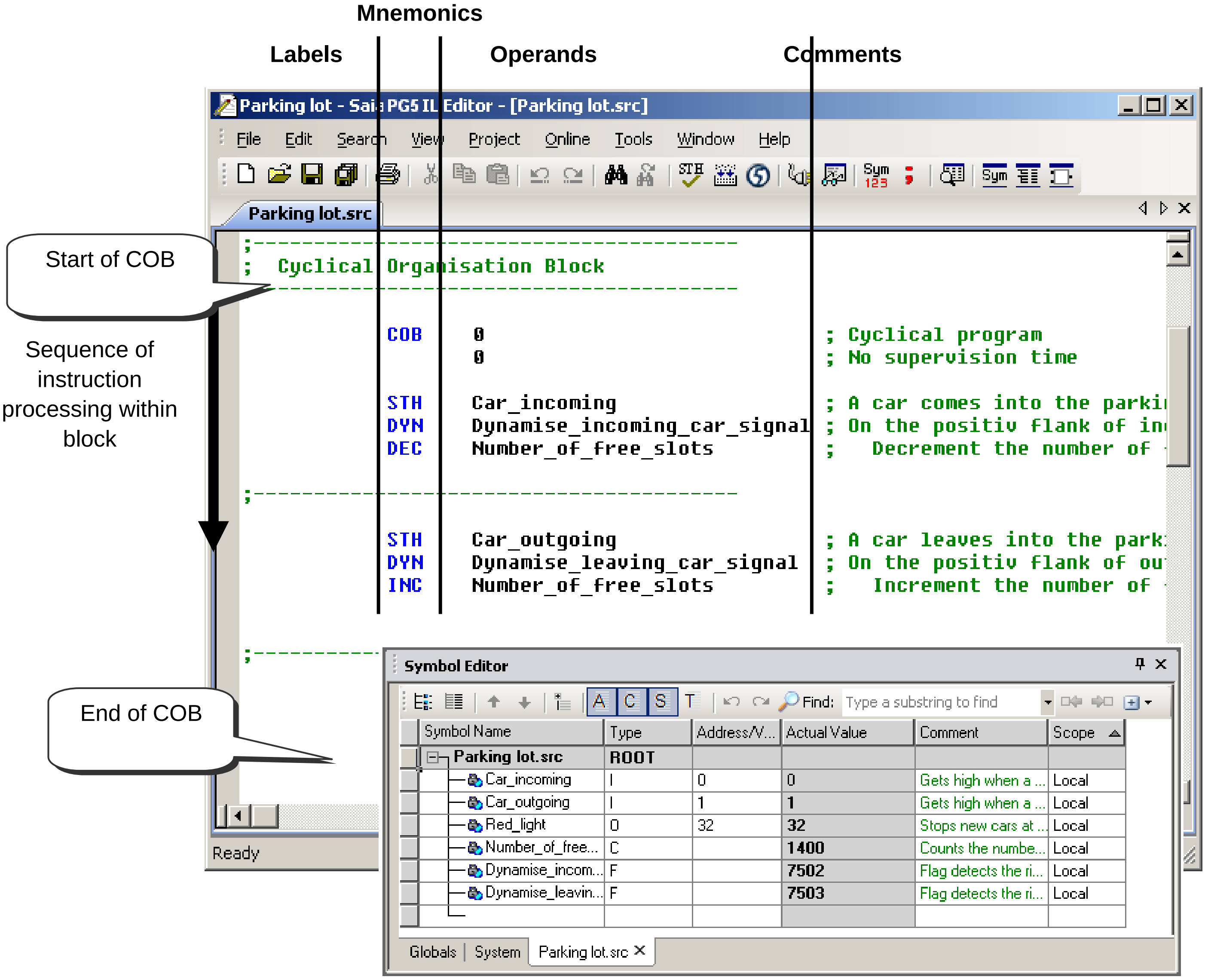
File Type:

- Fupla File (*.fup)
- Graftec File (*.sfc)
- Instruction List File (*.src)
- Profibus-DP Network File (*.dp)
- Profi-S-IO Network File (*.sio)
- LON Network File (*.lon)
- Watch Window File (*.5ww)

Description:

☑ Linked/Built ☑ Open file now

9.2 Layout of the IL Editor window


Mnemonics
Labels
Operands
Comments
Start of COB
Sequence of instruction processing within block
End of COB
Parking lot - Saia PG5 IL Editor - [Parking lot.src]
File Edit Search View Project Online Tools Window Help
Parking lot.src
Ready
Symbol Editor
Find:
Type a substring to find
Globals System Parking lot.src

```
;-------------------------------------------
;  Cyclical Organisation Block
;-------------------------------------------

        COB     0                             ; Cyclical program
                0                             ; No supervision time

        STH     Car_incoming                  ; A car comes into the parki
        DYN     Dynamise_incoming_car_signal  ; On the positiv flank of inc
        DEC     Number_of_free_slots          ;   Decrement the number of

;-------------------------------------------

        STH     Car_outgoing                  ; A car leaves into the park
        DYN     Dynamise_leaving_car_signal   ; On the positiv flank of ou
        INC     Number_of_free_slots          ;   Increment the number of


;-----------
```

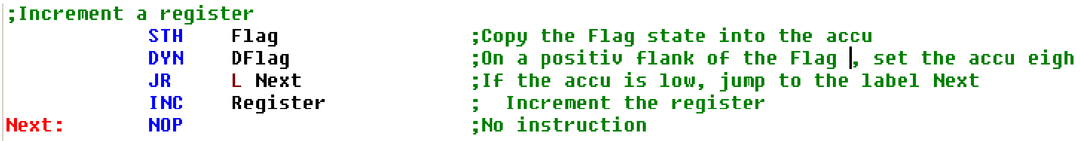
Symbol Name	Type	Address/V...	Actual Value	Comment	Scope
Parking lot.src	ROOT				
Car_incoming	I	0	0	Gets high when a ...	Local
Car_outgoing	I	1	1	Gets high when a ...	Local
Red_light	O	32	32	Stops new cars at ...	Local
Number_of_free...	C		1400	Counts the numbe...	Local
Dynamise_incom...	F		7502	Flag detects the ri...	Local
Dynamise_leavin...	F		7503	Flag detects the ri...	Local

The IL editor is similar to any other commercial text editor. The same editing features are present, such as *Copy/Paste* or *Find/Replace*. However, the IL editor offers more than just conventional text editing:

- Automatic formatting of each line as it's entered
- Syntax colouring, enabling each type of information to be identified
- Integrated *Symbol Editor* window
- Online step-by-step and debugging features

9.2.1 Editing a line of code

Label **Mnemo. Operand** **Comment**



```
;Increment a register
            STH     Flag                ;Copy the Flag state into the accu
            DYN     DFlag               ;On a positiv flank of the Flag , set the accu eigh
            JR      L Next              ;If the accu is low, jump to the label Next
            INC     Register            ;  Increment the register
Next:       NOP                         ;No instruction
```

IL program lines are formatted into 4 columns:

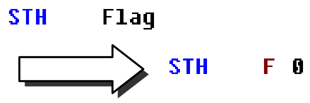
Label
Represented by the default colour red, the label is a symbol name for a program line, which is used as a destination for jump instructions, e.g. `JR L Next` .

Mnemonic
Represented by the default colour blue, the mnemonic is the instruction's name.

Operand
Represented by the default colour black, the operand defines the data type: input, output, flag, register, etc. which the instruction will operate on.

View Symbols or Values

The *View Symbols or Values* button allows either the operand address or its symbol to be displayed.

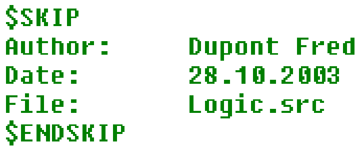


```
STH     Flag
```

```
STH     F 0
```

Comment
Program comments are shown in green and begin with a semi-colon. They are aligned on the right of the mnemonic and operand, but may also occupy a whole line.

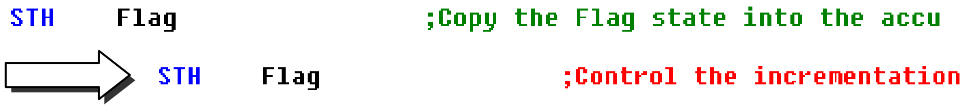
If the comment will take several lines, it can be edited between two directives: $SKIP and $ENDSKIP. These tell the assembler to disregard all text which appears between them.



```
$SKIP
Author:     Dupont Fred
Date:       28.10.2003
File:       Logic.src
$ENDSKIP
```

View User or Auto Comment

The *View User or Auto Comment* button can be used to view either the user comments attached to each line of the program, or the automatic comments attached to each symbol as defined in the *Symbol Editor* window.



```
STH     Flag                ;Copy the Flag state into the accu
```

```
STH     Flag                ;Control the incrementation
```

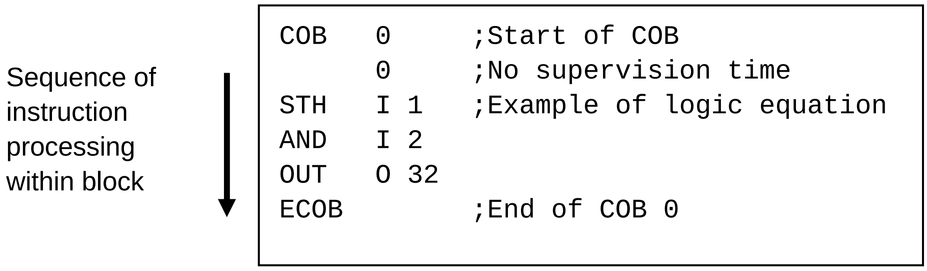
9.2.2 Automatic formatting of instruction lines

If the *Auto Format while typing* option is enabled, whenever *Enter* is pressed at the end of a line, the line is auto-formatted using the user-defined column widths. Options are defined from the menu command *Tools, Options*.

If auto-formatting is off, lines can be marked and formatted using the *Tools, Auto Format* menu command.

9.2.3 Creating an organization block

IL file for a small program



```
COB   0     ;Start of COB
      0     ;No supervision time
STH   I 1   ;Example of logic equation
AND   I 2
OUT   O 32
ECOB        ;End of COB 0
```

The Saia PCD programming language is structured using organization blocks, in which the user writes application programs.

Each block provides a particular service: cyclical organization blocks (COB) for cyclical programs; sequential blocks (SB) for sequential programs, program blocks (PB) for subroutines; function blocks (FB) for subroutines with parameters; exception organization blocks (XOB) for exception routines.

Blocks are delimited by a start instruction and an end instruction. For example, the instruction COB marks the start of a cyclic organization block, which ends with the same instruction preceded by the letter E for "end" (ECOB). All program code belonging to this block must be placed between the instructions COB and ECOB, never outside the block.

Even the smallest PCD program will always have a COB. Other blocks may then be added as required.

9.2.4 Sequence of processing for instructions and blocks

Within each block, the PCD processes program instructions line by line, from the start instruction to the end-of-block instruction.

The order in which instruction lines are written within an organization block is important. However, the order in which the organization blocks themselves are written is not important. Different rules define the sequence of block processing:

In a PCD coldstart, the programmable controller first looks for XOB 16, the coldstart block. If it is present, it will always be processed first, regardless of whether it is at the beginning or end of the file.

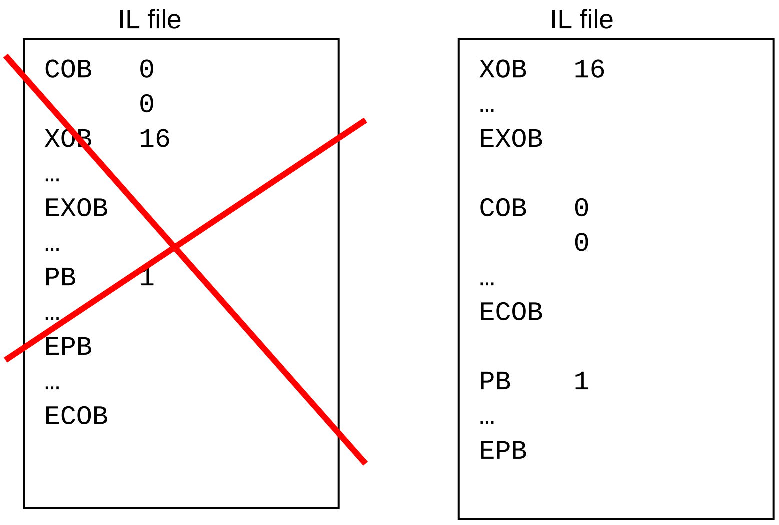
Then, the machine looks for COBs in the program and processes them in numerical order: COB 0, COB 1, … COB 15, regardless of the order in which they appear in the file. After the last COB, the program will start again from COB 0.

All the blocks for sequential programs (SB), subroutines (PB) and functions (FB) are called by the user program with the instructions CSB (Call SB), CPB (Call PB) and CFB (Call FB). The user program therefore determines when and in what order SBs, PBs and FBs are processed.

All exception blocks are automatically called as soon as the particular event concerned occurs. These events are unpredictable and may happen at any time. The order in which they are processed cannot be defined. Each hardware or software event is linked to a distinct XOB. These events cannot be modified by the user. However, the user is free to program which action to take within each of the XOBs.

9.2.5 Rules to follow when editing blocks

Even though blocks can be written in any order, the following rules must be followed:



IL file

```
COB    0
       0
XOB    16
…
EXOB
…
PB     1
…
EPB
…
ECOB
```

IL file

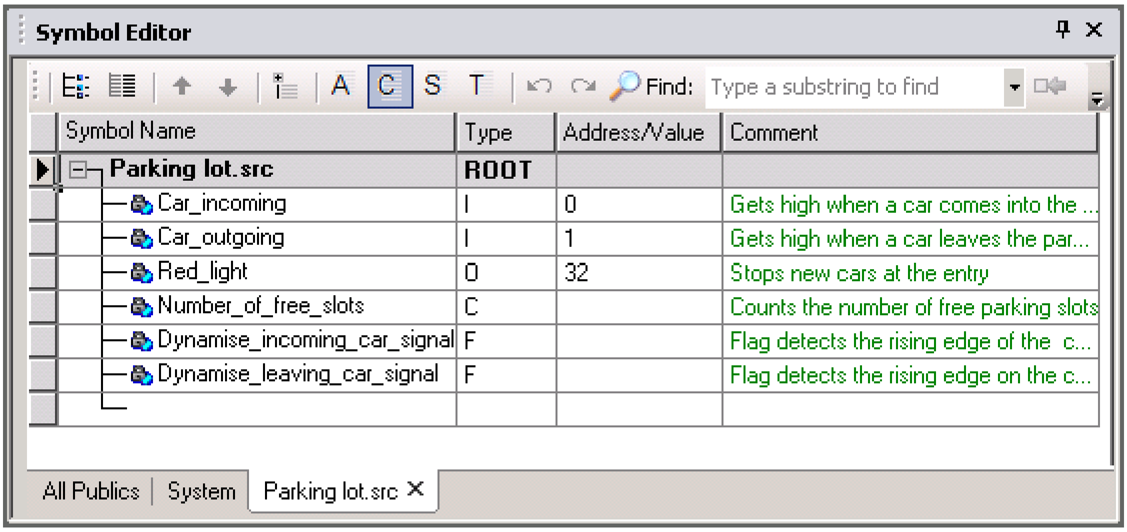
```
XOB    16
…
EXOB

COB    0
       0
…
ECOB

PB     1
…
EPB
```

Blocks cannot be written inside other blocks. They must always follow each other.
No program instructions may be defined outside a block, with the exception of symbol definitions, texts and data blocks.

9.3 *Symbol Editor* window

Sym

Show Hide Symbols Editor



Symbol Name	Type	Address/Value	Comment
Parking lot.src	ROOT		
Car_incoming	I	0	Gets high when a car comes into the ...
Car_outgoing	I	1	Gets high when a car leaves the par...
Red_light	O	32	Stops new cars at the entry
Number_of_free_slots	C		Counts the number of free parking slots
Dynamise_incoming_car_signal	F		Flag detects the rising edge of the c...
Dynamise_leaving_car_signal	F		Flag detects the rising edge on the c...

The *Symbol Editor* window contains a list of the data a program. It can be viewed with the *Show/Hide Symbol Editor* button, or via the menu command*View/Symbol Editor.* Each line defines all the information relative to an operand and constitutes a symbol:

Symbol Name

The symbol name is the name assigned to the input, output, flag, register, etc. Using a name is better than using a number because it makes the program easier to understand and easier to maintain. It allows changing an address, data type or comment from the *Symbol Editor* window and it is updated throughout the open file.

Syntax for symbol names

The first character is always a letter, followed by other letters, numbers, or the underscore character. Do not use accented characters (ö,è,ç,…).

Differences of case (upper or lower) have no significance: `MotorOn` and `MOTORON` are the same symbol.

Type

Defines the data type: input (I), output (O), register (R), counter (C), timer (T), TEXT, DB, etc. R FLOAT is a register which contains a floating point value.

Address

Each data type has its own range of available addresses:
Inputs and outputs: dependent on I/O modules inserted in PCD
Flags: F 0..16383
Registers: R 0..16383
Timers/counters: T/C 0..1599 (the number of timers is configured from the *Build Options*)

Comment

;

View User or Auto Comment

```
STH     Flag                ;Copy the Flag state into the accu
```

⇨
```
STH     Flag                ;Control the incrementation
```

The comment is linked to the symbol and can be viewed instead of the user comment linked to each line of program code.
Toggle with the button *View User* or *Auto Comment.*

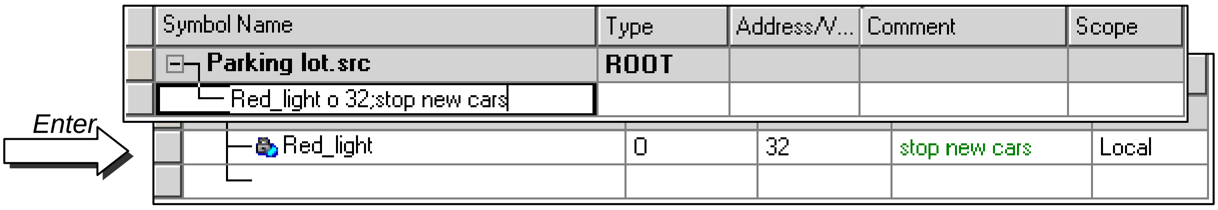
9.3.1 Add new symbol to *Symbol Editor* list

There are several ways to create new symbols.

Simple method

To add a symbol to the list, open the *Symbol Editor* window, position the mouse in the middle of the window and right-click to select the context menu *Insert Symbol*. Then fill in the fields: *Symbol Name*, *Type*, *Address/Value*, *Comment* and *Scope.*

Quick method 1



Symbol Name	Type	Address/V...	Comment	Scope
⊟ Parking lot.src	ROOT			
Red_light o 32;stop new cars				

Symbol Name	Type	Address/V...	Comment	Scope
Red_light	0	32	stop new cars	Local

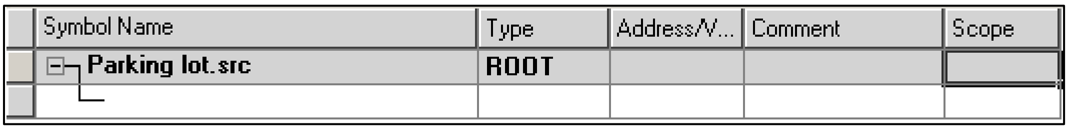
It is also possible to enter variables for the different information fields from the *Symbol Name* field. This is more practical and quicker. See example below.

Syntax to follow:

```
symbol_name  type  address  ;comment
```

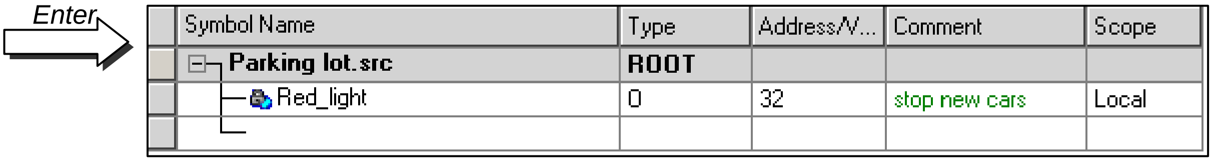
If the new symbol has been defined using the above syntax, pressing the *Enter* key on the keyboard will automatically validate and place information in the correct fields.

Quick method 2



Symbol Name	Type	Address/V...	Comment	Scope
⊟ Parking lot.src	ROOT			

```
sth  Red_light= o 32; stop new cars
```



Symbol Name	Type	Address/V...	Comment	Scope
⊟ Parking lot.src	ROOT			
Red_light	0	32	stop new cars	Local

Quick method 3

New symbols can also be added when editing the program. To do this, edit a line of program code with the mnemonic and its operand. For the operand, enter the symbol name and definition following the syntax below:

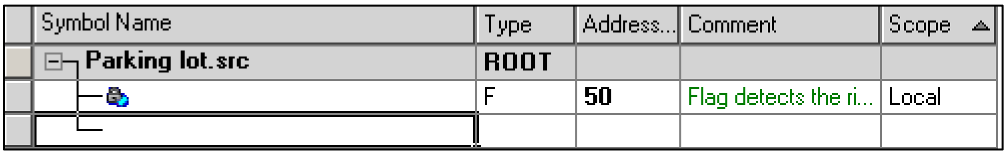
```
        symbol_name = type address  ;comment
e.g.    MySymbol=R 123 ;this is my symbol
```

Pressing the *Enter* key on the keyboard with automatically place the new symbol on the *Symbol Editor*.

9.3.2 Operand addressing modes

A symbol definition does not necessarily include all the information presented below. We distinguish between three types of addressing:

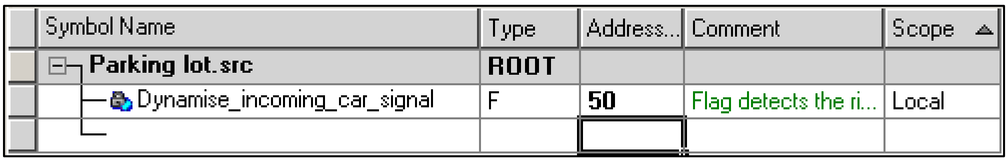
Absolute addresses



Symbol Name	Type	Address...	Comment	Scope
⊟ **Parking lot.src**	**ROOT**			
	F	**50**	Flag detects the ri...	Local

The data is defined only with a type and address (e.g. 32), and an optional comment. Using absolute addressing directly in the program is a disadvantage when changing the type or address. The user program will not be updated by changes made in the symbol list. Changes must be made manually for each line of a program. It is therefore preferable to use symbol names, with optional dynamic addressing.

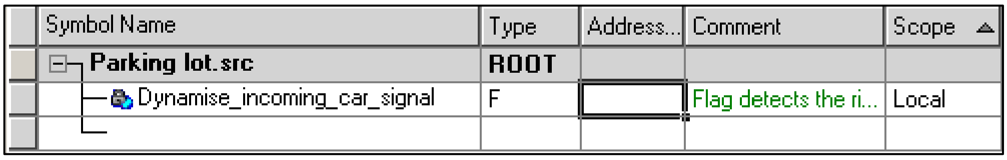
Symbol names



Symbol Name	Type	Address...	Comment	Scope
⊟ **Parking lot.src**	**ROOT**			
Dynamise_incoming_car_signal	F	**50**	Flag detects the ri...	Local

The data is defined with a symbol name, type, address and optional comment. Correction of symbol, type or address is supported from the symbol list and each user program line automatically updated if the symbol is changed.

Dynamic addressing



Symbol Name	Type	Address...	Comment	Scope
⊟ **Parking lot.src**	**ROOT**			
Dynamise_incoming_car_signal	F		Flag detects the ri...	Local

This is a form of symbolic addressing in which the address is not defined. The address is assigned automatically during the program build. The address is taken from an address range defined by the *Build Options*.. (See Project Manager.)

Note: Dynamic addressing is available with flags, counters, timers, registers, texts, DBs, COBs, PBs, FBs and SBs. However, absolute addresses must always be defined for inputs, outputs and XOBs.

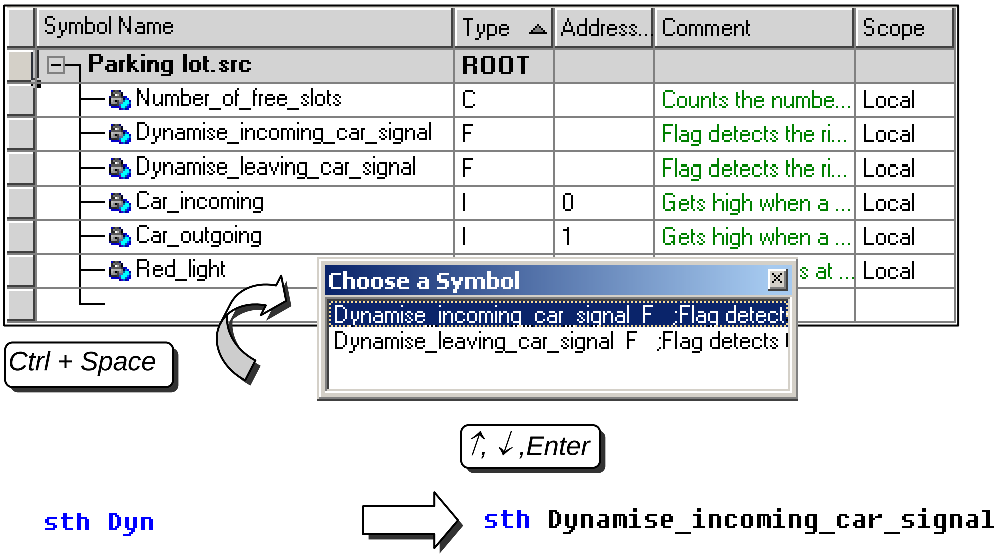
9.3.3 Using the *Symbol Editor*

When a program is edited, symbols already defined in the *Symbol Editor* window can be used in different ways:

Symbol entry from the keyboard

The symbol name is entered in full from the keyboard for each instruction that uses it. This method might allow a symbol name to be edited with a typing error, which would only become evident when the program was built.

Symbol entry by selective searching



Symbol Name	Type	Address..	Comment	Scope
Parking lot.src	ROOT			
Number_of_free_slots	C		Counts the numbe...	Local
Dynamise_incoming_car_signal	F		Flag detects the ri...	Local
Dynamise_leaving_car_signal	F		Flag detects the ri...	Local
Car_incoming	I	0	Gets high when a ...	Local
Car_outgoing	I	1	Gets high when a ...	Local
Red_light			s at ...	Local

Choose a Symbol

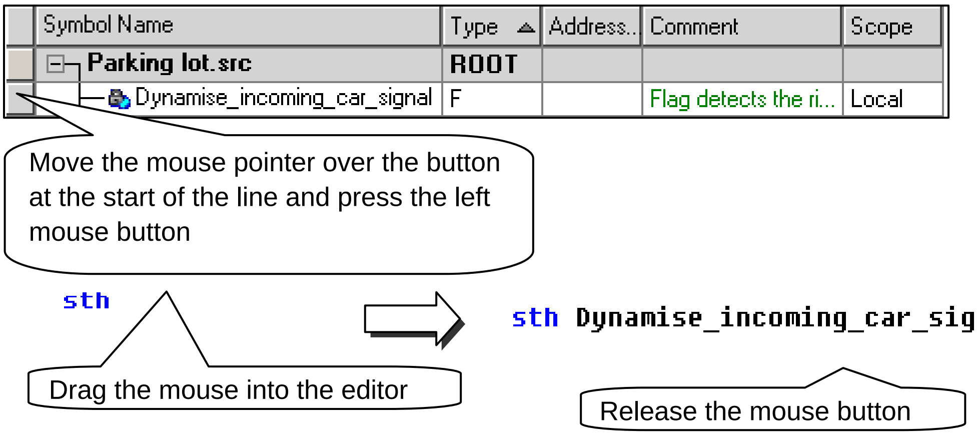
```
Dynamise_incoming_car_signal F  ;Flag detect
Dynamise_leaving_car_signal F  ;Flag detects l
```

```
sth Dyn
```

```
sth Dynamise_incoming_car_signal
```

If only the first few characters of the symbol name are entered from the keyboard, pressing the *Ctrl+Space* keys at the same time displays a window showing a list of all the symbols which start with the letters which have been typed. The required symbol can then be selected either with the mouse or the keyboard arrow keys (↑, ↓) and confirmed by pressing *Enter*.

Symbol entry by drag-and-drop



Symbol Name	Type	Address..	Comment	Scope
Parking lot.src	ROOT			
Dynamise_incoming_car_signal	F		Flag detects the ri...	Local

Move the mouse pointer over the button at the start of the line and press the left mouse button

```
sth
```

Drag the mouse into the editor

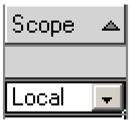
```
sth Dynamise_incoming_car_signal
```

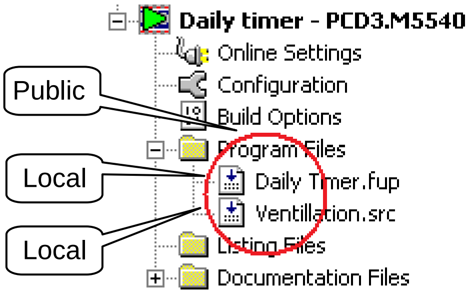
Release the mouse button

This way of using a symbol excludes any possibility of typing errors. In the *Symbol Editor* window, position the mouse pointer over the button at the start of the symbol line, press the left-hand mouse button and keep it down. Drag the mouse cursor into the IL editor and release the mouse button. The symbol chosen is inserted at the mouse pointer position.

9.3.4 Local, Public and External symbols

The view with the symbols definition includes a Scope cell to define the option: *Local*, *Public* or *External*.

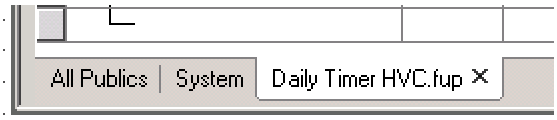




A symbol's scope defines the accessibility of the symbol:

Local symbols are accessible only within the file which contains the symbol definition. For example, only inside *Daily timer.fup*.

Public symbols are accessible from all files in the *device*. For example, publics symbols are shared by both the files *Parking lot.fup* and *Ventilation.src* in device *Daily timer*, regardless of which file defines the symbol.



The Symbol Editor typically shows three views: a view with the name of the open Fupla file, two views called *ALL Publics* and *System*:

The view with the name of the open file allows the definition of all the locals and publics symbols used by the program of this file.

New symbols created in the Symbol Editor or the Fupla editor are by default either *Local* or *Public* depending on an option defined by Fupla's *View, Options, Symbols, Add symbols with Public scope.*

The *ALL Publics* view shows all publics symbols in the device. The *System* view shows all the system symbols. The symbols on the *ALL Publics* and *System* pages are updated when a file is saved or when a *Build* is done.

These pages use the results of the *Build* to gather all the publics and system symbols from all the files in the device's program and show them in a single view.

To place a public or system symbol into the program, select the symbol on the Public or System view and do a drag-and-drop of the symbol onto the Fupla page. The reference to the public symbol is placed into the file's symbols page with the scope *External*. This shows that the symbol is defined in another file.

The symbols on the *ALL Publics* page are not editable. Public symbol definitions can only be edited from the file which defines them. You can use the context menu's *Goto Definition* command to open the file which defines the symbol. The *File* column shows the name of the file which defines the symbol, this is the file which must be opened to modify the symbols.

9.4 Introduction to the PCD instruction set

This section provides and overview of the PCD instruction set. For more detailed information, consult the full description of each instruction given in the *Instruction Guide 26/733* or on the PG5 help screens. To obtain specific help about an instruction from the IL editor: write the instruction, put the cursor on it and press key *F1*. General help is also available with the menu *Help, Instruction List Help.*

9.4.1 The accumulator (ACCU)

The accumulator is a binary value whose state is set by binary instructions and a some integer instructions. The PCD has just one accumulator, which may be considered as a special kind of flag. The state of the accumulator can be forced with the *ACC* instruction, which also allows the accumulator to be set to the value of a status flag (see description of status flags).

Examples:

`ACC H`

Forces accumulator state high

`ACC L`

Forces accumulator state low

`ACC C`

Inverts (complements) accumulator state

9.4.2 Binary instructions

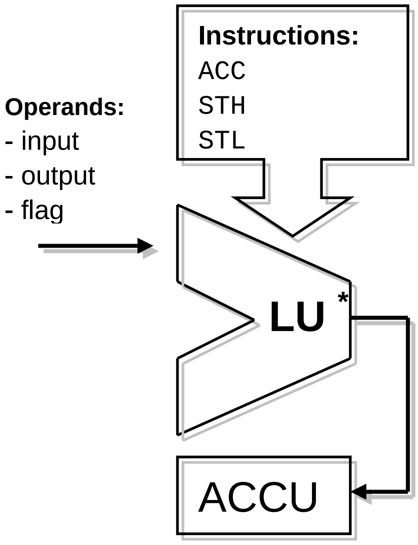
Binary instructions use operands that may have just one of two distinct states: 0 or 1 (low or high). These instructions are used to perform binary equations with the states of PCD inputs, outputs, flags, counters and timers.

Binary instructions always involve the accumulator. Some binary instructions affect the state of the accumulator:

Examples:
ACC H
Forces accumulator state high

ACC L
Forces accumulator state low

STH I 4
Copies state at input 4 to accumulator.
The accumulator state will be high if 24 volts are applied to input 4.
The accumulator state will be low if zero volts are applied to input 4.

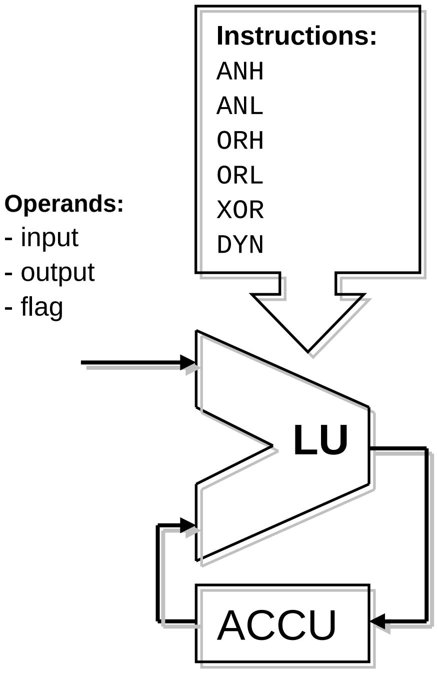


Other instructions read the state of the accumulator to execute a binary function and put the result back into the accumulator:

Examples:
ANH I 5
Reads accumulator state and executes logical AND function with state of input 5. The accumulator is set to the result.

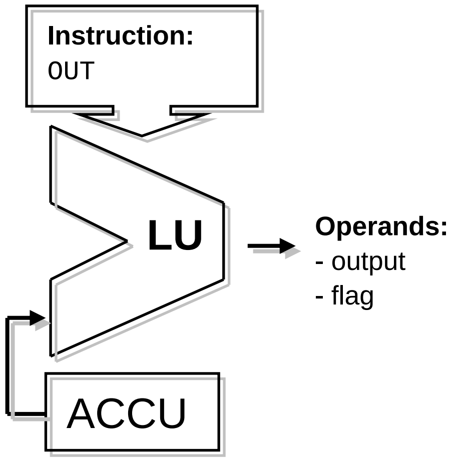
ORH F 100
Reads accumulator state and executes logical OR function with the state of flag 100. The accumulator is set to the result.

XOR T 3
Reads accumulator state and executes logical XOR function with the state of timer 3. The accumulator is set to the result.



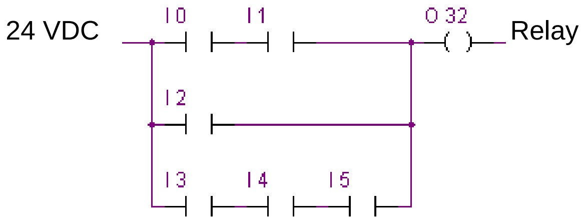
The result of any binary equation is always saved in the accumulator. The *OUT* instruction allows the content of the accumulator to be copied to an output or flag:

Example:
OUT O 32
Copies accumulator state to output 32.
If accumulator state is high, 24 volts will be applied to output 32.
If accumulator state is low, zero volts will be applied to output 32.



Example: programming a simple binary equation

This example of a program performs the binary equation: O32 = I0*I1+I2+I3*I4*I5
It may also be represented by the following diagram :

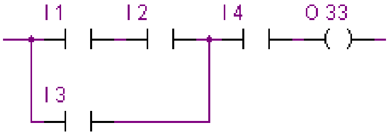


A binary equation always starts with a STH or STL instruction, which will then be followed by the necessary *ANH* (*), *ORH* (+), *XOR* functions.
Note that the ORH instruction has priority over ANH. Each ORH instruction marks the start of a new line of contacts in the above diagram. The partial or final result of a binary equation is always put in the accumulator. The *OUT* instruction enables the accumulator result to be used to modify the state of an output or flag.

```
COB    0   ;Start of cyclic program
       0
STH    I 0 ;Copies state of input I 0 to accumulator: Accu = I0
ANH    I 1 ;AND function between state of accumulator and
           ; input 1:Accu = I0*I1
ORH    I 2 ;OR function between state of accumulator and
           ; input 2:Accu= I0*I1+I2
ORH    I 3 ; Accu = I0*I1+I2+I3
ANH    I 4 ; Accu = I0*I1+I2+I3*I4
ANH    I 5 ; Accu = I0*I1+I2+I3*I4*I5
OUT    O 32;Copies result of equation present in accumulator
           ; to output
ECOB       ;End of cyclic program
```

Example: Programming a binary equation with a specific order of evaluation.

This example of a program performs the binary equation : O33 = (I1*I2+I4)*I3
It may also be represented by the following diagram :



It is sometimes necessary to change the order of priority of binary functions. Generally, we do this by putting brackets into the equations. However, the PCD instruction set does not support brackets. The equation must therefore be divided into two smaller equations. The first equation works out the result of the bracketed part and saves it temporarily to a flag, while the second equation takes the interim result saved on the flag and calculates the final result.

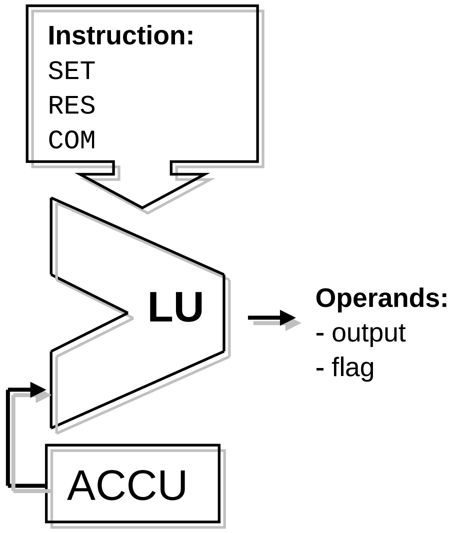
```
COB    0
       0
STH    I 1     ;First equation
ANH    I 2
ORH    I 4
OUT    F 0     ;Result of bracketed function: F0 =(I1*I2+I4)

STH    F 0     ;Second equation
ANH    I 3
OUT    O 33    ;Final result: O 33 = F0*I3
ECOB
```

Other binary instructions also allow the accumulator to be used to modifiy the state of an output or flag. Each instruction supports a different function.

Example:
SET O 32
If accumulator state is high, output 32 will be forced high. Otherwise the output will remain in its current state.

RES O 32
If accumulator state is high, output 32 will be forced low. Otherwise the output will remain in its current state.

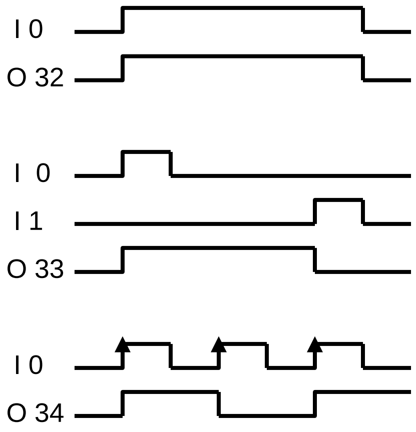
COM O 33
If accumulator state is high, output 33 will be inverted high. Otherwise the output will remain in its current state.



Example:

This example shows differences between the instructions OUT, SET, RES, and COM

```
COB   0
      0
STH   I 0
OUT   O 32  ;copy I 0 to O 32

STH   I 0
SET   O 33  ;set output 33 to 1

STH   I 1
RES   O 33  ;set output 33 to 0

STH   I 0   ;on rising edge of I 0
DYN   F 1
COM   O 34  ;invert output 34
ECOB
```



Some binary instructions end with the letter H or L. Instructions that end with L will invert the state of any information before performing their function.

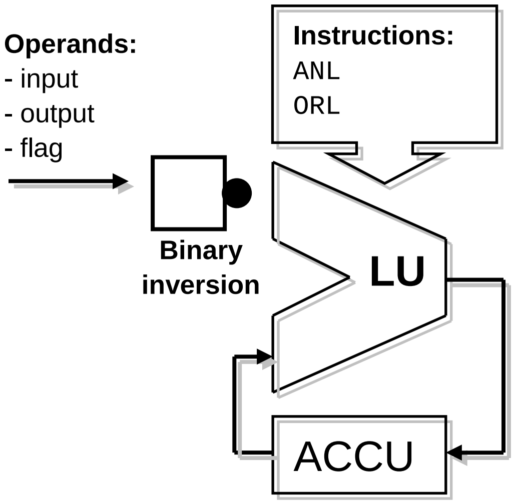
Examples:

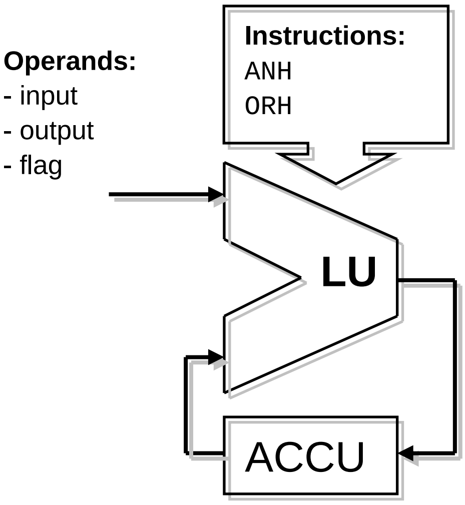
STH I 4
Copies state of input 4 to accumulator. Accumulator state is high if 24 volts are applied to input 4.

STL I 4
Copies inverse state of input 4 to accumulator. Accumulator state is low if 24 volts are applied to input 4.

ANH I 5
Performs a logical AND function between the accumulator state and the state of input 5.

ANL I 5
Performs a logical AND function between the accumulator state and the inverse state of input 5.





9.4.3 Edge detection

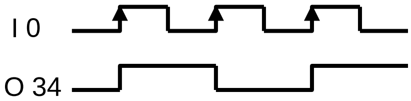
Binary instructions generally use the low or high binary state to perform a binary function or modify the state of an output or flag.

Sometimes it is not the low or high binary state that interests us, but the change of state.

To detect a rising edge, proceed as follows: place the result of a binary equation in the accumulator and use the *DYN* instruction to find the positive change. After the *DYN* instruction, the accumulator state will be high if a positive change has been detected, otherwise it will be low. The flag used by the *DYN* instruction may only be used for a single 'dynamisation' instruction. This is because it is used to conserve the state for the next program cycle.

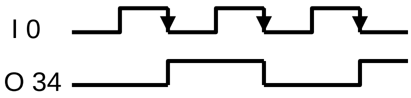
<u>Example:</u> detection of a rising edge

```
STH   I 0
DYN   F 3
COM   O 34
```



<u>Example:</u> detection of a falling edge

```
STL   I 0
DYN   F 3
COM   O 34
```



To help you see the influence of the *DYN* instruction on the program shown above, try removing the *DYN* instruction and see how the program behaves.

9.4.4 Status flags

Unlike binary instructions, integer 'word' instructions rarely use the accumulator. However, they almost always modify status flags.

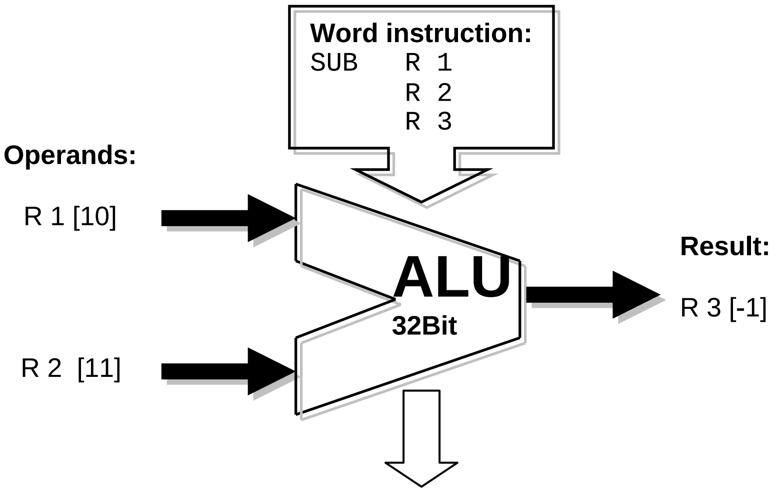
The PCD's 4 status flags are modified by word instructions and inform us of the result.

Flag positive	P	Set if the result is positive.
Flag negative	N	Set if the result is negative
Flag zero	Z	Set if the result is zero
Flag error	E	Set in case of error

The error flag may be set for a number of reasons, causing the exception block XOB 13 to be called:
- Overflow caused by an instruction which multiplies two large numbers
- Division by zero
- Square root of a negative number
- Error assigning the communications interface (SASI instruction)
- etc

Example: Status flags after a subtraction

Status flags are set depending on the result of a subtraction (R 3 = R 1 – R 2). Register values are shown in square brackets [ ]. The result of the subtraction is negative: flag N alone is set.



Word instruction:

```
SUB    R 1
       R 2
       R 3
```

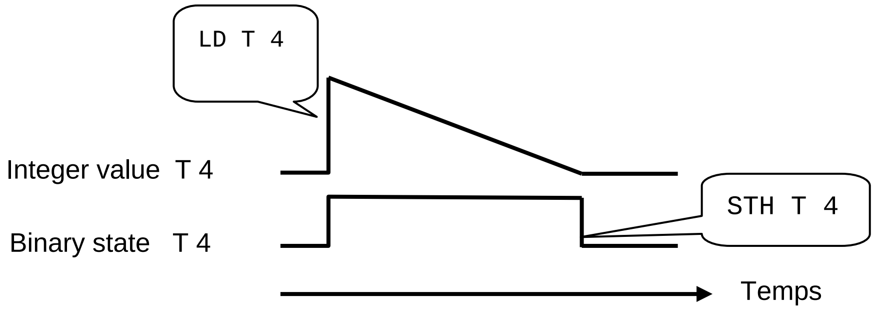
Status flags:

E	Z	N	P
0	0	1	0

If necessary, status flags can be copied to the accumulator for use with binary instructions, program jump instructions, or when calling PBs, FBs or SBs:

`ACC   P`	Copy status flag P to accumulator
`ACC   N`	Copy status flag N to accumulator
`ACC   Z`	Copy status flag Z to accumulator
`ACC   E`	Copy status flag E to accumulator

9.4.5 Instructions for timers

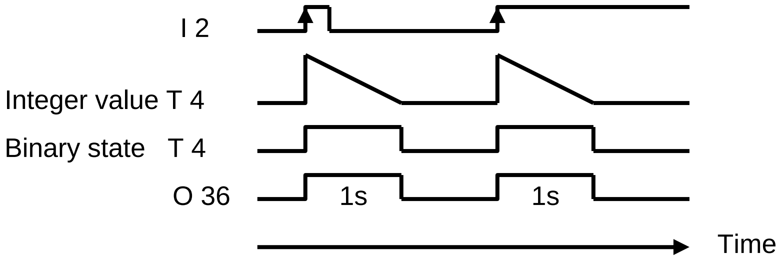


Timers contain two values: the integer delay time value and the timer's binary state.
To implement a delay time, load the time value as a positive integer that will determine the length of the delay time in tenths of a second[1]. The controller will automatically decrement the time value until it reaches zero. The timer's binary state is high while the time value is decrementing, and goes low when the time value reaches zero.

Loading a delay time	**Reading the state of the timer**
LD T 4 If the accumulator state is high, timer T 4 will be loaded with a constant of 10. Otherwise the timer will keep its current value.	Use a binary instruction, such as: STH T 4 , ANH T 4, ORH T 4, …

Example:
Send a one second pulse to output 36 for each rising edge at input 2

State diagram:



IL program:

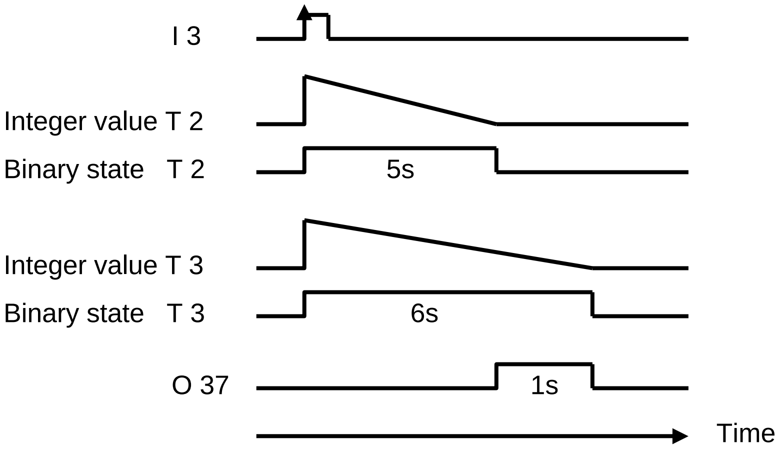
```
COB   0
      0
STH   I 2    ;Detection of rising edge at input 2
DYN   F 2    ;sets accu state high
LD    T 4    ;If accu is high, load time delay for 10 units of time
      10
STH   T 4    ;Copy logical state of time delay to output 36
OUT   O 36
ECOB
```

[1] A time base other than 1/10th of a second (default value) can also be set. This can be done from the *Build Options*..

Example:

Send a one-second pulse to output 37 with a 5 second delay for each rising edge at input 3

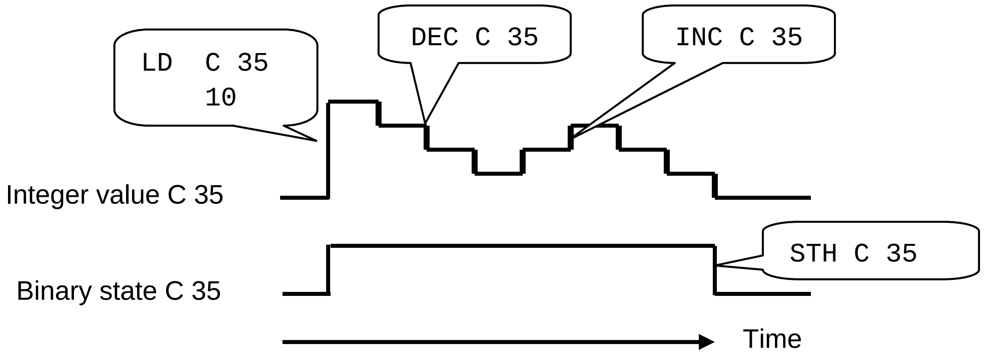
State diagram:



IL program:

```
COB    0
       0
STH    I 3
DYN    F 3
LD     T 2
       50
LD     T 3
       60
STH    T 2
XOR    T 3
OUT    O 37
ECOB
```

9.4.6 Instructions for counters



Like timers, counters also have two values: the integer count value and the binary state of the counter.
To implement counting, load the counter with a positive integer value.
Unlike timers, counters are only incremented or decremented by instructions in the user program. The counter's binary state is high when the count value is greater than zero and goes low when the count value reaches zero.

Loading a counter
LD C 35
10
If accumulator state is high, counter 35 will be loaded with a constant of 10. Otherwise the counter will keep its current value.

Reading the state of a counter

Use a binary instruction, such as:

STH C 35, ANH C 35, ORH C 35, …

Incrementing a counter
INC C 35
If accumulator state is high, counter 35 will increment by one unit. Otherwise the counter will keep its current value.

Decrementing a counter
DEC C 35
If accumulator state is high, counter 35 will decrement by one unit. Otherwise the counter will keep its current value.

Status flags
Instructions INC and DEC counter modify the status flags depending on the result of the operation (**Positive**, **Ne**gative, **Ze**ro, **Error**).

Example: Counting pulses from a binary input with a counter.

```
COB   0
      0
STH   I 2    ;Copy input state to accumulator
DYN   F 3    ;Force accu state high at positive edge of I 2
INC   C 35   ;If accu state is high, increment counter
ECOB
```

Instructions *STH* and *DYN* read information from input 2 and set the accu state high for a rising edge or low in the absence of an edge. Depending on the accu state, the *INC* instruction will increment counter 35.

9.4.7 Accumulator-dependent instructions

We have seen that binary instructions make much use of the accumulator, and that some word instructions also use it.

But not all instructions use the accumulator in the same way. There are 7 instructions which use it in a special way. These are the accumulator-dependent instructions. They are only processed if the accumulator has previously been set high. The accumulator state is therefore a determining condition.

The 7 accumulator-dependent instructions are listed below :

SET	
RES	
COM	
LD	Only for timers and counters
LDL	Only for timers and counters
INC	Only for timers and counters
DEC	Only for timers and counters

Example:
Create a time base that inverts an output once every second.
This example uses three instructions. The first (*STL*) uses the accumulator to put in it the timer's inverse state. The following two (*LD* and *COM*) depend on the accumulator. They will only load the time base and invert the output if the accumulator has previously been set high by the instruction *STL*.

```
COB   0
      0
STL   T 1   ;If the timer state is low, the accu state will be high
LD    T 1   ;load time delay with 10 units of time
      10
COM   O 38  ;invert output state
ECOB
```

9.4.8 Word instructions for integer arithmetic

These instructions are used for calculating arithmetical equations using integer format registers and constants. Each arithmetical instruction has several lines and applies operands to registers or constants, but the result will always be placed in a register.

Addition	**Subtraction**	**Square root**
ADD R 0 R 1 R 3 ;R3=R0+R1	SUB R 0 K 18 R 3 ;R3=R0-18	SQR R 100 R 101
Multiplication	**Division**	**Comparison**
MUL K 5 R 1 R 3 ;R3=5*R1	DIV R 0 R 1 R 3 ;R3=R0/R1 R 4 ;Reste	CMP R 0 R 1
Increment	**Decrement**	**Initialize register**
INC R 0 ;R0= R0+1	INC R 0 ;R0= R0+1	LD R 0 K 19 ; R 0 = 19

Status flags

All the above arithmetical instructions modify status flags according to the result of the operation (**Positive**, **Ne**gative, **Ze**ro, **Error**), with the exception of the instruction for loading a register with a constant (LD).

Differences between registers and timers/counters

Unlike counters, the instructions for loading a constant into a register, incrementing a register or decrementing a register are not dependent on accumulator state.

The register value to be incremented or decremented may be either a positive or negative integer.

Example:

Compare the contents of two registers and switch on three outputs, according to the following conditions:

Registers	O 32	O 33	O 34
R 0 > R 1	High	Low	Low
R 0 = R 1	Low	High	Low
R 0 < R 1	Low	Low	High

The compare instruction does a subtraction R 0 – R 1 and sets status flags according to the result:

Registers	P	N	Z	E
R 0 > R 1	1	0	0	0
R 0 = R 1	1	0	1	0
R 0 < R 1	0	1	0	0

```
CMP   R 0   ;Perform subtraction R 0 – R 1, status flags will be
      R 1   ; modified according to result of subtraction
ACC   P
OUT   O 32  ; R 0 > R 1
ACC   Z
OUT   0 33  ; R 0 = R 1
ACC   N
OUT   O 34  ;R 0 < R 1
```

9.4.9 Word instructions for floating-point arithmetic

These instructions are used for calculating arithmetical equations using floating-point format registers and constants. Each arithmetical instruction starts with the letter F to indicate that it's a floating-point instruction. The operands of these instructions are always registers, never constants. If a constant is needed, it must be loaded into a register and then the register can be used in the floating-point instruction.

Addition	**Subtraction**	**Square root**
FADD R 0 R 1 R 3 ;R3=R0+R1	FSUB R 0 R 1 R 3 ;R3=R0-R1	FSQR R 100 R 101 ;result
Multiplication	**Division**	**Comparison**
FMUL R 0 R 1 R 3 ;R3=R0*R1	FDIV R 0 R 1 R 3 ;R3=R0/R1	FCMP R 0 R 1
Sine	**Cosine**	**Arc tangent**
FSIN R 10 R 11 ;result	FCOS R 10 R 11 ;result	FATAN R 10 R 11 ;result

Exponent	Natural logarithm	Absolute value
FEXP R 20 R 21 ;result	FLN R 20 R 21 ;result	FABS R 30 R 31 ;result

Status flags
All the above instructions modify the status flags, with the exception of the *LD* instruction for loading a floating-point format constant.

Initialize a register
LD R 0 3.1415E0 ; R 0 = PI

9.4.10 Conversion of integer and floating-point registers

The PCD has separate instructions for arithmetic operations on integers and floating-point numbers. If an application program has to add or multiply two registers, one containing an integer and the other a floating-point number, one of the registers must be converted either to integer or floating-point before performing the arithmetical operation – both registers must contain data in the same format.

Convert integer-fltg point	Convert fltg point-integer
IFP R 0 ; integer -> float 0 ; exponent	FPI R 0 ;float ->integer 0 ; exponent

9.4.11 Index register

Each COB has a special register: the index register. The content of the index register can be checked with the following instructions:

SEI K 10	**SE**t **I**ndex register	Loads the index register with a constant of 10
INI K 99	**IN**crement **I**ndex register	Increments the index register and sets accu state high as long as: Index register <= K 99
DEI K 5	**DE**crement **I**ndex register	Decrements the index register and sets accu state high as long as: Index register >= K 5
STI R 0	**ST**ore **I**ndex register	Copies index register to register 0
RSI R 0	**R**e**S**tore **I**ndex register	Copies register 0 to index register

Many PCD instructions support the use of the index register. This register allows indirect addressing of registers, flags, inputs, outputs, timers etc, used by instructions in the program. These instructions are the same as those normally used, but the mnemonic has an additional letter *X*.

Example:
Registers are non-volatile. This means they keep their information when the power supply is cut or if there is a cold-start. If we want to make a range of 100 registers volatile, we would have to initialise these 100 registers with the value zero during the cold-start. To initialise a register with zero, we can use the following instruction:

```
LD   R 10
     K 0
```

If we have 100 registers (R 10 to 109) to initialise, we would have to write this instruction 100 times, changing the register address each time. That would be rather tedious.

A better solution is to initialise the index register with an index of zero and implement a program loop to load the first register with zero, incrementing the index. Therefore, for each loop, we load zero into a different register (R 10, R 11,…. R 109). At the 100th loop, the index counter reaches the maximum index value (K 99) and forces the accumulator state low. This causes the loop to be exited so that the rest of the program can be processed.

```
      XOB  16       ;Cold-start block
      SEI  K 0      ;Index = 0
Loop: LDX  R 10     ;Load register address 10 + index with zero
      INI  K 99     ;Increment index and modify accu state
      JR   H Loop   ;If accu is high, program jump to label Loop
      EXOB

      COB  0        ;Cyclic organization block
           0
      ...
      ECOB
```

9.4.12 Program jumps

The IL instruction set has three program jump instructions. They allow a sequence of instructions to be processed according to a binary condition binary, or program loops to be implemented for repetitive tasks (indexing).

Jump instructions		
JR	Jump relative	Jumps a few lines forward or back from the line containing the JR instruction
JPD	Jump direct	Jumps to a line number counting from the start of block (COB,PB,…)
JPI	Jump indirect	As JPD, but the line number is contained in a register

The jump destination is generally indicated by a label that defines a line of the program. However, it is also possible to define a relative jump with the number of lines to jump forward or back.

Jump using a line label :

```
      JR   L  Next
      INC  R 10
Next: NOP
```

Jump using the number of lines:

```
JR   L  +1
INC  R 10
NOP
```

The jump must always occur within a current block (COB, PB,…) never outside it.

If necessary, the jump may be implemented always, or only under a predetermined binary condition, such as the accumulator state or that of a status flag.

Syntax for an unconditional jump instruction

Mnemonic	**Label**	**Description**
JR		Jump always implemented on line corresponding to label
JPD		
JPI		

Syntax for a conditional jump instruction

Mnemonic	**Condition**	**Label**	**Description**
JR	H		If accu is high
JPD	L		If accu is low
JPI	Z		If status flag Z is high
	P		If status flag P is high
	N		If status flag N is high
	E		If status flag E is high

Example: Count pulses from a binary input binary with a register (relative jump)

Unlike counters, the instruction to increment a register does not depend on accumulator state. It is thereful practical to use a jump instruction to increment a register when only that is necessary.

```
      COB   0
            0
      STH   F 1         ;Copy flag state to accumulator
      DYN   F 2         ;Force accu high on rising edge of flag F1
      JR    L  Next     ;If accu state is low, jump to label Next
      INC   R 10
Next: NOP
...
ECOB
```

The instructions *STH* and *DYN* read information from flag F 1 and set the accu state high for a positive flank or low in the absence of a flank. Depending on accu state, the instruction *JR* either jumps to the line corresponding to the label *Next:* or increments the register with the instruction *INC*. The letter *L* indicates the condition for implementing a jump (in this example, the jump will only be implemented if the accumulator state is low).

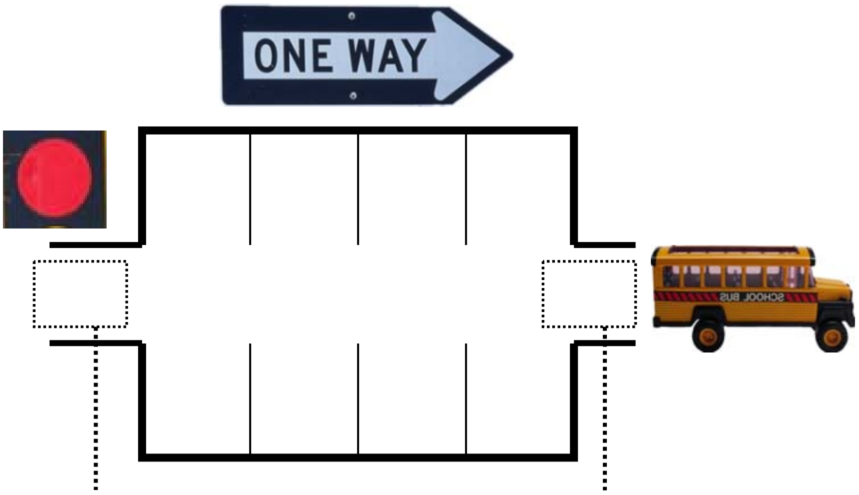
Example: Solution with an indirect jump

```
      COB   0
            0
      LD    R 2         ;Load line number into register
            Next
      STH   F 1         ;Copy flag state to accumulator
      DYN   F 2         ;Force accu state high on rising edge
                        ;  of flag F1
      JPI   L  2        ;If accu is low, jump to
                        ; line number defined in register 2
      INC   R 10
Next: NOP

ECOB
```

The indirect jump offers great flexibility. The program can itself modify the line number to which it will jump.

9.5 Editing a first application program

Count the number of spaces left in an 8-space parking lot and illuminate a red lamp when it is full.



The red lamp comes on when the parking lot is full:
Red_light
O 32

Vehicle entrance:
Car_incoming I 0

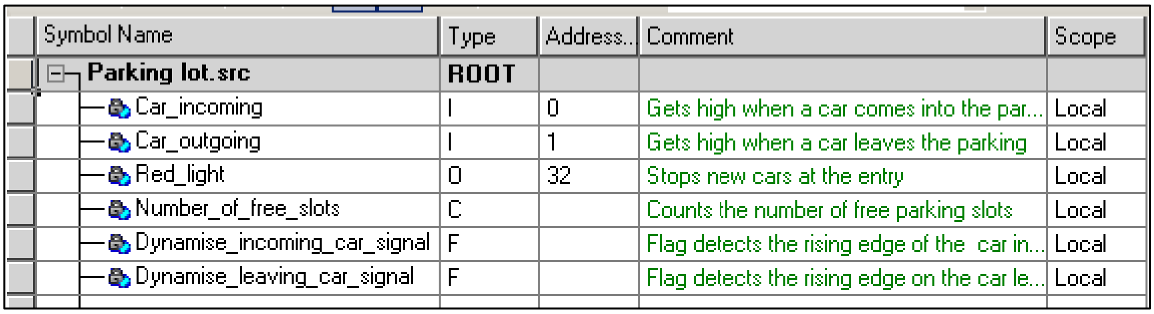
Vehicle exit:
Car_outgoing I 1

When the PCD powers up, we assume that all parking spaces are available. We must therefore start by initialising the free space counter with the value 8. This initialisation takes place once only, when the PCD starts up. We will therefore program it in the cold-start block: XOB 16. The remaining program functions will be carried out by a cyclical organisation block (COB).

At the entrance, the sensor *Car_incoming* delivers a pulse each time a new vehicle enters. The rising edge of this signal must be detected to decrement the free space counter.

At the exit, a second sensor *Car_outgoing* delivers a pulse each time a vehicle exits. The rising edge of this signal must be detected to increment the free space counter.

If the parking lot is full, the counter's integer value will indicate zero available spaces. The counter's logic state informs us of this situation when it is low. The red lamp at the entrance to the parking lot must therefore be illuminated.



Symbol Name	Type	Address..	Comment	Scope
⊟ **Parking lot.src**	**ROOT**			
Car_incoming	I	0	Gets high when a car comes into the par...	Local
Car_outgoing	I	1	Gets high when a car leaves the parking	Local
Red_light	O	32	Stops new cars at the entry	Local
Number_of_free_slots	C		Counts the number of free parking slots	Local
Dynamise_incoming_car_signal	F		Flag detects the rising edge of the car in...	Local
Dynamise_leaving_car_signal	F		Flag detects the rising edge on the car le...	Local

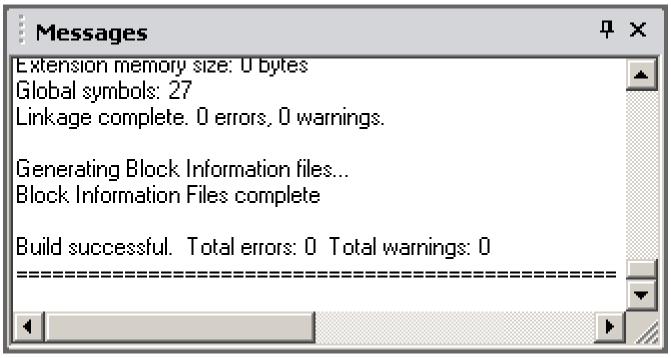
```
;Cold start organisation block
;------------------------------

    XOB   16                    ;Program executed at start up
    ACC   H
    LD    Number_of_free_slots  ;Initialize the free slots counter
          8                     ; with the value 8 (unconditionally)
    EXOB                        ;End of start-up program

;Cyclical Organisation Block
;---------------------------

    COB   0                     ;Cyclical program
          0                     ;No supervision time

    STH   Car_incoming          ;A car comes into the parking:
    DYN   Dynamise_incoming_car_signal ;On the rising edge,
    DEC   Number_of_free_slots  ; decrement number of free parking slots

;----------------------------------------

    STH   Car_outgoing          ;A car leaves into the parking:
    DYN   Dynamise_leaving_car_signal  ;On rising edge,
    INC   Number_of_free_slots  ; increment number of free parking slots

;----------------------------------------

    STL   Number_of_free_slots  ;Ff no more free parking slots
                                ; (counter state= Low)
    OUT   Red_light             ; set the  red light

    ECOB                        ;End of Cyclical program
```

9.6 Building the program

Build All Files

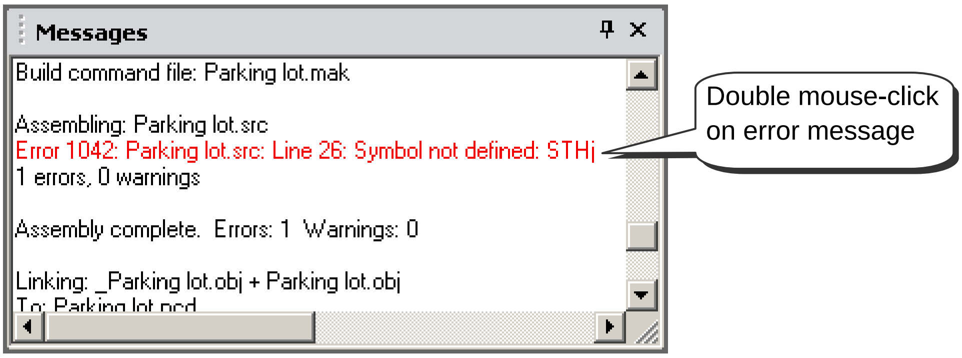
The user program is fully edited, but not yet usable by the PCD. It must be translated into a binary file. This is what the programming tool does when the user activates the button or menu *Rebuild All Files* in the Project Manager or IL editor.

The Messages window tells us how the build is proceeding. It will be noted that the build has assembly and linkage stages. If the program has been edited correctly, the build will end with the message: *Build successful. Total errors 0, Total warnings: 0*

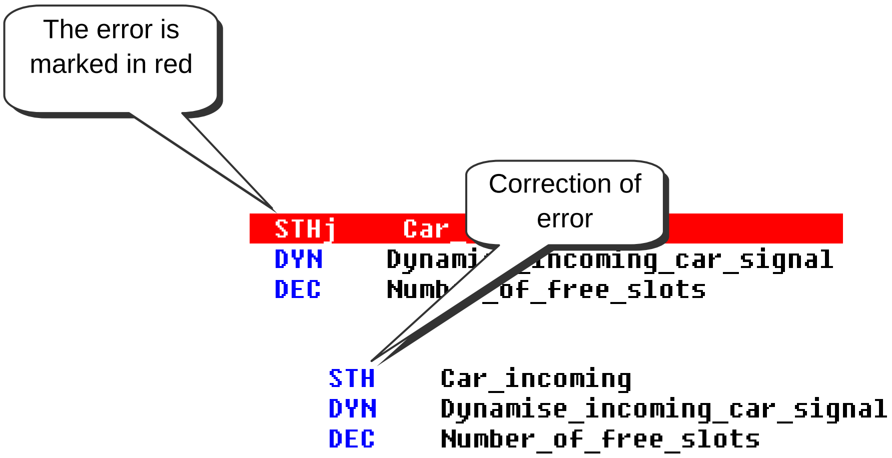


```
Extension memory size: 0 bytes
Global symbols: 27
Linkage complete. 0 errors, 0 warnings.

Generating Block Information files...
Block Information Files complete

Build successful.  Total errors: 0  Total warnings: 0
==================================================
```

Any errors will be indicated by a message in red. A double mouse-click on an error message will, if possible, open the relevant editor at the correct location.



```
Build command file: Parking lot.mak

Assembling: Parking lot.src
Error 1042: Parking lot.src: Line 26: Symbol not defined: STHj
1 errors, 0 warnings

Assembly complete.  Errors: 1  Warnings: 0

Linking: _Parking lot.obj + Parking lot.obj
To: Parking lot.pcd
```



```
STHj    Car
DYN     Dynami  _incoming_car_signal
DEC     Numb  _of_free_slots
```

```
STH     Car_incoming
DYN     Dynamise_incoming_car_signal
DEC     Number_of_free_slots
```

9.7 Load program into PCD

Download Program

Now that the application program is ready, it needs to be transferred from the PC into the PCD. In Project Manager, use either with the *Online, Download Program* menu command, or press the *Download Program* toolbar button.

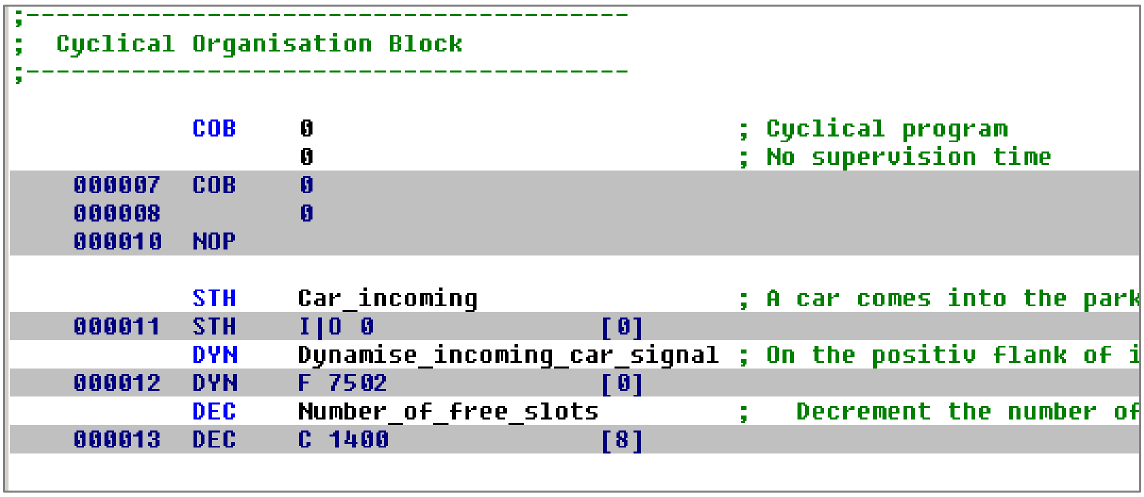
If any communications problems arise, check the *Online Settings*, the cable between the PC and the PCD (PCD8.K111 or USB), and make sure the PCD is switched on. A USB connection may take a few seconds before the PC is able to recognize the attached device.

9.8 Debugging a program

Programs are not always perfect in their first version. It is helpful to test them carefully. Testing a program is supported by the same editor used for editing it.

The white lines represent the original source code, with symbols and comments.

The grey lines represent the code produced by the build, with the addresses of operands and program line numbers.



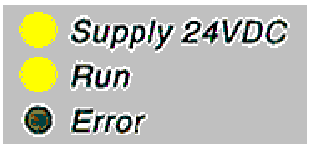
```
;----------------------------------------
;  Cyclical Organisation Block
;----------------------------------------

            COB     0                            ; Cyclical program
                    0                            ; No supervision time
    000007  COB     0
    000008          0
    000010  NOP

            STH     Car_incoming                 ; A car comes into the park
    000011  STH     I|O 0             [0]
            DYN     Dynamise_incoming_car_signal ; On the positiv flank of i
    000012  DYN     F 7502            [0]
            DEC     Number_of_free_slots         ;   Decrement the number of
    000013  DEC     C 1400            [8]
```

9.8.1 Go On/Offline, Run and Stop

Online mode allows communication with the PCD to monitor the mode of operation (Run, Stop, Step-by-step). Any information needed to test the program can also be displayed.

Press *Go On/Offline* button

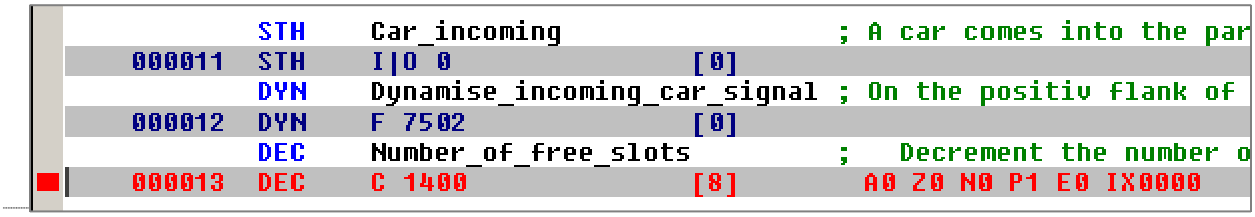
Put controller into Run mode with *Run* button



At the same time, note the RUN lamp, located on the front of the PCD. When the *Run* button is pressed, the RUN lamp comes on. The PCD is executing the user program.

When the *Stop* button is pressed, the RUN lamp goes off. The PCD stops executing the user program.

After *Stop*, note the line shown in red. It indicates the instruction at which the program stopped. The number in square brackets shows the contents of counter 1400. To the right is shown the accumulator and status flags states, and the index register value.



```
        STH    Car_incoming                 ; A car comes into the par
000011  STH    I|O 0                 [0]
        DYN    Dynamise_incoming_car_signal ; On the positiv flank of
000012  DYN    F 7502                [0]
        DEC    Number_of_free_slots         ;   Decrement the number o
000013  DEC    C 1400                [8]      A0 Z0 N0 P1 E0 IX0000
```

9.8.2 Step-by-step mode

Run to Cursor

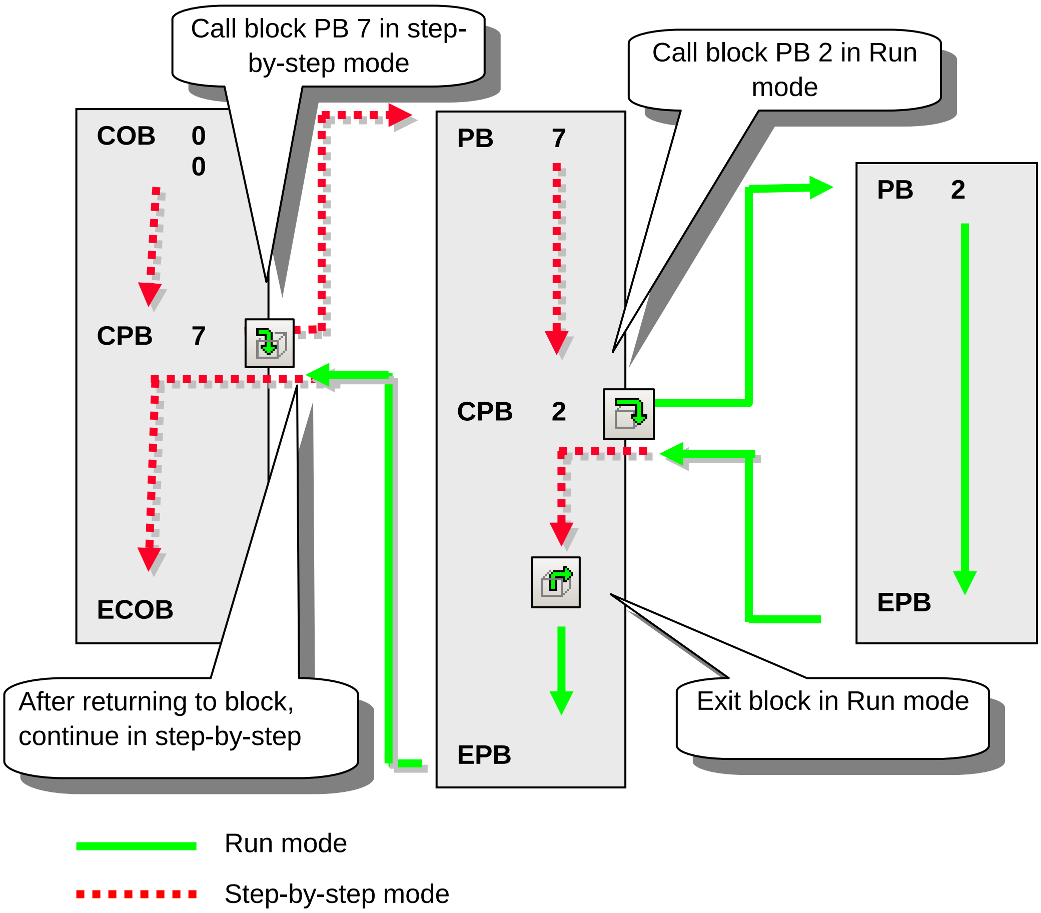
If the PCD is in Run mode, mark the first line to observe in step-by-step mode and press the *Run to Cursor* button. The PCD stops when it reaches the line with the cursor. Now begin step-by-step program execution by pressing the F11 key, or one of the buttons below.

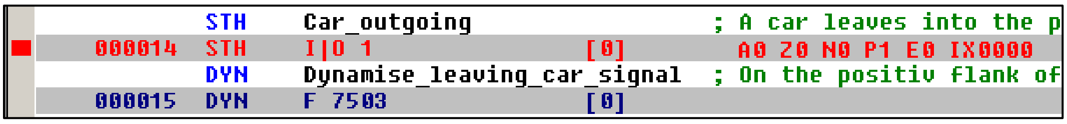
If the program calls any PBs, FBs or SBs, it is not always necessary to step through these with step-by-step mode. The following three options are available:

Step In: Enter the block and step through it.

Step Over: Process the called block in Run, then continue in step-by-step after returning to the block that made the call.

Step Out: If the program has entered a block whose content is of no interest, it is possible to exit it immediately in Run mode and then continue in step-by-step mode after returning to the block that made the call.


Call block PB 7 in step-by-step mode
Call block PB 2 in Run mode
COB 0 0
CPB 7
ECOB
PB 7
CPB 2
EPB
PB 2
EPB
After returning to block, continue in step-by-step
Exit block in Run mode
Run mode
Step-by-step mode



```
                STH     Car_outgoing                  ; A car leaves into the p
      000014    STH     I|O 1               [0]         A0 Z0 N0 P1 E0 IX0000
                DYN     Dynamise_leaving_car_signal   ; On the positiv flank of
      000015    DYN     F 7503              [0]
```

For each program step, note the line shown in red. It moves to the following instruction line. The figure in square brackets represents the logical state of input `I 1`. To the right are shown the accumulator and status flags states, and the index register value.

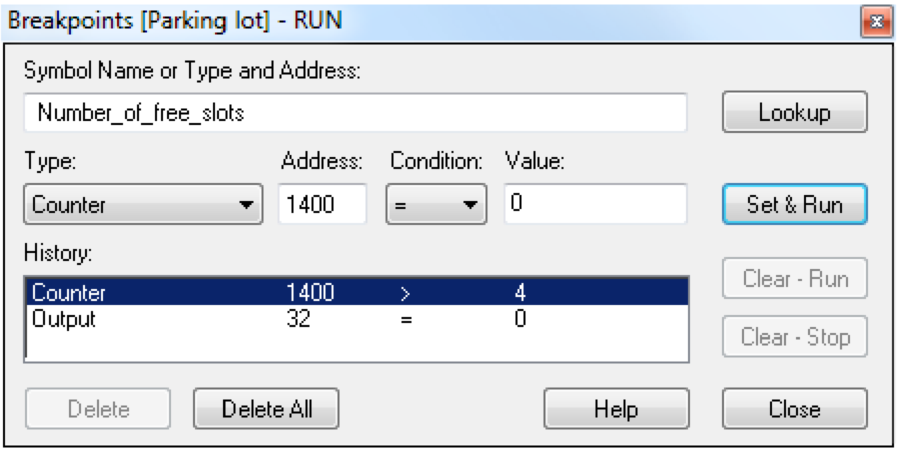
9.8.3 Breakpoints

Breakpoints let you stop the program at an event linked to a program line or a symbol:
State of an input, output, flag, status flag
Value present in a register or counter

Set/Clear Breakpoints

Breakpoint on a symbol

The breakpoint condition can be defined with the help of the *Online Breakpoints* menu, or of the *Set/Clear Breakpoint* button.



Breakpoints [Parking lot] - RUN

Symbol Name or Type and Address: Number_of_free_slots

Type: Counter
Address: 1400
Condition: =
Value: 0

History:

Counter	1400	>	4
Output	32	=	0

Using the above window, define the symbol *type* and *address*, or just drag a symbol from the Symbol Editor into the *Symbol Name* field, then set the breakpoint condition and state/value.

Selecting the *Set & Run* button forces the PCD into *conditional run* mode. The PCD's *Run* LED flashes and the PCD's *Run* button alternates between green and red.

The PCD automatically goes into stop mode when the breakpoint condition is reached. For example, when an instruction modifies the value of counter 1400 with a value greater than 4. The line following the last instruction processed by the PCD will be marked in red. It is then possible to continue processing the program in step-by-step mode, or with another breakpoint condition.

If necessary, conditional run mode can be interrupted in the following ways:
The *Clear* - *Run* button forces the PCD into RUN mode. The PCD's *Run* LED comes on and the PCD's *Run* button turns green.
The *Clear* - *Stop* button forces the PCD into stop mode. The PCD's *Run* LED goes off and the PCD's *Run* button turns red.

Breakpoint states which have been used before are stored in the breakpoint *History* list. They can be selected and activated with the *Set & Run* button.

Run to Cursor

Breakpoint on a program line

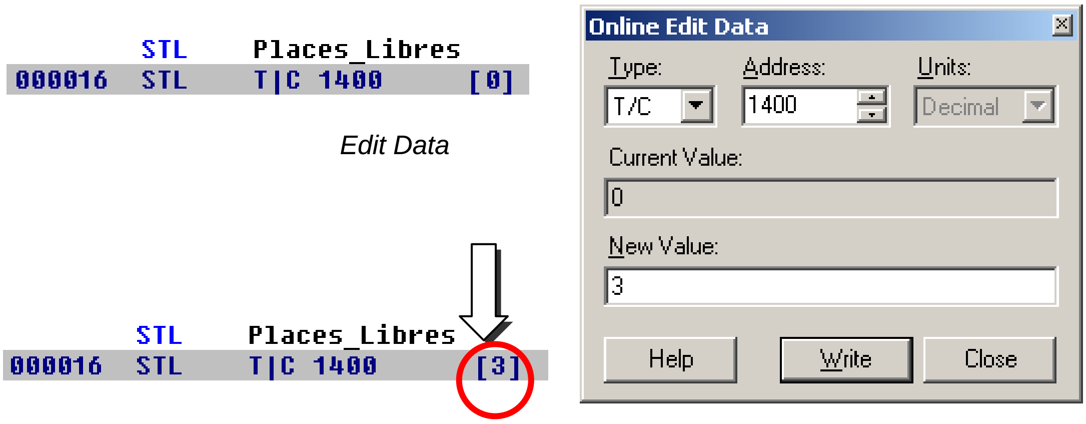
By selecting a program line, followed by the menu or button *Online, Run To Cursor*, the program can be made to stop at the line.

9.8.4 Online modification of the program and data

When testing a program step-by-step, it is helpful to modify the states/values of certain operands/symbols and check program behaviour under certain conditions.

Select one of the code view lines (grey) using the mouse and right-click to display the context menu.

The *Edit Data* context menu allows you to modify the operand state/value in the instruction selected.



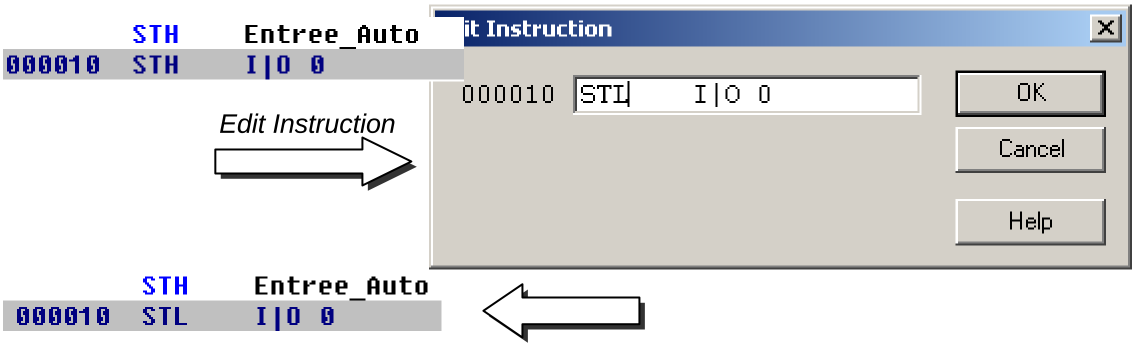
```
         STL    Places_Libres
000016   STL    T|C 1400        [0]
```

Edit Data

```
         STL    Places_Libres
000016   STL    T|C 1400        [3]
```

Type: T/C
Address: 1400
Units: Decimal
Current Value: 0
New Value: 3

The *Edit Instruction* command allows you to modify the mnemonic and address of the operand of the selected instruction line.



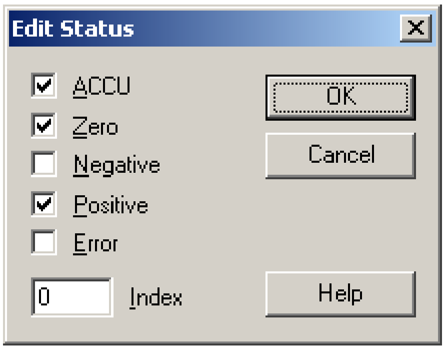
```
         STH    Entree_Auto
000010   STH    I|O 0
```

Edit Instruction

```
000010 STL    I|O 0
```

```
         STH    Entree_Auto
000010   STL    I|O 0
```

Status flags can also be modified with the help of the *Edit Status* context menu.



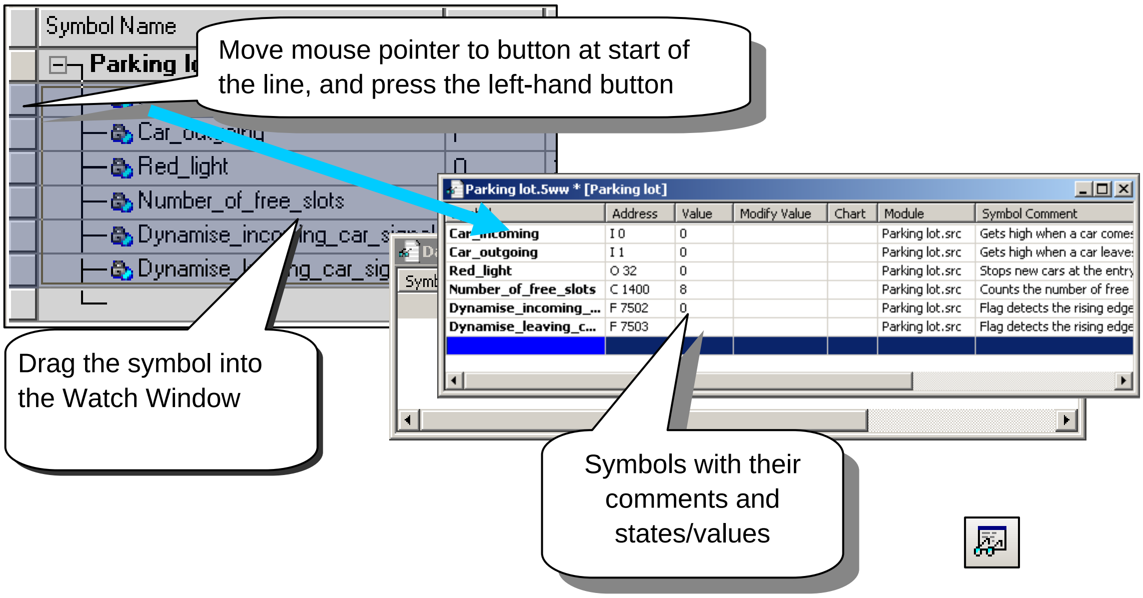
☑ ACCU
☑ Zero
☐ Negative
☑ Positive
☐ Error
0 Index

9.8.5 Viewing and modifying symbol states with the *Watch Window*

Another useful way of testing and viewing the state of symbols in our example is provided by the *Watch Window*. Use the Symbol Editor's *Add to Watch Window* command from the context menu.

Or press the *Watch Window* button, then drag symbols from the Symbol Editor into the *Watch Window*.

Watch Window



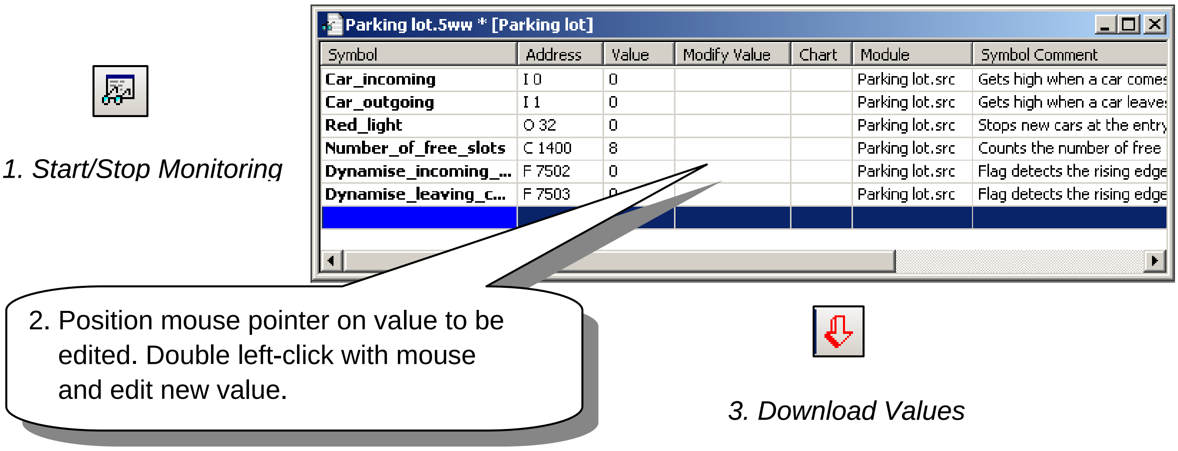
Move mouse pointer to button at start of the line, and press the left-hand button

Drag the symbol into the Watch Window

Symbols with their comments and states/values

Symbol	Address	Value	Modify Value	Chart	Module	Symbol Comment
Car_incoming	I 0	0			Parking lot.src	Gets high when a car comes
Car_outgoing	I 1	0			Parking lot.src	Gets high when a car leave
Red_light	O 32	0			Parking lot.src	Stops new cars at the entry
Number_of_free_slots	C 1400	8			Parking lot.src	Counts the number of free
Dynamise_incoming_...	F 7502	0			Parking lot.src	Flag detects the rising edge
Dynamise_leaving_c...	F 7503	0			Parking lot.src	Flag detects the rising edge

To modify the state/value of one of the symbols in the window, proceed as follows:



Symbol	Address	Value	Modify Value	Chart	Module	Symbol Comment
Car_incoming	I 0	0			Parking lot.src	Gets high when a car comes
Car_outgoing	I 1	0			Parking lot.src	Gets high when a car leave
Red_light	O 32	0			Parking lot.src	Stops new cars at the entry
Number_of_free_slots	C 1400	8			Parking lot.src	Counts the number of free
Dynamise_incoming_...	F 7502	0			Parking lot.src	Flag detects the rising edge
Dynamise_leaving_c...	F 7503	0			Parking lot.src	Flag detects the rising edge

1. Start/Stop Monitoring

2. Position mouse pointer on value to be edited. Double left-click with mouse and edit new value.

3. Download Values

9.9 Commissioning an analogue module

All program instructions presented up until now used digital inputs or outputs, which are accessed directly for an a single IL instruction, e.g. `ANH I 45`.

Analogue I/Os need a small program to read the values from each type of analogue module, which manages the multiplexing and A/D and D/A conversion. These can be programmed in IL, or using the new Device Configurator's *Media mapping* features which are described in the *Device Configurator* documentation.

9.9.1 Example for PCD2.W340 analogue input modules

If the PCD is equipped with a PCD2.W340 module, which has 8 universal input channels, the following routine may be used:

```
BA    EQU   O 96     ; Module base address in PCD

      ACC   H        ; ACCU must be high
      LD    R 100    ; Defines the measuring channel (0..7)
            2

      MUL   R 100
            K 32     ; Calculates
            R 100    ; control byte
      ADD   R 100    ; including
            K 264    ; release bit
            R 100

      SET   BA+15    ; Triggers A/D conversion

      BITO  9        ; Sends control byte
            R 100    ; including release bit
            BA+0     ; to W3xx

      BITIR 12       ; Reads 12 bits (0..4095) into R 77
            BA+0
            R 77

      RES   BA+15    ; Stop A/D conversion
```

The PCD2.W340 is a general-purpose analogue module which supports ranges 0..10V, 0..2.5V, 0..20mA and Pt/Ni 1000 temperature sensors. A bridge must be selected on the module to define the measurement range. Resolution is 12 bits, with a value range of 0..4095.

The routine shown above enters the channel defined in register 100 and supplies a raw measurement to register 77. For this module with a resolution of 12 bits, that corresponds to a measured value between 0 and 4095.

The user program must then convert the measurement into a standard physical unit.

9.9.2 Example for PCD2.W610 analogue output modules

Outputs work in a similar way to inputs.

If the PCD is equipped with a PCD2.W610 module, which has 4 universal analogue output channels, the following routine may be used:

```
BA    EQU    O 96       ; Module base address in PCD
      ACC    H          ; ACCU must be high
      LD     R 100      ; Defines output channel (0..6)
             2
      BITOR  2          ; Transfers channel to W6x0
             R 100
             BA+0
      BITOR  2          ; Writes 2 filler bits
             R 100
             BA+0
      LD     R 277      ; Defines digital value of output (0..4095)
             3879
      BITO   R 12       ; Transfer 12 bits of output value to W6x0
             R 277
             BA+0
      SET    BA+12      ; Triggers D/A conversion
```

A bridge must be selected on the module to define the output range: 0…20 mA or 0…10 V. Resolution is 12 bits, equating to 4095 distinct setpoint states.

The integer value at register 12 determines the output voltage or current at the channel defined in register 100:

Input value at register 12	Output voltage [V]	Output current [mA]
0	0	0
2047	5	10
4095	10	20

For more detailed information and sample IL programs for analogue modules, please refer to your hardware manual or the support website:
http://www.sbc-support.com

Contents

10 Additional tools

The Saia PG5® provides you with several additional utilities for a variety of services.

10.1 Data transfer utility

10.1.1 Using data transfer

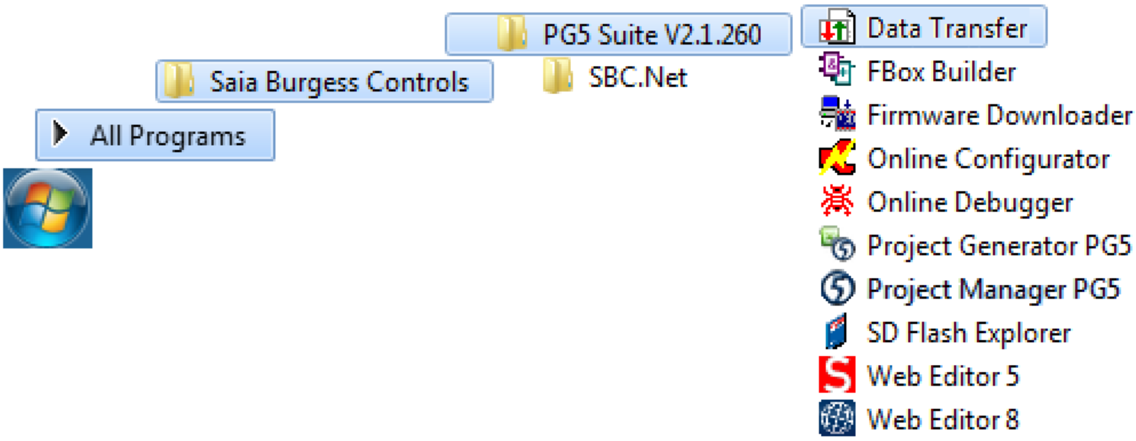
This tool is used to save PCD data states/values in an ASCII file (*.dt5) or to restore them from the file into PCD memory.

The following data is transferred with this tool:
inputs, outputs , flags, timers, counters, registers, data and text blocks.

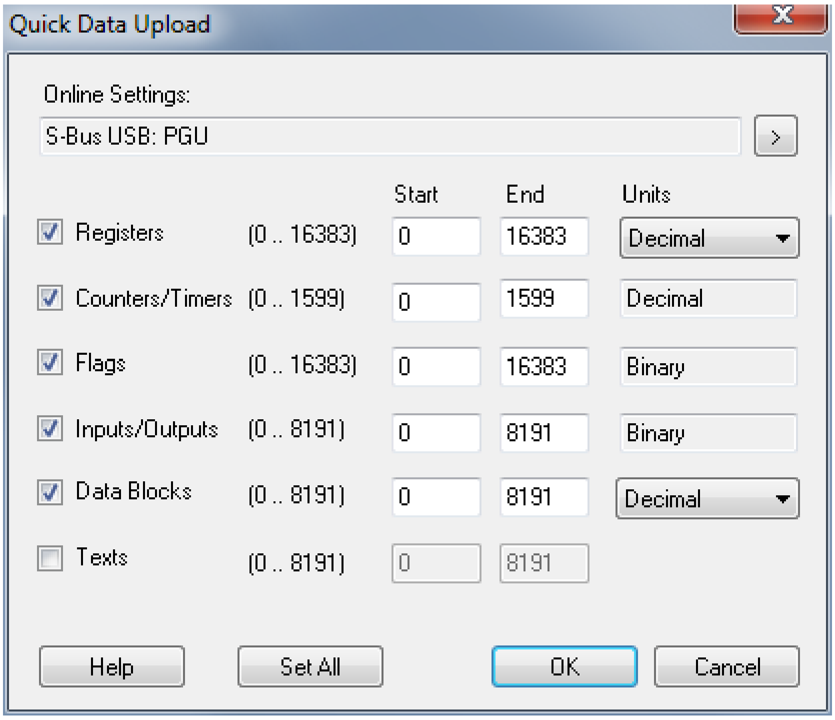
Caution! The PCD program and hardware configurations are not saved by the *Data Transfer* utility. To save the program, hardware configurations and data, it is advisable to back up the program. See description of Project Manager.

10.1.2 Start up *Data Transfer*

Start up the program with menu:
Start → Programs → Saia Burgess Controls → PG5 Suite 2.1 → Data Transfert



10.1.3 Save data with Quick Data Upload


Quick Data Upload

Online Settings:
S-Bus USB: PGU

		Start	End	Units
☑ Registers	[0 .. 16383]	0	16383	Decimal
☑ Counters/Timers	[0 .. 1599]	0	1599	Decimal
☑ Flags	[0 .. 16383]	0	16383	Binary
☑ Inputs/Outputs	[0 .. 8191]	0	8191	Binary
☑ Data Blocks	[0 .. 8191]	0	8191	Decimal
□ Texts	[0 .. 8191]	0	8191	

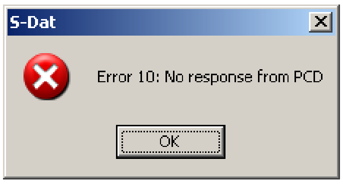
Quick Data Upload

Select menu *Online, Quick Data Upload …* or press the *Quick Data Upload* button to display the above window.

Select the types of data to save, address ranges, possibly also the display format for registers.

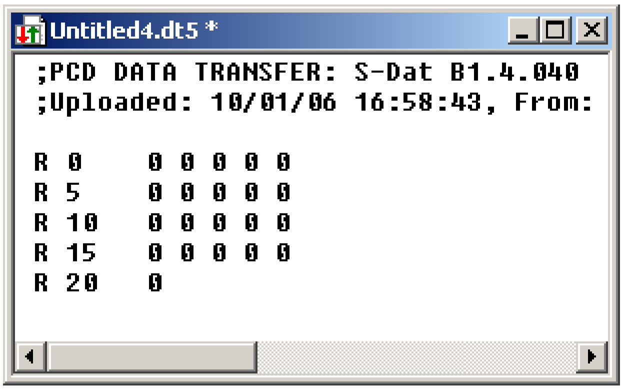
Select the OK button to upload data.

If a message like the one shown here is displayed, check the communications parameters using the menu *Online, Online Settings* and ensure that the PCD8.K111 cable correctly links the PC to the PCD.



Error 10: No response from PCD

Data upload takes a few moments to be displayed as follows:



```
;PCD DATA TRANSFER: S-Dat B1.4.040
;Uploaded: 10/01/06 16:58:43, From:

R 0     0 0 0 0 0
R 5     0 0 0 0 0
R 10    0 0 0 0 0
R 15    0 0 0 0 0
R 20    0
```

The data file can be edited with new values, then saved with the *File, Save* menu, or with the *Save* toolbar button.

10.1.4 Restore data

Open

Previously saved files can be displayed again with the *File, Open* menu, or the *Open* toolbar button.

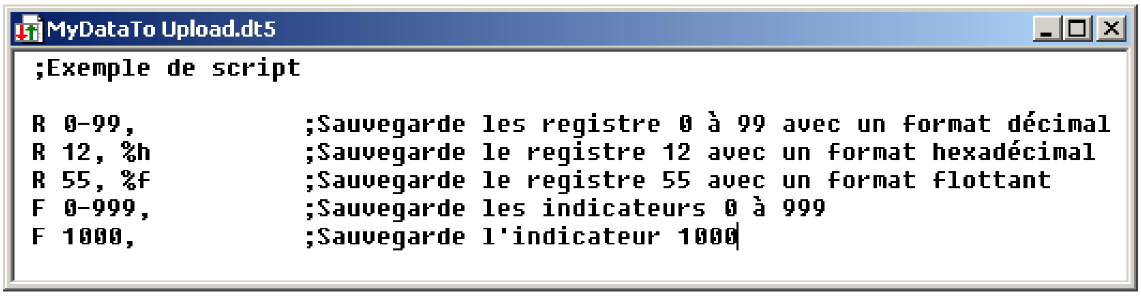
If necessary, the user can edit file values.

Download To PCD

Data is restored to PCD memory with the *Online, Download Data to the PCD* menu, or with the *Download* button.

10.1.5 Save data with help of script file

If necessary, the list of data to save can be edited in a script file. Example:



```
;Exemple de script

R 0-99,           ;Sauvegarde les registre 0 à 99 avec un format décimal
R 12, %h          ;Sauvegarde le registre 12 avec un format hexadécimal
R 55, %f          ;Sauvegarde le registre 55 avec un format flottant
F 0-999,          ;Sauvegarde les indicateurs 0 à 999
F 1000,           ;Sauvegarde l'indicateur 1000
```

Upload
From PCD

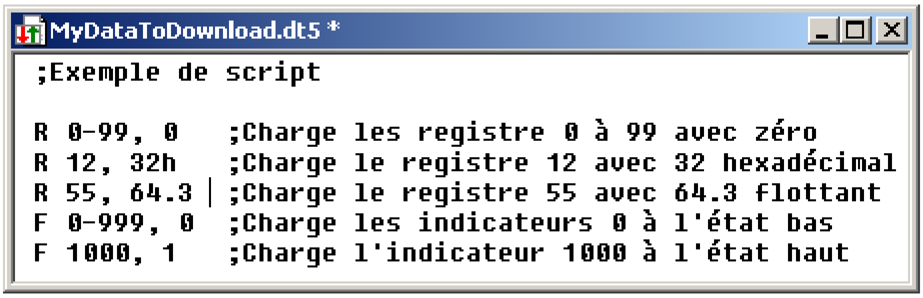
Select the *Online, Upload Data from PCD …* menu, or the *Upload* button, to upload PCD data into a second window, distinct from the control window.

For more information about script commands available, please refer to program help. See menu *Help, Help Topics F1, General.*

10.1.6 Restore data with help of script file

Download To PCD

A script file also allows you to edit data to be restored. Example:



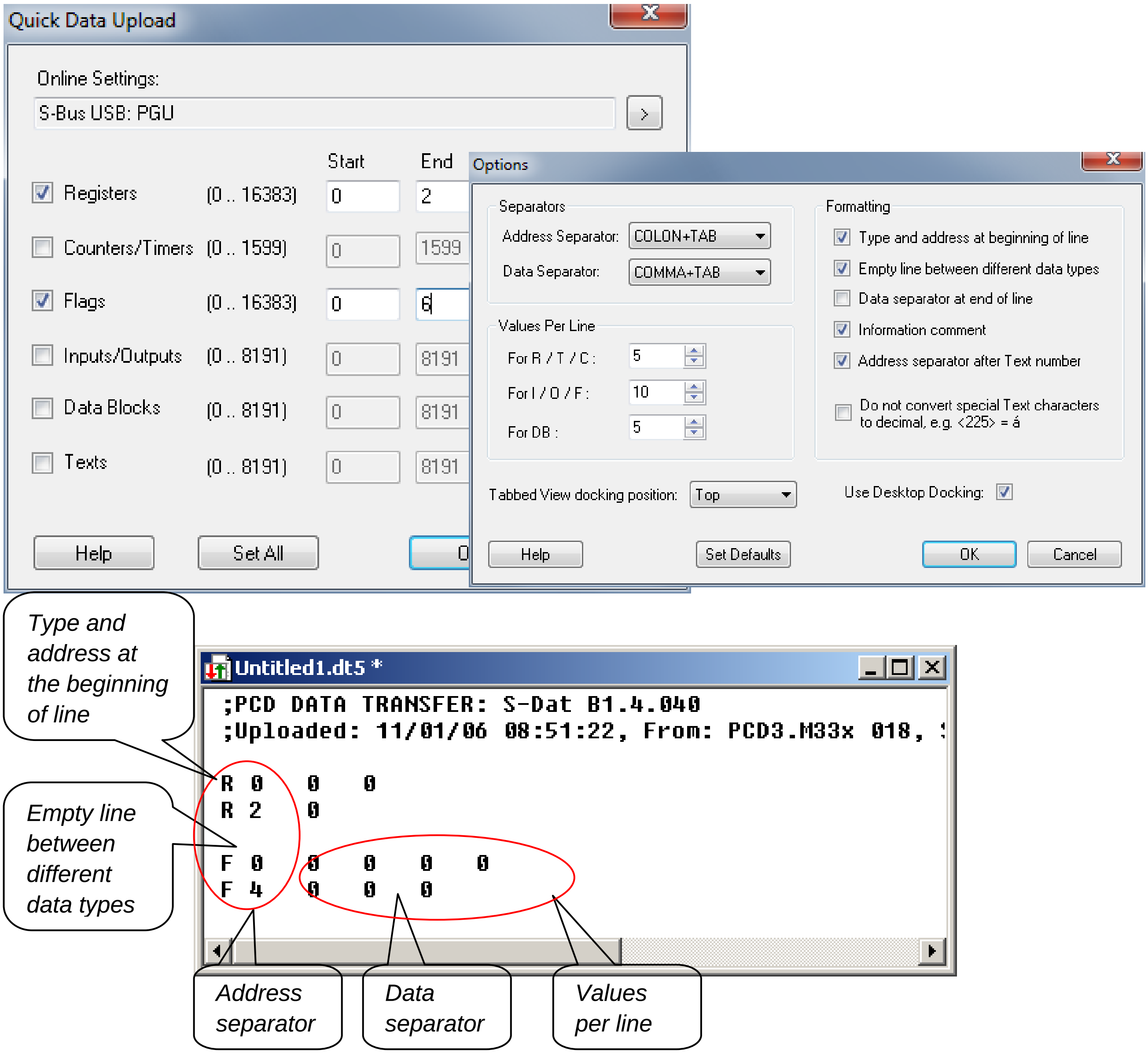
MyDataToDownload.dt5 *

```
;Exemple de script

R 0-99, 0     ;Charge les registre 0 à 99 avec zéro
R 12, 32h     ;Charge le registre 12 avec 32 hexadécimal
R 55, 64.3    ;Charge le registre 55 avec 64.3 flottant
F 0-999, 0    ;Charge les indicateurs 0 à l'état bas
F 1000, 1     ;Charge l'indicateur 1000 à l'état haut
```

Select the *Online, Download Data to PCD …* menu or the *Download* button to download script data to the PCD.

10.1.7 Upload options

The window displayed with the *Edit, Options* menu allows you to adjust the format of data to be saved in file '*.dt5'.
With the following options, a data file can easily be imported to a *Microsoft Excel* editor.



Quick Data Upload

Online Settings: S-Bus USB: PGU

		Start	End
☑ Registers	(0 .. 16383)	0	2
□ Counters/Timers	(0 .. 1599)	0	1599
☑ Flags	(0 .. 16383)	0	6
□ Inputs/Outputs	(0 .. 8191)	0	8191
□ Data Blocks	(0 .. 8191)	0	8191
□ Texts	(0 .. 8191)	0	8191

Options

Separators
Address Separator: COLON+TAB
Data Separator: COMMA+TAB

Values Per Line
For R / T / C : 5
For I / O / F : 10
For DB : 5

Formatting
☑ Type and address at beginning of line
☑ Empty line between different data types
□ Data separator at end of line
☑ Information comment
☑ Address separator after Text number
□ Do not convert special Text characters to decimal, e.g. <225> = á

Tabbed View docking position: Top
Use Desktop Docking: ☑

Untitled1.dt5 *

```
;PCD DATA TRANSFER: S-Dat B1.4.040
;Uploaded: 11/01/06 08:51:22, From: PCD3.M33x 018, 
R 0   0   0
R 2   0

F 0   0   0   0   0
F 4   0   0   0
```

10.1.8 Save data with command line mode

The *Data Transfer* tool can also be controlled with the help of DOS command lines. This allows batch files to be created for the regular, automatic saving of PCD data. The data can then be used by a Microsoft Excel program or database, …

Command line syntax:

SDAT [Name_of_file[.dt5][data…]][/R=nnn][/I0nnn][/A=nnn][/D=nnn]

Namee_of_file	Name of file to save/restore	
Data…	Definition of data to save. If no data is defined, the file is restored to the PCD	
	Format : <type><start>[-<end>][units]	
	type	R,C,O,F,DB (C= counters/timers, O = inputs/outputs) First address
	start	Last address
	end	D,H,F (Decimal, hexadecimal, floating point) for R,C,DB
	units	
/R=nnn	nnn = value per line for R,T,C,DB (1..256, default = 5)	
/I =nnn	nnn = value per line for I,O,F (1..256, default = 10)	
/A=nnn	nnn = address separator (TAB,SPACE,COMMA,COLON , default= TAB)	
/D=nnn	nnn = data separator (TAB,SPACE,COMMA,COLON , default= TAB)	

Example:

```
sdat5 MyDatas.dt5 R0-99 R12H R55F F0-999 F1000 /R005 /I010
```

10.2 Watch window

The *Watch Window* is an excellent tool for checking programs and installations. It allows all the data of an application to be viewed and modified online.

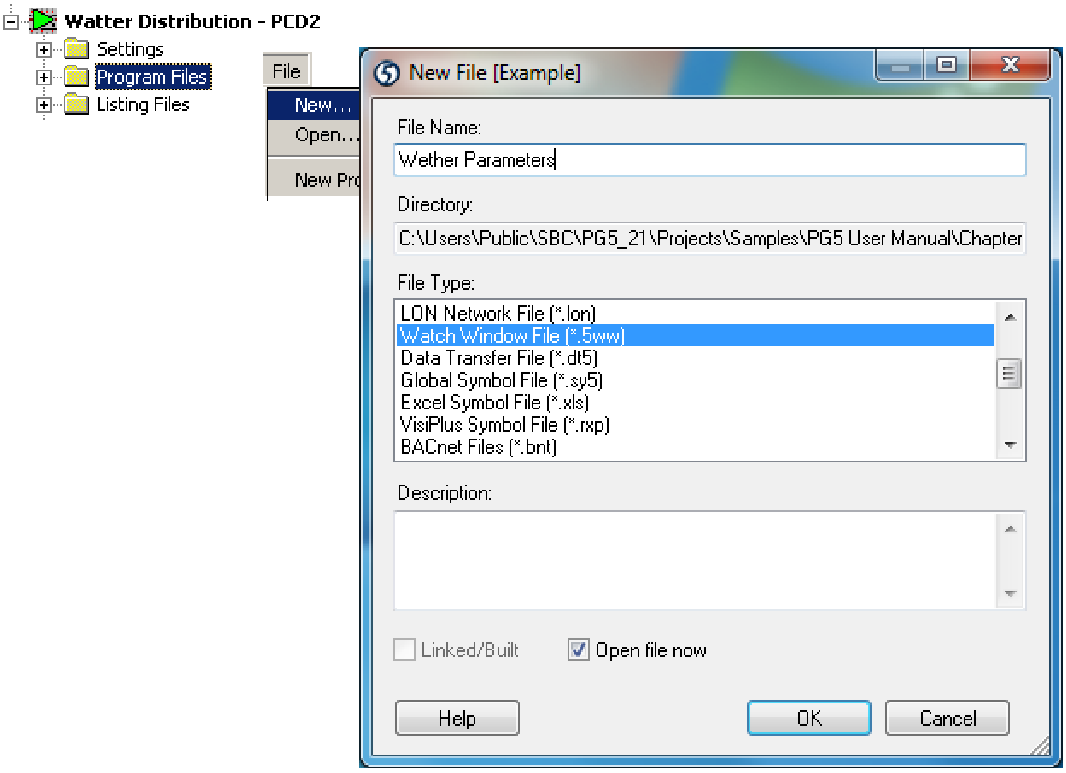
10.2.1 Open the *Watch Window*

Watch Window

The *Watch Window* is displayed by selecting the *View, Watch Window* menu, or with the *Watch Window* button.

It is also possible to prepare several different *Watch Windows* in the *Program File* directory of the project manager. Add a new *Watch Window File* (*.5ww) with the *File New* menu, or with the *New File* button.

New File



File Name:
Wether Parameters

Directory:
C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Chapter

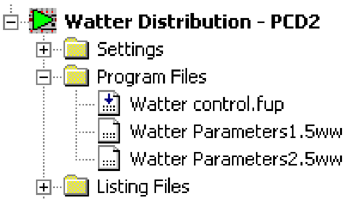
File Type:
- LON Network File (*.lon)
- Watch Window File (*.5ww)
- Data Transfer File (*.dt5)
- Global Symbol File (*.sy5)
- Excel Symbol File (*.xls)
- VisiPlus Symbol File (*.rxp)
- BACnet Files (*.bnt)

Description:

□ Linked/Built ☑ Open file now

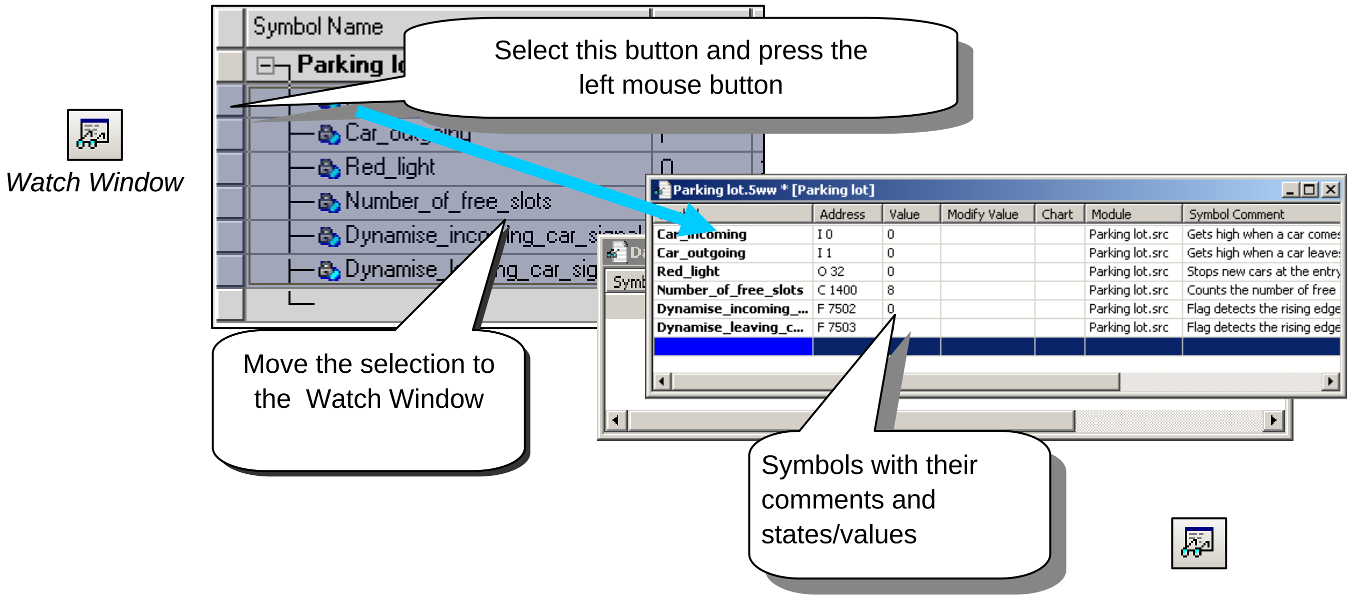
N.B.: Files of the type *.5ww are never linked to a project (no arrow inside the file icon). The information in them has no bearing on any program build.

To open a *.5ww file, select it with a double mouse-click, or mark the file and select the *File Open* menu.



10.2.2 Add data to a *Watch Window*

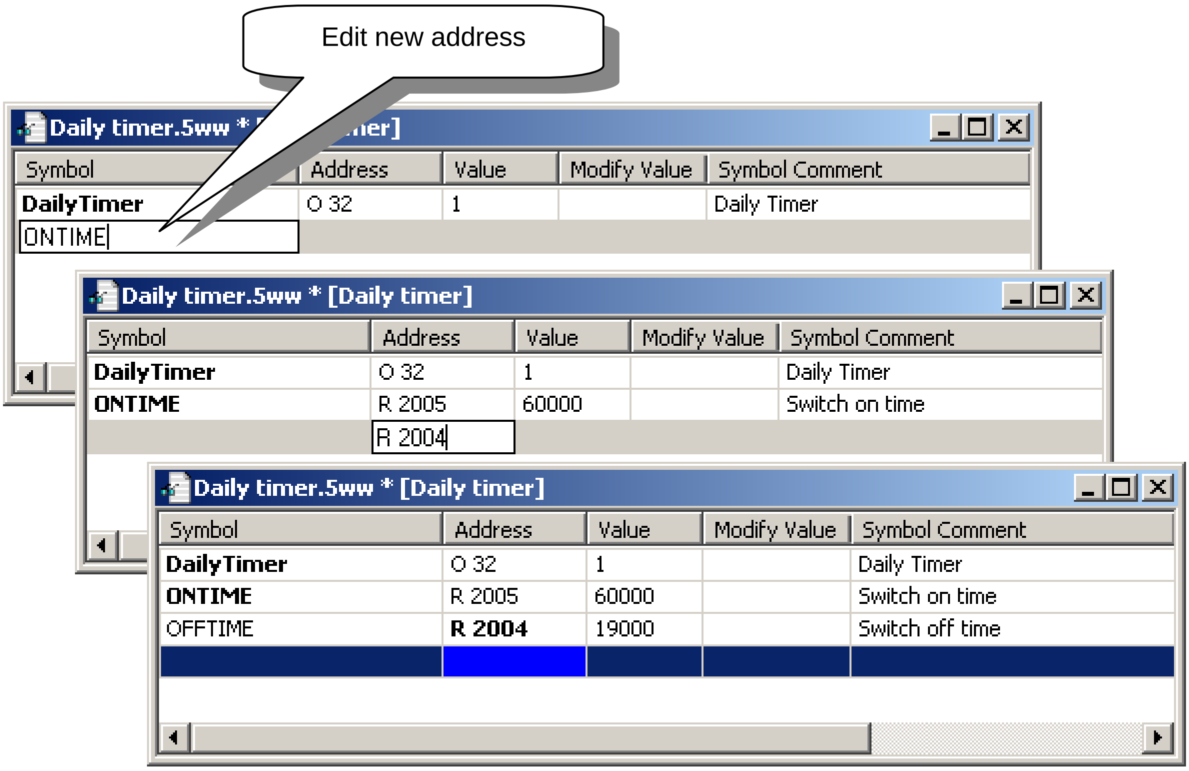
Drag symbols from the program or from the symbol editor into the *Watch Window.*


Watch Window
Symbol Name
Parking lo
Car_outgoing
Red_light
Number_of_free_slots
Dynamise_incoming_car_signal
Dynamise_leaving_car_sig
Select this button and press the left mouse button
Move the selection to the Watch Window
Symbols with their comments and states/values

Parking lot.5ww * [Parking lot]

Symbol	Address	Value	Modify Value	Chart	Module	Symbol Comment
Car_incoming	I 0	0			Parking lot.src	Gets high when a car comes
Car_outgoing	I 1	0			Parking lot.src	Gets high when a car leaves
Red_light	O 32	0			Parking lot.src	Stops new cars at the entry
Number_of_free_slots	C 1400	8			Parking lot.src	Counts the number of free
Dynamise_incoming_...	F 7502	0			Parking lot.src	Flag detects the rising edge
Dynamise_leaving_c...	F 7503				Parking lot.src	Flag detects the rising edge

It is also possible to edit symbols directly in the window:



Daily timer.5ww * [Daily timer]

Symbol	Address	Value	Modify Value	Symbol Comment
DailyTimer	O 32	1		Daily Timer
ONTIME				

Daily timer.5ww * [Daily timer]

Symbol	Address	Value	Modify Value	Symbol Comment
DailyTimer	O 32	1		Daily Timer
ONTIME	R 2005	60000		Switch on time
	R 2004			

Daily timer.5ww * [Daily timer]

Symbol	Address	Value	Modify Value	Symbol Comment
DailyTimer	O 32	1		Daily Timer
ONTIME	R 2005	60000		Switch on time
OFFTIME	R 2004	19000		Switch off time

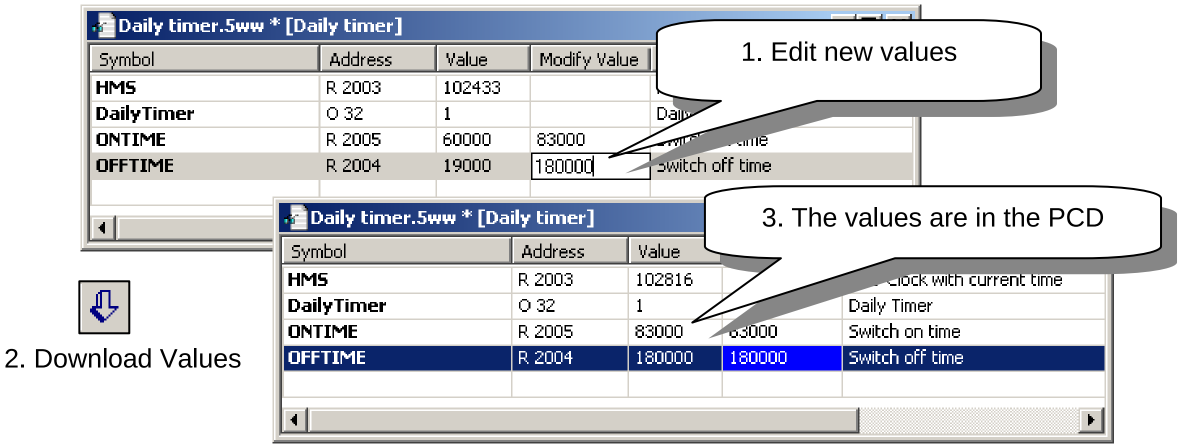
10.2.3 Online display of data

Start/Stop Monitoring

The *Start/Stop Monitoring* button lets you display values present in the PCD for each of the symbols in the Watch Window.
Check that the Watch Window's status bar indicates *RUN* mode. If necessary, force the PCD into *RUN* or *STOP* with the *Online* menu.

10.2.4 Online modification of data

The *Modify Value* column lets you define new values for a number of symbols and download them into the PCD by selecting the *Download Values* button.



Daily timer.5ww * [Daily timer]

Symbol	Address	Value	Modify Value	
HMS	R 2003	102433		
DailyTimer	O 32	1		Dai
ONTIME	R 2005	60000	83000	ime
OFFTIME	R 2004	19000	180000	Switch off time

1. Edit new values

2. Download Values

Daily timer.5ww * [Daily timer]

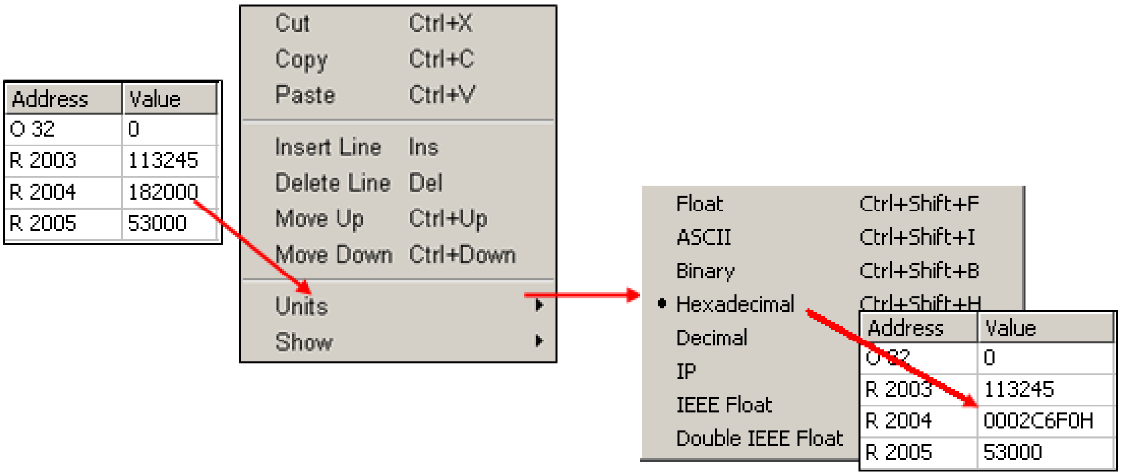
Symbol	Address	Value		
HMS	R 2003	102816		lock with current time
DailyTimer	O 32	1		Daily Timer
ONTIME	R 2005	83000	83000	Switch on time
OFFTIME	R 2004	180000	180000	Switch off time

3. The values are in the PCD

10.2.5 Display format

The display format of values can be adjusted as required.

Example: Display register R 2004 in hexadecimal



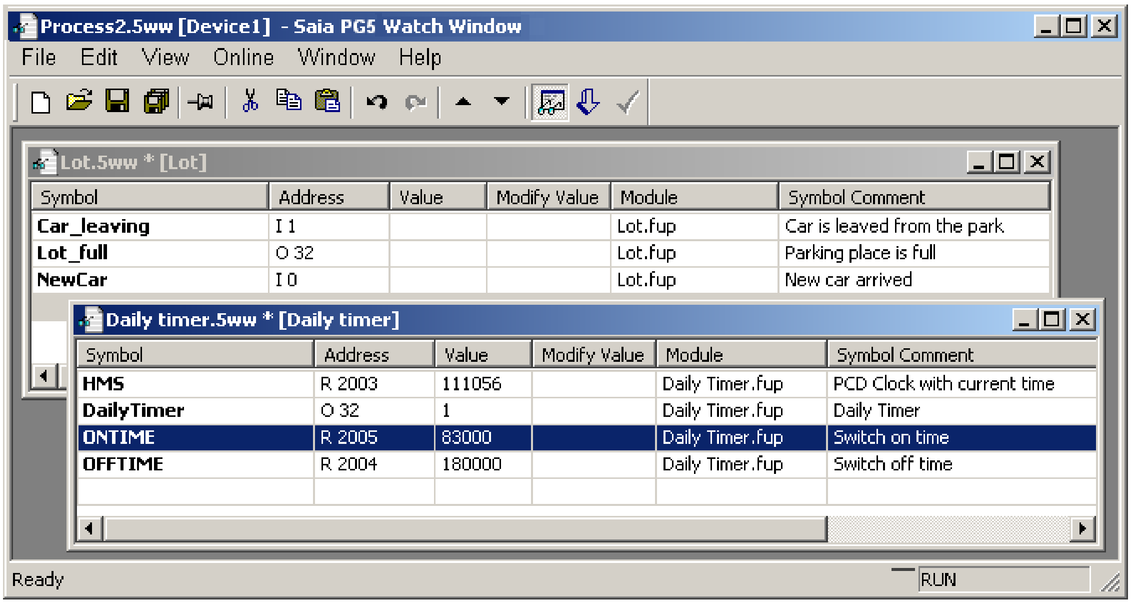
Address	Value
O 32	0
R 2003	113245
R 2004	182000
R 2005	53000

Address	Value
O 32	0
R 2003	113245
R 2004	0002C6F0H
R 2005	53000

10.2.6 Watch Window and applications with several devices

The Watch Window lets you open several documents at one time. The menu, toolbar and status bar always relate to the active window, i.e. the window identified by a blue header bar.

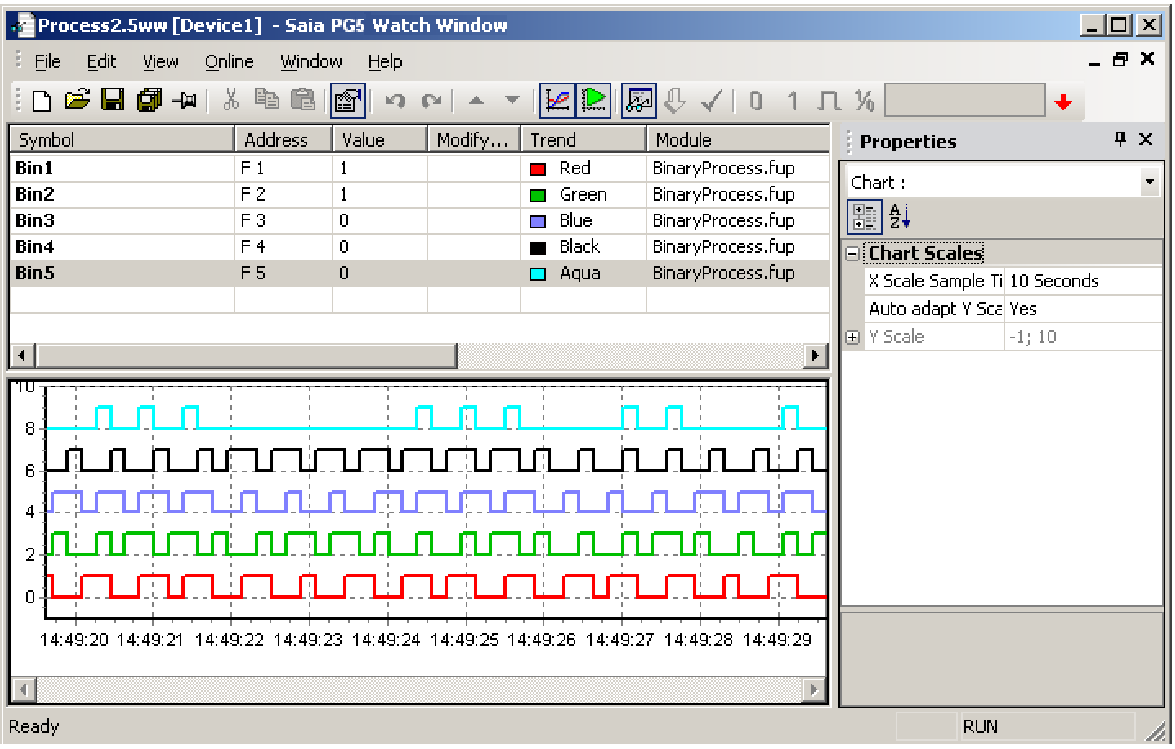
By default, each open Watch Window document uses the *Online settings* of the device to which it belongs. Data from different PCDs available in the project can therefore be displayed on the communications network..


Process2.5ww [Device1] - Saia PG5 Watch Window
File Edit View Online Window Help
Lot.5ww * [Lot]
Daily timer.5ww * [Daily timer]
Ready
RUN

Symbol	Address	Value	Modify Value	Module	Symbol Comment
Car_leaving	I 1			Lot.fup	Car is leaved from the park
Lot_full	O 32			Lot.fup	Parking place is full
NewCar	I 0			Lot.fup	New car arrived

Symbol	Address	Value	Modify Value	Module	Symbol Comment
HMS	R 2003	111056		Daily Timer.fup	PCD Clock with current time
DailyTimer	O 32	1		Daily Timer.fup	Daily Timer
ONTIME	R 2005	83000		Daily Timer.fup	Switch on time
OFFTIME	R 2004	180000		Daily Timer.fup	Switch off time

10.2.7 Trend Function



Symbol	Address	Value	Modify...	Trend	Module
Bin1	F 1	1		🟥 Red	BinaryProcess.fup
Bin2	F 2	1		🟩 Green	BinaryProcess.fup
Bin3	F 3	0		🟦 Blue	BinaryProcess.fup
Bin4	F 4	0		■ Black	BinaryProcess.fup
Bin5	F 5	0		□ Aqua	BinaryProcess.fup

Chart :

Chart Scales

X Scale Sample Ti	10 Seconds
Auto adapt Y Sca	Yes
Y Scale	-1; 10

Show/Hide Trend

Watch window can trace a chart with maximum 8 values: registers, flags etc…If more data needs to be traced, it is possible to open a new watch window file.

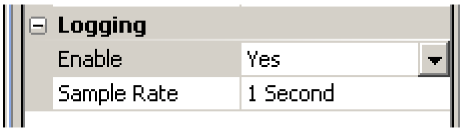
Select the button *Show /Hide Trend* to display the watch window chart, then set some symbols present in the grid with a *Trend* colour and start the trend with the corresponding button in the tool bar.

Start/Pause Trend Update

If we select the view with the symbols or the trend, the properties windows shows some adjustable parameters like the trend sample time and scales units.

10.2.8 Log Function

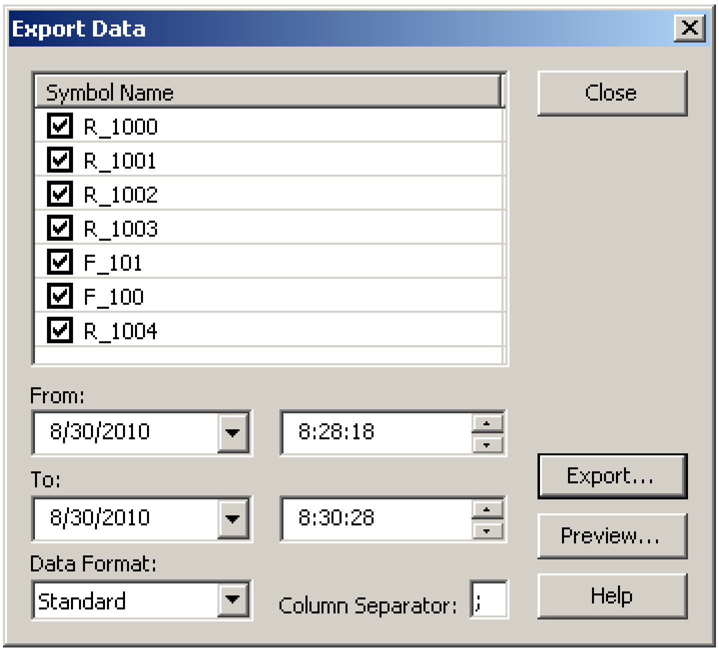
Open Watch Window and open its Properties Window from menu: “View->Properties Window”. Select one or several Symbols in the Watch Window grid and set the option “Logging Enable” to yes then set to no if the measurement is finished.



⊟ Logging

Enable	Yes
Sample Rate	1 Second

The menu “Online -> Export Data” allows selecting the data to be logged and the time period with date and time.



Export Data

Symbol Name
☑ R_1000
☑ R_1001
☑ R_1002
☑ R_1003
☑ F_101
☑ F_100
☑ R_1004

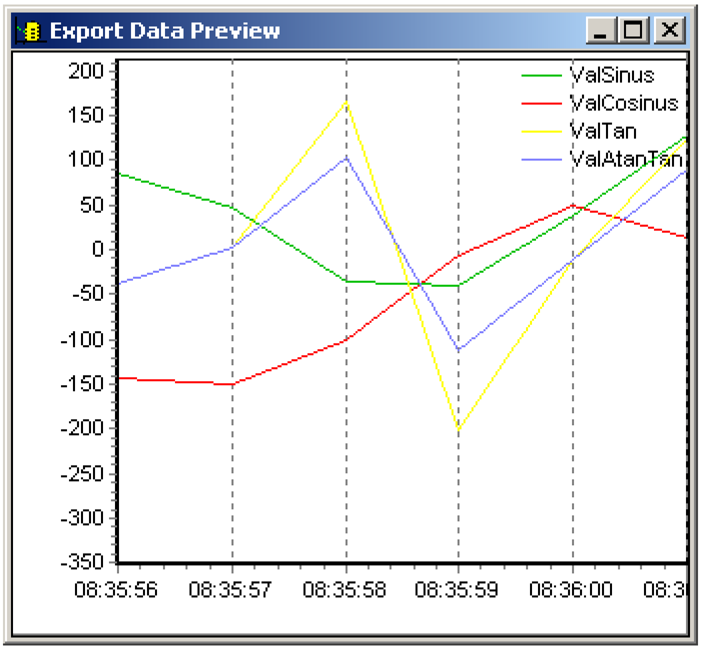
From: 8/30/2010 8:28:18

To: 8/30/2010 8:30:28

Data Format: Standard

Column Separator: ;

The button Preview displays the measurements



Export Data Preview

The button *Export* on *Export Data* dialog saves the trend data in to a file. User provides the name and location to save the file.

10.2.9 Symbols with a small and big magnitude on the same trend

If symbols values present on a trend have a different magnitude, the symbols with a wide variation use all the vertical scale and the symbols with a small vertical magnitude use only a small fraction of this vertical scale.

There is now two possibilities to improve the visibility of the values:

1. A ‘Trending scale factor’ can be defined in the properties of the symbol. It allows to amplifier or reduce the magnitude on the symbol values in the trend. The user must then take into account this factor to read the vertical scale in order to get the right value.

2. A second scale (second Y axis) can be add at the right of the trend. Select the symbol in the watch window grid to display the properties window and assign the symbol to the left or right scale with the properties option “Trending, Axis”.

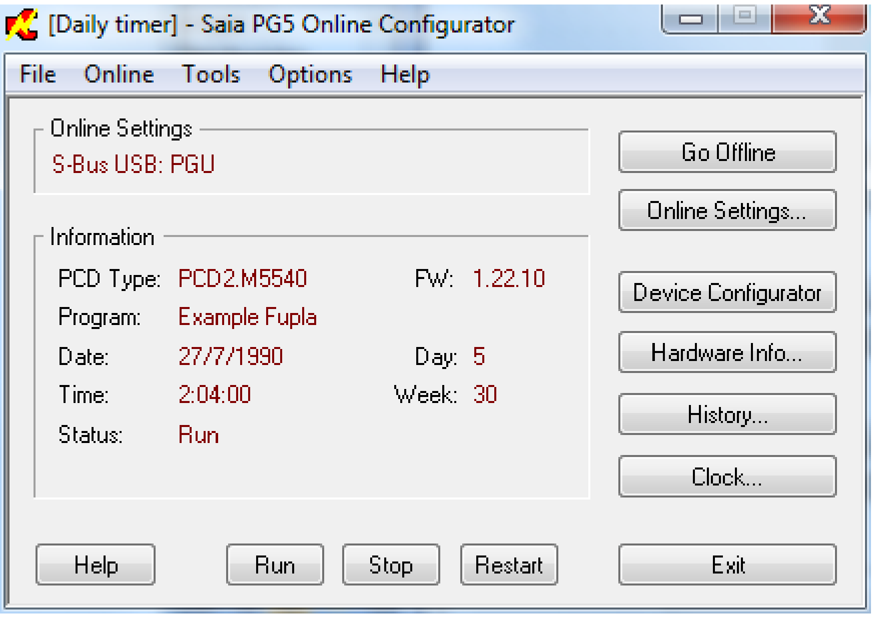
Note:
The trend is always better if the vertical scale is automatically adapted to the symbol magnitude. Select the trend properties and set the option “Left/Right Axis, Auto adapt Y Scale” with Yes.

10.2.10 Trend with several binary symbols

If the trend of several symbols has the same magnitude on the vertical scale, it is possible to define a offset that will be add to the symbol value. This offset is usually automatically defined for binary symbols and can be displayed or modified using the symbol properties “Trending, Offset”.

10.3 Online Configurator

Online Configurator



Online Settings
S-Bus USB: PGU

Information
PCD Type: PCD2.M5540 FW: 1.22.10
Program: Example Fupla
Date: 27/7/1990 Day: 5
Time: 2:04:00 Week: 30
Status: Run

PCD type	PCD type reference number
Version	Version of PCD firmware
Program Name	User program name
Date	PCD clock date (if no clock: 1/1/92)
Time	PCD clock time
Day	Day of week: 1 = Monday, ... 7 = Sunday
Week	Week number
Status	Mode of operation: Run, Stop, Halt, Conditional
Run	
Online settings	Connection direct PGU or S-BUS

If the information in red is not displayed, or if a *No response* message box is displayed, it is not possible to establish communications between the PCD and the *Saia PG5 Online Configurator.*

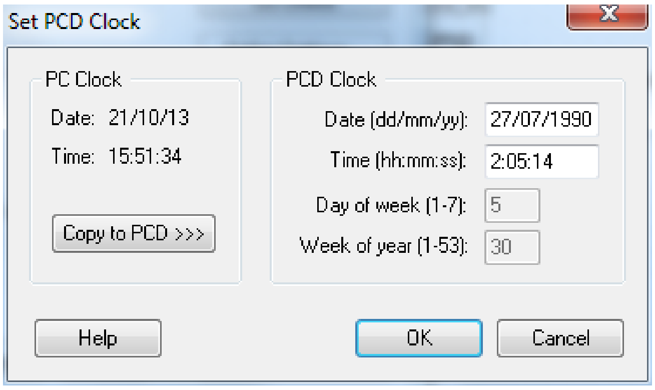
If so, please check:
Is the computer correctly connected to the PCD with PCD8.K111/USB cable?
Have communications parameters been selected correctly with the *Settings* button?

10.3.1 Adjust the PCD's clock

Clock...

1. Select the *Online configurator* button in the *SAIA PG5 Project Manager* window. Then select *Clock* button.

2. Copy time from the PC to the controller with the *Copy to PCD >>>* button, or adjust the clock in the *SAIA PCD Clock* fields.



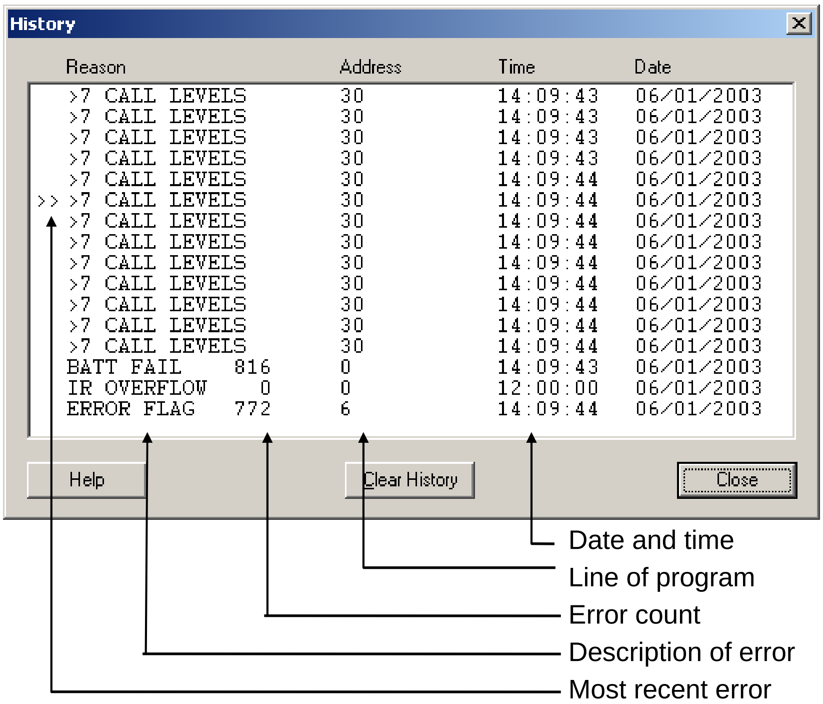
PC Clock
Date: 21/10/13
Time: 15:51:34

PCD Clock
Date (dd/mm/yy): 27/07/1990
Time (hh:mm:ss): 2:05:14
Day of week (1-7): 5
Week of year (1-53): 30

10.3.2 PCD History

History...

The *History* logs all hardware or software errors that occur during PCD operation. This table is permanently updated, even if the XOBs have not been programmed. Consult the history when the CPU's *Error* lamp comes on.



```
History
    Reason                     Address      Time        Date
    >7 CALL LEVELS             30           14:09:43    06/01/2003
    >7 CALL LEVELS             30           14:09:43    06/01/2003
    >7 CALL LEVELS             30           14:09:43    06/01/2003
    >7 CALL LEVELS             30           14:09:43    06/01/2003
    >7 CALL LEVELS             30           14:09:44    06/01/2003
 >> >7 CALL LEVELS             30           14:09:44    06/01/2003
    >7 CALL LEVELS             30           14:09:44    06/01/2003
    >7 CALL LEVELS             30           14:09:44    06/01/2003
    >7 CALL LEVELS             30           14:09:44    06/01/2003
    >7 CALL LEVELS             30           14:09:44    06/01/2003
    >7 CALL LEVELS             30           14:09:44    06/01/2003
    >7 CALL LEVELS             30           14:09:44    06/01/2003
    >7 CALL LEVELS             30           14:09:44    06/01/2003
    BATT FAIL     816          0            14:09:43    06/01/2003
    IR OVERFLOW     0          0            12:00:00    06/01/2003
    ERROR FLAG    772          6            14:09:44    06/01/2003

 Help                 Clear History                        Close
```

Notes:

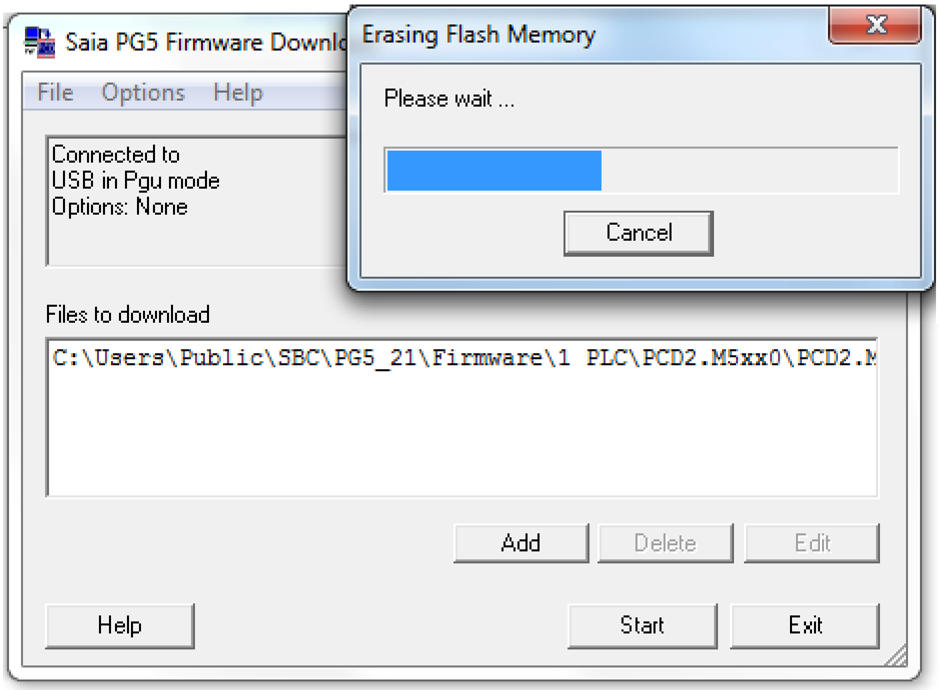
If an error can be traced to a line of the program, it will be specified. Otherwise it is displayed in hexadecimal.

XOB 0 only appears if it has been programmed.

10.4 Updating firmware. *(Firmware Downloader)*

Sometimes the program firmware has to be updated to benefit from the latest PCD product innovations.

Saia PCD firmware can be reloaded in flash memory using a little utility accessed with the *Tool, Firmware Downloader* menu of the Project Manager.



Connected to
USB in Pgu mode
Options: None

Files to download

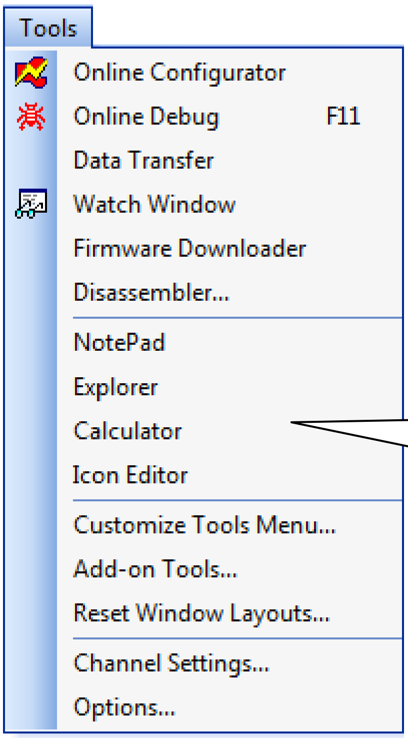
C:\Users\Public\SBC\PG5_21\Firmware\1 PLC\PCD2.M5xx0\PCD2.M

Please wait ...

Download instructions:
The *ADD* button adds a new firmware file (*.blk) to the list: *Files*.
The most recent firmware files are available in directory *FW* on the PG5 distribution CD.
Use menu *File, Settings* to adjust communications parameters to PGU mode (only mode currently supported).
Select firmware to download into PCD.
Download the firmware with the *Start* button. A dialogue box indicates the progress of data transfer.
When data transfer is complete, the PCD's *Run*, *Halt* and *Error* LEDs will start to flash. The PCD is reorganizing information in its memory. Please wait a further minute before powering off the controller, or continuing your work.

10.5 User menus

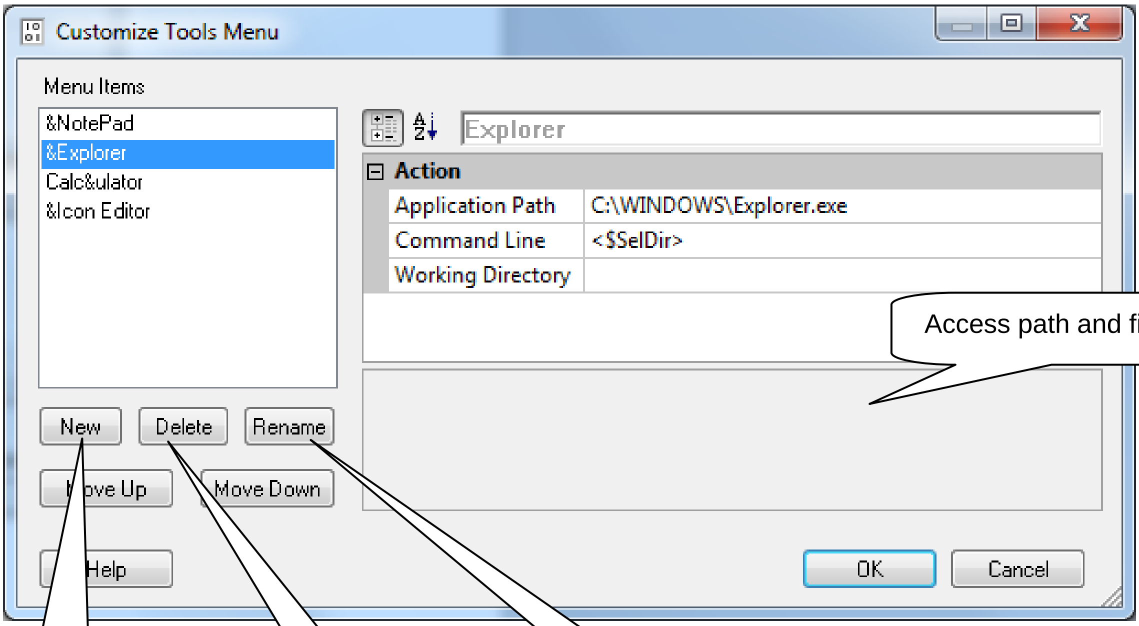
The *Tools* menu of the *Saia PG5 Project Manager* window can be extended with shortcuts to your favourite programs.



This menu has been added to the *Tools* menu with the command *Customize Menu...*

.

To add a shortcut, use the *Tools, Customize Menu* command. Press *Help* for more details.



Application Path	C:\WINDOWS\Explorer.exe
Command Line	<$SelDir>
Working Directory	

Access path and filename

Create a new menu item

Delete a menu item

Change menu item order

Contents

11 Saia PCD Networks (S-Net)

11.1 Summary

Automation solutions often consist of several decentralized PCD controllers, terminals and supervision computers, connected by a communications network. Each station controls part of the process, and exchanges data with the other stations on the network.

To guarantee the flexibility of such a concept, the PCD system supports several types of communications network. Each network has its own capabilities, so the user should choose the network which is most appropriate for the application.

The PG5 is an effective tool for implementing these solutions:

- *Saia PG5 Project Manager* provides an overview of the stations (PCDs) and their configuration parameters including the network's communications parameters.

- The Fupla or IL editor allows the programming of the data exchange between PCD stations on the network.

The programming examples described in the following chapters are all installed with the PG5, and serve as basis to test and understand the functionality of the data exchange across different PCD networks. You will notice that some examples are very close to full practical implementations.

11.2 Choice of network

The choice of network depends on the application's requirements. These are the available S-Net network types:

- Profi-S-Bus : fieldbus network based at the Profibus FDL standard
- Ether-S-Bus : information network based on the standard Ethernet
- Serial S-Bus : network based on serial interface RS 485/232
- S-Bus Modem : network based on analogue or digital telephone line
- Profi-S-IO : fieldbus network based on the standard Profibus DP
- Profibus DP: fieldbus network based on the standard Profibus DP

The different networks are distinguished by their services, technical characteristics and their application domains.

11.2.1 Supported services

Although all the communication networks support the transport of PCD data as inputs, outputs, flags, registers etc., some also support the programming, control and commissioning of the PCD systems through the network using the PG5 tools.

11.2.2 Design features

11.2.2.1 Communications speed

The communications speed defines the reaction time for the transfer of data between the stations. If the amount of data to be transferred is large, or if the reaction time must be short, then the communication speed must be high. Note that if the communication speed of the network is adjustable, the same speed must be used by all stations on the network.

11.2.2.2 Maximum distance

The distance between stations can be a limitation for stations which are a long way apart. The maximum distance cannot be exceeded without amplification of the electrical signals, using a repeater or switch / Hub. Generally the maximum distance also depends on the communications speed. The higher the speed, the shorter the distance. Reducing the communications speed can often be a solution for crossing greater distances.

11.2.2.3 Communications protocol

The "protocol" is the message format used for data exchange between stations on the network. We can compare the protocol to the language used when two people speak to each other - they will only understand each other if they speak the same language. Likewise, two stations can only exchange data if they use the same protocol.

The protocols of some communications networks are official standards. This is a great advantage when equipment from different manufacturers must communicate. Field busses and sensors often use the standard Profibus DP protocol.

On certain communication networks like Ethernet or Profibus FDL it is possible to support data exchange using different protocols on the same physical network. But in all cases, the two communicating stations must use the same protocol.

11.2.2.4 Data exchange master-slave or multi-master mode

A "master-slave" network is composed of one master station and several slave stations. The master station controls the exchange of data between the slave stations.

A "multi-master" network is composed of several master stations, and several slave stations. Each master station can exchange data with other master or slave stations.

In both cases, direct data exchange between slave stations is not allowed.

11.2.2.5 Application domains

Some networks are designed for specific uses. For example, Profibus DP is a protocol oriented towards the machinery domain. The protocol of this network is well standardized, and a lot of compatible equipment from many suppliers allows data transfer on the same bus as used for the motor commands etc.

The Ether-S-Bus network is more oriented towards supervision systems, OPC servers, or can simply be used by the PG5 programming and commissioning tools.

Serial S-Bus provides an easy way to connect PCD systems. It is a very economical network, supporting the same services as Ether-S-Bus via RS-485, but also through analogue and ISDN telephone lines (S-Bus Modem).

Communication network S-Net

Services :	**Ether-S-Bus**	**Profi-S-Bus**	**Serial S-Bus**	**S-Bus Modem**	**Profi-S-IO Profibus DP**
PCD Programming	Yes	Yes	Yes	Yes	No
Data Exchange	Yes	Yes	Yes	Yes	Yes
Characteristics :					
Max. transmission speed	10 and 100 Mbd	12 Mbd	38.4 /115.2 Kbd	38.4 /115.2 Kbd	12 Mbd
Max. distance without repeater or switch/Hub	100 m	100 m	1200 m	-	100 m
Cable type	4 twisted pairs	1 twisted pair	1 twisted pair	-	1 twisted pair
Protocol	Saia PCD	Saia PCD	Saia PCD	Saia PCD	Normalized ISO
Exchange mode	Multi-Master	Multi-Master	Master-Slave	Multi-Master	Master-Slave
Max. number of stations	Unlimited	126	254	Unlimited	126
Application Domain	Industry, building	Industry, building	Industry, building	Industry, building	Industry, building

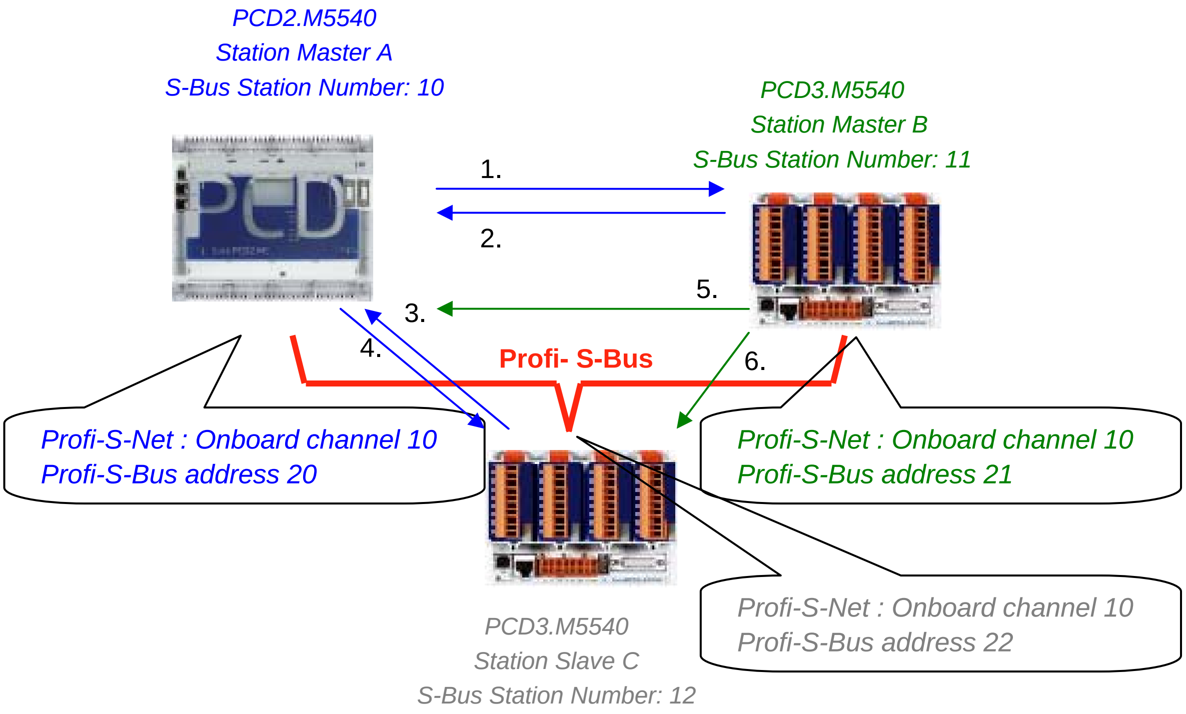
The new Profi-S-Bus network merges all the advantages of a multi-master network and a high communications speed into a fieldbus network intended for industrial automation applications.

Contents

12 Profi-S-Bus

This example shows how to exchange data, such as Registers and Flags, between the PCDs connected to a Profi-S-Bus network

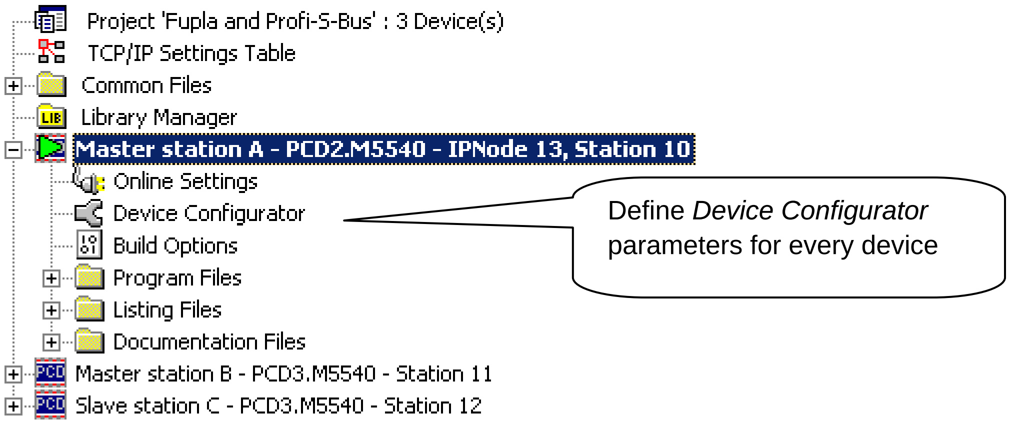
12.1 Profi-S-Bus network Example



12.2 Examples of the Data Exchange in Profi-S-Bus

	Master with data exchanges	*Data on the network*	*Passive master or slave*
	Master station A		***Master station B***
1	*Blinker0 .. 7* *F 0 .. 7*	*Write 8 flags in the Master station B*	*Station_A.Blinker0 .. 7* *F 100 .. 107*
2	*Master_B .Value100* *R 125*	*Read 1 register in the Master station B*	*Value100* *R 25*
			Slave station C
3	*Slave_C.Binary0 .. 7* *F 100 .. 107*	*Read 8 flags in the slave station C*	*Binary0 .. 7* *F 20 .. 27*
4	*Value0 .. 5* *R 0 .. 5*	*Write 6 registers in the slave station C*	*Master_A. Value0 .. 5* *R 20 .. 25*
	Master station B		***Master station A***
5	*Temperature1 .. 4* *Dynamic registers*	*Write the temperature measures to the slave C*	*Master_B.Temperature1 .. 4* *R 100 .. 104*
			Slave station C
6	*Temperature1 .. 4* *Dynamic registers*	*Write the temperature measures to the master A*	*Master_B.Temperature1 .. 4* *R 100 .. 104*

12.3 The PG5 Project



Project 'Fupla and Profi-S-Bus' : 3 Device(s)
TCP/IP Settings Table
Common Files
Library Manager
Master station A - PCD2.M5540 - IPNode 13, Station 10
Online Settings
Device Configurator
Build Options
Program Files
Listing Files
Documentation Files
Master station B - PCD3.M5540 - Station 11
Slave station C - PCD3.M5540 - Station 12

Define *Device Configurator* parameters for every device

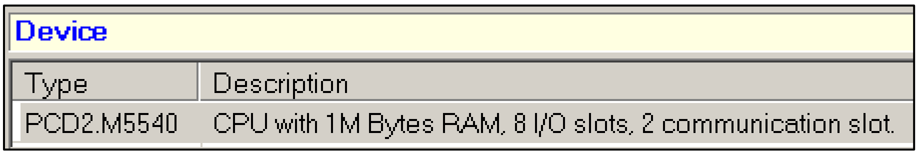
Saia PG5 Project Manager

The *Saia PG5 Project Manager* shows all the PCD stations in an application's Project, and also the network communication parameters. We will begin with adding a device to the Project for each of the Network Stations.

12.4 *Device Configurator* parameters

The *Device Configurator* parameters are the similar for a master and Slave station.

12.4.1 Define the device type



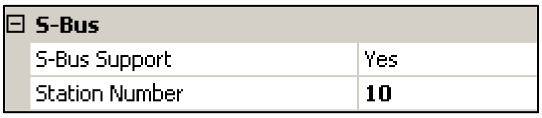
Device

Type	Description
PCD2.M5540	CPU with 1M Bytes RAM, 8 I/O slots, 2 communication slot.

Device Type

Define the PCD type

12.4.2 Define S-Bus station number in the Network



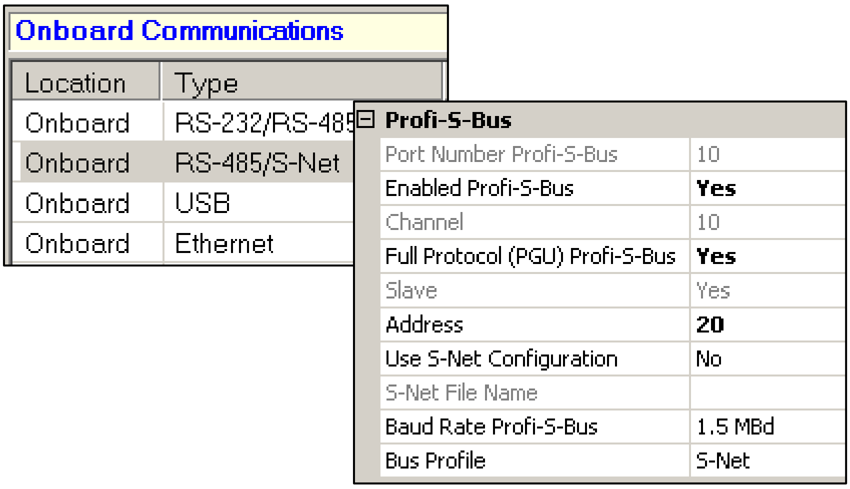
S-Bus	
S-Bus Support	Yes
Station Number	**10**

Device properties:

Station Number

S-Bus station number is common to all communication channels of the PCD.

12.4.3 Define communication channel of the Profi-S-Bus



Onboard Communications

Location	Type
Onboard	RS-232/RS-485
Onboard	RS-485/S-Net
Onboard	USB
Onboard	Ethernet

⊟ **Profi-S-Bus**	
Port Number Profi-S-Bus	10
Enabled Profi-S-Bus	**Yes**
Channel	10
Full Protocol (PGU) Profi-S-Bus	**Yes**
Slave	Yes
Address	**20**
Use S-Net Configuration	No
S-Net File Name	
Baud Rate Profi-S-Bus	1.5 MBd
Bus Profile	S-Net

Onboard Communication, properties:

Full Protocol (PGU) Profi-S-Bus

Define the channel as slave or PGU. This definition can be accumulated with master function, adding a SASI Fbox in Fupla program.

Slave + PGU

Slave PGU

Supports data exchange with master stations, supervision systems and terminals. It also supports the PG5 programming tools.

Slave

Supports only data exchange with other master stations, supervision systems and terminals.

Address

Profi-S-Bus station number connected to channel.

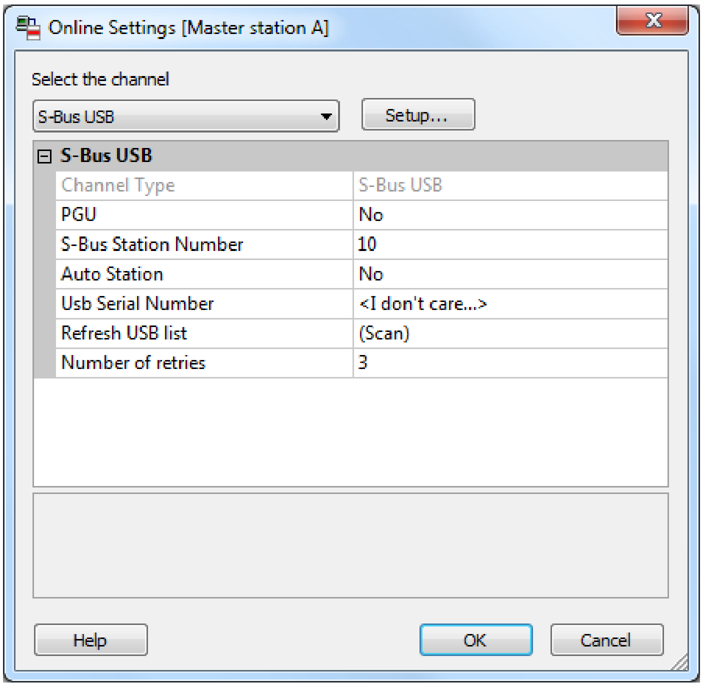
Baud Rate Profi-S-Bus

Communication speed must be the same for all stations on the network.

Bus Profile

Transmission timings are grouped in three profiles: S-Net, DP or user-defined. With the user-defined profile, you can define your own *timings* using the *Bus Parameter* button. The profile must be identical for all network stations. The S-Net Profile is necessary when using RIO PCD3.T76x in the network.

12.4.4 Download the *Device Configurator* parameters in the device



Online Settings [Master station A]

Select the channel

S-Bus USB

S-Bus USB

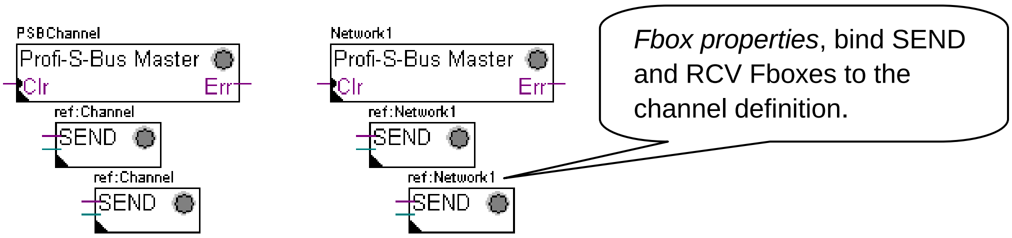
Channel Type	S-Bus USB
PGU	No
S-Bus Station Number	10
Auto Station	No
Usb Serial Number	<I don't care...>
Refresh USB list	(Scan)
Number of retries	3

With the new PCD systems, the Device Configurator parameters can be downloaded via a USB connection. It is necessary just to define *Online Settings* with the channel *Profi-S-Bus + PGU*.

Download the parameters to the PCD using *Download Configuration* on the *Device Configurator* window.

12.5 Fupla Program

12.5.1 Assign the channel using SASI Fbox



Fbox properties, bind SEND and RCV Fboxes to the channel definition.

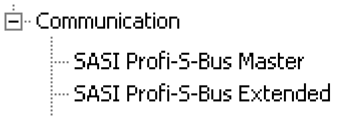
Assignment is done using a SASI Fbox, placed at the beginning of the Fupla File. Each communication network needs its own SASI Fbox, because the parameters are different depending on the network, the same for Master or Slave stations.

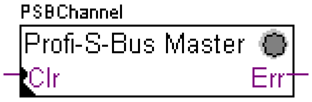
If the PCD uses more communication channels, define each channel using corresponding SASI Fbox. Then place the mouse over the SASI Fbox and using the context menu select Fbox properties, define a different *Name* for the Fbox of each channel. This name allows binding the exchange Fboxes SEND and RCV with SASI Fbox corresponding to the channel.

According to the network, the communication channel parameters can be partially defined from the adjust parameters of the SASI Fbox, and to be completed in the *Device Configurator*..

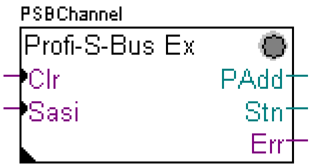
The channel number is always defined in the adjust parameters of the SASI FBox. The channel number depends from PCD Hardware and on the communication hardware used: slot B1, B2, serial interface PCD7.F, …

12.5.2 Assign Master channel





Master Station



Master Station with timings definitions

The assignment of the Master channel is done by combining the *Device Configurator* parameters with one of the Fboxes above.
Only the communication channel and the timings of the Master Channel can be adjusted from the Fbox. Other parameters are all defined in the *Device Configurator*.

Adjust parameters:

Channel
Defines the corresponding channel of the serial interface connected in the network. Depends from the PCD and his hardware.

Timing
The Timeout is general defined with the value by default (0) and will be adjusted only for the particular applications (Gateway).

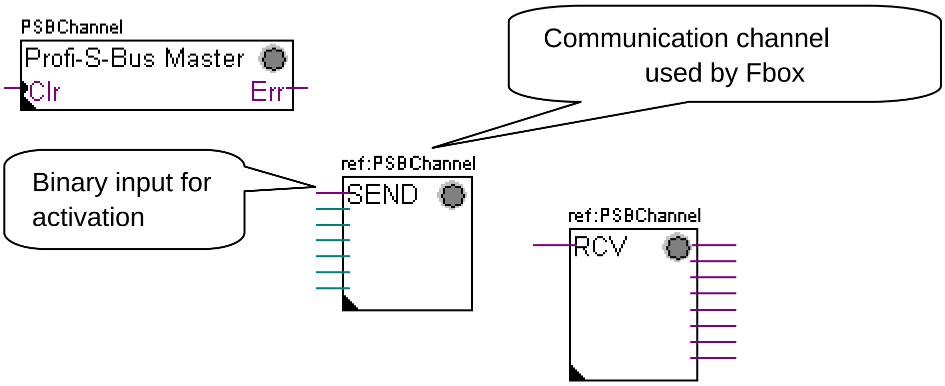
12.5.3 Assign slave channel

No SASI FBox is necessary for the slave station in the Profi-S-Bus network. All definitions necessary are already present in the *Device Configurator*.

12.5.4 Principles of data exchange in a multi-master network

A multi-master communication network has more than one master station. Master Stations are the only stations authorized to read or write the data of the other master and slave stations. Data exchange between slaves is not allowed.
With a Multi-master communication mode, data exchange is carried out between the masters in the network. Only one master at a time holds a token which authorizes it to exchange data with other master or slave stations on the network. When the master has finished transferring the data, the token is passed to the next master, which is then free to exchange data with the other masters or slaves. The token circulates automatically between the master stations, the slaves never have the token and so cannot read or write the data of other stations in the network.

12.5.5 Data Exchange between master and slave stations



User-controlled data exchange between stations is done using Fupla Fboxes placed on the Fupla pages, chosen the *Fbox Selector*. You will find the Fboxes to write (SEND) or to read (RCV) data packets, and also support different data formats: binary, integer, floating point, Data Block, etc.

The *SEND* or *RCV* Fbox can be resized to increase or decrease the number of inputs and outputs, defining the data packet to be exchanged with another station.

The address of the Communication Channel, used by data transmission Fbox is defined by the symbol shown at the top left of the Fbox, which binds it to the SASI Fbox of the same name in which the channel address is defined. This symbol can be edited by putting the mouse on the Fbox and selecting the context menu's *Fbox Properties.*

Each *SEND* and *RCV* Fbox has a binary input for activation of the data exchange. If this input is permanently high, data exchange will repeated as fast as possible. If a short pulse is applied to the input, data exchange will be executed at least once, but it is always possible to force it using the Execute button, or by a Restart Cold the PCD with *Initialization* option of the *adjust parameters.*

Master station data present at the inputs of the SEND Fbox, are sent to the Slave station defined in *adjust window*. Whereas the data present at the output of the RCV Fbox comes from the slave station defined by the parameters of the adjust window: address of the slave station, source element and base address.

Only the master stations are programmed with the *SEND* and *RCV* Fboxes! The slave stations can only be assigned with the communication channel.

According to the Fboxes used, the *adjust parameters* allows the definition of the slave stations to which data can be sent from the master station (SEND), or from which slave stations the Master can read data (RCV).

Adjust parameters.

Profi-S-Bus Address
Defines the number of the Profi-S-Bus slave station.

Source, destination station
Defines the number of the S-Bus slave station

Source, destination element
Defines the type of the data to write or read from the slave.

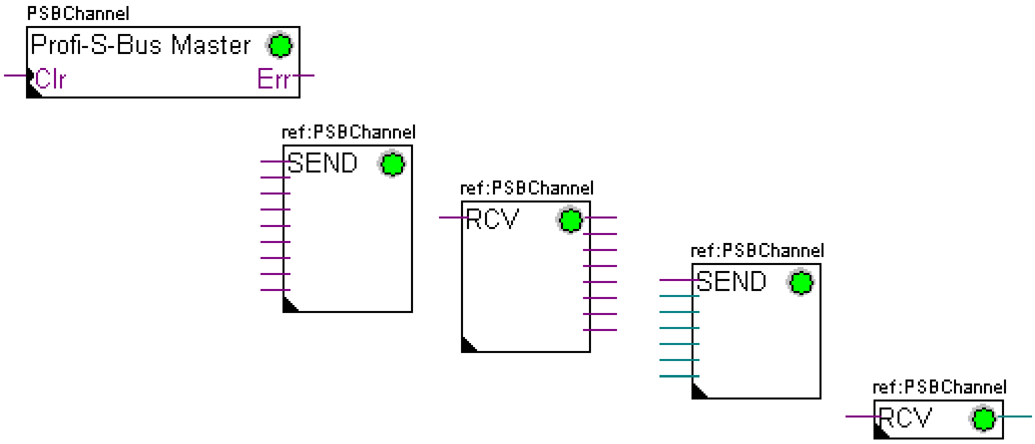
Source, destination address
Defines the start address of the data to write or read in the slave. The number of the exchanged data values depends on the number of the inputs or outputs of the SEND or RCV Fbox.

12.5.6 Diagnostics

If the program is Online, a green or red LED is displayed at the top right of the *SASI*, *SEND* or *RCV* Fbox. Green indicates that the data transmission is OK, red indicates an error.

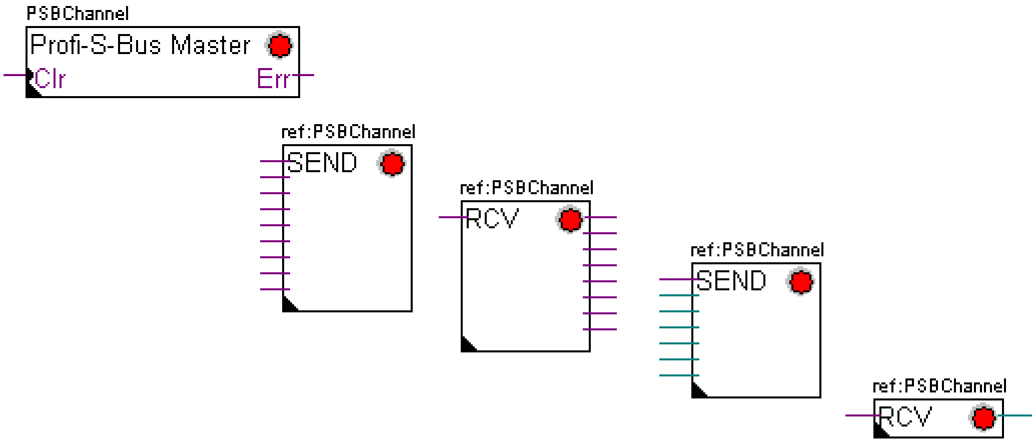
Correct functionality

All the Fbox are green, data exchange are done correctly.



No data can be exchanged in the network

SASI Fbox, *SEND* and *RCV* are red; no data can be exchanged in the network.

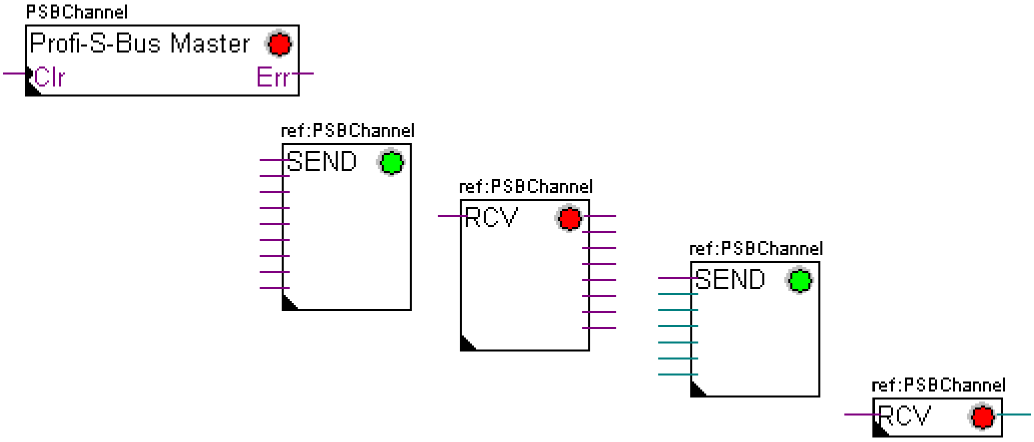


Possible corrective actions in master or slave station:

- Verify the *Device Configurator*
- Verify that the *Device Configurator* parameters have been downloaded into the PCD
- Verify that all stations use the same profile: S-Net, DP
- Verify that all stations communicate at the same speed
- Verify that the defined communication channel with the *Device Configurator* and *SASI* function are identical (same channel number)
- Verify that the PCD is equipped with the necessary communication hardware
- Verify that the stations are connected to the network and are powered on
- Verify the network wiring
- Verify that the firmware version supports Profi-S-Bus

<u>Only some Fboxes do not exchange data</u>

SASI Fbox and some *SEND* and *RCV* Fboxes are red. The Fbox in green exchanges the data correctly



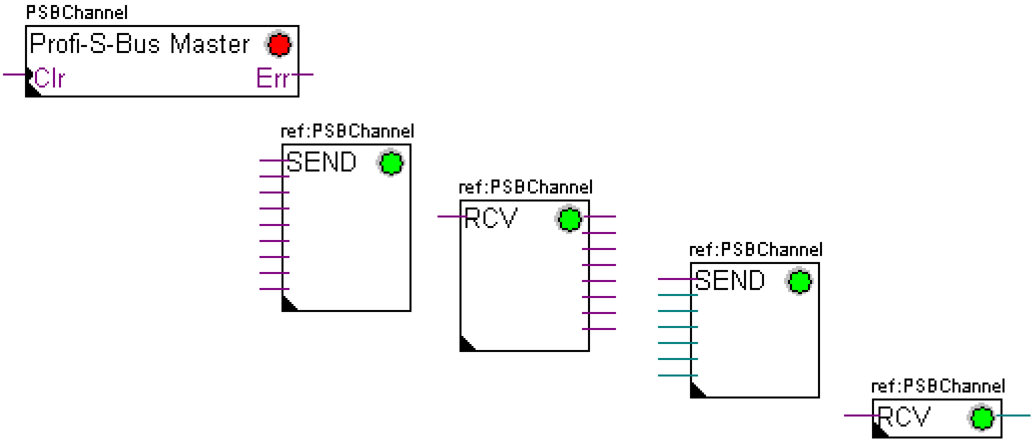
Possible corrective actions in the master station
Verify the parameters of the *adjust window* of the red *SEND* and *RCV* Fbox.
Verify that the slave address is present in the network.

Possible corrective actions in the slave station
For every red *SEND* and *RCV* Fbox, view the slave station number and verify the concerned stations.

- Verify if the *Device Configurator* parameters are defined correctly
- Verify if the PCD is equipped with necessary communication hardware
- Verify if the stations are connected to the network and are powered on
- Verify the network wiring
- Verify if the firmware version supports Profi-S-Bus

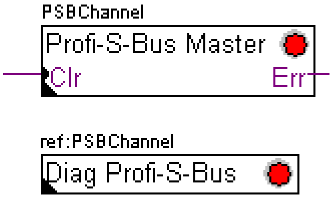
Only SASI Fbox is red

Open adjust window of the *SASI* Fbox, and clear the last error using *Clear* button.



Diagnostic Fbox

If SASI lamp is red, it is always possible to obtain a diagnostic while consulting the adjust window of the *SASI Diagnostic* function. This Fbox should be placed just below *SASI* Fbox.



12.6 IL programm

12.6.1 Assign master Channel using SASI instruction

Mode Profi-S-bus Master

Register with slave station address

First address of the range of 8 flags and one diagnostic register

```
$SASI
TEXT 10   "MODE:PSM,R0500;DIAG:F1000,R0501;"
$ENDSASI

     SASI    10          ; Address off communication channel
             10          ; Address of the text with assignation parameters
```

The assignation of the channel is done using SASI instruction, which is placed at the beginning of the program: Graftec initialization sequence or initialization bloc XOB 16.

SASI instruction contains two parameters: communication channel address and address of the text with all the necessary channel parameters.

Text assignation parameters are different from one communication network to other, same as for slave or master station.

If the PCD exploit more communication channels de, each channel must be defined using SASI instruction and assignation text.

Depending of the network, channel parameters can be completed with *Device Configurator* parameters.

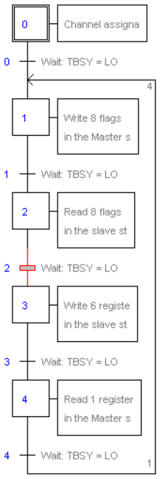
12.6.2 Assign slave channel

No SASI FBox is necessary for the slave station in the Profi-S-Bus network. All definitions necessary are already present in the *Device Configurator.*

12.6.3 Principles of data exchange in a multi-master network

A multi-master communication network has more than one master station. Master Stations are the only stations authorized to read or write the data of the other master and slave stations. Data exchange between slaves is not allowed.
With a Multi-master communication mode, data exchange is carried out between the masters in the network. Only one master at a time holds a token which authorizes it to exchange data with other master or slave stations on the network. When the master has finished transferring the data, the token is passed to the next master, which is then free to exchange data with the other masters or slaves. The token circulates automatically between the master stations, the slaves never have the token and so cannot read or write the data of other stations in the network.

12.6.4 Data Exchange between master and slave stations



Initial Step: channel assignation

Step: data exchange

Transition: wait end of the data exchange

Data exchange between the stations is the sequential program: The assignation of the communication channel is treated only once, data exchange in the network will be executed only if the previous exchange of the data's is finished. That's why we propose to treat IL data exchange with Graftec Editor.
Initial Step allows assigning the communication channel at the Restart Cold of the PCD.
Other Steps are executed in loop, and step one supports one data package.

Every Step is separated by one Transition which tests diagnostic flag TBSY, and defines if data Exchange is finished. We are authorized to exchange data's defined by step which follows, only if TBSY is Low.

Data Exchange using a Step

Before to exchange data, we must define address of the slave station in the register, which is declared for this by text assignation:

Define the address of the slave station

```
LDL     R 500   ; Register address with the slave station address
        11      ; S-Bus address

LDH     R 500   ; Register address with slave station address
        21      ; Profi-S-Bus Address
```

Data exchange between the stations is supported using two instructions:
STXM for writing data in the slave station (*SEND*)
SRXM for reading data in the slave station (*RCV*)

Each instruction contains four parameters: Channel address, number of data's to exchange, address of the first data source, and the destination.

Write 8 Flags (F 0... F 7) in the slave station (F 200... F 207)

```
STXM   10       ; Channel address
       8        ; Number of the data's to exchange
       F 0      ; address of the first source data (local Station)
       F 200    ; address of the first destination data (slave Station)
```

Read a register (R 25) of the slave station (R 125)

```
SRXM   10       ; Channel address
       1        ; Number of the data's to exchange
       R 25     ; address of the first source data (local Station)
       R 125    ; address of the first destination data (slave Station)
```

Note:
Only the master stations are programmed with STXM and SRXM ! The slave stations must only be assigned with the communication channel.

.

Waiting the transmission end de using the transition

```
STL    F 1003   ; Verify that TBSY is in Low state
```

Le Assignation text defines a range of 8 diagnostic flags for communication. Third flag will go in the high state during the data transmit, and in low state when exchange is finished.

12.6.5 Diagnostics

Channel assinations

In the case of the communication problem, verify if the channel assignation is donne correctly. Analyse the program step by step, and verify that the SASI instruction doesn't display a flag error.If the channel assignation isn't donne correctly, then the communication will not work.

Possible corrective actions in master or slave station:

- Verify the *Device Configurator*
- Verify that the *Device Configurator* parameters have been downloaded into the PCD
- Verify that all stations use the same profile: S-Net, DP
- Verify that all stations communicate at the same speed
- Verify that the defined communication channel with the *Device Configurator* and *SASI* instruction are identical (same channel number)
- Verify that the PCD is equipped with the necessary communication hardware
- Verify that the stations are connected to the network and are powered on
- Verify the network wiring
- Verify that the firmware version supports Profi-S-Bus

Data’s are not exchanged in the network

Assignation Text defines a range with 8 diagnostic flags for the communication, Fifth Flag (*TDIA: Transmitter diagnostic*) will go in the high state during the data transmit error. Step by step test of the communication program, allows determining the instructions STXM and SRXM in error.

Attention: if the communication error occurs, then the diagnostic flag TDIA stays in high state, until the diagnostic register will not be reset to zero.

Possible corrective actions in the master station
Verify the parameters of the instructions STXM and SRXM in error. Verify that the slave address is present in the network.
Possible corrective actions in the slave station
For every instruction STXM and SRXM in error, read the slave station number and verify concerned stations.

- Verify if the *Device Configurator* parameters are defined correctly
- Verify if the PCD is equipped with necessary communication hardware
- Verify if the stations are connected to the network and are powered on
- Verify the network wiring
- Verify if the firmware version supports Profi-S-Bus

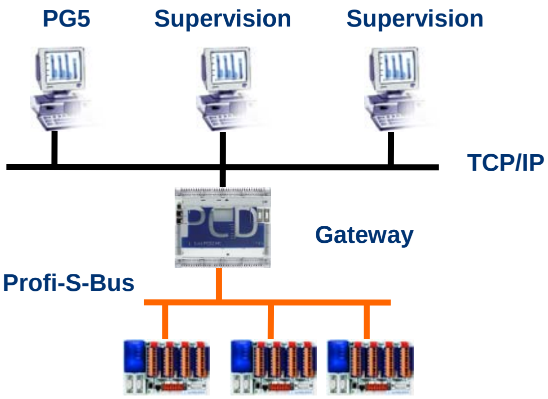
Diagnostic register

Diagnostic register can give us more information’s about the nature the communication error. Display the binary content of the register and compare it with the descriptions of the PCD manual or the communication network manual.

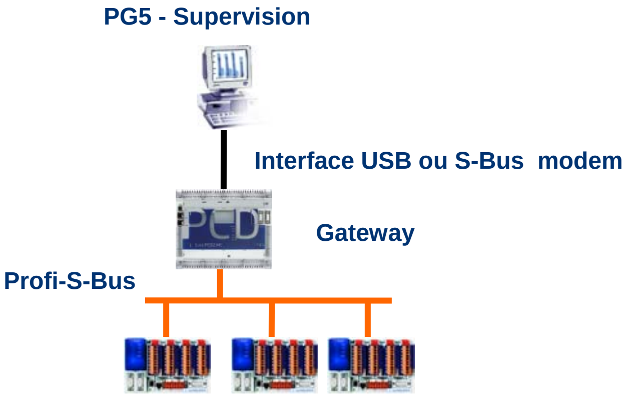
12.7 Gateway Function

The *Gateway* feature is commonly used to allow two different communication networks to communicate together, or adapt a programming tool (PG5) or a supervision system (Visi+) to use a different network that the one usually supported.

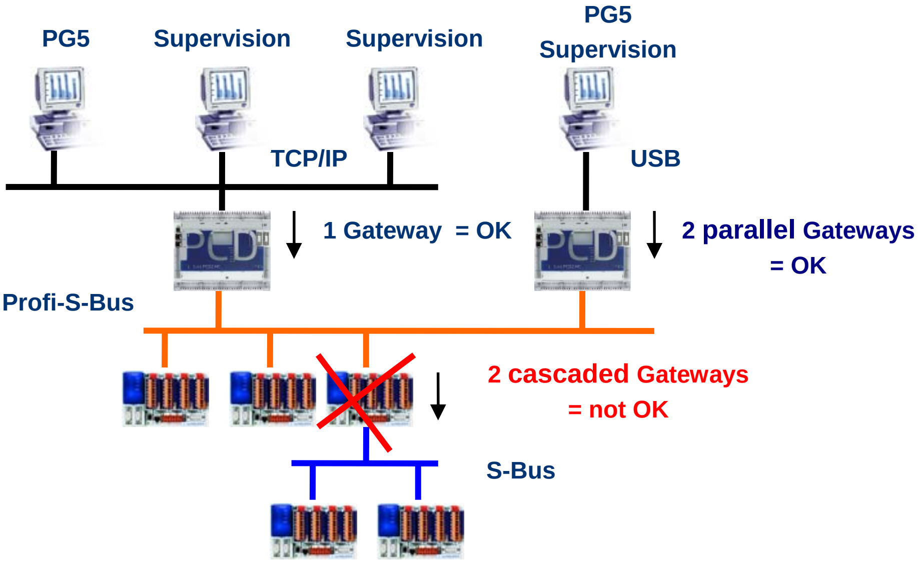
12.7.1 Application



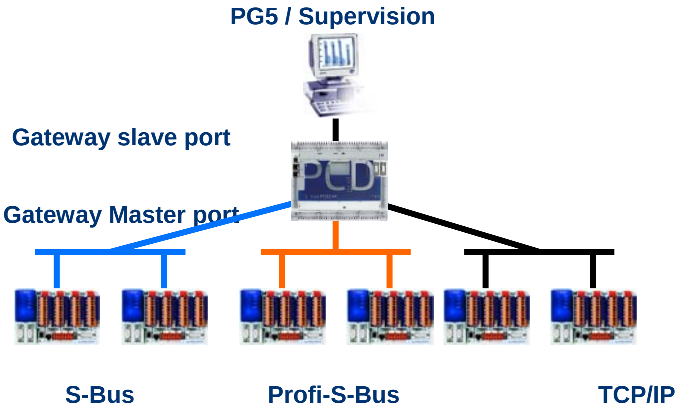
The *Gateway* function creates a bridge between two networks, for example to link an Ethernet network with a Profi-S-Bus network. In this way the PCD systems exchange data on a common bus, specific to the automation field and separated from information network of the company. But the PCs running the PG5 software or the supervision system Visi+ can exchange still data with the PCDs.



The *Gateway* function can be used as an interface between a communications network and the external world. For example, to make modem or USB communication interfaces.



To respect the communication timings, we cannot define two cascaded Gateways functions. But it is possible to define two parallel Gateways on the same network.



If necessary, a Gateway can make a bridge between to several communication sub networks.

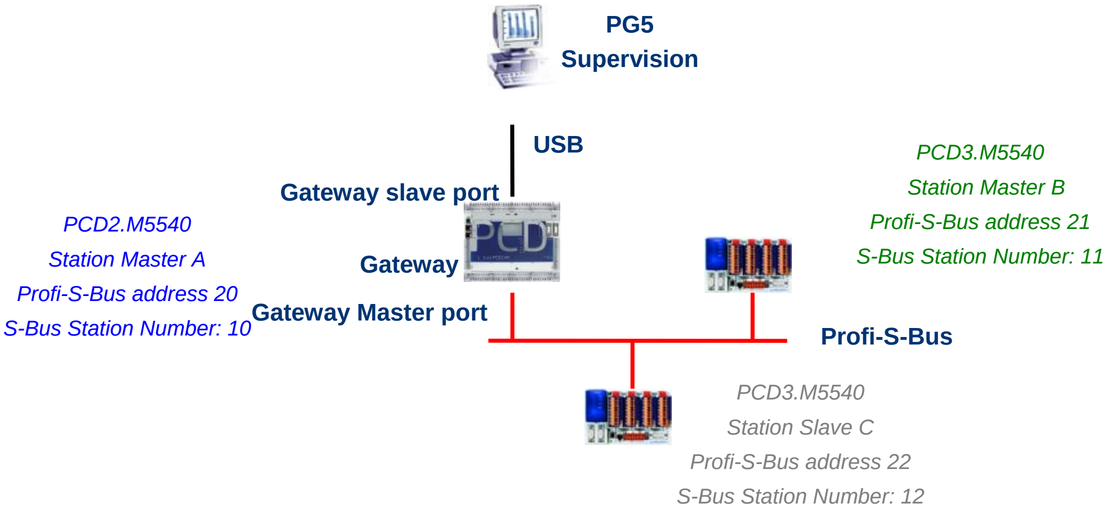
12.7.2 Configuration of the Gateway PGU function

It is easy to configure the *Gateway* function; it doesn’t need any program, only some parameters in the *Device Configurator*.

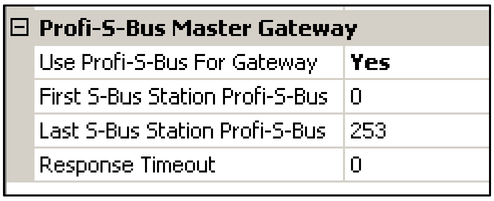
Generally, only a *Gateway Slave Port* and a *Gateway Master Port* should be defined, then all is automatically supported by *Gateway* function.

If the message received by the *Gateway Slave Port* is not for the local station (the *Gateway*), then data is re-transmitted via one of the sub-networks connected to the *Gateway Master Port*, according to the address ranges defined for the sub-network.

Example: Gateway USB, Profi-S-Bus



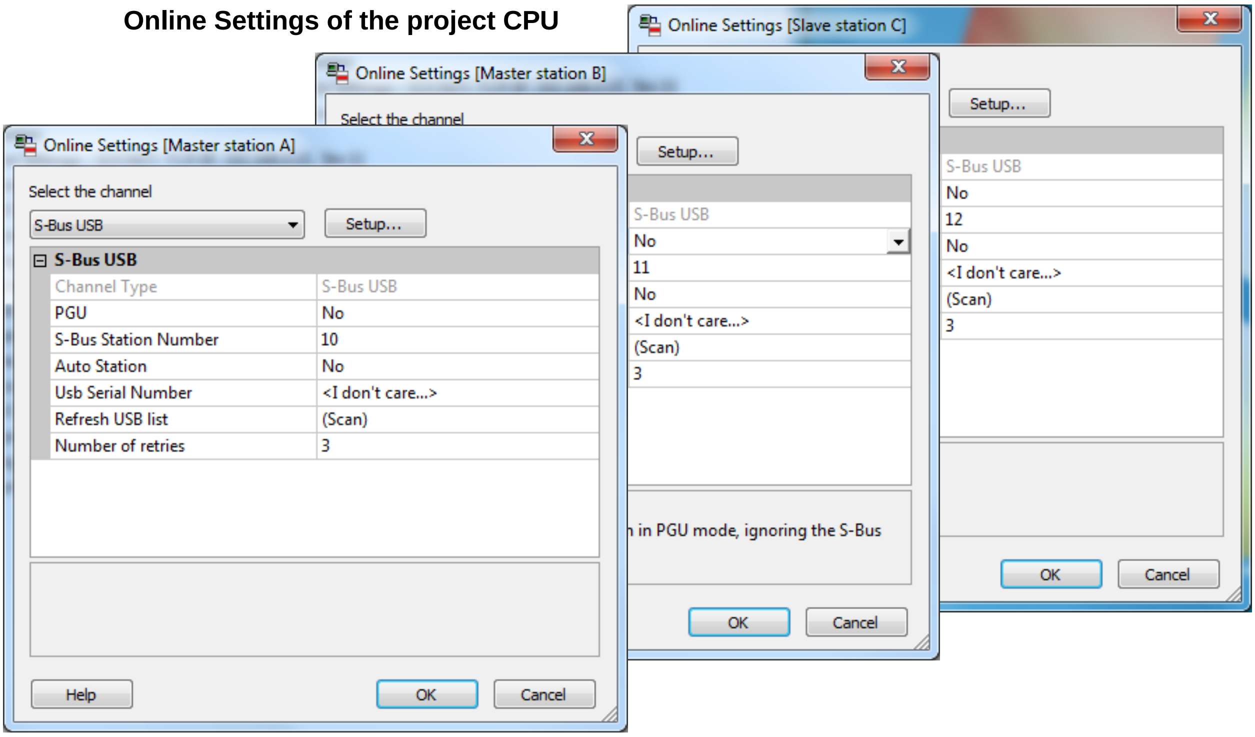
Onboard Communication, properties of the Master A station



⊟ Profi-S-Bus Master Gateway	
Use Profi-S-Bus For Gateway	**Yes**
First S-Bus Station Profi-S-Bus	0
Last S-Bus Station Profi-S-Bus	253
Response Timeout	0

The USB Gateway is an exception; it doesn't need any parameters for the *Gateway Slave port*, only the *Gateway Master port* must be defined.
(Don't forget to download the new configuration into Master A!)

Online Settings of the project CPU



Online Settings [Master station A]

Select the channel: S-Bus USB

⊟ S-Bus USB	
Channel Type	S-Bus USB
PGU	No
S-Bus Station Number	10
Auto Station	No
Usb Serial Number	<I don't care...>
Refresh USB list	(Scan)
Number of retries	3

Online Settings [Master station B]

Select the channel

	S-Bus USB
	No
	11
	No
	<I don't care...>
	(Scan)
	3

in PGU mode, ignoring the S-Bus

Online Settings [Slave station C]

	S-Bus USB
	No
	12
	No
	<I don't care...>
	(Scan)
	3

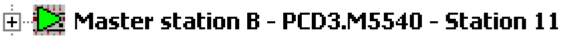
To make a USB communication with each PCD, the *Online Settings* should be configured with USB channel and S-Bus station number.

Testing the functionality of the Gateway Function

Slave station C - PCD3.M5540 - Station 12

Activate one of the device, *Master B* or *Slave C*, of the project and Go Online for testing the communication with the station.

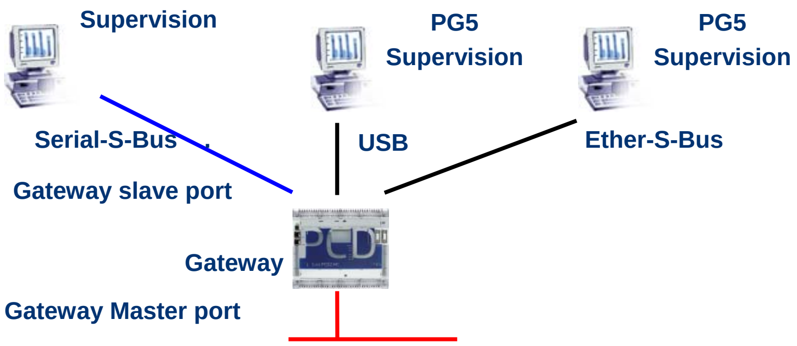
If necessary, the *Online Configurator* allows you to verify the station number online. It is also possible to download the program in the active device and to test it, staying always connected via USB cable to station *Master A*


Master station B - PCD3.M5540 - Station 11

To communicate with another network station, activate the device and Go Online.

Remark:
With the *Gateway* feature, only the slave S-Bus station number is defined, the Profi-S-Bus station number is not taken into account because the telegrams are addressed to all Profi-S-Bus stations (Broadcast).

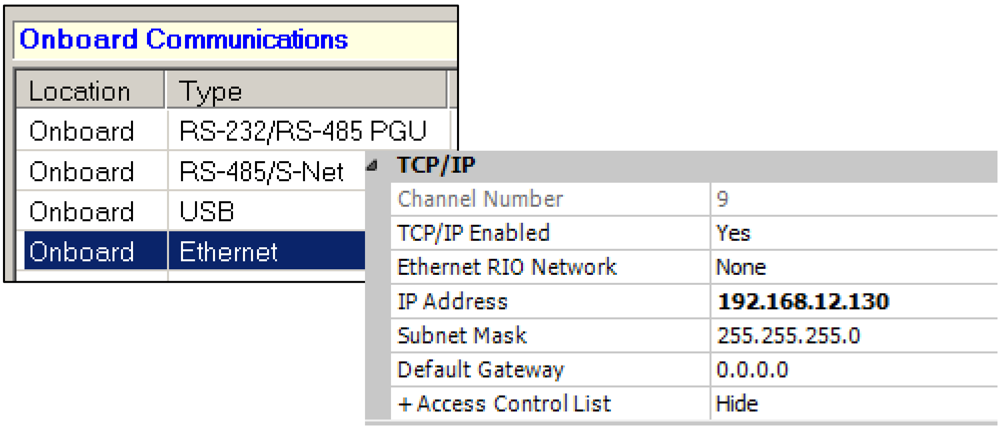
12.7.3 Configuration of the Gateway Slave port supplementary slave



The Gateway Slave port is a way to access the network from outside.
If necessary, a second or the third *Gateway Slave port* can be defined.

Device Configurator **parameters**
In general, the PCD supports only one slave PGU channel. But the new controllers may support more PGU port on the same PCD. The configuration of the second Gateway Slave PGU is supported by the *Device Configurator.*

Example: add a second Gateway Ether-S-Bus, Profi-S-Bus


Onboard Communications

Location	Type
Onboard	RS-232/RS-485 PGU
Onboard	RS-485/S-Net
Onboard	USB
Onboard	Ethernet

TCP/IP

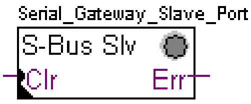
Channel Number	9
TCP/IP Enabled	Yes
Ethernet RIO Network	None
IP Address	**192.168.12.130**
Subnet Mask	255.255.255.0
Default Gateway	0.0.0.0
+ Access Control List	Hide

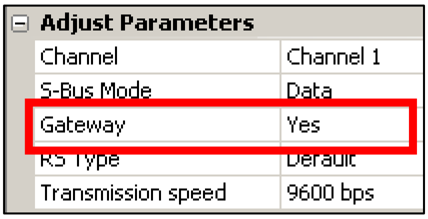
The second *Gateway Slave port PGU* is added, configuring the *Device Configurator* with the node and TCP/IP address.

Fupla or IL Program
It is possible to use a supplementary SASI Fbox/instruction and add a second *Gateway Slave port*.

this *Gateway slave port*, without PGU functionality, will not support the PG5 programming tools, but only a supervision system terminal. Only reading and writing PCD data are supported: registers, flags, etc.

Example Fupla: add a third Serial-S-Bus, Profi-S-Bus





⊟ Adjust Parameters	
Channel	Channel 1
S-Bus Mode	Data
Gateway	Yes
RS Type	Default
Transmission speed	9600 bps

The adjust *Gateway* parameter then must be defined with option *Yes*. According to channel type, the parameters of the adjust window should also correctly defined.

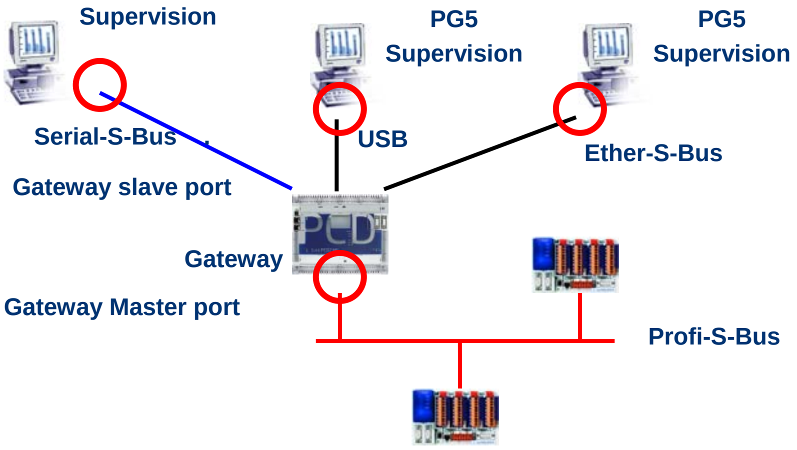
Example IL : add a third Serial-S-Bus, Profi-S-Bus

Use the following text to assign the channel:

```
$SASI
TEXT 11   "UART:9600; MODE:GS2; DIAG:F1110, R0501;"
$ENDSASI
```

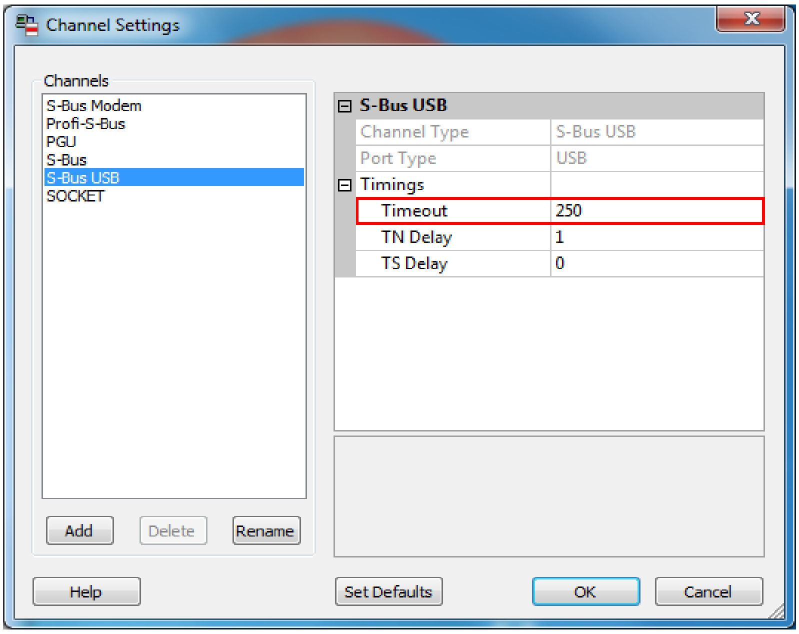
Flag and diagnostic register
Mode S-Bus Gateway Slave Data mode
Transmission speed

12.7.4 Communication Timing



Generally the communication *timing* is defined with default values and this works correctly. But the use of the *Gateway* feature increases the times of the reactions necessary for the data exchange. It is then sometimes necessary to adjust the timeout of the master stations which use the *Gateway*. The above picture shows which are the master channels whose timeouts must be adjusted.

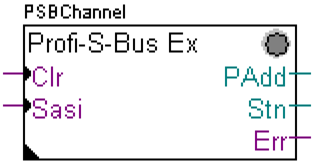
To adjust the *Timeout* of the PG5, use *Online Settings* of the *Master Station A*:

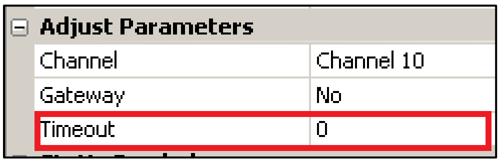


Channels
- S-Bus Modem
- Profi-S-Bus
- PGU
- S-Bus
- S-Bus USB
- SOCKET

S-Bus USB	
Channel Type	S-Bus USB
Port Type	USB
Timings	
Timeout	250
TN Delay	1
TS Delay	0

To adjust the *Timeout* of the data exchange program to the PCD, use Fbox: *SASI Profi-S-Bus Extended*





Adjust Parameters	
Channel	Channel 10
Gateway	No
Timeout	0

12.8 Other References

For more information's, you can also refer to the following manuals:

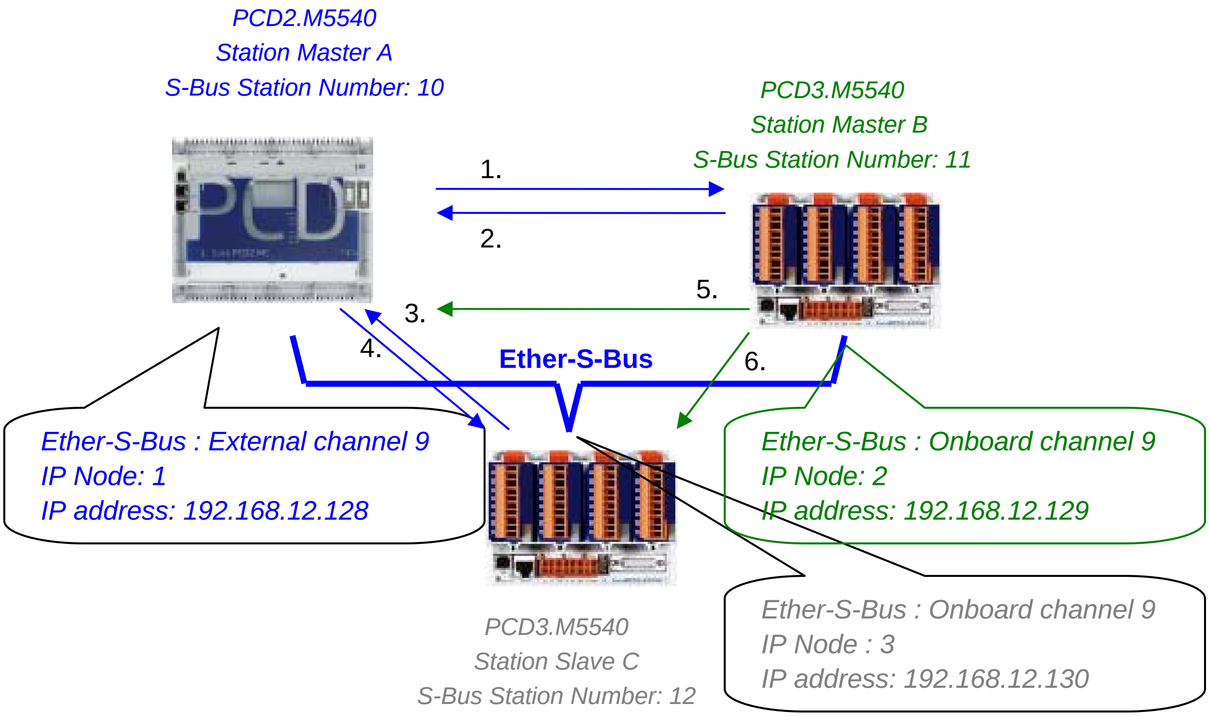
- Instruction Guide 26/133
- Profi-S-Bus (in preparation)
- Example of the project Profi-S-Bus installed with your PG5

Contents

13 Ether-S-Bus

This example shows how to exchange data, such as Registers and Flags, between the PCDs connected to an Ether-S-Bus network

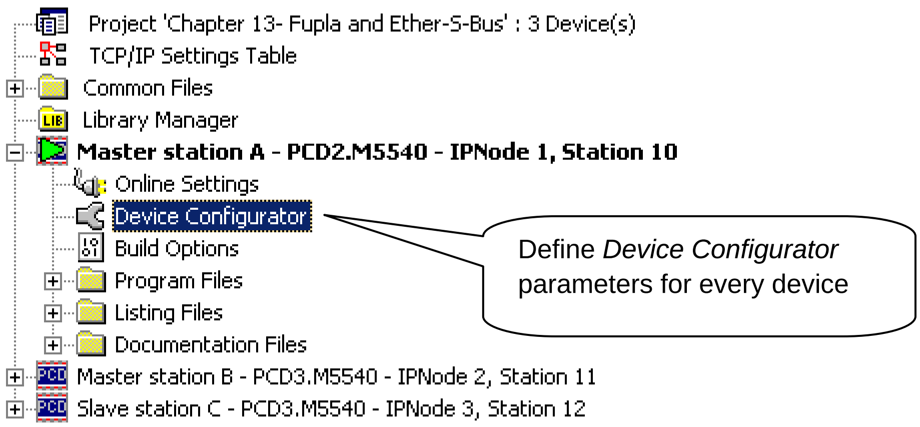
13.1 Ether-S-Bus network Example



13.2 Examples of the Data Exchange in Ether-S-Bus

	Master with data exchanges	*Data on the network*	*Passive master or slave*
	Master station A		***Master station B***
1	*Blinker0 .. 7* *F 0 .. 7*	*Write 8 flags in the Master station B*	*Station_A.Blinker0 .. 7* *F 100 .. 107*
2	*Master_B .Value100* *R 125*	*Read 1 register in the Master station B*	*Value100* *R 25*
			Slave station C
3	*Slave_C.Binary0 .. 7* *F 100 .. 107*	*Read 8 flags in the slave station C*	*Binary0 .. 7* *F 20 .. 27*
4	*Value0 .. 5* *R 0 .. 5*	*Write 6 registers in the slave station C*	*Master_A. Value0 .. 5* *R 20 .. 25*
	Master station B		***Master station A***
5	*Temperature1 .. 4* *Dynamic registers*	*Write the temperature measures to the slave C*	*Master_B.Temperature1 .. 4* *R 100 .. 104*
			Slave station C
6	*Temperature1 .. 4* *Dynamic registers*	*Write the temperature measures to the master A*	*Master_B.Temperature1 .. 4* *R 100 .. 104*

13.3 The PG5 Project



Project 'Chapter 13- Fupla and Ether-S-Bus' : 3 Device(s)
- TCP/IP Settings Table
- Common Files
- Library Manager
- **Master station A - PCD2.M5540 - IPNode 1, Station 10**
  - Online Settings
  - Device Configurator
  - Build Options
  - Program Files
  - Listing Files
  - Documentation Files
- Master station B - PCD3.M5540 - IPNode 2, Station 11
- Slave station C - PCD3.M5540 - IPNode 3, Station 12

Define *Device Configurator* parameters for every device

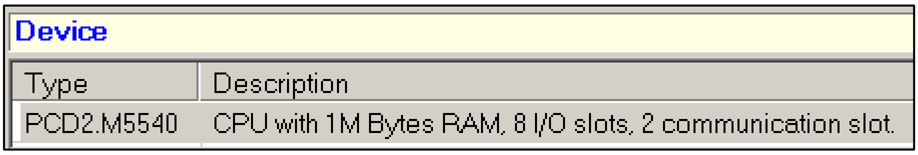
Saia PG5 Project Manager

The *Saia PG5 Project Manager* shows all the PCD stations in an application's Project, and also the network communication parameters. We will begin with adding a device to the Project for each of the Network Stations.

13.4 *Device Configurator* parameters

The *Device Configurator* parameters are the similar for a master and Slave station.

13.4.1 Define the device type



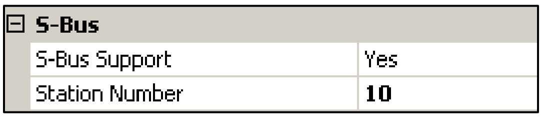
Device

Type	Description
PCD2.M5540	CPU with 1M Bytes RAM, 8 I/O slots, 2 communication slot.

Device Type

Define the PCD type

13.4.2 Define S-Bus station number in the Network



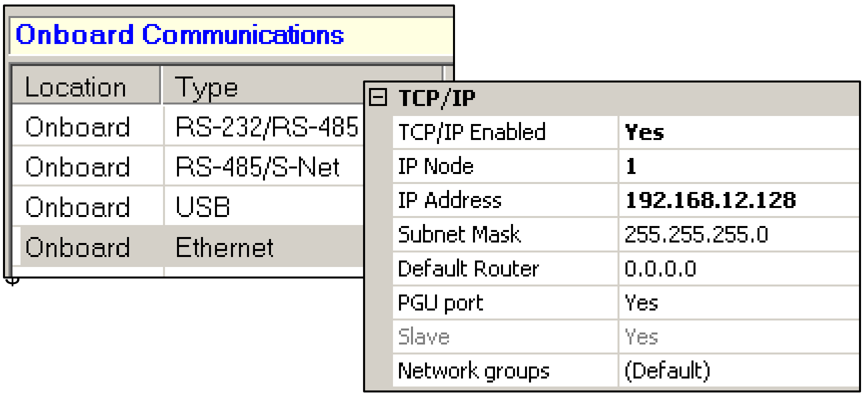
⊟ **S-Bus**	
S-Bus Support	Yes
Station Number	**10**

Device properties:

Station Number

S-Bus station number is common to all communication channels of the PCD.

13.4.3 Define communication channel of the Ether-S-Bus



Onboard Communications

Location	Type
Onboard	RS-232/RS-485
Onboard	RS-485/S-Net
Onboard	USB
Onboard	Ethernet

⊟ TCP/IP

TCP/IP Enabled	**Yes**
IP Node	**1**
IP Address	**192.168.12.128**
Subnet Mask	255.255.255.0
Default Router	0.0.0.0
PGU port	Yes
Slave	Yes
Network groups	(Default)

Onboard Communication, properties:

IP Node

TCP/IP node number. The Node is used in the SEND and RCV Fbox-es to define a Slave station with witch the data’s has to be exchanged.

IP Address

Ether-S-Bus station number connected to channel.

PGU Port

Define the channel as slave or PGU. This definition can be accumulated with master function, adding a SASI Fbox in Fupla program.

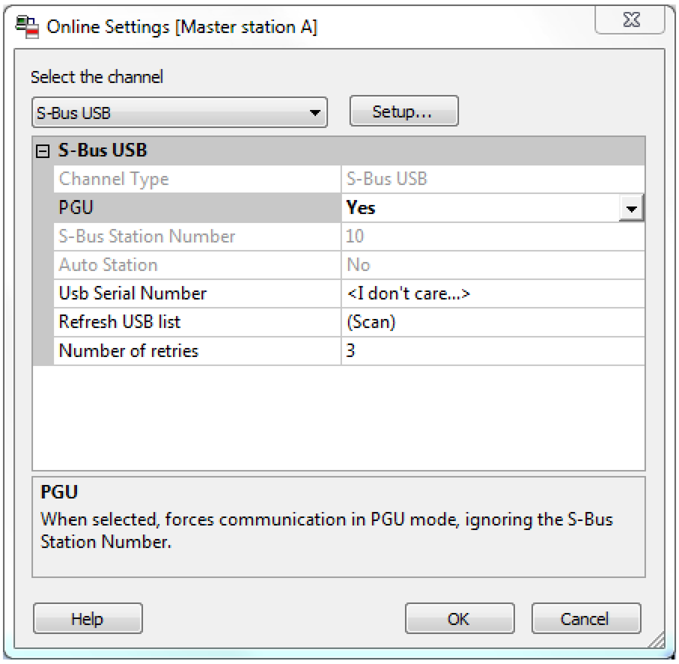
Slave + PGU

Supports data exchange with master stations, supervision systems and terminals. It also supports the PG5 programming tools.

Slave

Supports only data exchange with other master stations, supervision systems and terminals.

13.4.4 Download the *Device Configurator* parameters in the device



Online Settings [Master station A]

Select the channel

S-Bus USB

S-Bus USB	
Channel Type	S-Bus USB
PGU	Yes
S-Bus Station Number	10
Auto Station	No
Usb Serial Number	<I don't care...>
Refresh USB list	(Scan)
Number of retries	3

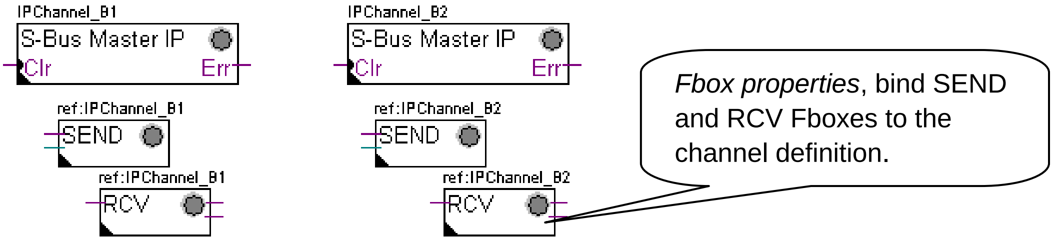
PGU
When selected, forces communication in PGU mode, ignoring the S-Bus Station Number.

With the new PCD systems, the Device Configurator parameters can be downloaded via a USB connection. It is necessary just to define *Online Settings* with the channel *Ether-S-Bus* + *PGU*.

Download the parameters to the PCD using *Download Configuration* on the *Device Configurator* window.

13.5 Fupla Program

13.5.1 Assign the channel using SASI Fbox



Fbox properties, bind SEND and RCV Fboxes to the channel definition.

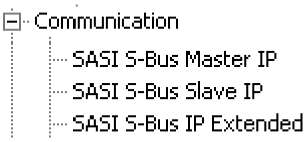
Assignment is done using a SASI Fbox, placed at the beginning of the Fupla File. Each communication network needs its own SASI Fbox, because the parameters are different depending on the network, the same for Master or Slave stations.

If the PCD uses more communication channels, define each channel using corresponding SASI Fbox. Then place the mouse over the SASI Fbox and using the context menu select Fbox properties, define a different *Name* for the Fbox of each channel. This name allows binding the exchange Fboxes SEND and RCV with SASI Fbox corresponding to the channel.

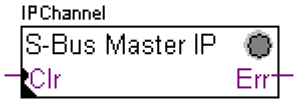
According to the network, the communication channel parameters can be partially defined from the adjust parameters of the SASI Fbox, and to be completed in the *Device Configurator.*

The Channel number is always defined in the adjust parameters of the SASI FBox. The channel number depends from PCD Hardware and on the communication hardware used: slot B1, B2, serial interface PCD7.F, …

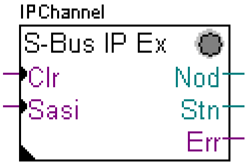
13.5.2 Assign Master channel



- Communication
  - SASI S-Bus Master IP
  - SASI S-Bus Slave IP
  - SASI S-Bus IP Extended



Master station



Master/Slave station + timing definitions

The assignment of the Master channel is done by combining the *Device Configurator* parameters with one of the Fboxes above.

__Adjust parameters:__

Channel
Defines the channel number connected in the network. Depends from the PCD and his hardware.

Timing
The Timeout is general defined with the value by default (0) and will be adjusted only for the particular applications (Gateway).

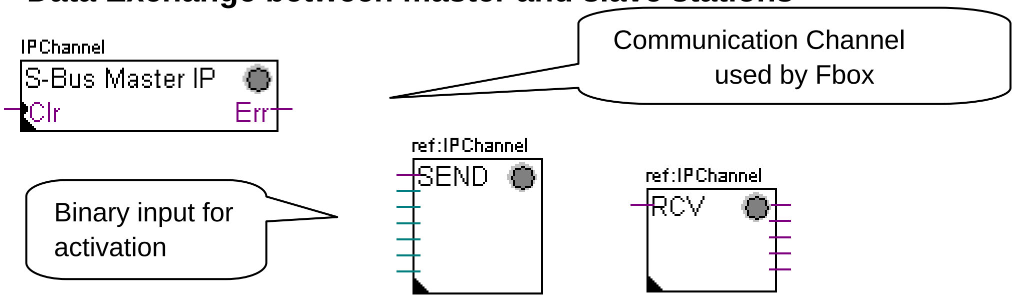
13.5.3 Assign slave channel

No SASI FBox is necessary for the slave station in the Ether-S-Bus network. All definitions necessary are already present in the *Device Configurator*.

13.5.4 Principles of data exchange in a multi-master network

A multi-master communication network has more than one master station. Master Stations are the only stations authorized to read or write the data of the other master and slave stations. Data exchange between slaves is not allowed.
With a Multi-master communication mode, data exchange is carried out between the masters in the network. Only one master at a time holds a token which authorizes it to exchange data with other master or slave stations on the network. When the master has finished transferring the data, the token is passed to the next master, which is then free to exchange data with the other masters or slaves. The token circulates automatically between the master stations, the slaves never have the token and so cannot read or write the data of other stations in the network.

13.5.5 Data Exchange between master and slave stations



User-controlled data exchange between stations is done using Fupla Fboxes placed on the Fupla pages, chosen the *Fbox Selector*. You will find the Fboxes to write (SEND) or to read (RCV) data packets, and also support different data formats: binary, integer, floating point, Data Block, etc.

The *SEND* or *RCV* Fbox can be resized to increase or decrease the number of inputs and outputs, defining the data packet to be exchanged with another station.

The address of the Communication Channel, used by data transmission Fbox is defined by the symbol shown at the top left of the Fbox, which binds it to the SASI Fbox of the same name in which the channel address is defined. This symbol can be edited by putting the mouse on the Fbox and selecting the context menu's Fbox *Properties.*

Each *SEND* and *RCV* Fbox has a binary input for activation of the data exchange. If this input is permanently high, data exchange will repeated as fast as possible. If a short pulse is applied to the input, data exchange will be executed at least once, but it is always possible to force it using the Execute button, or by a Restart Cold the PCD with *Initialization* option of the *adjust parameters.*

Master station data present at the inputs of the SEND Fbox, are sent to the Slave station defined in *adjust window*. Whereas the data present at the output of the RCV Fbox comes from the slave station defined by the parameters of the adjust window: address of the slave station, source element and base address.

Only the master stations are programmed with the *SEND* and *RCV* Fboxes! The slave stations can only be assigned with the communication channel.

According to the Fboxes used, the *adjust parameters* allows the definition of the slave stations to which data can be sent from the master station (SEND), or from which slave stations the Master can read data (RCV).

Adjust parameters.

IP Node
Defines the node number of the Ether-S-Bus slave station.

Source, destination station
Defines the number of the S-Bus slave station

Source, destination element
Defines the type of the data to write or read from the slave.

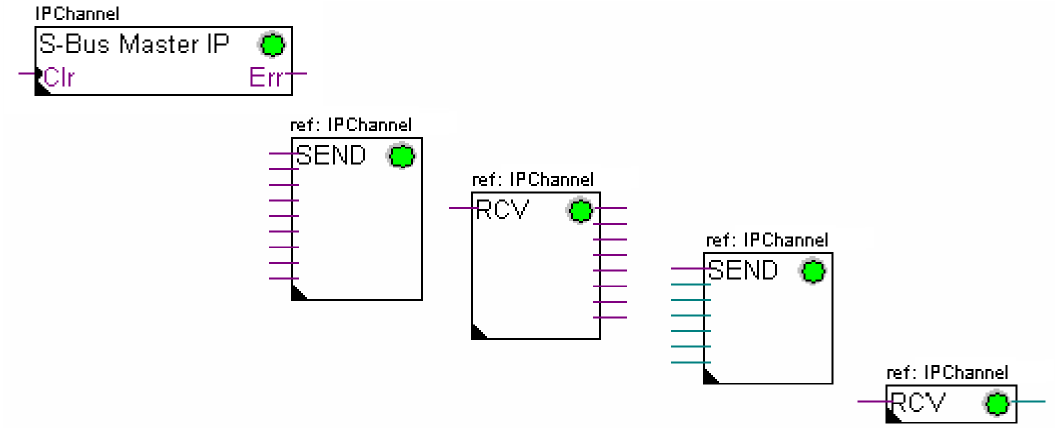
Source, destination address
Defines the start address of the data to write or read in the slave. The number of the exchanged data values depends on the number of the inputs or outputs of the SEND or RCV Fbox.

13.5.6 Diagnostics

If the program is Online, a green or red LED is displayed at the top right of the *SASI*, *SEND* or *RCV* Fbox. Green indicates that the data transmission is OK, red indicates an error.

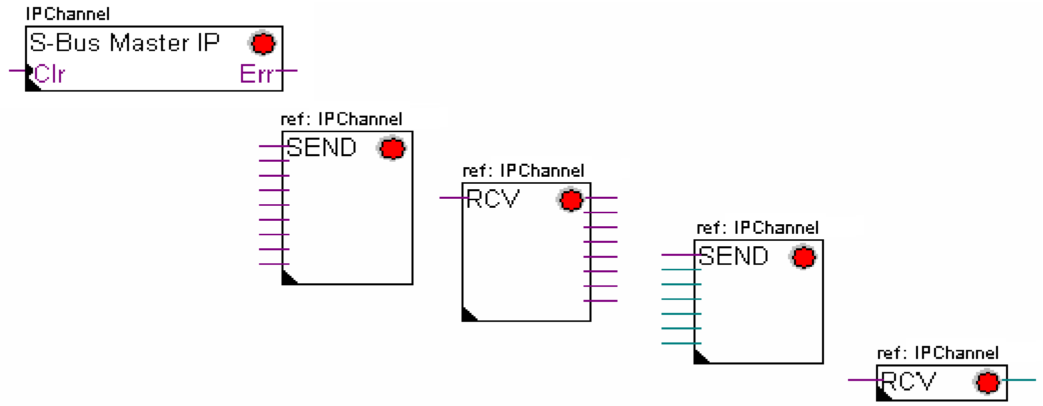
Correct functionality

All the Fbox are green, data exchange are done correctly.



No data can be exchanged in the network

SASI Fbox, *SEND* and *RCV* are red; no data can be exchanged in the network.

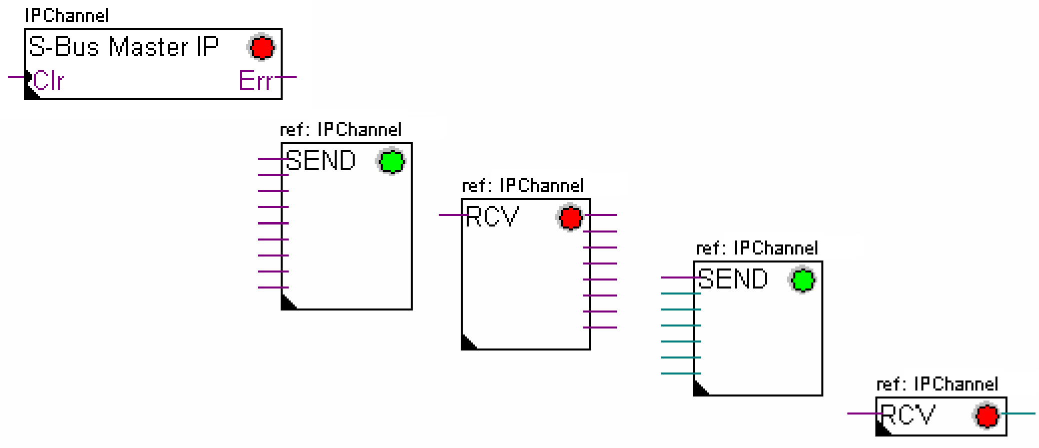


Possible corrective actions in master or slave station:

- Verify the *Device Configurator*
- Verify that the *Device Configurator* parameters have been downloaded into the PCD
- Verify that the communication Channel defined with the *Device Configurator*, and SASI function are identical (same channel number)
- Verify that the PCD is equipped with the necessary communication hardware
- Verify that the stations are connected to the network and are powered on
- Verify the network wiring
- Verify that the firmware version supports Ether-S-Bus

Only some Fboxes do not exchange data

SASI Fbox and some *SEND* and *RCV* Fboxes are red. The Fbox in green exchanges the data correctly



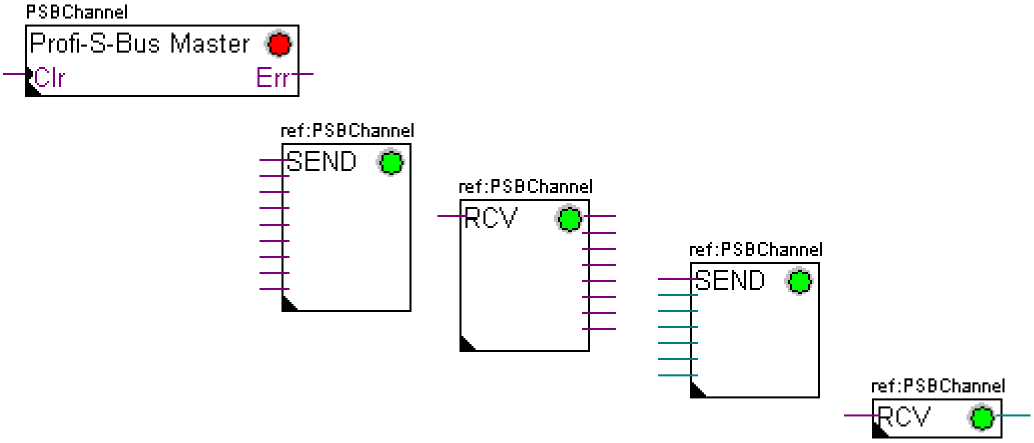
Possible corrective actions in the master station
Verify the parameters of the *adjust window* of the red *SEND* and *RCV* Fbox.
Verify that the slave address is present in the network.

Possible corrective actions in the slave station
For every red *SEND* and *RCV* Fbox, view the slave station number and verify the concerned stations.

- Verify if the *Device Configurator* parameters are defined correctly
- Verify if the PCD is equipped with necessary communication hardware
- Verify if the stations are connected to the network and are powered on
- Verify the network wiring
- Verify if the firmware version supports Ether-S-Bus

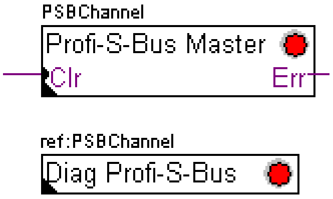
Only SASI Fbox is red

Open adjust window of the *SASI* Fbox, and clear the last error using *Clear* button.



Diagnostic Fbox

If SASI lamp is red, it is always possible to obtain a diagnostic while consulting the adjust window of the *SASI Diagnostic* function. This Fbox should be placed just below *SASI* Fbox.



13.6 IL program

13.6.1 Assign the master channel using SASI instruction

Mode Ether-S-bus Master

Register with slave station address

First address of the 8 flag range of the diagnostic register

```
$SASI
TEXT 10   "MODE: EM, R0500; DIAG: F1000, R0501;"
$ENDSASI

      SASI    8          ; Address of the communication channel
              10         ; Address of the text with the assign parameters
```

Channel assignation is done using SASI instruction, which is placed in the beginning of the program: initialization of the Graftec sequence, or initialization block XOB 16.

SASI instruction contains two parameters: The address of the communication channel and the text address, with all necessary channel parameters.

The parameters of the assignation text are different from one network to other, also for master or slave station.

If the PCD exploits more communication channels, define each channel using SASI instruction and assignation text.

According to network, channel parameters can be completed with *Device Configurator* parameters.

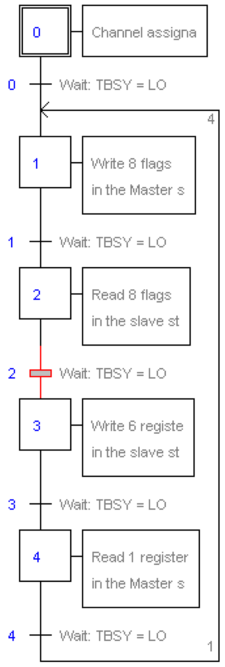
13.6.2 Assign slave channel

No SASI instruction is necessary for the slave station in the Ether-S-Bus network. All definitions necessary are already present in the *Device Configurator*.

13.6.3 Principles of data exchange in a multi-master network

A multi-master communication network has more than one master station. Master Stations are the only stations authorized to read or write the data of the other master and slave stations. Data exchange between slaves is not allowed.
With a Multi-master communication mode, data exchange is carried out between the masters in the network. Only one master at a time holds a token which authorizes it to exchange data with other master or slave stations on the network. When the master has finished transferring the data, the token is passed to the next master, which is then free to exchange data with the other masters or slaves. The token circulates automatically between the master stations, the slaves never have the token and so cannot read or write the data of other stations in the network.

13.6.4 Data Exchange between master and slave stations



Initial Step: channel assignation

Step: data exchange

Transition: wait end of the data exchange

Data exchange between the stations is the sequential program: The assignation of the communication channel is treated only once, data exchange in the network will be executed only if the previous exchange of the data's is finished. That's why we propose to treat IL data exchange with Graftec Editor.
Initial Step allows assigning the communication channel at the Restart Cold of the PCD.
Other Steps are executed in loop, and step one supports one data package.

Every Step is separated by one Transition which tests diagnostic flag TBSY, and defines if data Exchange is finished. We are authorized to exchange data's defined by step which follows, only if TBSY is Low.

Data Exchange using a Step
Before to exchange data, we must define address of the slave station in the register, which is declared for this by text assignation:
Define the address of the slave station

```
LDL     R 500   ; Register address with the slave station address
        11      ; S-Bus address

LDH     R 500   ; Register address with slave station address
        2       ; IP Node
```

Data exchange between the stations is supported using two instructions:
STXM for writing data in the slave station (*SEND*)
SRXM for reading data in the slave station (*RCV*)

Each instruction contains four parameters: Channel address, number of data's to exchange, address of the first data source, and the destination.

Write 8 Flags (F 0... F 7) in the slave station (F 200... F 207)

```
STXM  8       ; Channel address
      8       ; Number of the data’s to exchange
      F 0     ; address of the first source data (local Station)
      F 200   ; address of the first destination data (slave Station)
```

Read a register (R 25) of the slave station (R 125)

```
SRXM  8       ; Channel address
      1       ; Number of the data’s to exchange
      R 25    ; address of the first source data (local Station)
      R 125   ; address of the first destination data (slave Station)
```

Note:
Only the master stations are programmed with STXM and SRXM ! The slave stations must only be assigned with the communication channel.

Waiting the transmission end de using the transition

```
STL   F 1003  ; Verify that TBSY is in Low state
```

Le Assignation text defines a range of 8 diagnostic flags for communication. Third flag will go in the high state during the data transmit, and in low state when exchange is finished.

13.6.5 Diagnostics

Channel assinations
In the case of the communication problem, verify if the channel assignation is donne correctly. Analyse the program step by step, and verify that the SASI instruction doesn’t display a flag error.If the channel assignation isn’t donne correctly, then the communication will not work.

Possible corrective actions in master or slave station:

- Verify the *Device Configurator*
- Verify that the *Device Configurator* parameters have been downloaded into the PCD
- Verify that all stations use the same profile: S-Net, DP
- Verify that all stations communicate at the same speed
- Verify that the defined communication channel with the *Device Configurator* and *SASI* instruction are identical (same channel number)
- Verify that the PCD is equipped with the necessary communication hardware
- Verify that the stations are connected to the network and are powered on
- Verify the network wiring
- Verify that the firmware version supports Ether-S-Bus

Data's are not exchanged in the network

Assignation Text defines a range with 8 diagnostic flags for the communication, Fifth Flag (*TDIA: Transmitter diagnostic*) will go in the high state during the data transmit error. Step by step test of the communication program, allows determining the instructions STXM and SRXM in error.

Attention: if the communication error occurs, then the diagnostic flag TDIA stays in high state, until the diagnostic register will not be reset to zero.

Possible corrective actions in the master station
Verify the parameters of the instructions STXM and SRXM in error. Verify that the slave address is present in the network.
Possible corrective actions in the slave station
For every instruction STXM and SRXM in error, read the slave station number and verify concerned stations.

- Verify if the *Device Configurator* are defined correctly
- Verify if the PCD is equipped with necessary communication hardware
- Verify if the stations are connected to the network and are powered on
- Verify the network wiring
- Verify if the firmware version supports Ether-S-Bus

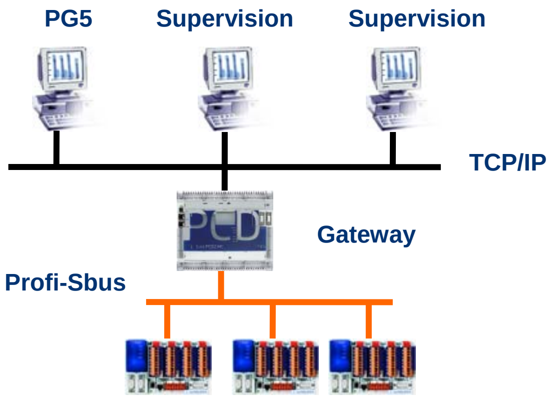
Diagnostic register

Diagnostic register can give us more information's about the nature the communication error. Display the binary content of the register and compare it with the descriptions of the PCD manual or the communication network manual.

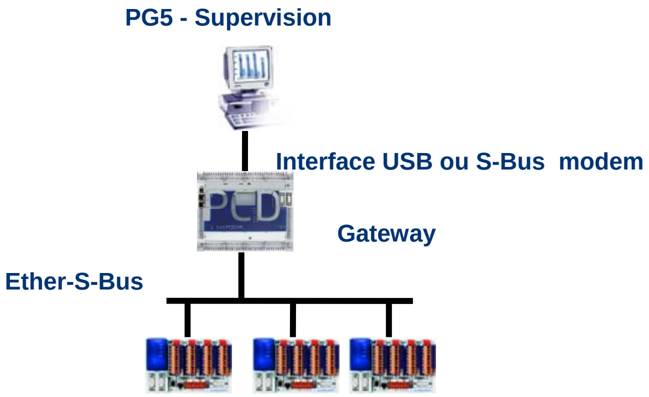
13.7 Gateway Function

The *Gateway* feature is commonly used to allow two different communication networks to communicate together, or adapt a programming tool (PG5) or a supervision system (Visi+) to use a different network that the one usually supported.

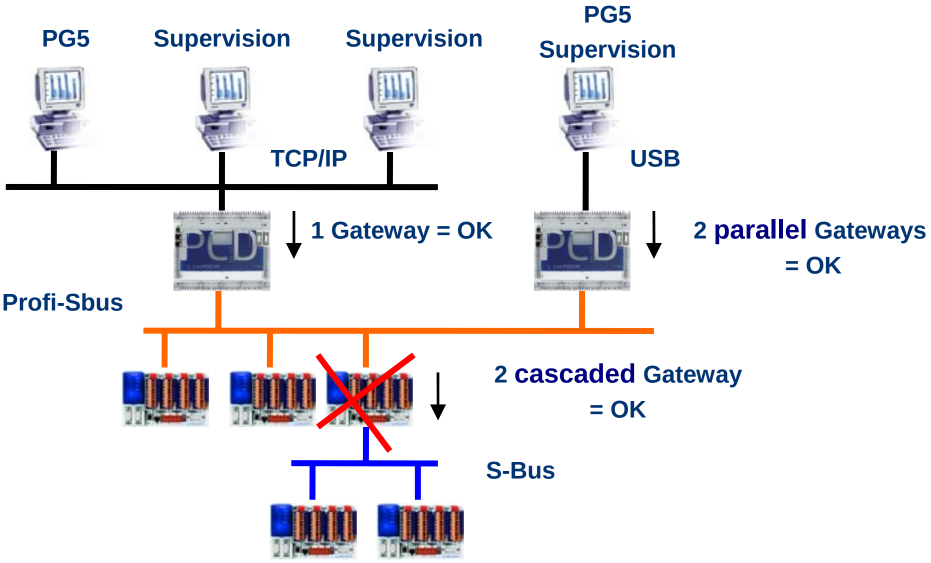
13.7.1 Application



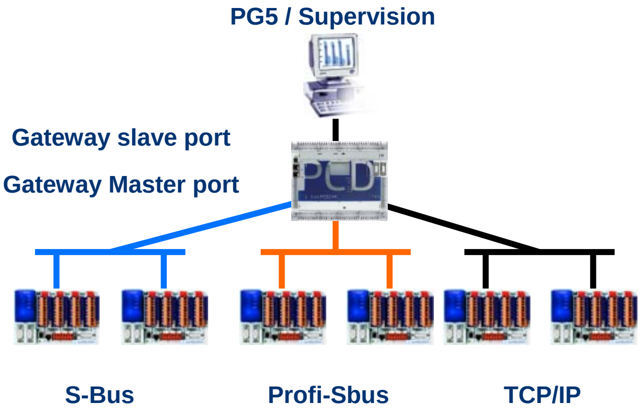
The *Gateway* function creates a bridge between two networks, for example to link an Ethernet network with a Profi-S-Bus network. In this way the PCD systems exchange data on a common bus, specific to the automation field and separated from information network of the company. But the PCs running the PG5 software or the supervision system Visi+ can exchange still data with the PCDs.



The *Gateway* function can be used as an interface between a communications network and the external world. For example, to make modem or USB communication interfaces.



To respect the communication timings, we cannot define two cascaded Gateways functions. But it is possible to define two parallel Gateways on the same network.



If necessary, a Gateway can make a bridge between to several communication sub networks.

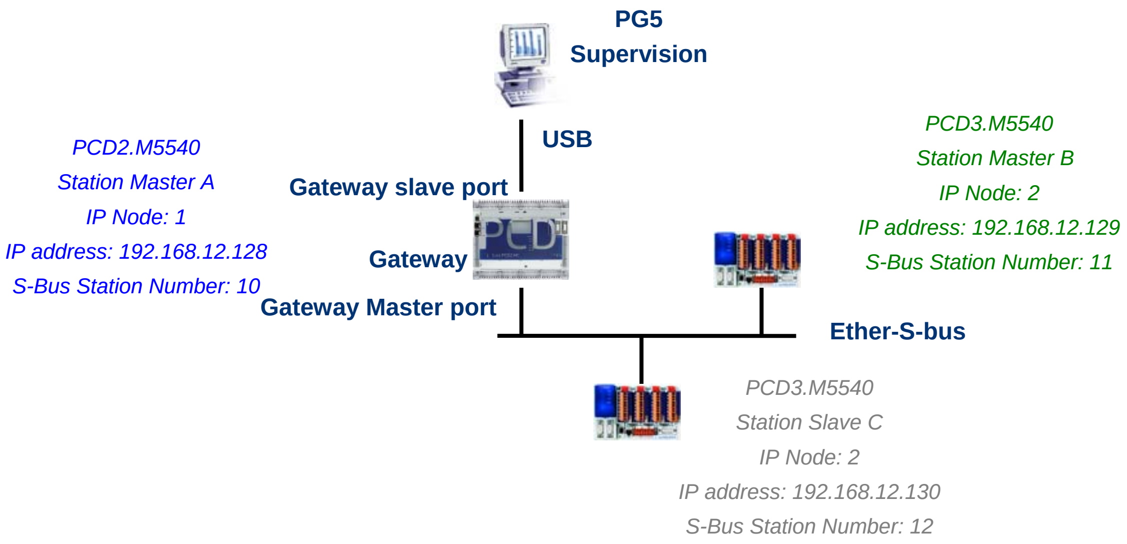
13.7.2 Configuration of the Gateway PGU function

It is easy to configure the *Gateway* function; it doesn't need any program, only some parameters in the PCD *Device Configurator*.

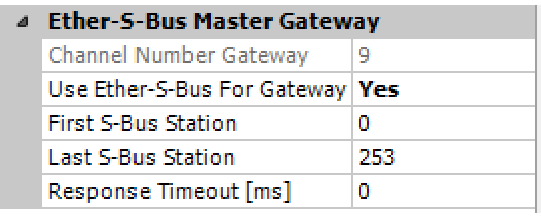
Generally, only a *Gateway Slave Port* and a *Gateway Master Port* should be defined, then all is automatically supported by *Gateway* function.

If the message received by the *Gateway Slave Port* is not for the local station (the *Gateway*), then data is re-transmitted via one of the sub-networks connected to the *Gateway Master Port*, according to the address ranges defined for the sub-network.

Example: Gateway USB, Ether-S-Bus



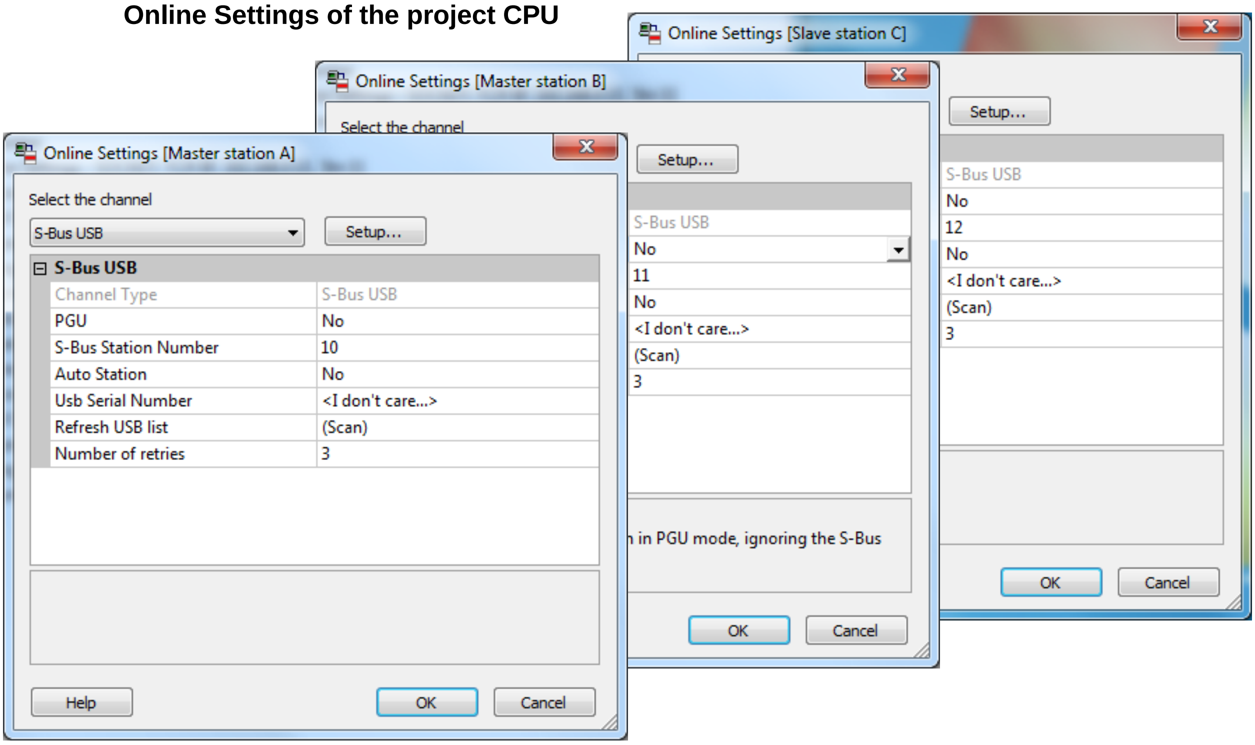
Onboard Communication, properties of the Master A station



Ether-S-Bus Master Gateway	
Channel Number Gateway	9
Use Ether-S-Bus For Gateway	**Yes**
First S-Bus Station	0
Last S-Bus Station	253
Response Timeout [ms]	0

The USB Gateway is an exception; it doesn't need any parameters for the *Gateway Slave port*, only the *Gateway Master port* must be defined.
(Don't forget to download the new configuration into Master A!)

Online Settings of the project CPU



Online Settings [Master station A]

Select the channel: S-Bus USB

S-Bus USB	
Channel Type	S-Bus USB
PGU	No
S-Bus Station Number	10
Auto Station	No
Usb Serial Number	<I don't care...>
Refresh USB list	(Scan)
Number of retries	3

Online Settings [Master station B]

Select the channel

S-Bus USB
No
11
No
<I don't care...>
(Scan)
3

in PGU mode, ignoring the S-Bus

Online Settings [Slave station C]

S-Bus USB
No
12
No
<I don't care...>
(Scan)
3

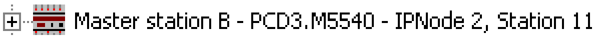
To make a USB communication with each PCD, the *Online Settings* should be configured with USB channel and S-Bus station number.

Testing the functionality of the Gateway Function

Slave station C - PCD3.M5540 - IPNode 3, Station 12

Activate one of the device, *Master B* or *Slave C*, of the project and Go Online for testing the communication with the station.

If necessary, the *Online Configurator* allows you to verify the station number online. It is also possible to download the program in the active device and to test it, staying always connected via USB cable to station *Master A*

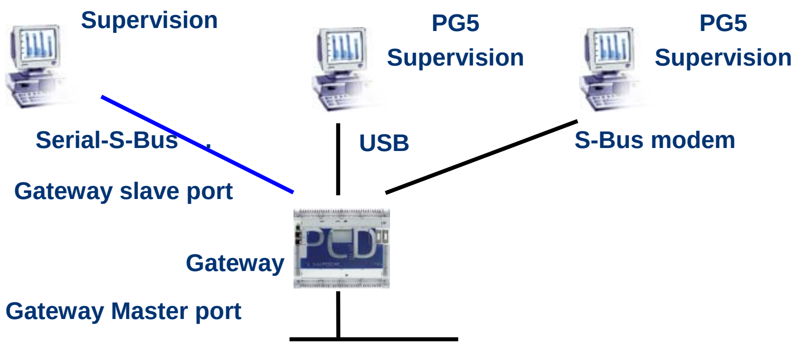


Master station B - PCD3.M5540 - IPNode 2, Station 11

To communicate with another network station, activate the device and Go Online.

Remark:
With the *Gateway* feature, only the slave S-Bus station number is defined, the Ether-S-Bus station number is not taken into account because the telegrams are addressed to all Ether-S-Bus stations (Broadcast).

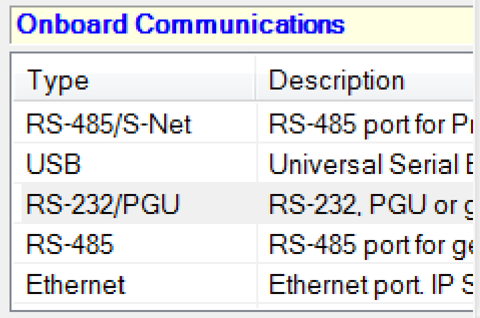
13.7.3 Configuration of the Gateway Slave port supplementary slave



The Gateway Slave port is a way to access the network from outside.
If necessary, a second or the third *Gateway Slave port* can be defined.

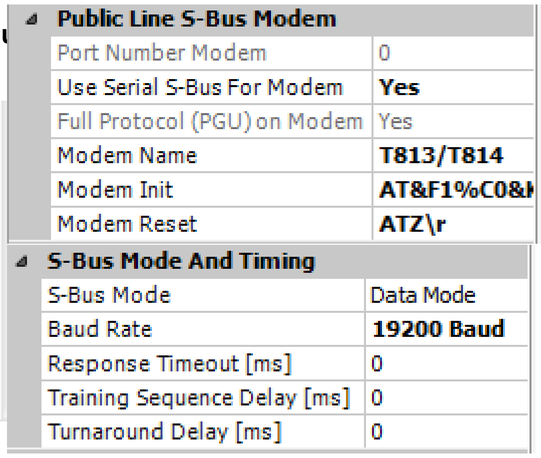
***Device Configurator* parameters**
In general, the PCD supports only one slave PGU channel. But the new controllers may support more PGU port on the samedevice. The configuration of the second Gateway Slave PGU is supported by the *Device Configurator.*

Example: add a second Gateway S-Bu



Onboard Communications

Type	Description
RS-485/S-Net	RS-485 port for Pr
USB	Universal Serial E
RS-232/PGU	RS-232, PGU or g
RS-485	RS-485 port for ge
Ethernet	Ethernet port. IP S



Public Line S-Bus Modem

Port Number Modem	0
Use Serial S-Bus For Modem	**Yes**
Full Protocol (PGU) on Modem	Yes
Modem Name	**T813/T814**
Modem Init	**AT&F1%C0&**
Modem Reset	**ATZ\r**

S-Bus Mode And Timing

S-Bus Mode	Data Mode
Baud Rate	**19200 Baud**
Response Timeout [ms]	0
Training Sequence Delay [ms]	0
Turnaround Delay [ms]	0

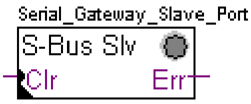
The second *Gateway Slave port PGU* is added, configuring the *Device Configurator* with the parameters for the modem.

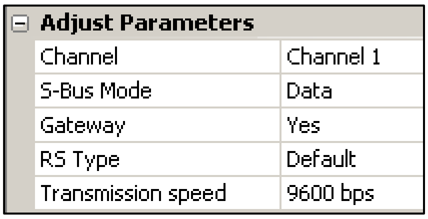
Fupla or IL Program

It is possible to use a supplementary SASI Fbox/instruction and add a second *Gateway Slave port*.

this *Gateway slave port*, without PGU functionality, will not support the PG5 programming tools, but only a supervision system terminal. Only reading and writing PCD data are supported: registers, flags, etc.

Example Fupla: add a third Serial-S-Bus, Ether-S-Bus





Adjust Parameters

Channel	Channel 1
S-Bus Mode	Data
Gateway	Yes
RS Type	Default
Transmission speed	9600 bps

The adjust *Gateway* parameter then must be defined with option *Yes*. According to channel type, the parameters of the adjust parameters should also correctly defined.

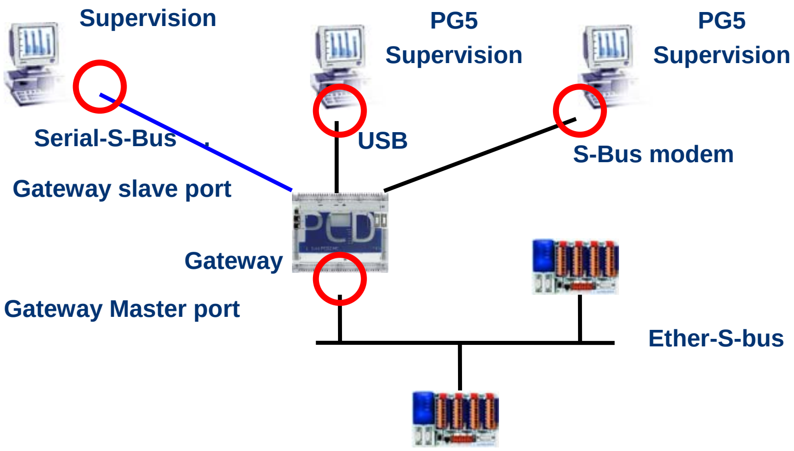
Example IL : add a third Serial-S-Bus, Ether-S-Bus

Use the following text to assign the channel:

```
$SASI
TEXT 11   "UART:9600; MODE:GS2; DIAG:F1110, R0501;"
$ENDSASI
```

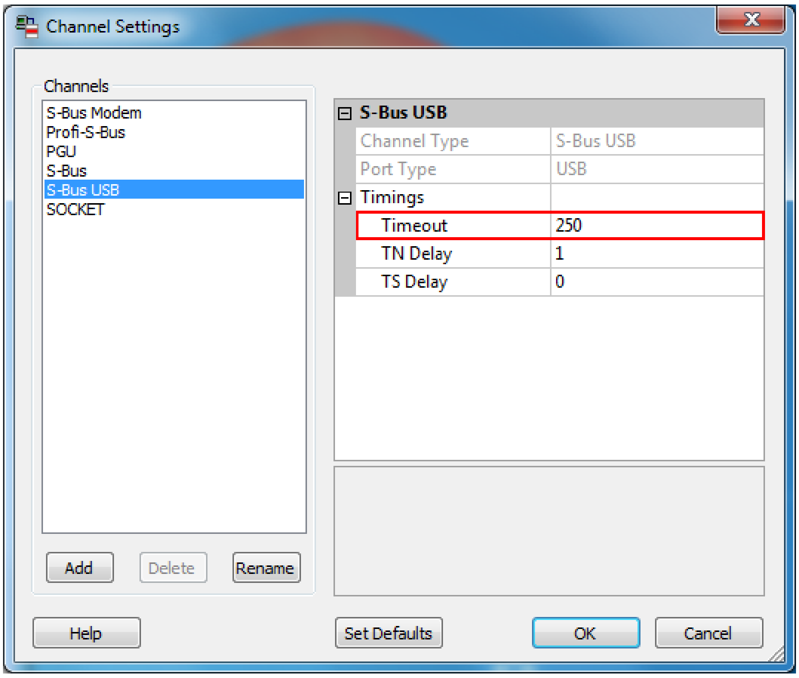
Flag and diagnostic register
Mode S-Bus Gateway Slave Data mode
Transmission speed

13.7.4 Communication Timing



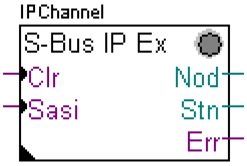
Generally the communication *timing* is defined with default values and this works correctly. But the use of the *Gateway* feature increases the times of the reactions necessary for the data exchange. It is then sometimes necessary to adjust the timeout of the master stations which use the *Gateway*. The above picture shows which are the master channels whose timeouts must be adjusted.

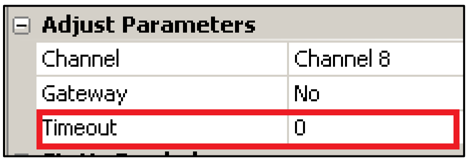
To adjust the *Timeout* of the PG5, use *Online Settings* of the *Master Station A*:



S-Bus USB	
Channel Type	S-Bus USB
Port Type	USB
Timings	
Timeout	250
TN Delay	1
TS Delay	0

To adjust the *Timeout* of the data exchange program to the PCD, use Fbox: *SASI S-Bus IP Extended*





Adjust Parameters	
Channel	Channel 8
Gateway	No
Timeout	0

13.8 Other References

For more information’s, you can also refer to the following manuals:

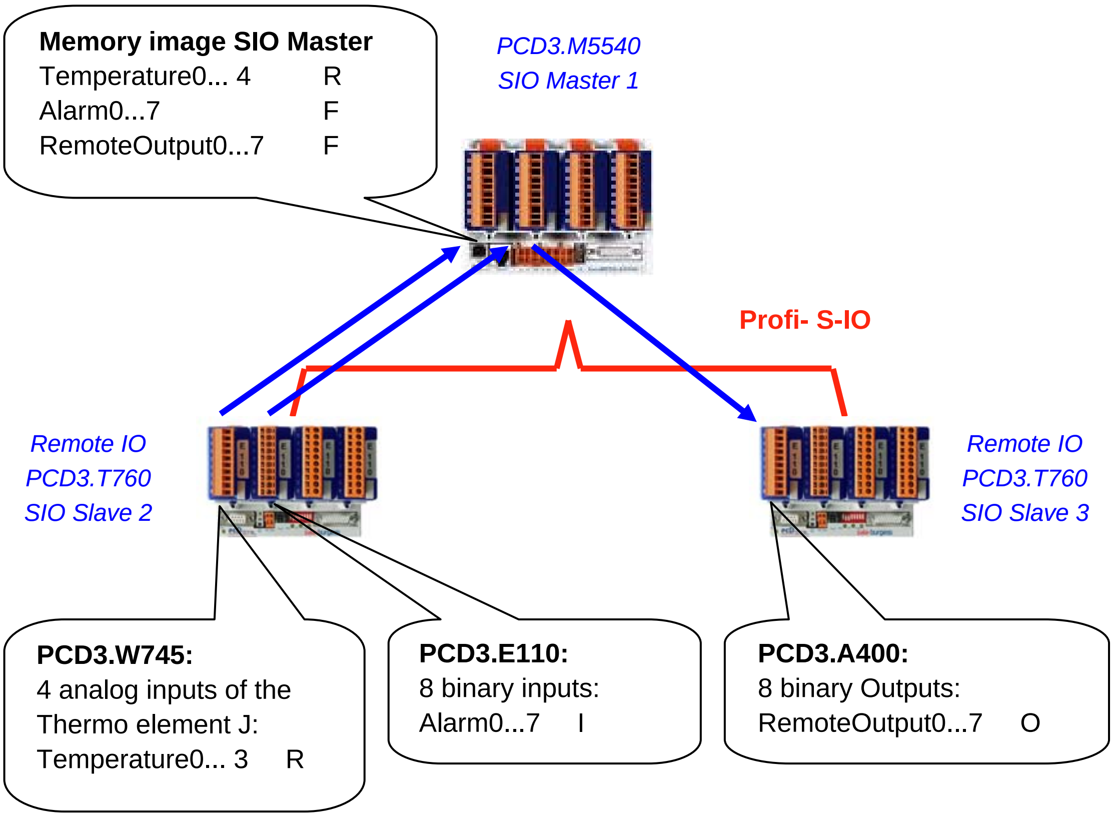
- Instruction Guide 26/133
- Ethernet TCP/IP 27/776
- Example of the Ether-S-Bus project installed with your PG5

Contents

15 Profi-S-IO

This example shows how remote binary and analog inputs and outputs from the PCD3.T7xx RIO are used.

15.1 Profi-S-IO network example



15.2 General functionality

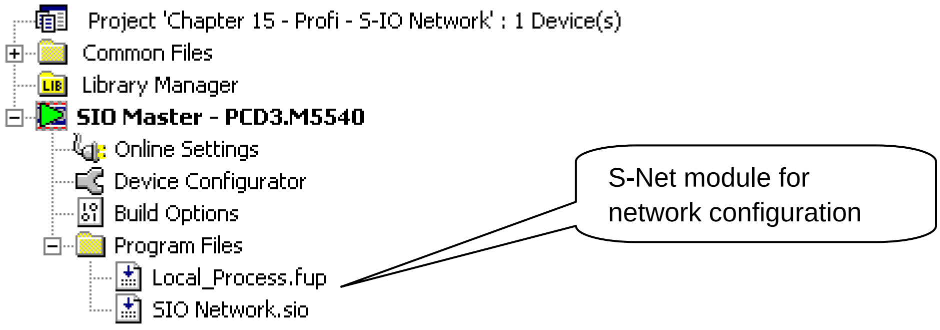
With both Profibus DP and Profibus-S-IO, network data exchange is configured using the S-Net Configurator. No Fupla or IL code needs to be written, and no *Device Configurator* need to be configured (apart from the communications module types and bus parameters if using the PCD2.M480 or PCD3).

The configurator defines each slave station on the network, and which I/O modules are fitted. I/O data from these remote I/Os is mapped to symbols or absolute addresses in the master station. Code generated by the S-Net configurator continually transfers I/O data from the slaves to and from the memory image in the master.

When the program is compiled, S-Net generates all the code needed to continually transfer the data between the remote slave stations and the master station's memory image at the start/end of every cycle. The I/O image data can be accessed directly by the master station's Fupla or IL programs.

In this way, network data exchange is clearly separated from the process control.

15.3 PG5 project



Project 'Chapter 15 - Profi - S-IO Network' : 1 Device(s)
Common Files
Library Manager
SIO Master - PCD3.M5540
Online Settings
Device Configurator
Build Options
Program Files
Local_Process.fup
SIO Network.sio

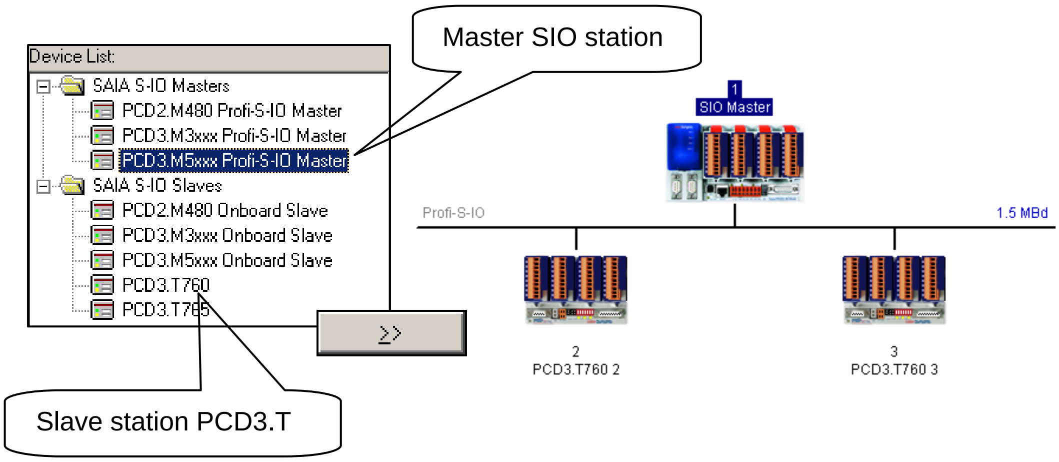
S-Net module for network configuration

The S-Net configurator file is added to the master station in the same way as Fupla or IL files, using *File New*, selecting the "Profi-S-IO Network File (.sio)" file type.

S-Net configurator usage is similar for both Profi-S-IO and Profibus DP data exchange. The only differences are:

- File extension of the configuration: .SIO, .DP
- The supported devices in the network: SIO = Saia PCD devices, DP = devices for Saia PCD+ other suppliers.
- Bus timing profiles: S-Net or DP.

15.4 Defining stations on the network



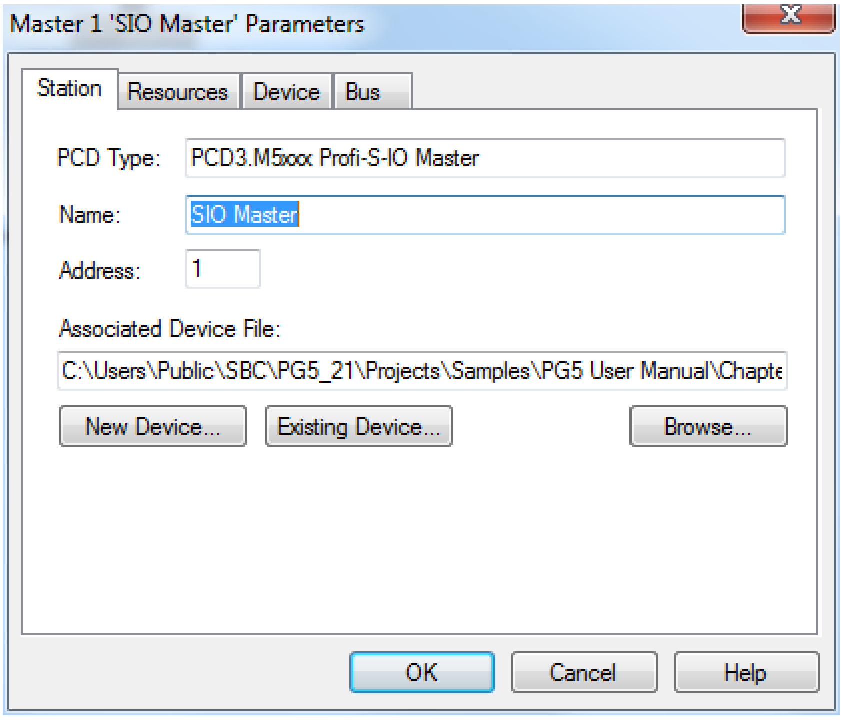
Device List:
SAIA S-IO Masters
PCD2.M480 Profi-S-IO Master
PCD3.M3xxx Profi-S-IO Master
PCD3.M5xxx Profi-S-IO Master
SAIA S-IO Slaves
PCD2.M480 Onboard Slave
PCD3.M3xxx Onboard Slave
PCD3.M5xxx Onboard Slave
PCD3.T760
PCD3.T765

Master SIO station

Slave station PCD3.T

For each station, select the station type in the device list, and add it in the network with the **>>** button.

15.5 Configuring the master station



Master 1 'SIO Master' Parameters

PCD Type: PCD3.M5xxx Profi-S-IO Master

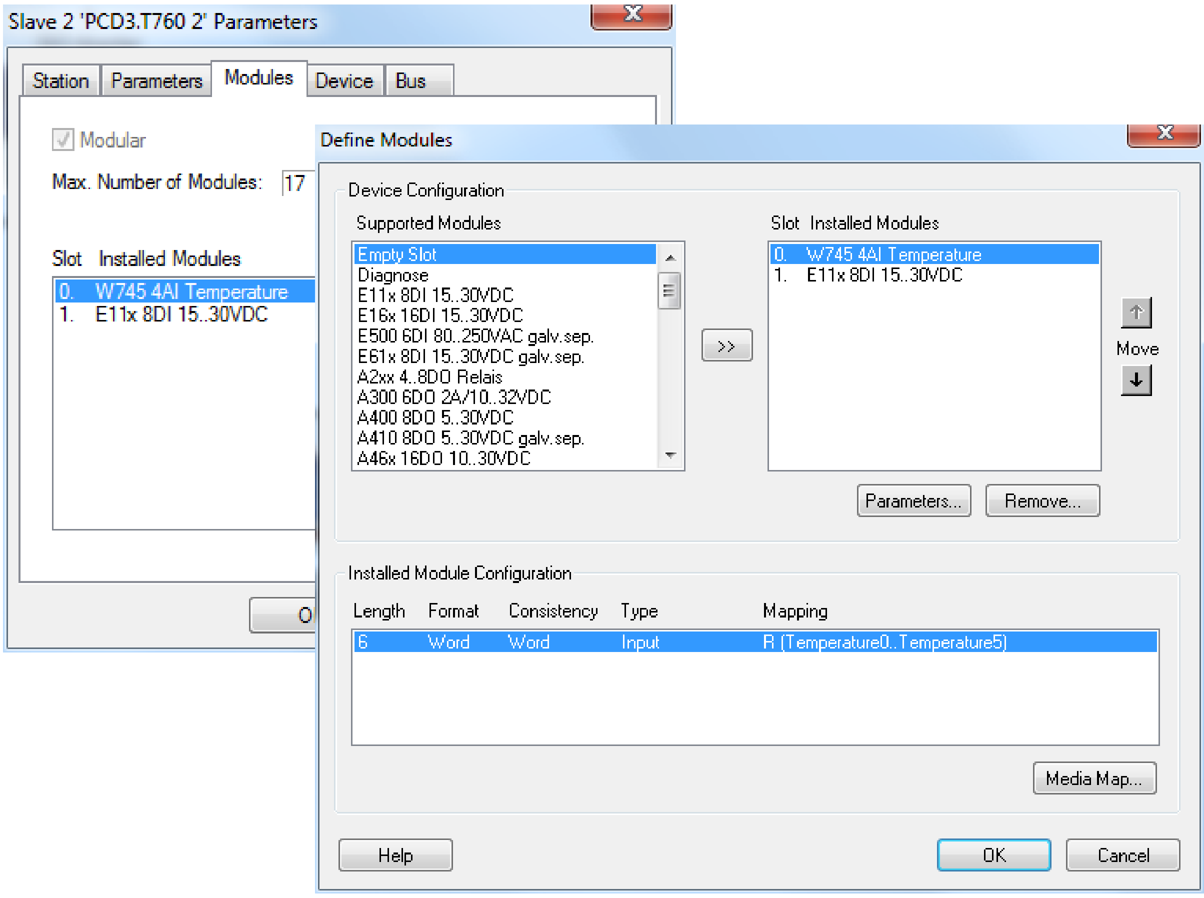
Name: SIO Master

Address: 1

Associated Device File:

C:\Users\Public\SBC\PG5_21\Projects\Samples\PG5 User Manual\Chapte

The only information which needs to be defined for the master station is the *Associated* device *File*, which is the access path of the master device. This where S-Net will create the master station's network control file. This dialog box also allows the station name and address to be defined.



Slave 2 'PCD3.T760 2' Parameters

☑ Modular

Max. Number of Modules: 17

Slot	Installed Modules
0.	W745 4AI Temperature
1.	E11x 8DI 15..30VDC

Define Modules

Device Configuration

Supported Modules

Empty Slot
Diagnose
E11x 8DI 15..30VDC
E16x 16DI 15..30VDC
E500 6DI 80..250VAC galv.sep.
E61x 8DI 15..30VDC galv.sep.
A2xx 4..8DO Relais
A300 6DO 2A/10..32VDC
A400 8DO 5..30VDC
A410 8DO 5..30VDC galv.sep.
A46x 16DO 10..30VDC

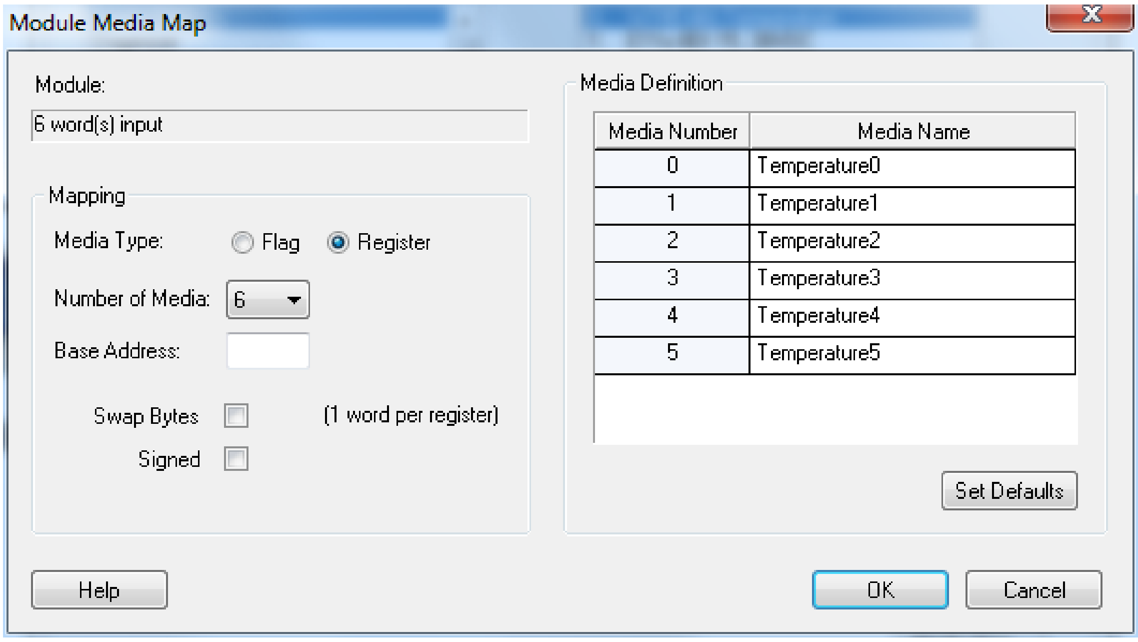
Slot	Installed Modules
0.	W745 4AI Temperature
1.	E11x 8DI 15..30VDC

Installed Module Configuration

Length	Format	Consistency	Type	Mapping
6	Word	Word	Input	R (Temperature0..Temperature5)

For each input/output module fitted in the slave station, select the module type in the *Supported Modules* list and add it to the *Installed Modules* list using the **>>** button. Ensure that the *Slot* number corresponds to the slot where the module is actually installed, use the up/down Move arrows to change the slot.

15.6.2 Configuring symbol names for remote data



Module Media Map

Module: 6 word(s) input

Mapping

Media Type: ○ Flag ● Register

Number of Media: 6

Base Address:

Swap Bytes □ (1 word per register)

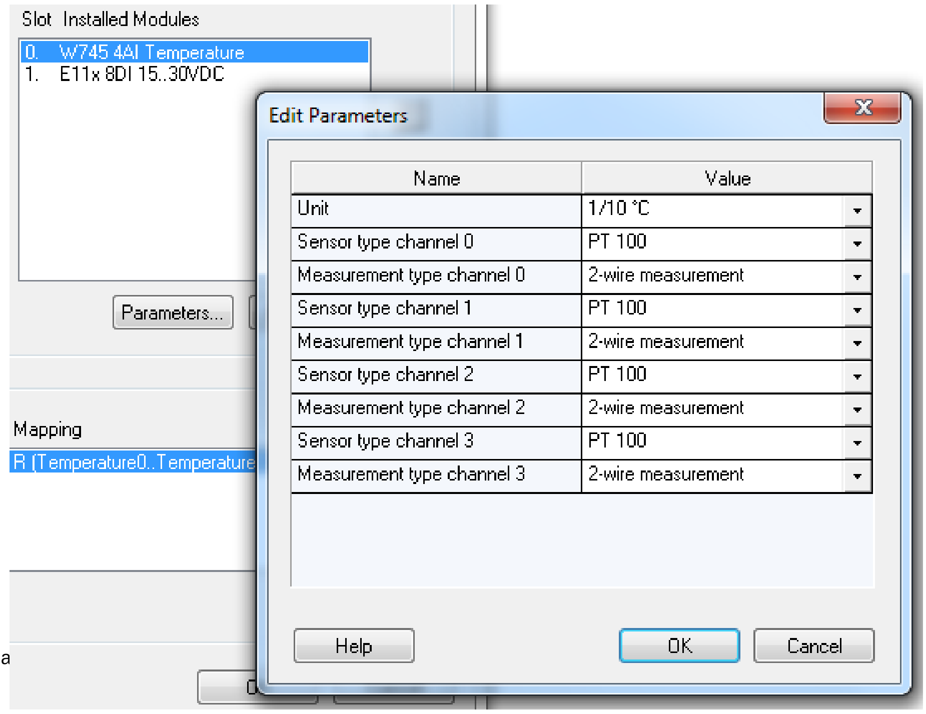
Signed □

Media Definition

Media Number	Media Name
0	Temperature0
1	Temperature1
2	Temperature2
3	Temperature3
4	Temperature4
5	Temperature5

For each module in the *Installed Modules* list, select the module and press the *Media Map* button to define symbol names and media types for the module's data. If necessary, a base address for the first flag or register in the master station can be defined. But the easiest way is to leave the "Base Address" field empty, so that dynamic addresses are used.

15.6.3 Configuring I/O parameters



Slot Installed Modules
0. W745 4AI Temperature
1. E11x 8DI 15..30VDC

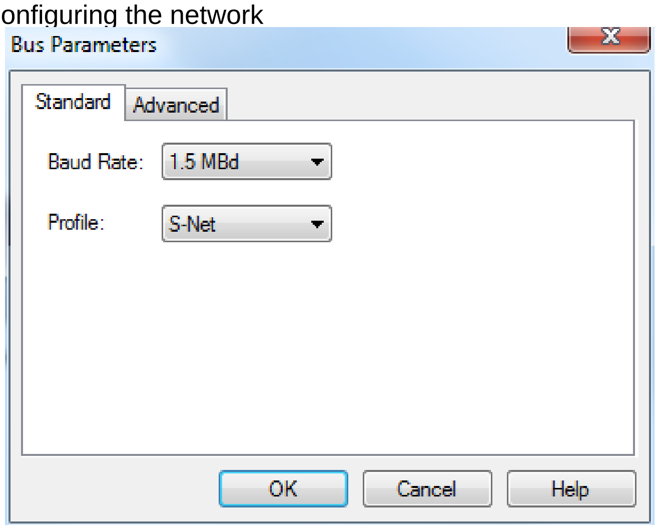
Mapping
R (Temperature0..Temperature

Edit Parameters

Name	Value
Unit	1/10 °C
Sensor type channel 0	PT 100
Measurement type channel 0	2-wire measurement
Sensor type channel 1	PT 100
Measurement type channel 1	2-wire measurement
Sensor type channel 2	PT 100
Measurement type channel 2	2-wire measurement
Sensor type channel 3	PT 100
Measurement type channel 3	2-wire measurement

With some modules, such as analogue measurement modules, additional parameters should be defined for selecting units, sensor types etc. These are configured by selecting the module and pressing the *Parameters* button.

Configuring the network



Bus Parameters

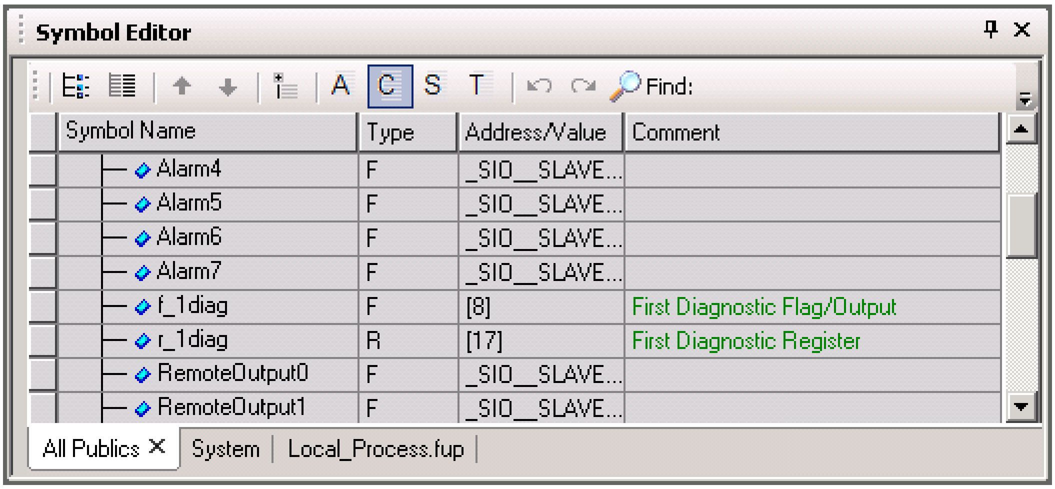
Baud Rate: 1.5 MBd

Profile: S-Net

The communications speed and bus profiles are defined using the *Edit - Bus Parameters* menu command.

Note:
If a PCD7.T7xx station is connected to the network, always choose the "S-Net" bus profile.

15.7 Using network symbols in Fupla or IL programs

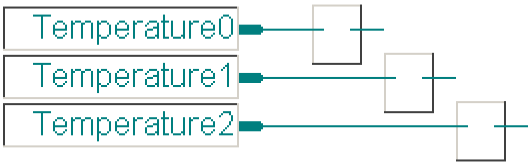


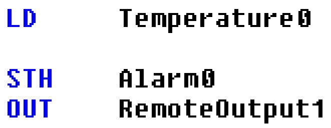
Symbol Editor

Symbol Name	Type	Address/Value	Comment
Alarm4	F	_SIO__SLAVE...	
Alarm5	F	_SIO__SLAVE...	
Alarm6	F	_SIO__SLAVE...	
Alarm7	F	_SIO__SLAVE...	
f_1diag	F	[8]	First Diagnostic Flag/Output
r_1diag	R	[17]	First Diagnostic Register
RemoteOutput0	F	_SIO__SLAVE...	
RemoteOutput1	F	_SIO__SLAVE...	

STH   Alarm0
OU

```
LD      Temperature0

STH     Alarm0
OUT     RemoteOutput1
```





```
LD      Temperature0

STH     Alarm0
OUT     RemoteOutput1
```

After compilation of the S-Net file (*Project / Compile* menu command), the Symbol Editor displays a new page containing the accessible network symbols. These symbols can be used directly in Fupla and IL programs.

15.8 Further information

For more information please refer to these manuals:

- Profibus DP 26/ 765
- Profi-S-IO (in preparation)
- Example Profi-S-IO project installed with your PG5

Technical data

Technical data

Operating system	Windows 8 and Windows 8.1 (64 bits) Windows 7 (32 and 64 bits) and Windows XP (32 bits). Microsoft .Net 4.0 Client Profile and Microsoft .Net 4.0 Extended. .Net installer is available on the installation disk: <DVD> :\Windows\ dotNetFx40_Full_x86_x64.exe
PC	For best performances, we recommend installing PG5 2.1 on a PC with multi-core CPU running at a minimum of 2 GHz with a minimum of 2 GB RAM (4 GB ore more is recommended). The installation package requires about 600 MB free space on your hard disk.
PCD instruction set	All 150 PCD instructions are supported
Standard FBoxes	The PG5 has over 250 standard Fboxes
Programming languages	Instruction List (IL), FUPLA (FBD) and GRAFTEC (SFC)
CPUs supported	All Saia PCD® models are supported (excluding the xx7 Series)
Compatibility	PG3 and PG4 and PG5 1.x programs can still be used with PG5 2.1
Communication	TCP/IP, SBC S-Bus, PROFIBUS DP, BACnet and LONWORKS® communication are present in PG5.

Saia-Burgess Controls AG
Bahnhofstrasse 18
CH-3280 Murten / Switzerland

Telephone ++41 26 672 71 11
Telefax ++41 26 670 44 43

E-mail: info@saia-pcd.com
Homepage: www.saia-pcd.com
Support: www.sbc-support.com

Your local contact:

Printed in Switzerland 26/732 E10 01. 2006 Subject to change without notice.