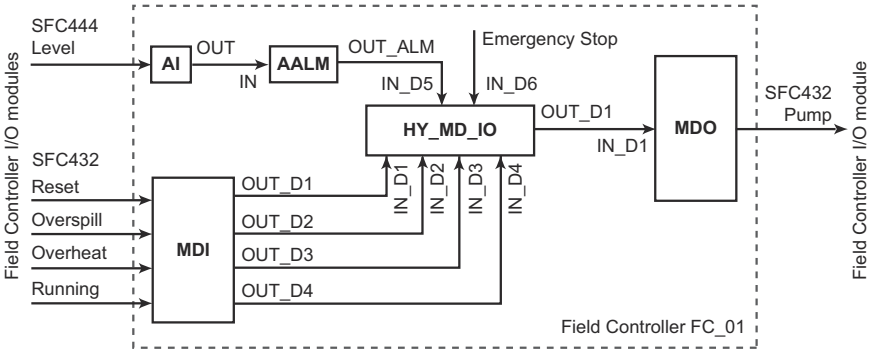
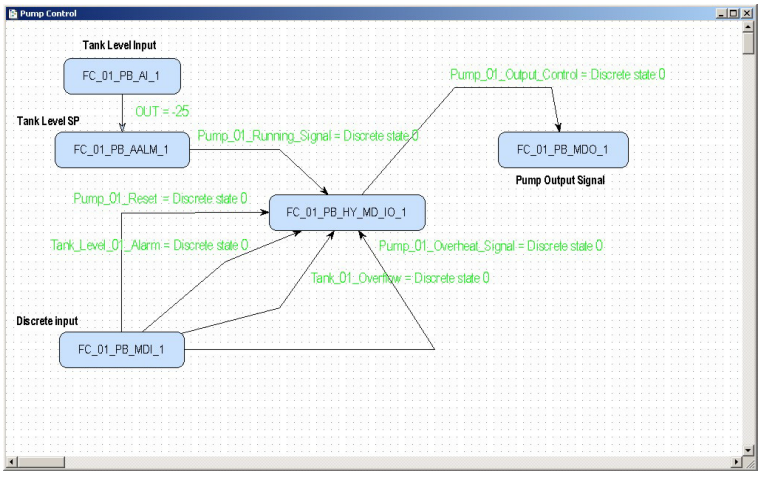
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Operating Instructions

ControlCare Application Designer

IEC 61131-3 Ladder Logic (LD) Tutorial





BA 038S/04/en/06.10
Product Version 2.05.xx
70101386

Endress+Hauser
People for Process Automation

Table of Contents

Revision History

Product version	Manual	Changes	Remarks
2.01.xx	BA038S/04/en/08.05	Original manual	
2.02.xx	BA038S/04/en/07.06	Program (Open PCS)	■ FBD language now available ■ CC libraries always active (Chapter 5.2.2) ■ Optimize for speed now default (Chapter 5.2.9)
		Program (Application Designer)	■ FB schedule configured by drag&drop (Chap. 4.5) ■ Incremental download (Chap. 6.3)
		Editorial	■ BA035S/04/en/12.0
2.03.xx	BA035S/04/en/06.07	Program	■ Chapter 5 shortened: Conversion of FF to boolean now automatic when FF data structure not ticked ■ Parameter HYB_STATUS_OPTS added Block to show control status of hybrid parameters ■ IEC61131-1 Simulation now possible (Chap. 5.3)
		Going on-line	■ New HSE Network Tools program ■ New Field Controller Web Server program
2.04.xx	BA035S/04/en/12.08	Application Designer	■ Aliasing added to Function block characterization ■ IEC 61131-2 language selected in FB attributes ■ Screenshots and text revised to new procedure
		OpenPCS	■ Chapter 6.1 I/O mapping deleted (done by aliasing)
2.05.xx	BA035S/04/en/06.10	Editorial	■ Version, documentation table, Windows support ■ Webserver screenshot updated
		Trouble-Shooting	■ FRC LED description updated for battery power

Product Version

Details of product version and the individual components of Application Designer Suite can be seen in the About ControlCare dialog:

Start=>Programs=>Endress+Hauser=>ControlCare=>Tools=>About ControlCare

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1 Safety

1.1 Designated use

ControlCare is a field-based control system comprising hardware and software components. It can be used to visualize, monitor and control production processes. The approved usage of the individual units used in the system can be taken from the corresponding parts of the operating instructions.

The software described in this particular manual allows the programming of the hybrid function block in IEC 61131-3 language as well as the engineering, configuring and commissioning of a ControlCare SFC162 FOUNDATION Fieldbus or SFC173 PROFIBUS Field Controller. Ladder Logic language has been taken as an example, and the building of appropriate control strategies using these and the function blocks contained in the Field Controller and connected devices are described.

1.2 Installation, commissioning and operation

ControlCare Field Controllers have been designed to operate safely in accordance with current technical safety and EU directives. Essential to their use is the ControlCare Application Designer software suite, which allows control strategies to be created for FOUNDATION Fieldbus and PROFIBUS I/O applications. Field devices, links, junction boxes, cables and other hardware comprising the Fieldbus sytem must also be designed to operate safely in accordance with current technical safety and EU directives.

If devices are installed incorrectly or used for applications for which they are not intended, or if the controller is not configured correctly, it is possible that dangers may arise. For this reason, the system must be installed, connected, configured, operated and maintained according to the instructions in this and the associated manuals: personnel must be authorised and suitably qualified.

1.3 Operational safety

Location

Field Controllers must be mounted in a permanent and weather-protected location in a safe area. The environment shall be a metal cabinet or an installation frame with a well grounded mounting plane. The environment shall be protected.

Hazardous areas

The controller must be connected to networks operating in explosion hazardous areas via barriers or other safety components. When installing components in explosion hazardous areas:

- Ensure that all installion and maintenance personnel are suitably qualified
- Check that all equipment has the appropriate safety certificates
- Observe the specifications in the device certificates as well as national and local regulations.

This topic is discussed in BA013S (FF Guidelines) and BA034S (PROFIBUS Guidelines).

EMC

All modules are suitable for industrial use and conform with the following standard, see Appendix:

- EN 61326: 1997/A1: 1998
  Interference emmision: Class A apparatus
  Interference immunity: as per Annex A, industrial environment

Depending upon the environment in which the bus is operating, particular attention should be paid to the grounding of the bus cables. This topic is discussed in BA013S (FF Guidelines) and BA034S (PROFIBUS Guidelines).

IP Address

A ControlCare Field Controller is normally configured from a workstation connected into the control system backbone. You will require a unique IP address to set it up.

Warning

- The use of IP addresses is strictly controlled. Usually your system administrator will be authorised to allocate unique addresses. Assigning an unauthorised address to a Field Controller may result in conflicts within your system and the failure of the associated devices!

It is recommended that ControlCare Field Controllers and OPC servers are not installed in an office network, as the large data packets exchanged between office equipment may lead to timeouts and intermittent communication errors. Ideally, the ControlCare system network should operate within its own IP domain; if this is not possible it should be separated from other parts of the network by a managed switch.

Since the system can be accessed and manipulated through the various ControlCare tools, it is advisable to control access both to the workstation and the folders in which the configuration is stored. Always make a back-up of the project.

Technical improvement

Endress+Hauser reserves the right to make technical improvements to its software and equipment at any time and without prior notification. Where such improvements have no effect on the operation of the equipment, they are not documentated. If the improvements effect operation, a new version of the operating instructions is normally issued.

1.4 Conventions and icons

In order to highlight safety relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding icon in the margin.

Safety conventions

Icon	Meaning
	A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned
	**Caution!** Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument
	**Warning!** A warning highlights actions or procedures which, if not performed correctly, will lead to personal injury, a safety hazard or destruction of the instrument

1.5 ControlCare documents

Table 1.1 indicates the documents, planned and realized, containing safety relevant information, installation, commissioning and operating instructions for the equipment and software associated with ControlCare.

All documentation available at the time of release is included on the ControlCare CD-ROM and is installed in **Start=>Programs=>Endress+Hauser=ControlCare=Manuals** during set-up.

Component	Description	Document type	Designation	Order No.
System	ControlCare System Overview	Operating manual	BA016S/04/en	56004883
	ControlCare System Design	Operating manual	BA039S/04/en	Planned
	ControlCare System Specifications	Operating manual	BA040S/04/en	56004888
Software	Application Designer Overview	Operating manual	BA017S/04/en	70104301
	Application Designer: Local I/O Tutorial	Operating manual	BA032S/04/en	71095009
	Application Designer: FF Tutorial	Operating manual	BA019S/04/en	70101151
	Application Designer: PROFIBUS Tutorial	Operating manual	BA036S/04/en	70101152
	Application Designer: MODBUS Tutorial	Operating manual	BA037S/04/en	70101153
	Application Designer: IEC 61131-3 Ladder Logic Tutorial	Operating manual	BA038S/04/en	70101386
	Application Designer: IEC 61131-3 Structured Text Tutorial	Operating manual	BA056S/04/en	71060063
	Field Control (OPC) Servers	Operating manual	BA018S/04/en	71031428
	SFC162 Visitor	Operation manual	BA069S/04/en	71113457
Field Controller	Hardware Installation Guide	Operating manual	BA021S/04/en	56004885
	Commissioning and Configuration	Operating manual	BA035S/04/en	56004887
Function Blocks	Function Block Manual	Operating manual	BA022S/04/en	56004886
Set-Up	Getting Started	Operating manual	BA020S/04/en	56004884
General	FOUNDATION Fieldbus Guidelines	Operating manual	BA013S/04/en	70100707
	PROFIBUS Guidelines	Operating manual	BA034S/04/en	56004242

Tab. 1-1: ControlCare Documentation

2 Task Description

This tutorial describes the steps necessary for setting up the project described below. It does not aim to give an exhaustive account of Application Designer functions, but rather shows you one of a number of methods to reach your goal. The tags and names used in the tutorial are imaginary and will be different in a proper application. A full description of Application Designer functions is to be found in Application Designer Overview BA017S/04/en and Drawing Tool BA032S/04/en (in preparation). Function block descriptions are to be found in BA022/04/en, Function Block manual.

2.1 Pump control for tank level

For this tutorial, the case of pump control for tank level will be used, see Fig. 2-1.

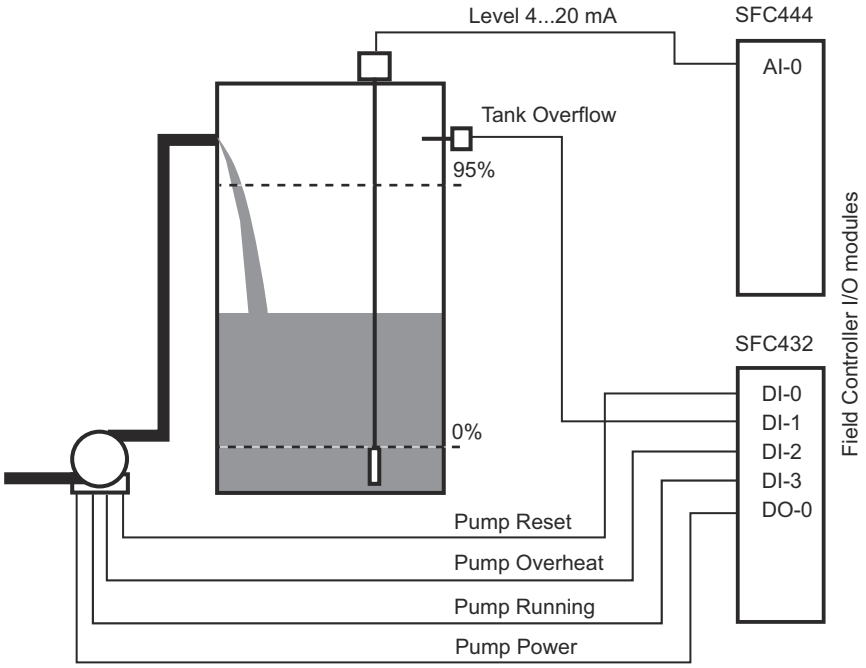


Fig. 2-1: Overview of pump control for tank filling

A centrifugal pump is used to fill the tank with liquid. The level of liquid in a tank is monitored by a level transmitter which outputs a corresponding 4 mA to 20 mA signal. When the tank is full (=95%) the pump must be switched off. In order to provide overspill protection for the tank, should the level transmitter fail, a level limit switch with relay output is built in at an appropriate height. The pump itself provides Overheat and Running signals, and a switch is provided for pump reset.

The signals are acquired by Field Controller I/O modules as follows:

- 4 mA to 20 mA level to AI-0 input of a SFC444 Analog Input module
- Level Overflow, Pump Reset, Pump Overheat and Pump Running signals to DI-0 to DI-3 inputs of a SFC432 Mixed Discrete I/O module: 0 V = False, 24 V = True
- Pump output current from DO-0 output of the SFC432 Mixed Discrete I/O module: NO relay, False = Pump ON, True = Pump OFF, Fail Safe = Pump OFF

For the tutorial the control is done in a PROFIBUS SFC173 Field Controller, but since there is no PROFIBUS DP network connected to it, the procedure described also applies to the FOUNDATION SFC162 Fieldbus Controller.

Fig. 2-2 shows a schematic diagram of the pump control application. The analog level input is fed to an Analog Alarm block that generates a true signal when the "full" level is reached. This is a standard function block, and eliminates the need to provide a similar signal conditioning program within the hybrid block. All discrete signals are connected directly to the hybrid function block which generates an output signal according to the status of the application.

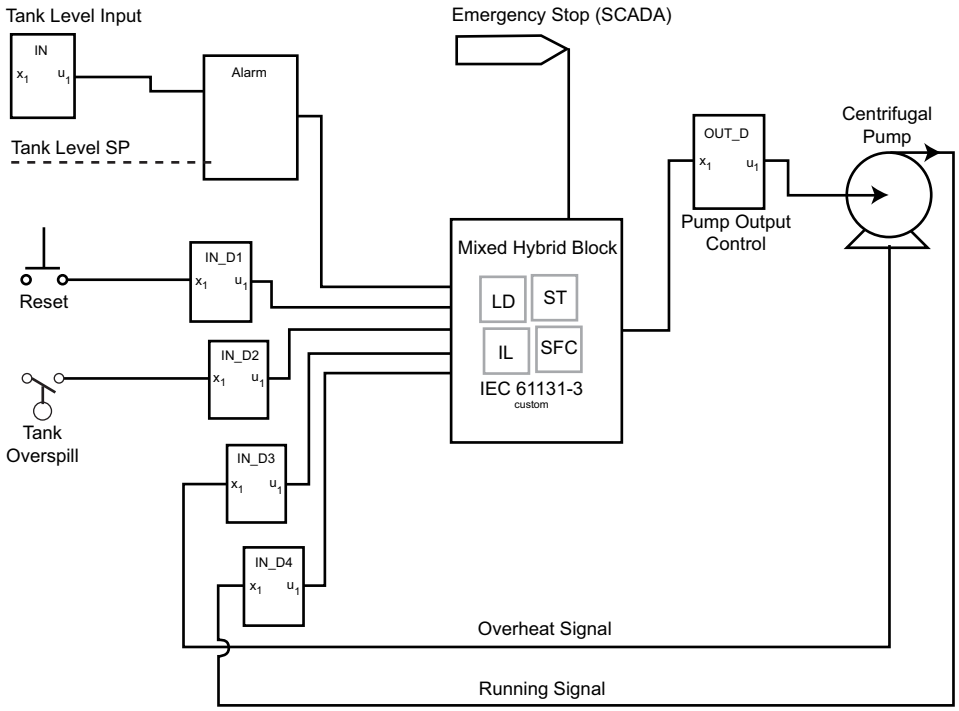


Fig. 2-2: Schematic diagram of pump control application

2.1.1 Control strategy

Fig. 2-3 shows the corresponding control strategy. The level signal is fed to the Analog Input block, and after scaling to 0% to 100% is passed on to the Analog Alarm block. This generates a true or false signal according to the level in the tank. The discrete input signals are collected in a Multiple Discrete Input block and the pump output control signal is fed to a Multiple Discrete Output block. The control algorithm is programmed in the hybrid block.

It should be noted that the control strategy can also be created with 4x Discrete Input blocks and and 1x Discrete Output block.

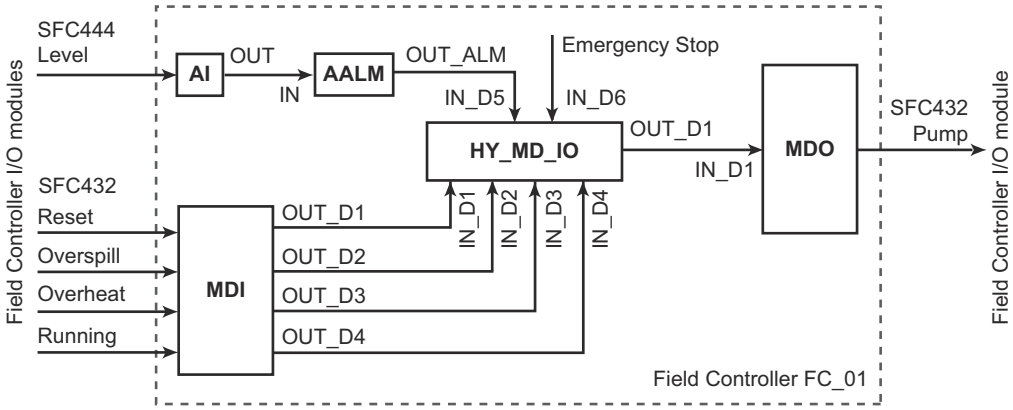


Fig. 2-3 Control strategy for pump control application

2.1.2 Control algorithm

The tank overflow and pump overheat conditions must lead to immediate switch off of the pump. The pump running signal is automatically generated by the pump itself, and is provided, e.g. for a visualization of the application. The truth table for the hybrid function block has is as follows:

Function	IN_D1	IN_D2	IN_D3	IN_D4	IN_D5	IN_6	OUT_D1
Tank "Empty"	–	–	–	–	False	–	False
Tank Full	–	–	–	–	True	–	True
Tank Overflow	–	True	–	–	–	–	True
Pump Reset	True	–	–	–	–	–	True
Pump Overheat	–	–	True	–	–	–	True
Pump Running	–	–	–	True	–	–	False
Pump Emergency Off	–	–	–	–	–	True	True

2.1.3 Aliasing

For this tutorial the signals will be aliased as follows:

Block	Signal	Block	Signal	Alias
MDI	**OUT_D1**	HY_MD_IO	**IN_D1**	Pump_01_Reset
	OUT_D2		**IN_D2**	Tank_Level_01_Alarm
	OUT_D3		**IN_D3**	Tank_01_Overflow
	OUT_D4		**IN_D4**	Pump_01_Overheat_Signal
AALM	**OUT_ALM**		**IN_D5**	Pump_01_Running_Signal
Input via IEC OPC Server			**IN_D6**	Pump_01_Operator_Entry_Emergency
HY_MD_IO	**OUT_D1**	MDO	**IN_D1**	Pump_01_Output_Control

2.1.4 Network

The project uses a PROFIBUS SFC173 Field Controller with local I/O. The procedure for a FOUNDATION Fieldbus SFC162 is exactly the same. The network is assumed to be constructed as shown in Fig. 2-4.

- The level signal is acquired via a SFC444 Analog Input module
- The level overspill and pump signals are acquired by a SFC432 Discrete Input/Output module
- The pump is connected to a SFC432 Discrete Input/Output module.

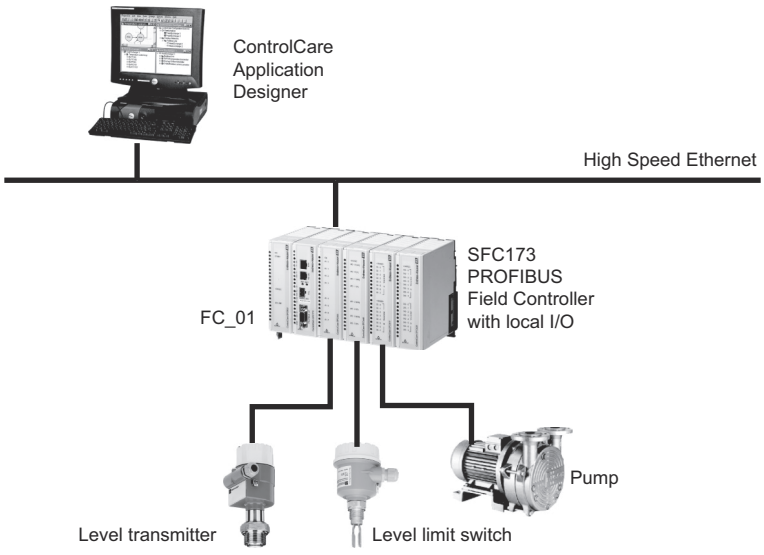


Fig. 2-4 Network for application example

2.2 Preliminaries

2.2.1 Installation and commissioning

Before you can start the IEC 61131-3 Ladder Logic tutorial, the Application Designer Suite must be installed on your computer, the SFC173 PROFIBUS Controller installed and commissioned and a connection made to your computer. Instructions on how to do this are to be found in:

- Operating Instructions BA020S/04/en, Getting Started
- Operating Instructions BA021S/04/en, Field Controller: Hardware Installion
- Operating Instructions BA035S/04/en, Field Controller: Commissioning and Configuration

Not all project steps are described in detail, so it is recommended that you also have the PROFIBUS or FOUNDATION Fieldbus tutorials at hand:

- Operating Instructions BA019S/04/en, Application Designer: FOUNDATION Fieldbus tutorial
- Operating Instructions BA036S/04/en, Application Designer: PROFIBUS tutorial

2.2.2 Rack assembly

The SFC173 Field Controller, SFC444 Analog Input module and SFC432 Discrete I/O module have combined power demand of 132 mA @ 24 VDC and 940 mA@ 5 VDC. Even allowing for a tolerance of 20%, this is easily covered by a SFC050 or SFC056 rack power module (300 mA @ 24 VDC and 3000 mA @ 5 VDC). See Chapter 10 of BA040S/04/en, ControlCare, System Specifications.

The Field Controller and local I/O are mounted on a SFC901A rack assembly with **address = 1** (I/O cannot be mounted on a rack with the address "0".) The parameters for commissioning the Field Controller are shown in Table 2-1.

Rack 1	**Slot 0**	**Slot 1**	**Slot 2**	**Slot 3**
Module	SFC050	SFC173	SFC444	SFC432
IO_TYPE_Rx	No I/O	No I/O	8 Analog Input	8 DiscIn 4 DiscOut
Channel Group A	–	–	1209	1309
Channel Group B	–	–	–	1319

Tab. 2-1: Parameter settings for rack in hardware configuration and function blocks

Note!

- The channels used to connect to the modules to the function blocks are given by the Rack (R), Slot (S), Group (G) and I/O point (P) indices = RRGSP, whereby counting starts at "0".
- Since Multiple Discrete Input and Output blocks are being used for the discrete signals, the I/O point index is "9", see BA035S/04/en, Field Controller, Commissioning and Configuration.

2.2.3 External devices

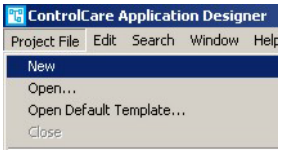
ControlCare local I/O modules are available with passive electrical circuits only, so that any connected devices or external circuits must have their own power supply, see BA035S/04/en, Field Controller, Commissioning and Configuration.

3 Create a PROFIBUS Network

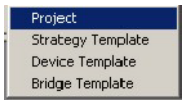
3.1 Create a new project

1 Start ControlCare Application Designer by clicking on the icon on your destop or via **Start => Programs => Endress+Hauser => ControlCare => ControlCare Application Designer**

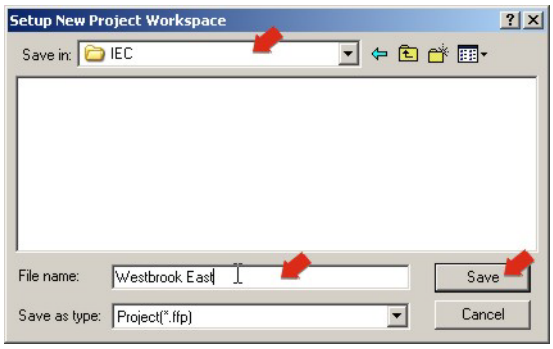
2 The project starts from a blank application screen
– With the right mouse key select **Project File=>New**



3 The **Document Type** box appears: Click the option **Project**



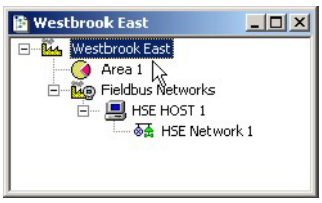
4 The **New Project** dialog box opens:



1. Choose the folder where the project will be saved.
2. Type the name of the project in the File Name box.
3. Click **Save.**

If the new project is not to be created, click **Cancel.**

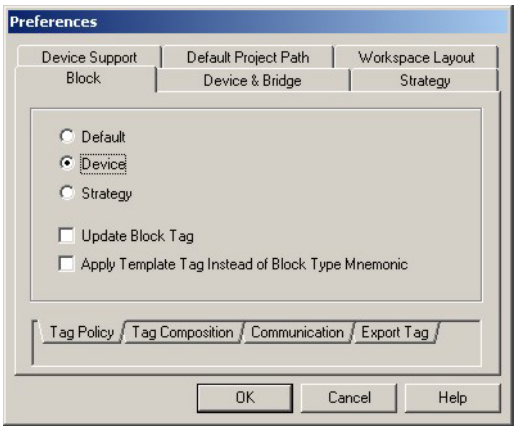
5 ON saving, ControlCare Application Designer
– automatically creates a folder with the entered file name within the selected folder
– automatically creates a project, adding the HSE Network network and the HSE Host



3.2 Determine the naming preferences

Before you start, you can set preferences for the way your project is created. Of particular interest at this stage is the labelling of the function blocks.

1 Press **Project File** => **Preferences**
  – The **Preferences** Dialog appears



Tag Policy

Tag Policy determines how the blocks are labelled by default if no tag names are entered

1 Select the folder **Block** and the subfolder **Tag Policy**, then check the following buttons
  – **Device**
  – **Update Block Tag**

2 Press **OK** to confirm your selection
  – Application Designer will now automatically rename any blocks created in the control strategy window as they are assigned to the devices by adding the device tag as prefix.

Tag Composition

Tag Composition determines how the block identifiers are added to the block tag if no block name is entered.

1 Select the subfolder **Tag Composition**:
  – Default setting is "_".
  – **This is mandatory if hybrid function blocks are to be used**
  – Check **Prefix**

2 Press **OK** to confirm your selection
  – Application Designer will now automatically compose the blocks according to your selection, e.g. TagName_Block_n.

Export Tag

Export Tag causes tags to be automatically exported every time the project goes online

1 Select the subfolder **Export Tag**
  – Check the **Automatic** button
  – Press **OK** to confirm your selection

Strategy

Strategy determines the default shape of the function block icons in the stratagy window and also whether the aliasing function is enabled

1 Select the subfolder **Strategy**
  – Select the default shape for function block objects
  – Select "Aliasing Input Dialog Box"
  – Press **OK** to confirm your selection

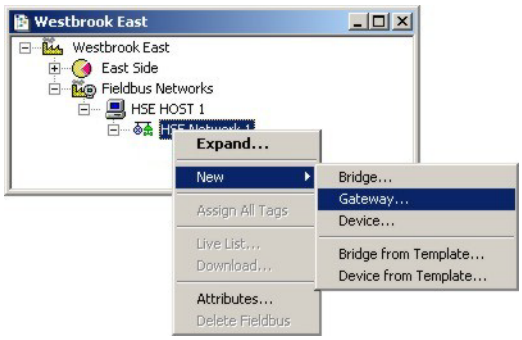
3.3 Add a gateway (SFC173)

Note!

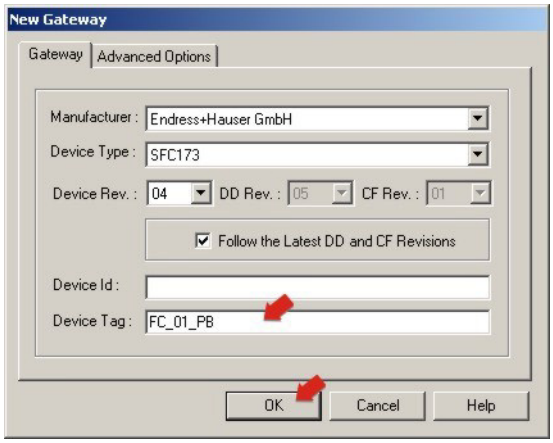
- If you are using a FOUNDATION Fieldbus SFC162 Field Controller, the procedure is exactly the same, except that you must add a "bridge" not a "gateway".

1 In the project workspace, click on "**+**" to expand the tree:

2 Now right-click on the **HSE Network** leaf and select **New=>Gateway**



3 The **New Gateway** dialog box appears:
Select the SFC173 Field Controller and type in a device TAG = **FC_01_DP**



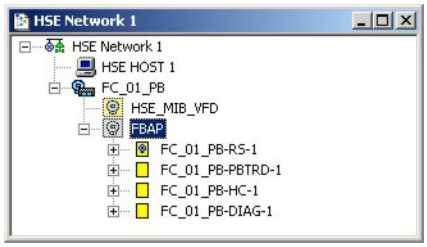
If you do not type in a tag, the default will be "Gateway n", where n is a consecutive number.

4 Press **OK** to create the Gateway.

5 Right-click on the **Project File** menu and select **Save Entire Configuration** to save the project.

3.4 Set up the Hardware Configuration block

1 Double click on the **HSE Network** leaf, the HSE Network window opens:
- Expand the **FC_01_PB** and **FBAP** leaves

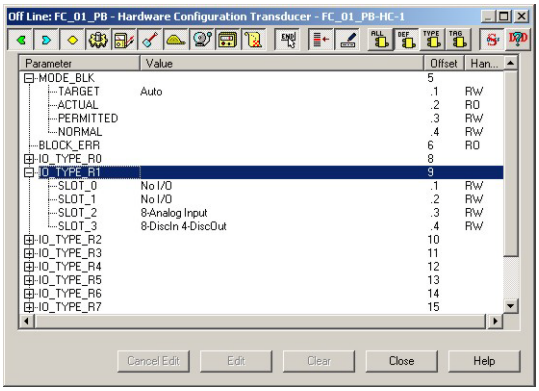


2 Double-click on the **FC_01_PB_HC_1** leaf to open the **Off Line Characterization** dialog To change parameters:

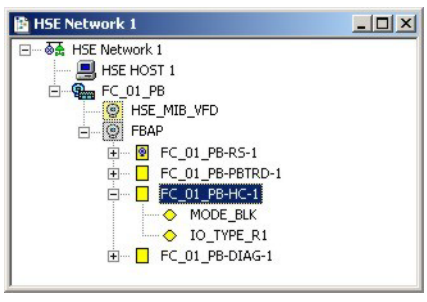
- Expand the parameter leaf
- Double click on value space
- Enter the parameter or select it from the drop-down menu
- Confirm with End **Edit**

3 Expand the **MODE_BLK** parameter left and check that **Target** is set to **Auto**

4 Expand the **IO_TYPE_R1** parameter leaf and set the following parameters, see Table 2-1, Chapter 2.2.2
- **Slot_0**: No I/O
- **Slot_1**: No I/O
- **Slot_2**: 8 Analog Input
- **Slot_3:** 8 DiscIn 4 DiscOut



5 Click **Close**, then save the configuration
- Right-click on the **Project File** menu and select **Save Entire Configuration** to save the project, which now looks like this.

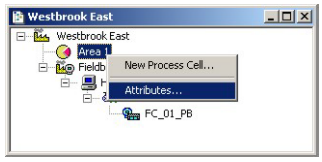


4 Create a Control Strategy

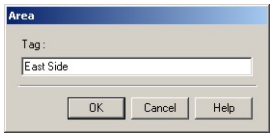
Having created a physical view of the process instrumentation, in this case the Field Controller, the next step is to create control strategy. This is done in the logical view of the plant. This represents the plant as Areas/Process Cells in accordance with ISA S88/IEC 61518. Only one Area is allowed in the project, but this may have any number of Process Cells.

4.1 Add a Process Cell

1 Click on the "**Area 1**" leaf in the project and select **Attributes...**

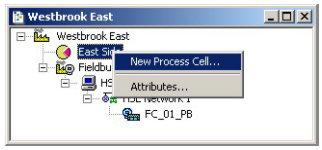


2 The **Attributes** dialog box appears

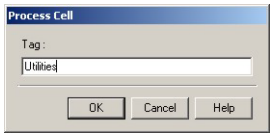


– Enter a name for the area, e.g. East Side
– Click **OK** to store your changes

3 Click on the Area leaf again and select **New Process Cell...**



4 The **Process Cell** dialog box appears



– Enter a name for the process cell, e.g. Utilities
– Click **OK** to store your changes

5 Your project should now look something like this:

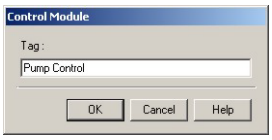
6 Open **Project File**, then press **Save Entire Configuration**, to save the project.

4.2 Add a Control Module

1 Double-click on the Process Cells leaf – a new window with the name of the leaf opens

2 Right-click on the top leaf and select **New Control Module**

3 The **Control Module** dialog box appears



– Enter a name for the control module, e.g. Pump Control
– Click **OK** to store your changes

4 The project now looks something like this:

5 For a real project, Step 2 and 3 would be repeated until all the required control modules for a particular process cell have been added. This allows each control loop or control loop group to be set up and viewed in its own control strategy window.

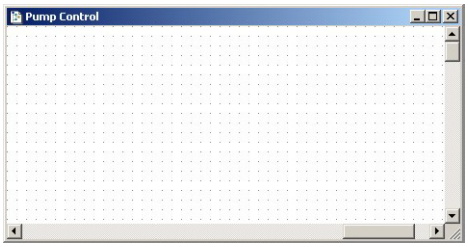
6 Open **Project File**, then press **Save Entire Configuration**, to save the project.

4.3 Add Function Blocks to the Control Strategy

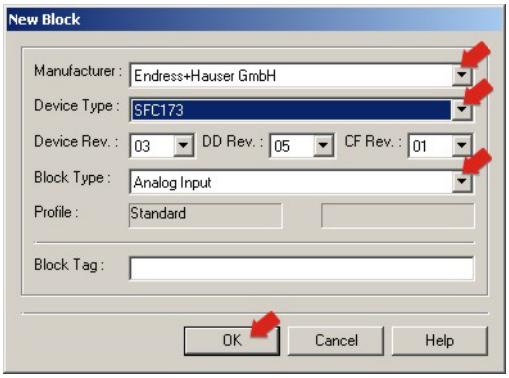
Note!

- The function blocks used in the tutorial are selected from the device manufacturer's device list. It is also possible to select standard function blocks from the "Fieldbus Foundation" list. This ensures that the control strategy can be executed in any device that supports a particular standard block, irrespective of vendor.
- Endress+Hauser devices support standard function blocks and offer them in the manufacturer specific list.

1 Double-click on the control module leaf or right-click and select **Expand** to open the **Control Strategy** workspace - this has the same name as the leaf

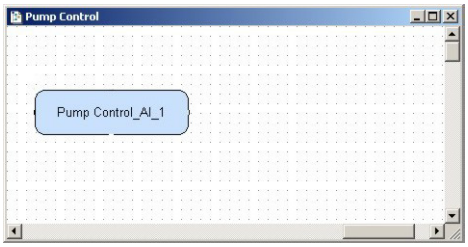


2 Press the Function Block button in the toolbar and click in the workspace
– The **New Block** dialog appears



– Select the **Manufacturer** = Endress+Hauser
– Select the **Device Type** = SFC173
– Select the **Block Type** = Analog Input
– Press **OK** to create the function block

3 The block now appears in the strategy window with the default name



4 Repeat Steps 2 and 3 for the Analog Alarm, Multiple Discrete Input, Hybrid with Discrete I/Os and Multiple Discrete Output blocks

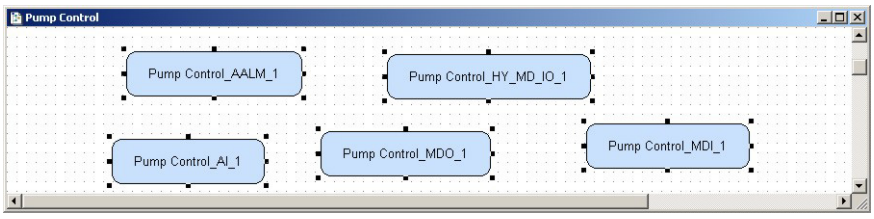
- Level Analog Alarm:
  Manufacturer = Endress+Hauser
  Device Type = SFC173
  Block Type = Analog Alarm

- Level Overspill and Pump Signal Inputs
  Manufacturer = Endress+Hauser
  Device Type = SFC173
  Block Type = Multiple Discrete Input

- IEC 61131-3 Programming
  Manufacturer = Endress+Hauser
  Device Type = SFC173
  Block Type = Hybrid with Discrete I/Os

- Pump Control
  Manufacturer = Endress+Hauser
  Device Type = SFC173
  Block Type = Multiple Discrete Output

5 The control strategy now looks like this



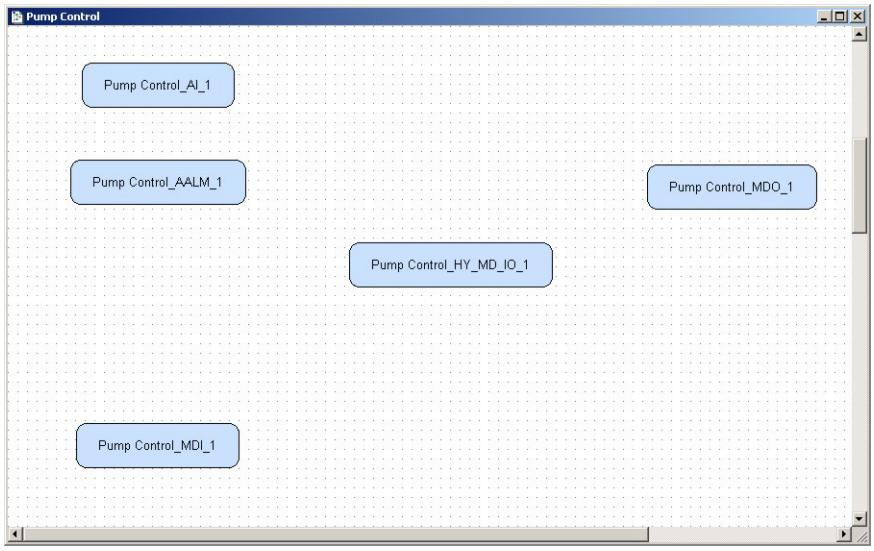
6 Open **Project File**, then press **Save Entire Configuration**, to save the project.

°Note!

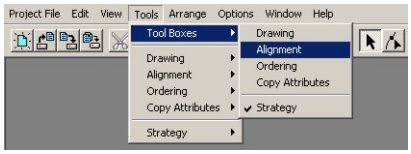
- If you are using the FOUNDATION Fieldbus SFC162 Field Controller, select the blocks from the corresponding SFC162 Block Type list

4.4 Add the Function Block links

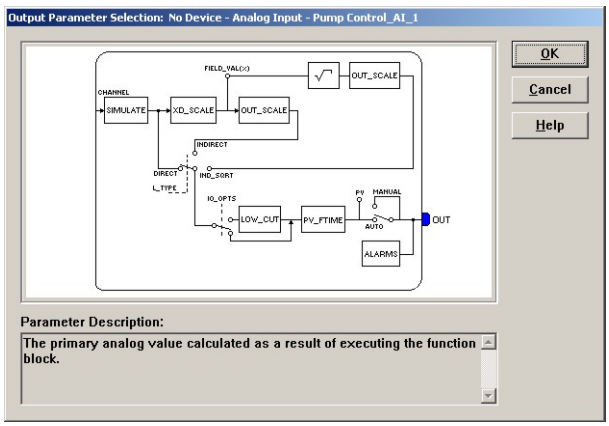
1 In the Control Strategy workspace position the blocks according to your strategy



- The blocks can be dragged and dropped by selecting and holding down the right mouse key
- The blocks can be aligned by selecting, then via **Tools => Alignment => e.g. Middle** followed by a click on the block to which the alignment is to be made
- The **Tools** menu also contains other standard drawing functions such as toolbars, standard shapes, line thickness, colours etc.



2 Click on **Function Block Link** button in the tool bar, the cursor changes to a cross
- Select the **Pump Control_A1_1 block** with the cross:
  the **Output Parameter Selection** dialog appears

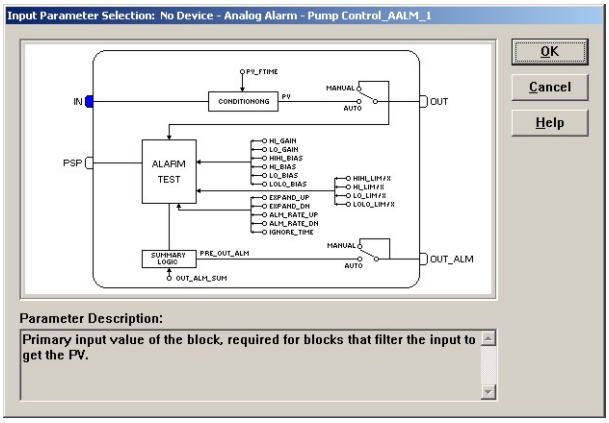


- OUT contains the level value

3 Click the box next to **OUT** – it changes color – then click on **OK**

- The **Output Parameter Selection** dialog closes
- The cursor is now connected to a blue dotted line
- Place the Cursor in the Pump Control_AALM_1 block and click to make the link

4 When the link is made, the **Input Parameter Selection** dialog for the Alarm block appears

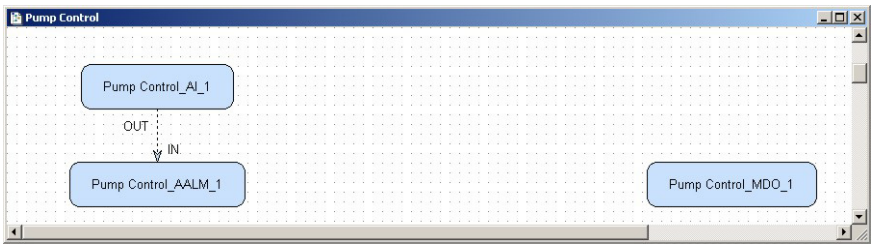


- Click the box next to **IN** – it changes color – then click on **OK**

5 The **Rename** dialog now appears: in this tutorial the alias function will be used when the I/O blocks are characterized, Chapter 4.6, for this reason:

- Press **OK** without making an entry - the link retains the standard name

6 When the **Rename** dialog disappears, the link is made and appears as below:

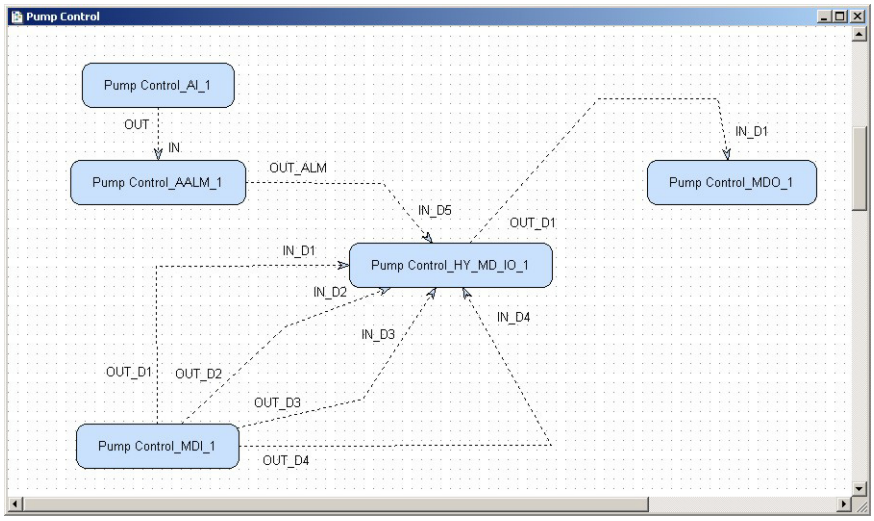


- You may have to move the parameter legends "IN" and "OUT" by selecting and positioning with the left mouse key depressed

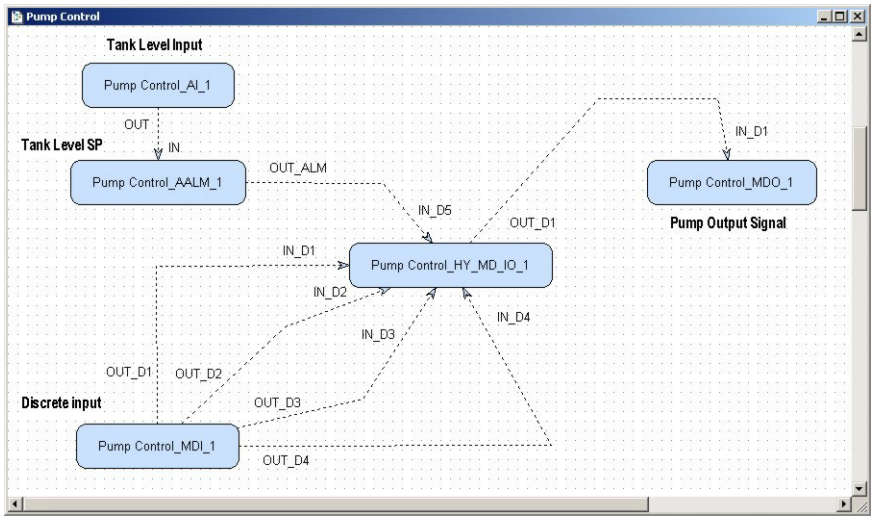
7 Repeat steps 2 to 5 and make the following links between the function blocks

- Pump Control_AALM_1 to Pump Control_HY_MD_IO_1
  OUT_ALM to **IN_D5**
- Pump Control_MDI_1 to Pump Control_HY_MD_IO_1=
  OUT_D1 to **IN_D1**
  OUT_D2 to **IN_D2**
  OUT_D3 to **IN_D3**
  OUT_D4 to **IN_D4**
- Pump Control_HY_MD_IO_1 to Pump Control_MDO_1
  OUT_D1 to **IN_D1**

8 Your Control Strategy now looks something like this



9 By using the **Tools => Drawings => Text** option, you can now add text to the strategy to make clear the function of each block and parameter:



10 Click on the **Project View** workspace and **Export Tags**..., see Chapter 4.7
– Open **Project File**, then press **Save Entire Configuration**, to save the project.

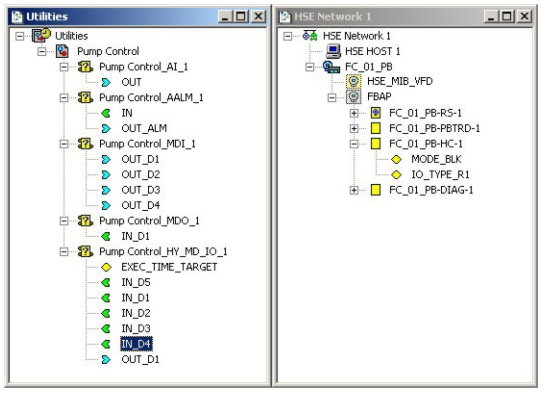
4.5 Attach the function blocks to the Field Controller

The blocks that are always necessary for the Field Controller (RS, PBTR0, HC and DIAG) are created automatically when it is added to the Fieldbus Network. Do not delete these blocks! The order of attachment of the strategy function blocks to the Field Controller determines the order of execution.

- First attach the input blocks
- Then attach the control and logic blocks in the order of execution
- Finally attach the output blocks

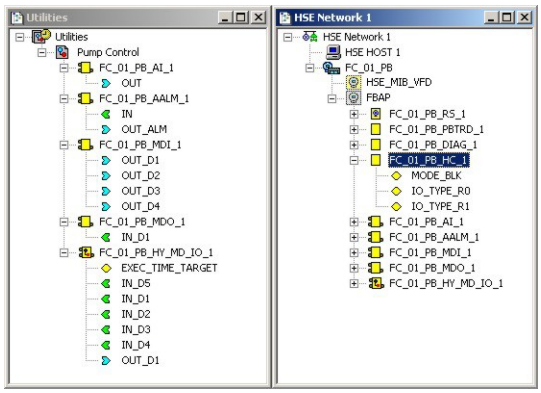
If necessary, the order of the blocks can be adjusted by drag & drop.

1 Close the Control Strategy window and place the **Utilities** (Control Module) and **HSE Network 1** dialogs side-by-side
   – The function blocks and links you created have been added to the Utilities tree
   – There is a question mark "?" in each function block icon



2 Drag and drop the Pump Control_AI_1 block from the Utilities into the HSE Network 1 dialog and place it on the FB VCF leaf
   – The block is attached to the Field Controller
   – The name changes (set to do so in Preferemces, see Chapter 3.2)
   – The question mark disappears from the block in the Utilities dialog

3 Repeat step 2 for all blocks – your project now looks like this:



4 Open **Project File**, then press **Save Entire Configuration**, to save the project.

4.6 Characterize the I/O function blocks

The Analog and Digital I/O blocks can now be characterized as follows.

1 In the **HSE Network 1** dialog, double-click on the block leaf
   – The **Off Line Characterization** dialog for the block appears

2 To change parameters:

   – Expand the parameter leaf
   – Double click on value space
   – Enter the parameter or select it from the drop-down menu
   – Confirm with End **Edit**

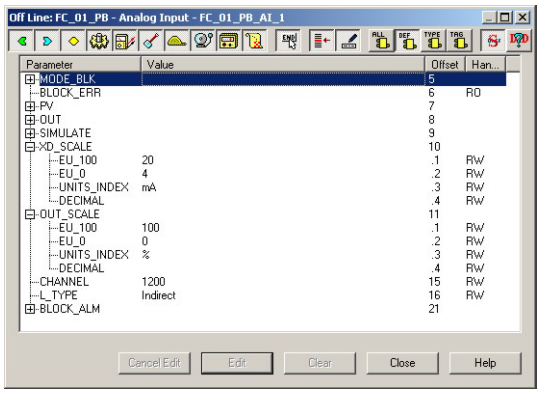
3 Click **Close** to close the block and

4.6.1 Analog Input block

The AI block is attached to the SFC444 Analog Input module. This delivers a 4 mA to 20 mA signal that must be scaled to 0 % to 100%. The channel parameter is that in Table 2-1, Chapter 2.2.2.

1 Double-click on **FC_01_PB_AI_1** and enter the following parameters

   – **MODE_BLK**
      TARGET: Auto
   – **XD_SCALE**
      EU_100: 20
      EU_0: 4
      UNITS_INDEX: mA
   – **OUT_SCALE**
      EU_100: 100
      EU_0: 0
      UNITS_INDEX: %
   – **CHANNEL:** 1200
   – **L_TYPE**: Indirect



2 Press **Close** to close the dialog

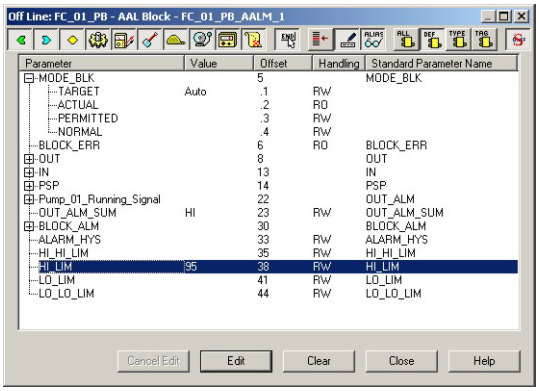
3 Open **Project File**, then press **Save Entire Configuration**, to save the project.

4.6.2 Analog Alarm block

The Analog alarm block monitors the incoming level signal. When the signal exceeds the HI limit = 95%, the OUT_ALM signal changes from FALSE to TRUE

1 Double-click on **FC_01_PB_AALM_1** and enter the following parameters

- **MODE_BLK**
  TARGET: Auto
- **OUT_ALM_SUM:** Hi
- **HI_LIM:** 95



2 Now alias the **OUT_ALM** parameter by changing the standard name (must start with a letter, use underlines not spaces):

- Select the **OUT_ALM** line by clicking over it with the mouse then click over the parameter
- Enter the new name: "Pump_01_Running_Signal", see Chapter 2.1.3
- Press **End Edit** to store the change

3 Press **Close** to close the dialog

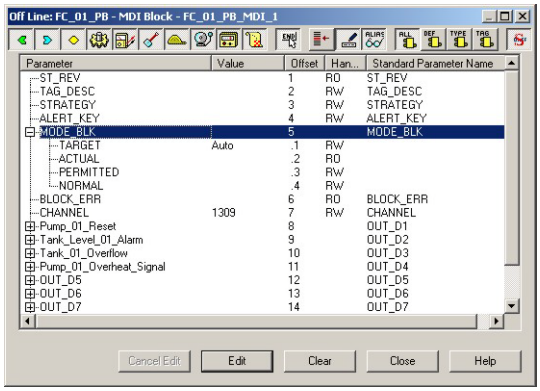
4 Open **Project File**, then press **Save Entire Configuration**, to save the project.

4.6.3 Multiple Discrete Input block

The MDI block is attached to the SFC432 Discrete Input/Output module. This delivers FALSE for a 0 VDC signal and TRUE for a 24 VDC signal. The channel parameter is that in Table 2-1, Chapter 2.2.2.

1 Double-click on **FC_01_PB_MDI_1** and enter the following parameters

- **MODE_BLK**
  TARGET: Auto
- **CHANNEL:** 1309



2 Now alias the **IN_D1** to **IN_D4** parameters by changing the standard names (must start with a letter, use underlines not spaces):

- Select the **IN_Dx** line by clicking over it with the mouse then click over the parameter
- Enter the new names, see Chapter 2.1.3
  IN_D1: Pump_01_Reset
  IN_D2: Tank_Level_01_Alarm
  IN_D3: Tank_01_Overflow
  IN_D4: Pump_01_Overheat_Signal
- Press **End Edit** are each entry to store the change
- Press **Enter** to store

3 Press **Close** to close the dialog

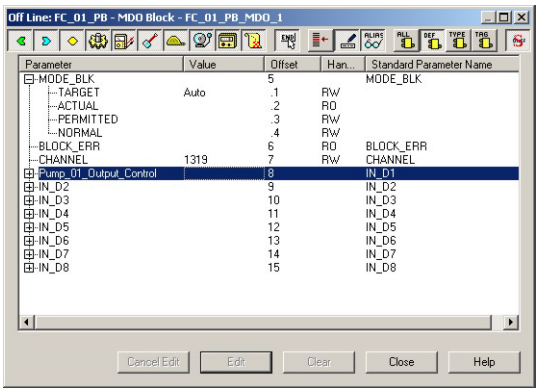
4 Open **Project File**, then press **Save Entire Configuration**, to save the project.

4.6.4 Multiple Discrete Output block

The MDO block is attached to the SFC432 Discrete Input/Output module to which the pump power is connected. A FALSE signal causes the relay to close and the pump runs. A TRUE signal causes the relay to open and the pump stops. The relays are Normally Open (NO) so that a in the event of a power failure, the pump fails to safe = stop. The channel parameter is that in Table 2-1, Chapter 2.2.2.

1 Double-click on **FC_01_PB_MDO_1** and enter the following parameters

- **MODE_BLK/ TARGET**: Auto
- **CHANNEL:** 1319



2 Now alias the **OUT_D1** parameter by changing the standard name (must start with a letter, use underlines not spaces):

- Select the **OUT_DI** line by clicking over it with the mouse then click over the parameter
- Enter the new name: "Pump_01_Output_Control", see Chapter 2.1.3
- Press **End Edit** to store the change

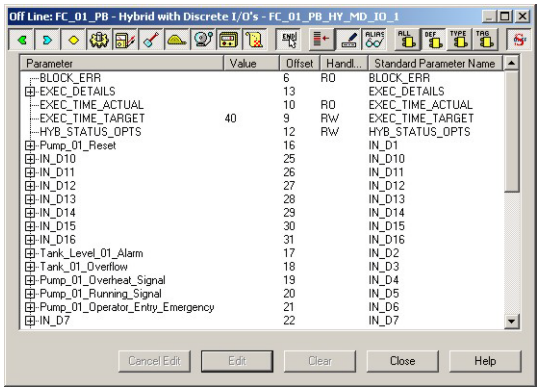
3 Press **Close** to close the dialog

4 Open **Project File**, then press **Save Entire Configuration**, to save the project.

4.6.5 Hybrid Discrete I/O block

The HY_MD_IO block adds the logic to the control strategy. It must be put into Auto. At this point the target execution time **EXEC_TIME_TARGET** should be left at the default value of 30 ms.

1 Double-click on **FC_01_PB_HY_MD_IO_1**



– Expand the **Mode Block** node and check that the **Target** is set to **Auto**
– Set the parameter **HYB_STATUS_OPTS** to **Set Ouputs to Good Non Cascade**

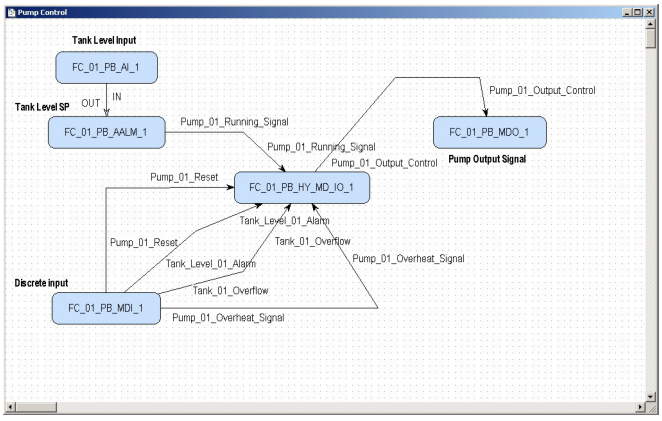
2 Parameters that should receive an OPC Tag for use by e.g. a SCADA program must also be aliased in the hybrid block, in our example we want to allow the operator to switch off the pump in an emergency by using IN_D6:

– Select the **IN_D6** line by clicking over it with the mouse then click over the parameter
– Enter the new name: "Pump_01_Operator_Entry_Emergency"
– Press **End Edit** to store the change

3 Press **Close** to close the dialog

4 Open **Project File**, then press **Save Entire Configuration**, to save the project.

5 If you open the strategy window again, you will see the links now have the alias names



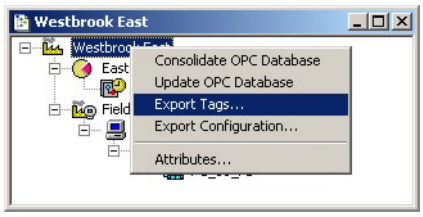
6 Since the input and output signals for a particular link now have the same names, you may want to hide some:
– Right click on the link, select **Labels** and click on the parameter you want to hide
– The label is hidden when there is no tick on the "Show...." parameter

4.7 Export tags

Note!

- You should use the Export Tags function everytime you change the configuration of the project, so that the OPC server information is always up-to-date.
- Application Designer can be set to automatically export the tags every time the project goes online, see Chapter 3.2.

1 Activate the project view by clicking in its workspace
   – Right click on the project name, a context menu appears



2 Select the option **Export Tags...**.
   – The Export Tags dialog confirms the successful export

   – Press **OK** to close the dialog

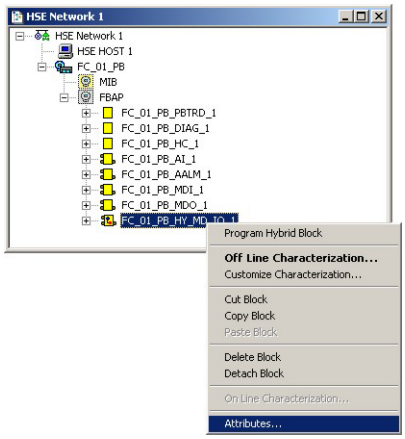
3 Open **Project File**, then press **Save Entire Configuration**, to save the project.Program the Hybrid Function Block

The hybrid function block can now be programmed using IEC 61131-3 Ladder Logic.

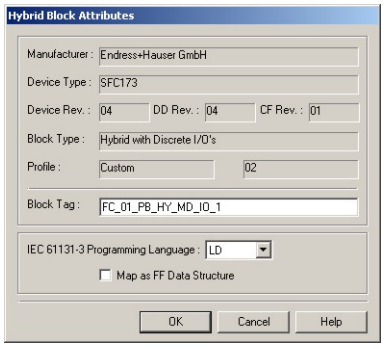
5 Program the Hybrid Function Block

5.1 Set the IEC 61131-3 programming language

1 In the **HSE Network 1** tree, right click on **FC_01_PB_HY_MD_IO_1** and select **Attributes**



2 The **Attributes** dialog opens:

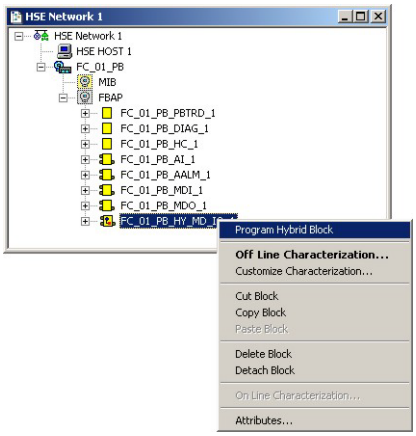


- In the **IEC 61131-3 Programming Language** menu select **LD** (Ladder Logic)
- Map as FF Data Structure should now have no tick, if this is not the case, untick
- Press **OK** to confirm the selection

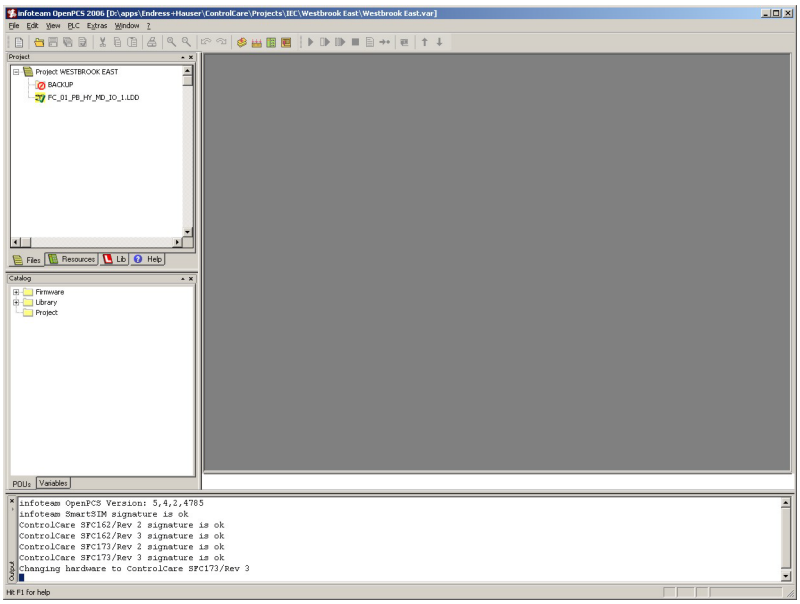
5.2 Program the hybrid function block

5.2.1 OpenPCS programming tool

1 In the **HSE Network 1** tree, right click on **FC_01_PB_HY_MD_IO_1** and select **Program Hybrid Block**

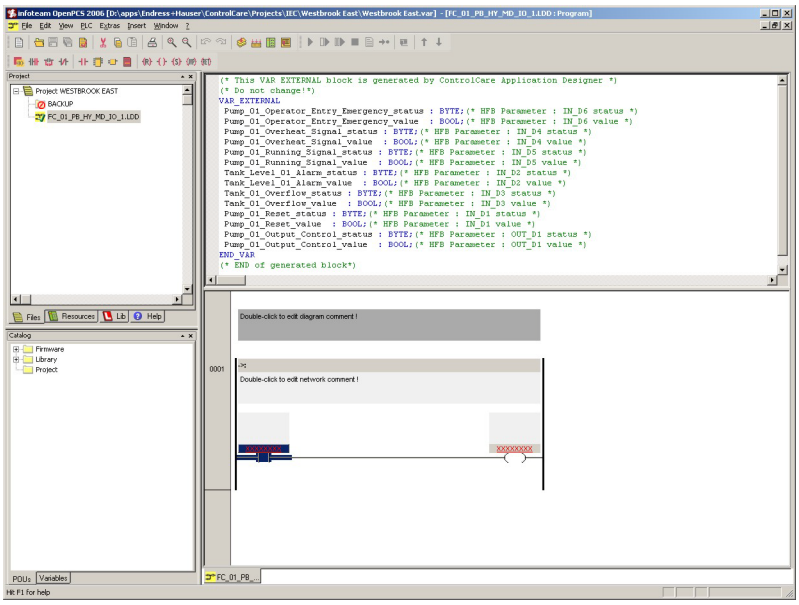


2 The OpenPCS programming tool opens:



- The **Files** pane of the Project window shows the program files
- The **Resources** pane shows the hybrid block task attached to the Field Controller
- The **Lib** pane shows the libraries available
- The **Help** pane opens the Online help tree
- The **Catalog** window might also appear – it can be closed by pressing the "x"
- The **Log** window tracks program events – it can be closed by pressing the "x"

3 Double-click on FC_01_PB_HY_MD_IO_1.LDD: the editor opens with the declared external variables (the log window at the bottom was closed for this screenshot)



5.2.2 Declare additional variables

Additional variables used by the structured text program must be declared with name and data type in the upper right-hand pane before programming starts. Table 6-1 lists the various types of declaration supported. The declaration opens with the variable type and is closed with END_VAR. The various types are created with default value zero for real and integer variables and FALSE for booleans.

Variable type	Access Rights		Function
	External	Internal	
VAR	–	RW	Local variable that is readable and writable to its own block only
VAR_INPUT	RW	R	Input variable that is readable and writable to an external block, but only readable to its own block
VAR_OUTPUT	R	RW	Output variable that is readable and writable to its own block, but only readable to an external block
VAR_IN_OUT	RW	RW	I/O variable readable and writable to its own and an external block (call by reference)
VAR_EXTERNAL	RW	RW	External I/O variable, declared as global in its own block, that is readable and writable to its own and an external block, whereby any change is immediately effective in all blocks where it is used
VAR_GLOBAL	RW	RW	Global I/O variable, declared as external in its own block, that is readable and writable to it own and an external block, whereby any change is immediately effective in all blocks where it is used
VAR_ACCESS	RW	RW	Global I/O variable (access path) that is readable and writable in its own and an external block resident in a different controller, whereby any change is immediately effective in all blocks where it is used

Tab. 5-1: Variable declaration types

Attributes

The declarations can be modified to define a particular behaviour of the variables contained within them by adding one of the attributes in Table 6.2.

Attribute type	Function
RETAIN	Variable that retains its value when the controller is switched off or restarted
CONSTANT	Variable that retains a constant value, i.e. not writable
OPC	Variable that is readable and writable in the IEC OPC Server – Local varibles declared with the prefix OPC_ are also visible in the IEC OPC server

Tab. 5-2: Declaration attribute types

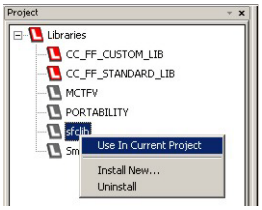
In this exercise there are no additional variables to declare.

5.2.3 Activate the libraries

ControlCare activates two libraries by default:

- **CC_FF_CUSTOM_LIB** to map the custom FF function blocks
- **CC_FF_STANDARD_LIB** to map the standard FF function blocks

These appear red in the library pane (select the **Lib** tab)

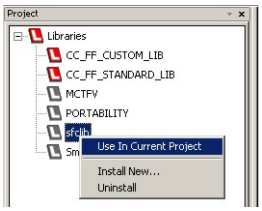


Note!
- For ControlCare Product Version 2.01.xx, the libraries have to be activated by hand
- For SFC programming the sfclib must be activated, see below and the OpenPCS online help

Activating a library

In order to activate additional libraries, e.g. sfclib for SFC programming, the following procedure is used:

1 Select the **Lib** pane:
  – Right-click on e.g **sfclib** and select **Use in Current Project**
  – The project book turns red = active



Installing a library

If the libraries are not installed:

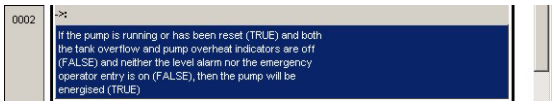
1 Right-click on **Libraries**, select **Install New...**,

2 Browse to the folder containing the LIB files and select the library required

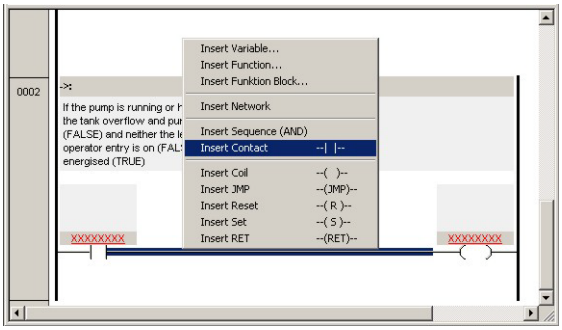
3 Press **OK** twice to install.

5.2.4 Create the ladder logic

1 If required, insert a comment indicating the function performed by double clicking in the space below the scissors and entering the text

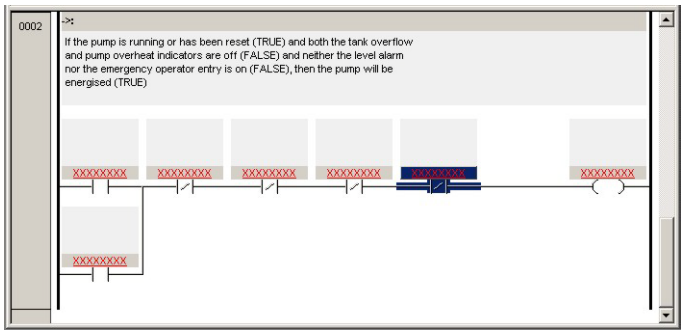


2 Now insert the diagram elements by right clicking on the selected rung and selecting **Insert Contact**

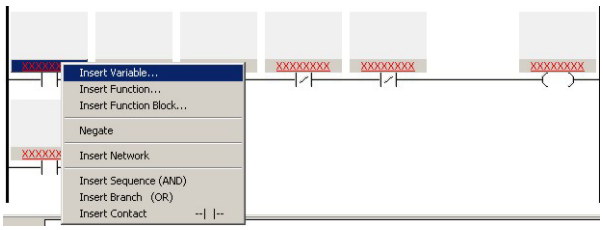


- A contact can be negated by right-clicking on the contact and selecting **Negate**
- An OR can be created by right-clicking on the contact and selecting **Insert Branch (OR)**
- An AND can be created by right-clicking on the contact and selecting **Insert Sequence (AND)**

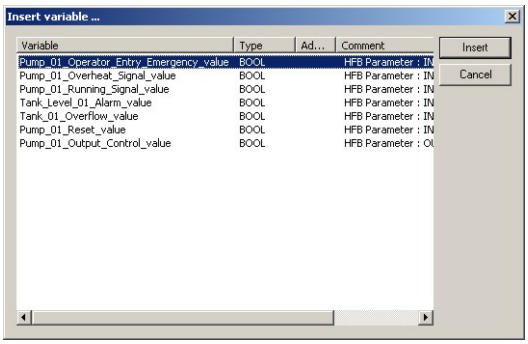
3 Now proceed to create the logic sequence:
- OR Contact
- 4x negated contacts



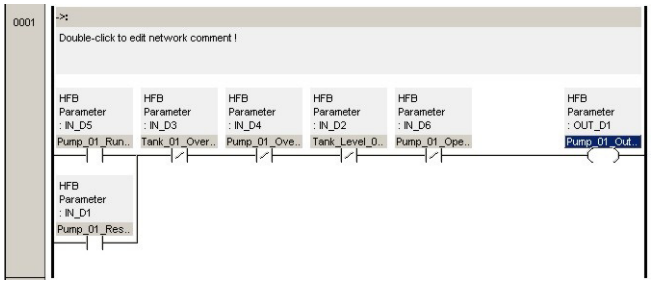
4 Now right-click on the first contact and select **Insert Variable**
- The Insert variable dialog Opens



5 Select Pump_01_Running_Signal_value
– The variable is assigned to the contact



6 Repeat Steps 1 and 2 for the variables
Pump_01_Reset_B_value,
Tank_01_Overflow_value,
Pump_01_Overheat_Signal_value,
Pump_01_Operator_Entry_Emergency_value,
Tank_01_Level_Alarm_value,
Pump_01_Control_Output_value

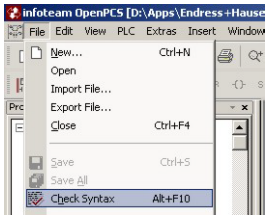


7 The logic is now complete

5.2.5 Trouble-shoot the project

Now that the project is complete, it is recommended that the project is checked for errors.

1 Open the **File** menu and select **Check Syntax**



2 OpenPCS runs a check on all syntax in your program and publishes a log at the bottom of the workspace.
– If errors are found eliminate them and check the syntax again
– You can move from error to error with the F4 and Shift F4 keys

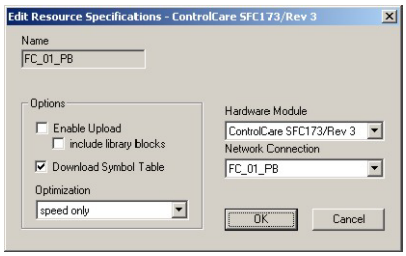
3 When the program is free of errors, open the **File** menu and select **Save All.**

5.3 IEC 61131-3 Simulation

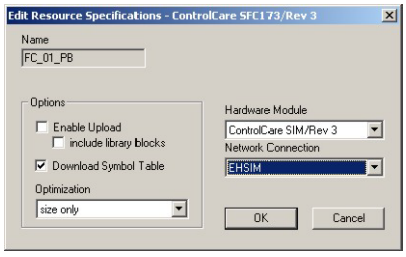
OpenPCS allows the simulation of the IEC 61131-3 program without the need for hardware. It is recommended that the program is tested with this function before it is downloaded to the Field Controller.

5.3.1 Resources

1 Click on **PLC** and select **Resource Properties** from the PLC menu
   – The **Edit Resource Specifications** dialog opens



2 In the **Edit Resource Specifications** dialog

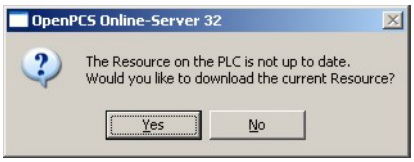


   – Select Hardware Module: ControlCare SIM/Rev 3
   – Select Network Connection: EHSIM
   – Select Optimization: Size only
   – Press **OK** to confirm the changes and close the dialog

3 Click on **PLC** and select **Rebuild Active Resources** (alternatively, press CTRL+F7)
   – You can now go "Online" with the simulation.

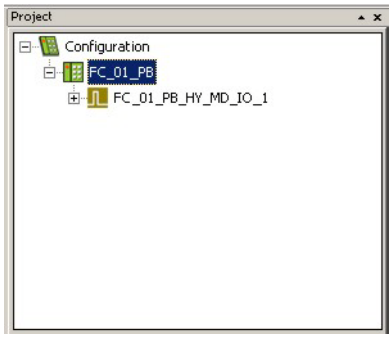
5.3.2 Go "Online"

1 Click on **PLC** and select **Online** from the PLC menu
   – If appropriate an **OpenPCS Online Server 32** message appears



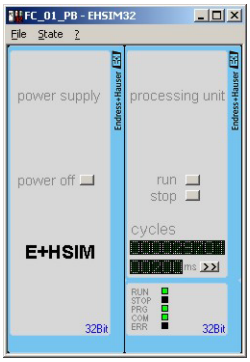
   – Press **Yes** to download the resource to the server

2 Press the **Resource** tab and click on the Field Controller in the project window
Note!



- If there is more than one Field Controller in the project, it appears green and the others red.
- To activate different controller, right click on it and select **Set Active**, its colour changes to green

3 Click on **PLC** and select **Coldstart** from the PLC menu
   – The Field Controller simulation now runs



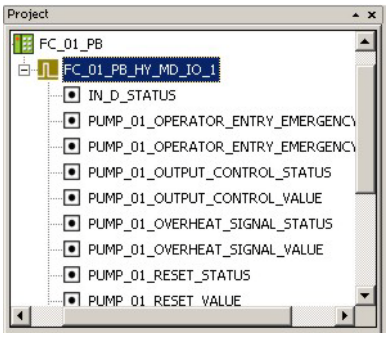
   – The buttons Power Off, Run and Stop simulate the corresponding operating modes of the Field Controller
   – The Cycles display show number of cycles simulated and cycle time in ms
   – The LEDs simulate the LEDs on the Field Contoller
   – To change the macrocycle time, press the **>>** button and enter a new value in the **Cycle Time** dialog, confirming with **OK**

4 The simulation is closed by clicking on **PLC** and select **Offline** from the PLC menu

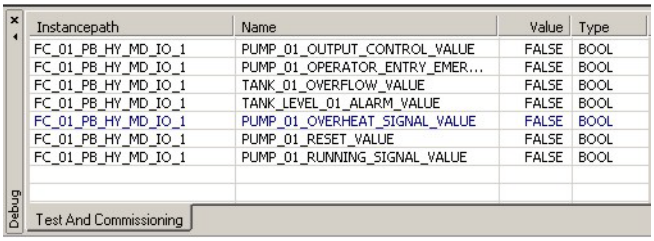
5.3.3 Watch list

By placing selected input and ouput variables in a watch list, the logic can then be checked.

1 Press the **Resource** tab and expand the **FC_01_HY_MAD_IO_1** node
– A list of input and output variables appears

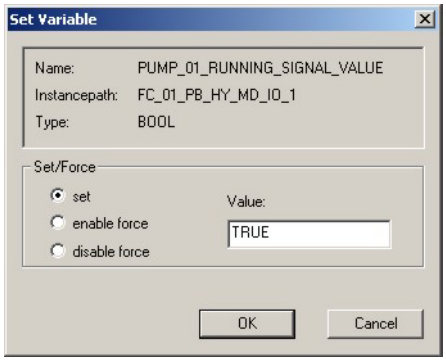


2 Double-click on a parameter to place it in the watch list



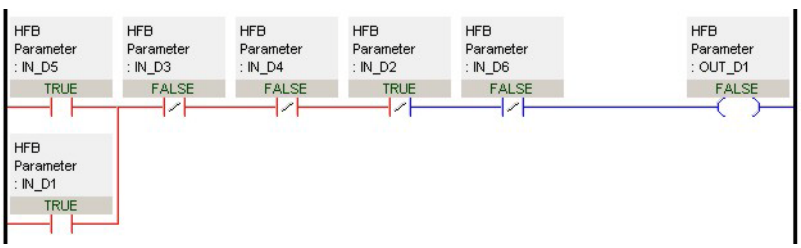
– Parameters can be deleted by selecting the parameter line and pressing DEL

3 Right-click on the watch list "value field" and enter a value in the **Set Variable** dialog



– Press **OK** to confirm the entry and close the dialog

4 Check the logic by seeing the effect of parameter changes on the outputs



5.4 Optimize performance

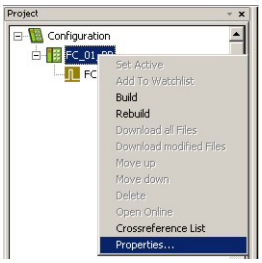
If the IEC 61131-3 simulation was used, the resources must be respecified before the project is compiled and downloaded, see Chapter 6.

OpenPCS allows the hybrid function block to be optimized for speed or size during compilation. Default setting is optimized for speed. Optimizing for size causes the block to run slower than if it is speed optimized, and is recommended only when there are memory problems, e.g. when a large number of hybrid function blocks with long programs are in use or when simulating without Field Controller hardware, see Chapter 5.3.

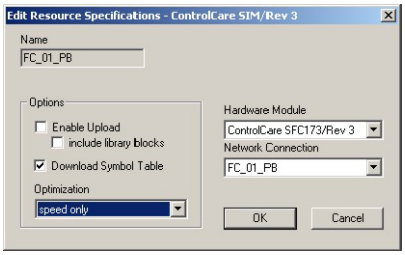
Changing the performance settings

The settings are made in both the resources and the hybrid function block

1 Click on the **Resources** tab, then right-click on **Controller** leaf and select **Properties**

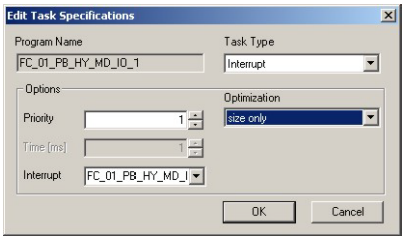


2 The **Edit Resource Specifications** dialog appears



- Select Hardware Module: ControlCare SFC173/Rev 3
- Select Network Connection: FC_01_PB
- Select Optimization: Speed only
- Press **OK** to confirm the changes and close the dialog

3 Now right-click on the **Function Block** leaf and select **Properties**
- The **Edit Task Specifications** dialog appears



- In the **Optimization** pull-down menu select e.g. "**speed only**", then press **OK**

6 Go On-line

6.1 Connect to the Field Controller

In order to download the project, the host computer and Field Controllers must be allocated IP addresses in the same address range. It is possible to do this on the workbench before installation or after the Field Controller and other components have been physically installed in the Fieldbus network (subnet).

Warning

- The use of IP addresses is strictly controlled. Usually your system administrator will be authorised to allocate unique addresses. Assigning an unauthorised address to a Field Controller may result in conflicts within your system and the failure of the associated devices!

Note!

- The tools that setup the network use Ethernet services that may be blocked by Windows Firewall. Normally the firewall will be unblocked for the tools during installation, but it might be necessary to stop the firewall should they not function properly. If you are not sure how to stop the firewall, consult your system administrator.

Before starting, check the following:

- **Internet Protocol TCP/IP** is installed on your computer
- You have administration rights for your computer
- You have an set of IP addresses that have been authorized by your IT department
- Any proxy server for your Internet Browser is disabled

The procedures described in this chapter are for Windows XP. For other Windows systems consult your system administrator.

Note!

- When the Field Controllers are physically connected together with the Host computer via Ethernet, HSE Network Setup will see the them irrespective of the IP address domain to which they belong

6.1.1 Set the IP address of the host computer

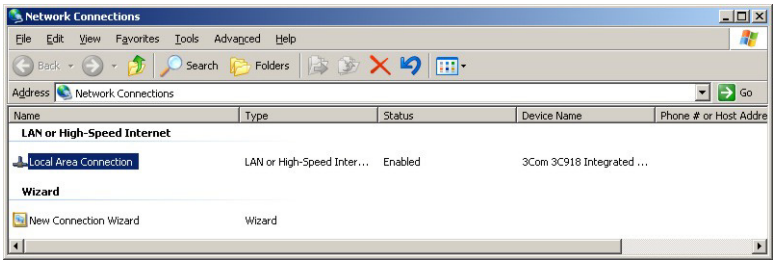
SFC173 Field Controllers are delivered with the default IP address:

- 192.168.164.101

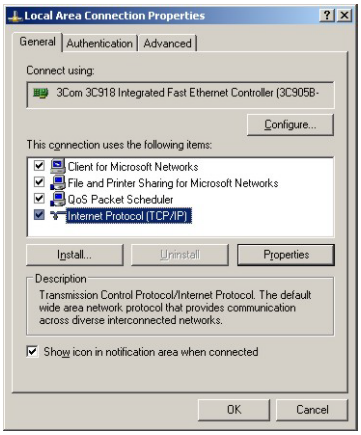
In order that the host computer can communicate with the Field Controller Web Server, it must be allocated an IP address in the same address domain, e.g. 192.168.164.200. If you are not sure how to do this, consult your network administrator.

Procedure

1 Right-click **Start =>Settings =>Control Panel =>Network Connections**



2 Right-click **Local Area Connection => Properties**

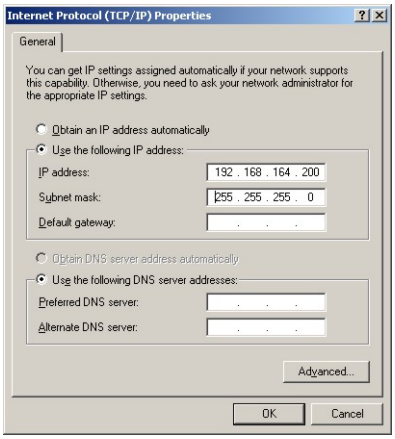


3 Using the left mouse button, double-click **Internet Protocol (TCP/IP)** or click once, then click **Properties**.

4 Note the original values of IP address and Subnet Mask of the computer to restore them if necessary at end of the operation.

5 Change the IP address and the Subnet Mask of the host computer to those required by the application. In the example, an address in the same subnet as the Field Controller.

– IP Address 192.168.164.XXX and network mask (Subnet Mask) 255.255.255.0.
– Do not use the address 192.168.164.100, as this is reserved as default address for Field Controller SFC162



6 Click on the **OK** button to complete the procedure, close the other dialogs with **OK** and **Close**.

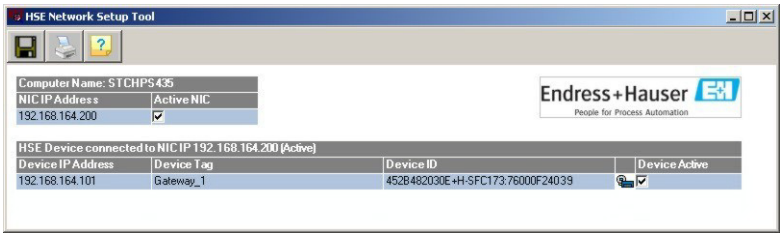
6.1.2 Set the Field Controller IP address

Note!

■ It is recommended that Field Controllers of the same type are introduced one by one to the network.

1 Call HSE Network Setup:
Programs =>Endress+Hauser=>ControlCare=>Tools=>HSE Network Setup

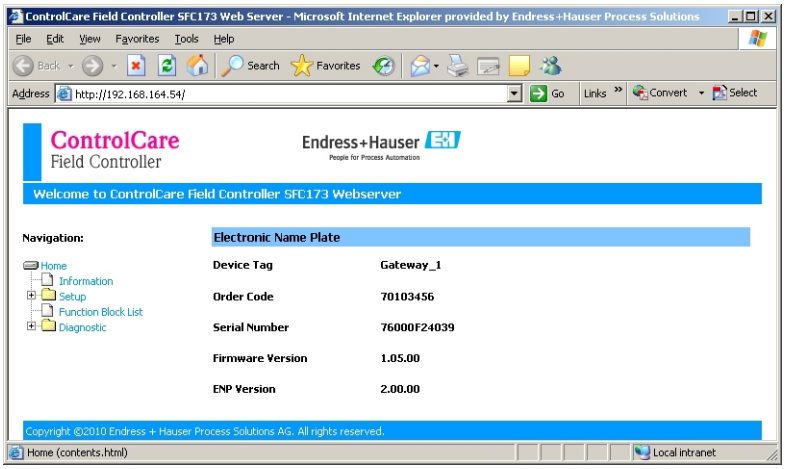
2 HSE Network Setup is launched and searches for Field Controllers in the Ethernet network.



– All Field Controllers in the network appear, irrespective of their IP domain.
If this is not the case:
– Check that the proxy server of your Internet Browser is switched off
– Check that the windows firewall is not blocking the program (switch off)
– Check all cables and switches
– If you find two or more Field Controllers with the same IP address, disconnect all but one from the network

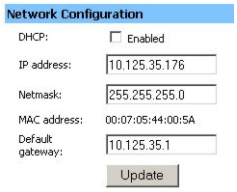
3 If your computer has more than on NIC card, select the one you want to use for communication with the Field Controllers by ticking "Active NIC" and Press .

4 Right-click on the Field Controller, the address of which is to be changed:
the Field Controller Web Server opens



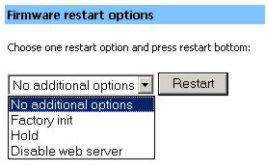
– The Web Server will only open if the host computer and the Field Controller have IP addresses in the same IP domain.

5 Expand the **Setup** node and click **Network**
– Enter User Name "pcps" and Password "pcps" to open the **Network Configuration** dialog



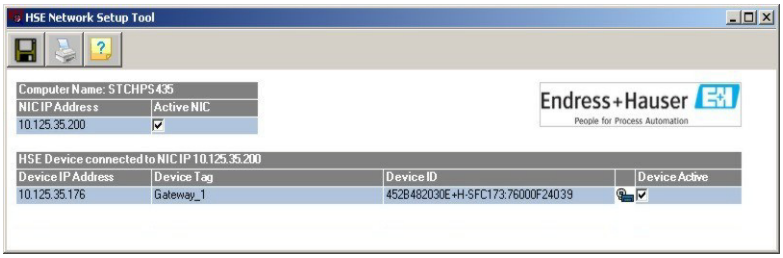
– Enter the required IP address, in our example 10.125.35.176
– Enter a netmask, normally 255.255.255.0
– If required, enter a default gateway, usually address xxx.xxx.xxx.1 in the selected domain

6 Press **Update** to change the IP address
– You are now asked to restart the Field Controller
– Select the **Restart** node



– Select "**No additional options**" from the drop-down menu and press **Restart**
– Close the Web Browser
– The Field Controller disappears from HSE Network Setup and reappears with the new IP address

7 Now set the address of he host computer to the same domain as the Field Controllers, see Chapter 6.1.1 - in our example 10.125.35.200
   – Restart **HSE Network Setup**



   – Tick the Field Controller, so that it appears in the HSE Live List associated with the computer's active NIC card.
   – Press to save the configuration.
   – You are now ready to download the project

Note!

- If you have more than one Field Controller on the network, Repeat Steps 4 to 6 for all other Field Controllers, introducing them one by one to the network.

6.2 Generate the live lists

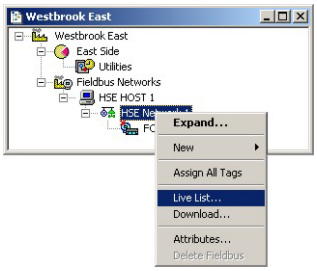
6.2.1 HSE live list

Once the Computer and Field Controller are able to communicate with each other, the connection to the network can be checked by creating a live list.

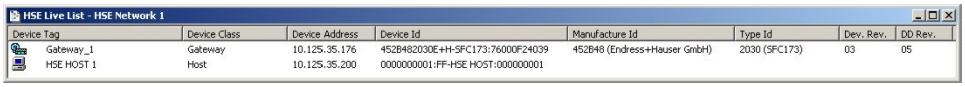
1 Press the **On-Line** button in the menu toolbar
   – The project goes on on-line

   – A red cross appears against the Field Controller in the Project workspace

2 In the Project workspace, right click on **HSE Network** and select **Live List**



   – A live list is generated of the devices on the HSE network

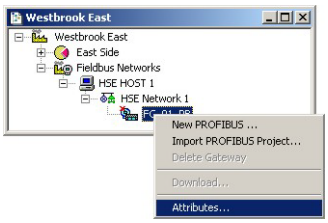


Note!

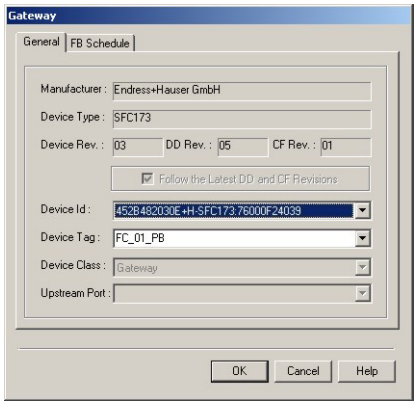
- It may take sometime to generate the live list
  – The devices found first go grey
  – Their profiles (all important device-specific data) including IP address are read
  – On successful completion of profile reading, the devices are shown in full black

6.2.2 Assign the Field Controller Device ID

1 In the project workspace, right click on the **Field Controller** (FC_01_PB) and select **Attributes**...

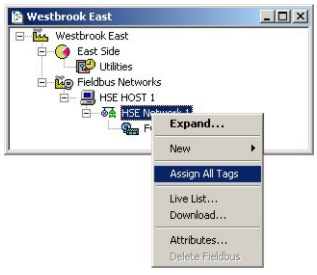


2 The **Attributes** dialog opens
- Open the drop-down menu of the **Device ID** and select the Field Controller associated with the displayed TAG (in our case FC_01_PB) - the serial number is on the front panel
- Do this even though the correct ID is already displayed - the program expects it!



- Confirm your choice with **OK**

3 Right-click on the **HSE Network 1** leaf and select **Assign All Tags**



4 The Tag FC_01_PB is assigned to the Field Controller
- The Field Controller in the HSE live list goes grey
- When the Tag has been assigned, it goes black again

5 Open **Project File**, then press **Save**, to save the project

6.3 Download the project

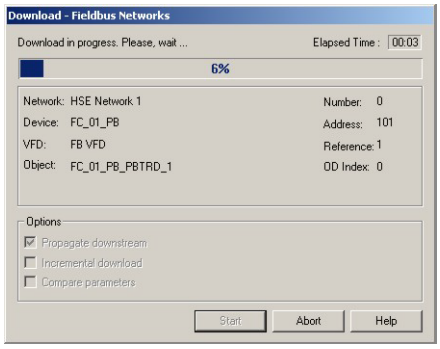
Both the project in ControlCare Application Designer and that in OpenPCS must be downloaded to the Field Controller. The downloads can be made in any order.

Note!
- The procedure below describes the initial download for the entire HSE network.
- Partial downloads can be made later from lower leaves, when changes are confined to this level
- Incremental downloads can be made to a running project by checking the boxes **Incremental Download** and **Compare Parameters**: Unaffected Local I/Os will hold their last values (bumpless transition).

6.3.1 Download the control strategy

1 In the Project workspace right-click on **HSE Network 1**and select **Download**

2 The **Download dialog** appears



– Press **Start** to start the download

3 The download will be interrupted if the project has not been configured properly, e.g.

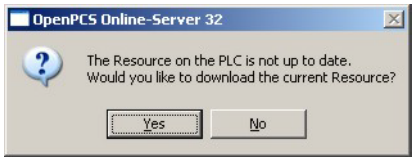
– The Field Controller Tag has not been assigned correctly => Assign Field Controller tags, Chapter 6.2.2
– The I/O moduels have not been correctly defined, see Chapter 4.6

4 When the download is successfully completed, the dialog is closed, and you are ready to download the hybrid block configuration

6.3.2 Download the OpenPCS project

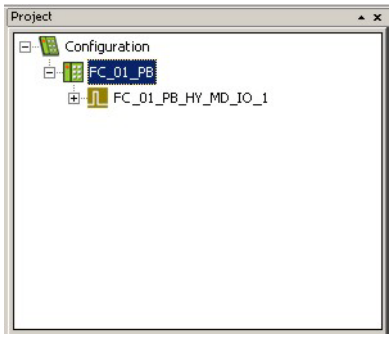
1 Start OpenPCS by right clicking on **FC_01_PB_HY_MD_IO_1** in the **HSE Network 1** tree and selecting **Program Hybrid Block**:
- If OpenPCS is already running, close it before performing this step
- The attribute settings are exported to OpenPCS
- Click **OK** to open the OpenPCS workspace

1 Click on **PLC** and select **Online** from the PLC menu
- If appropriate an **OpenPCS Online Server 32** message appears



- Press **Yes** to download the resource to the server

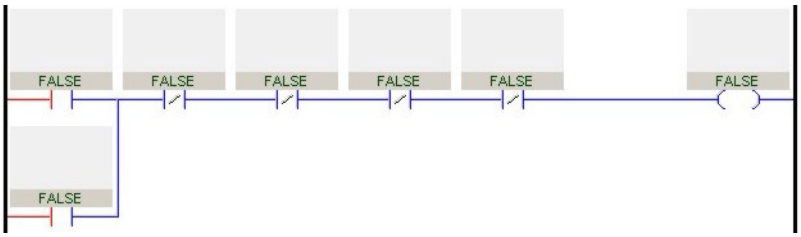
2 Press the **Resource** tab and click on the Field Controller in the project window



3 Click on **PLC** and select **Coldstart** from the menu: the hybrid block is started (set to Auto).

4 If there is more than one controller in the project, each must be cold-started as follows:
- Right click on the controller and select **Set Active**, its colour changes from red to green
- Click on **PLC** and select **Coldstart** from the menu
- All hybrid blocks attached to the controller are forced to Auto

5 Now check the project files
- You will see that the names in the ladder logic are now replaced by values

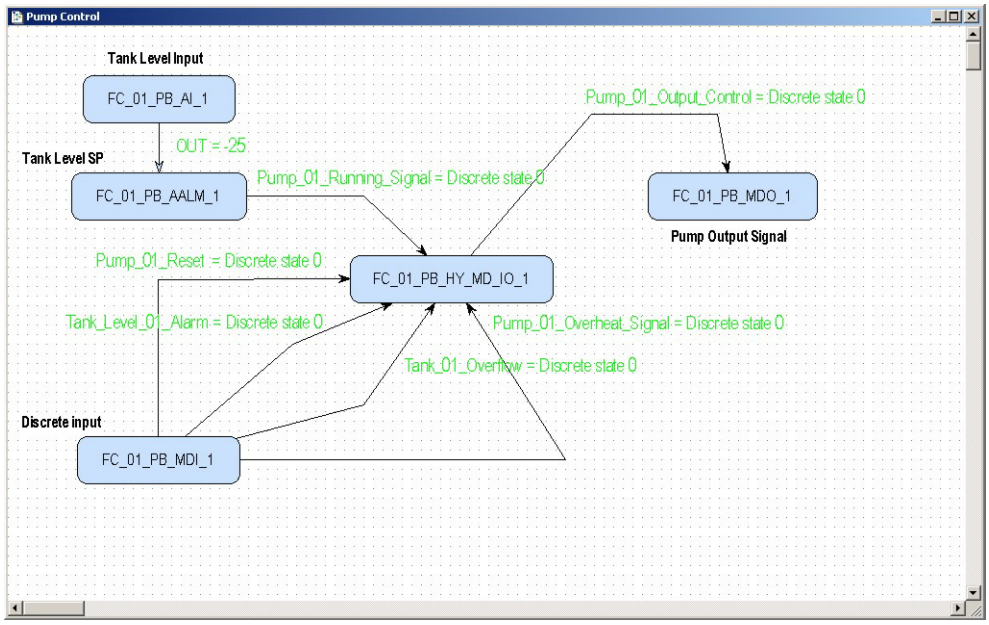


6 OpenPCS offers a number of options for monitoring values and changing the program without stopping execution, e.g. on-line editing –see the on-line help for details.

6.4 Check the control stategy

6.4.1 Control strategy

1 Click in the Control Strategy workspace (Pump control) and press the button in the menu toolbar – the control strategy also goes "on-line"



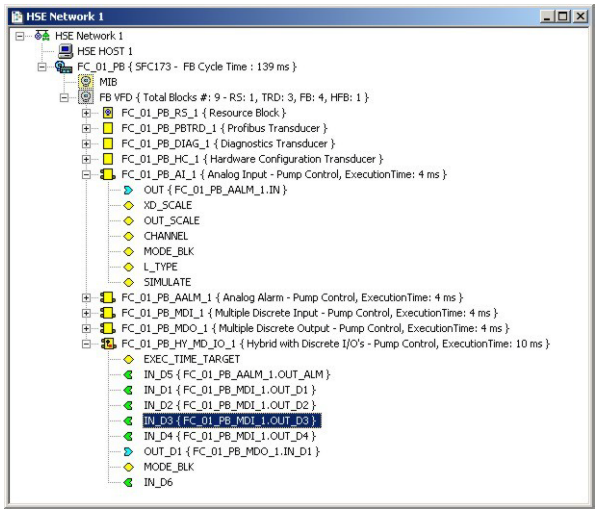
– Values appear in green when the status is good
– Values appear in red if the status is bad - at this stage this is an indication of a communication, block configuration, strategy configuration or device parametrization error

Note!
In the strategy above all input signals have been hidden

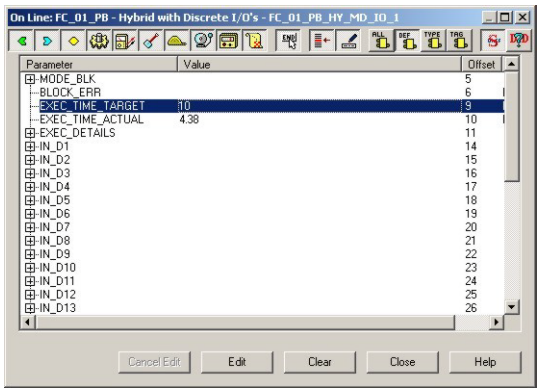
2 If you have the possibility of changing the signals, change each input in turn and check the effect on your strategy.

6.4.2 Optimization of hybrid block execution time

1 Open the **HSE Network 1** dialog, then click on the "details" icon in the menu bar
   – The execution times are shown next to each block
   – The **FC_01_PB_HY_MD_IO_1** block executes at the default time of 30 ms



2 Right-click on the **FC_01_PB_HY_MD_IO_1** block and select **On Line Characterization**



   – The parameter **EXEC_TIME_ACTUAL** shows the time in which the block is executing
   – Observe the value for a couple of minutes and note the highest value

3 Now change the function block execution time to the new value
   – Right-click on **FC_01_PB_HY_MD_IO_1** and select **On Line Characterization**
   – Double-click on the "value space" next to the parameter **EXEC_TIME_TARGET**
   – Enter a value 10% to 20% higher than the highest observed actual execution time
   – Press **End Edit** to store the value and **Close** to quit the dialog.

4 Right-click on the Gateway node (FC_01_DP) and select **FB Schedule Download**
   – The new value is downloaded to the Field Controller
   – The strategy now runs with the new target execution time

5 Repeat Steps 1 to 4 for all hybrid blocks in the strategy

Note!

- **EXEC_TIME_ACTUAL** will be too high if the ladder logic program is being monitored on-line by OpenPCS. Close the application before checking the value.

6.5 Modify the project

6.5.1 On-line characterization

Once the project is on-line you may want to change parameters to e.g. tune the control-loop or eliminate configuration errors. With the exception of the **SP** parameter, the function block must be put out of service before the parameter is changed:

1 In the Control strategy workspace double-click on the function block you want to modify, or in the HSE network 1 or Control module workspace, right-click on the function block and select **On-line Characterization**

2 The function block **On-line Characterization** dialog appears:

- Open the **Mode** leaf and double-click in the space next to **Target**
- Set the Target to **OOS** (Out of Service)
- Click **End Edit** to set the parameter

3 Change the parameters you wish to modify

- If appropriate, open the parameter leaf and double-click in the space next to the parameter you require
- Enter the new parameter or select it from the drop-down menu
- Click **End Edit** to set the parameter
- Repeat the procedure for all the parameters you wish to modify

4 Put the function block back into standard operating mode

- Open the **Mode** leaf and double-click in the space next to **Target**
- Set the Target back to the original value (**Auto** (Automatic) or **Cas** (Cascade))
- Click **End Edit** to set the parameter
- Check that the **Mode** really changes to the Target Mode (failure to do so indicates a configuration error)
- Press **Close** to store the values (if you are prompted - answer with **Yes**)

5 Click on the **Project View** workspace and **Export Tags**..., see Chapter 3.10
- Open **Project File**, then press **Save Entire Configuration** to save the project

6 Put the Control stategy back "on-line" to check the results of your modification, Chapter 6.4.

6.5.2 Off-line characterization

You may prefer to change parameters off-line, e.g. when modifying the control strategy or adding new functions to the project.

1 If you are on-line, press the **Off-line** button in the menu toolbar
alternatively, in the PROFIBUS network or Control module workspace, right-click on the function block and select **Off-line Characterization**
– The function block **Off-line Characterization** dialog appears

2 Change the parameters you wish to modify

– If appropriate, open the parameter leaf and double-click in the space next to the parameter you require
– Enter the new parameter or select it from the drop-down menu
– Click **End Edit** to set the parameter
– Repeat the procedure for all the parameters you wish to modify
– Press **Close** to store the values

3 Click on the **Project View** workspace and **Export Tags**..., see Chapter 3.10
– Open **Project File**, then press **Save Entire Configuration** to save the project

4 Press the **On-line** button in the menu toolbar to go on-line again

5 Download the modified project
– In the Project workspace right-click on **HSE Network 1**and select **Download**
– Follow the procedure in Chapter 6.3

6 Put the Control stategy back "on-line" to check the results of your modification, Chapter 6.4.

6.6 Packing and unpacking the project

In order to install the project at the customer's site, the project can be packed and unpacked. It is important to remember, especially if you have not been using the actual project devices to test your project, that the instruments on site may be have newer (or even older) DD/GSD/CFF files than the ones you use. The latest DD/GSD/CFF files must then be uploaded to the project and corresponding corrections must be made to configuration, before it is downloaded to the Field Controller. The is done with the **Import Device Support...** item in the **Project File** menu, see Operating Instructions BA017S/04/en, Chapter 3.1.5.

6.6.1 Pack the project

1 Select **Project File => Pack Project...**
- The **Pack Project** dialog appears
- Browse to the folder where the files will be created
  You can create a folder with the Make New Folder button
- Enter the name of the project
- Press **Save** to save the packed project
- Press **OK** to close the successful packing message dialog

6.6.2 Unpack the project

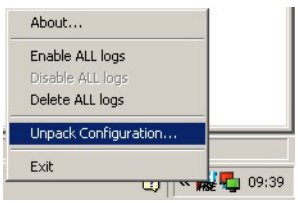
1 Select **Project File => Unpack Project...**
- In the **Unpack Project** dialog
- Browse to the folder where the packed project is located
- Click on the name of the project
- Press **Open** to save the packed project

2 In the **Browse for Folder** dialog:
- Browse to the folder where the project is to be installed
  You can create a folder with the Make New Folder button
- Press **OK** to start upacking
- Press **OK** to acknowledge the successful unpacking of the project

6.6.3 Unpack the OPC data base only

For some applications it may be necessary to update the OPC data base of a SCADA program that has no provision for importing new DDs etc.. This can be done in Application Designer, which allows the separate unpacking of the OPC data base.

1 Go online, then right-click on the **HSE OPC Server** icon in the system tray



2 Select Unpack Configuration...:
- Unpack the OPC data base to the folder required according to the Steps 1 and 2 in Chapter 6.6.2 above.

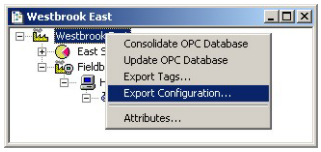
6.7 Export the configuration

For documentation purposes, the project configuration can be exported to an existing ODBC file data source, e.g. Oracle, a machine database, e.g. Excel to provide a record of the current status of the project or to an XML sheet for viewing with a browser.

6.7.1 File data source folder

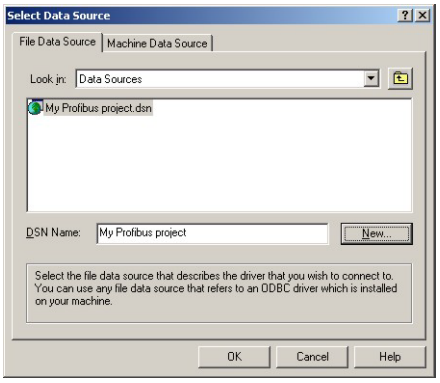
The file data source must have been created before the export.

1 In the Project window, right-click on the Project icon and select **Export Configuration**:



2 The **Select Data Source** dialog box appears

3 In the **File Data Source** folder, select the source that describes the driver that you wish to connect to. You can use any file data source that refers to an ODBC driver which is installed on your machine.
- Use the **New...** button and **Look In** dropdown menu to browse or
- Click the data source icon to select the driver:



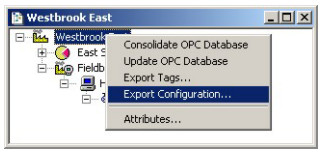
- Press **OK** to make the connection

6.7.2 Machine data source folder

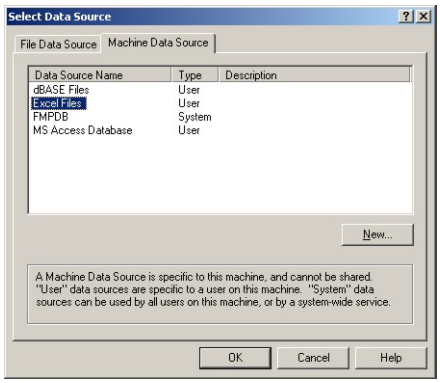
The **Machine Data Source** is specific to the machine, and cannot be shared. "User" data sources are specific to a user on the machine; "System" data sources can be used by all users on the machine, or by a system-wide service. The Machine Data Source must have been created before export.

Procedure

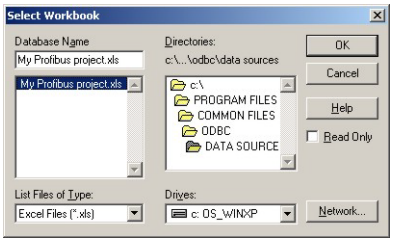
1 In the Project window, right-click on the Project icon and select **Export Configuration**:



2 The **Select Data Source** dialog box appears
- Click on the **Machine Data Source** tab to open the folder
- Double-click the data source name to select the machine, e.g. Excel:

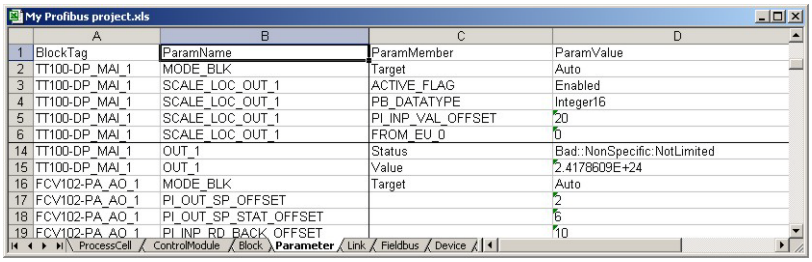


3 The **Select Workbook** dialog box will appear:
- Select the folder where the data file is and double-click the workbook icon.



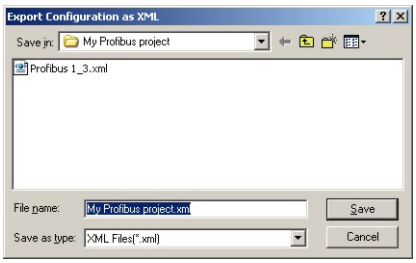
- Your project configuration will be exported to the workbook file.
- A message box appears on completion - press OK

4 Open the Excel file to check the result:

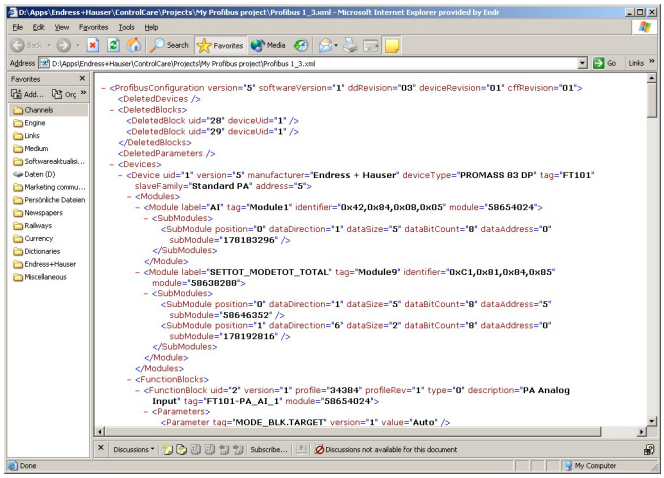


6.7.3 XML file

1 Click in the Project workspace and select **Project File =>Export => Configuration as XML**
– The **Export Configuration as XML dialog** appears



2 Enter a **File Name** and **Save In** location, then press **Save**
– The project is saved as an XML file at the selected location



6.8 Close Application Designer and OpenPCS

When you have completed your session, close Application Designer and OpenPCS

6.8.1 Application Designer

1 If you are on-line, press the **Off-line** button in the menu toolbar

2 If you have made any modifications while you were on line, you will be prompted to store them
   – If appropriate answer with **Yes**

3 Close the project by clicking on **Project File => Close**

4 Exit Application Designer by clicking on **Project File => Exit**

5 The Field Controller continues to operate with the project configured according to the last download/on-line correction
   – If you switch off the Controller, the project remains stored in its memory(provided the battery DIP switch is on, see BA021S/04/en: Field Controller, Hardware Installation)
   – It is initialized and re-executed as soon as the Controller is switched on again

6.8.2 Open PCS

1 Open the **PLC** menu and select **Offline**

2 Open the **File** menu and select **Exit**
   – You will be prompted to save if your project has been changed since the last download

6.8.3 Reconnecting Application Designer

Provided your computer is operating in the same IP address domain as the Field Controller, you can reconnect at any time.

1 Start up Application Designer and select the Project you require

2 Press the **On-line** button in the menu toolbar

3 Expand the various workplaces as required

4 Click in the **Control Strategy** workspace and press the button in the menu toolbar – the control strategy goes "on-line" with the last configuration that was downloaded.

6.8.4 Reconnecting OpenPCS

Provided your computer is operating in the same IP address domain as the Field Controller, you can reconnect at any time.

1 Start up OpenPCS, open the **File** menu and select the project you require

2 Open the **PLC** menu and select **Online**

7 Trouble-Shooting

7.1 Factory initialisation and reset

Warning!

- Do not use the pushbuttons located in the Field Controller unless you are certain that you want to reset the system.

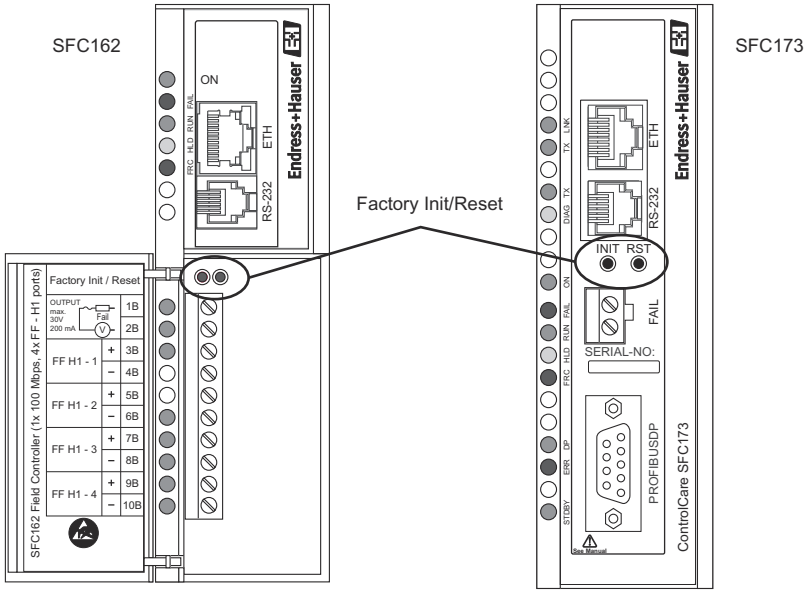


Fig. 7-1: Front panels of SFC162 and SFC 173 Field Controllers

Two pushbuttons located on the Field Controller, see Fig. 7-1, allow the system to be initialised and reset. The function and effect of the buttons is described in the table below.

- To "click " the pushbuttons use a pointed instrument (e.g. a ballpoint pen).

Other functions of the two buttons are to be found Chapter 7 of the Operating Instructions BA035S/04/en, Field Controller: Commissioning and Configuration..

Function	Effect	Procedure
Reset	Resets system: the last configured IP Address is used	▪ Click the right pushbutton – the system **resets (takes several seconds)** ▪ If no IP Address is found, a new one is assigned automatically ▪ Verify that the **RUN** and **ETH LNK** LEDs are lit.
Factory Init	Deletes application, the last configured IP Address is retained	▪ Keeping the left pushbutton pressed, click the right pushbutton ▪ Check that the **FORCE** LED flashes once a second. ▪ Release the left push button. The system resets, see above.

7.2 Trouble-shooting tables

7.2.1 Field Controller

	Problem	Remedy
1	**HSE Network Setup/FC Tools** does not find any Field Controller	■ Disable the Windows firewall (normally a message appears ask whether you should unbock the program) ■ Disable the proxy server for your Internet browser ■ Check that you are using the correct Ethernet cables, see ETH LINK below ■ Check that all etehrnet switches are powered up ■ Check that the network adapter is on and OK: Execute a PING command to its own IP, via DOS PROMPT. ■ Check if the Ethernet connection is OK: Execute a PING command to the Field Controller.
2	Field Controller appears intermittently in **FC Tools**	Host and Field Controller are in different subnets. ■ Normal behaviour, but for firmware download both host and Field Controller must be in the same subnet
3	**HSE Network Setup/FC Tools** does not show all the Field Controllers that are in the network	There is probably an IP address conflict in the network. ■ Disconnect all the Field Controllers except one from the from the sub-network ■ If necessary, change its IP address ■ Now reconnect the other Field Controllers one after the other, if necessary changing their IP addresses
4	**Field Controller Web Server** does not open	No Ethernet connection ■ Disable the Windows firewall ■ Disable the proxy server for your Internet browse ■ Wrong subnet IP address Host and Field Controller must be in same subnet ■ Wrong subnet mask Host and Field Controller must have same subnet mask
5	**Firmware** begins to execute but after a certain time it stops	It might be a configuration problem. ■ Use the **Factory Init** procedure and configure the Field Controller again. ■ If the problem persists, see the relevant chapter in Operating Instructions BA035S/04/en, Field Controller, Commissioning and Configuration
6	**HOLD** LED remains lit	If the **HOLD** LED remains lit after the Field Controller has been turned on, the firmware may be invalid. ■ Update the firmware, see the relevant chapter in Operating Instructions BA035S/04/en, Field Controller, Commissioning and Configuration
7	**ETH LNK** LED does not light	Check if the cable is connected correctly, or that the cable is not damaged. Check the specification of the cables: ■ SFC 954 - Cable Standard. To be used in a network between the Field Controller and a Switch/Hub. (preferred configuration) ■ SFC 955 - Crossed Cable (Cross). To be used point to point between a PC and the Field Controller (some PCs/laptops may have problems with crossed cable)
8	**FRC** LED is flashing (Force)	Field Controller is powered up for the first time ■ Battery is not switched on (see BA021S/04/en, p50) Field Controller is in reset mode ■ Complete the **RESET** procedure Field Controller is in normal operation ■ Battery is flat: – No problem if controller remains powered up – If power is switched off, the project will be lost and must be downloaded again from Application Designer on repowering
9	**ERR** LED lit (SFC173)	At least one slave is not delivering cyclic data – Slave not connected to Profibus – Slave not switched on – Slave not correctly configured (PROFIBUS Configurator)

7.2.2 Application Designer

	Problem	Remedy
1	Field Controller does not appear in HSE live list	No connection to Field Controller ■ See Remedies for Items 1, 2 and 4, Chapter 7.4.1 ■ Field Controller is on HOLD, set it to RUN mode ■ IP address is not configured correctly, use PING to check
2	Field Controller appears but always stays grey in HSE Live List	No connection to Field Controller ■ Check that host and Field Controller are in same subnet
3	Red cross appears on the Field Controller	No communication with Field Controller ■ No Ethernet connection with Field Controller, check connection, IP address etc, see above ■ No Device ID set in the Field Controller (Attributes)
4	Red cross appears on Fieldbus/Profibus	No communication with fieldbus/Profibus ■ No communicaton with Field Controller, see above ■ Fieldbus/Profibus not connected to controller ■ DP bus parameter mismatch (Profibus)
5	Red cross appears on field device	No communication with fieldbus device ■ No communicaton with Field Controller, see above ■ No communicaton with fieldbus/Profibus, see above ■ No Device ID set (Attributes) ■ Tag not assigned (Assign Tag) ■ DP address is not unique (Profibus) ■ DP address at device not the same as that configured in PROFIBUS configurator (Profibus)
6	A device does not appear in the live list	Communication error ■ The device is not powered up ■ The project has been updated but no download has been made yet
7	Configuration will not download	You have either a communication problem or the configuration is not complete ■ Check that you are on-line - press the On-line button ■ Check that your computer is in the same address subnet ■ Check that you have assigned the Field Controller tag ■ Check that you have exported all tags OPC server ■ Check that the parameters are in the recommended order ■ Check that the OPC server is running (look for icon in bottom line) ■ Try "Update" from the Field Controller node (SFC162 only, takes several minutes) and download again
8	PROFIBUS configuration will not download	You have either a communication problem or the configuration is not complete ■ Try downloading from HSE Network node, see above, if this does not work, check points below ■ Configuration mismatch between PROFIBUS Configurator and Application Designer – Have PROFIBUS device blocks been deleted? – If so, reconfigure project in PROFIBUS Configurator
9	Parameter appears red in the on-line control strategy	The parameter has a bad status ■ Check that the Block Mode is Auto (or Cas) ■ Check that the block has been correctly configured ■ Check that the device is still live (live list) ■ Check that the device address is the same as that you have in your configuration (live list) ■ Check that the parameter has been correctly configured ■ Check that the tags were exported (Export Tags)
10	FB links do not work	Project not downloaded correctly, e.g. partial download when bridge has HSE links ■ Repeat full download from the HSE Network node

For your notes

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