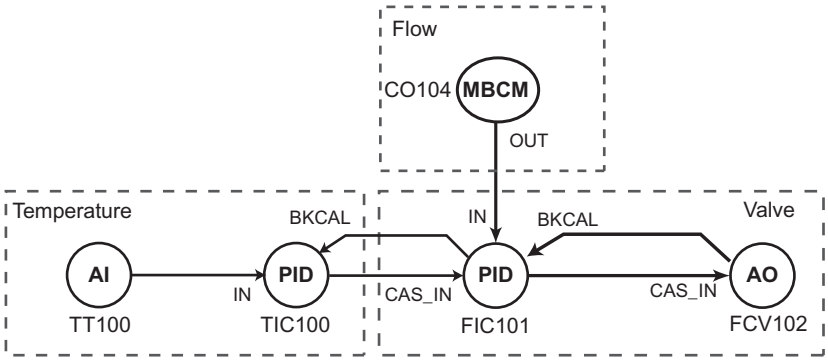
Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

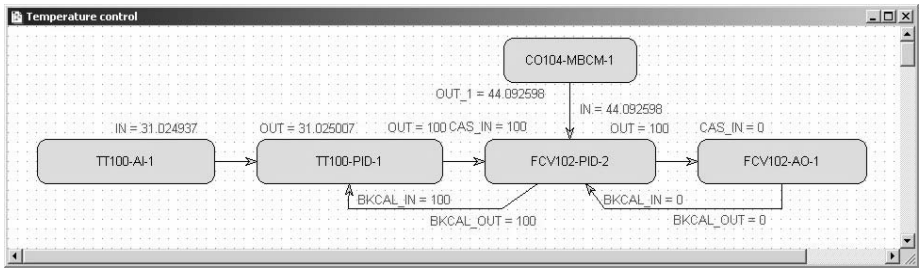
Operating Instructions

ControlCare Application Designer

MODBUS Tutorial

MODBUS





BA 037S/04/en/06.07
Product Version 2.03.xx
70101153

Endress+Hauser
People for Process Automation

Table of Contents

Revision History

Product version	Manual	Changes	Remarks
2.01.xx	BA037S/04/en/08.05	Original manual	
2.02.xx	BA037S/04/en/07.06	Product	▪ FB schedule configured by drag&drop (Chap.3.8 and 4.5.2) ▪ Incremental download (Chap. 3.11.6 and 4.7.6)
		Editorial	▪ Update version and documentation tables
2.03.xx	BA035S/04/en/06.07	Program	▪ New preferences dialog (packing) ▪ Assign All Tags added
		Going on-line	▪ New HSE Network Tools program ▪ New Field Controller Web Server program
		Trouble-Shooting	▪ New FC Tools program and firmware download ▪ New Exchange procedure

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 modules. 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 Modbus devices (master or slave) connected to a SFC162 FOUNDATION Fieldbus or SFC173 PROFIBUS Field Controller to be engineered, configured and commissioned. In addition, appropriate control strategies can be built using the function blocks contained in the controller and connected devices.

1.2 Installation, commissioning and operation

ControlCare Field Controller modules 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, which allows control strategies to be created for both FOUNDATION Fieldbus and PROFIBUS 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 (FOUNDATION Fieldbus 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 (FOUNDATION Fieldbus Guidelines) and BA034S (PROFIBUS Guidelines).

IP Address

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!

Since the system can be accessed and manipulated through the various Field Contoller 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 Field Controller.

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 Drawing Tool	Operating manual	BA032S/04/en	Planned
	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
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 Modbus

This tutorial describes all steps necessary for integrating Modbus values into a SFC162 or SFC173 Field Controller. It does not aim to give an exhaustive account of the associated Application Designer functions, but rather shows you one of a number of methods to reach your goal. It is assumed that the user is familiar with the programming of Modbus masters and slaves.

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. Function block descriptions are to be found in BA022S/04/en, Function Block manual.

2.1 Description

MODBUS is a quasi-industrial standard developed some years ago by Gould-Modicon and provides a messaging service that may run on a variety of physical layers. For the SFC162 and SFC173 Field Controllers, there are two possibilities for integrating Modbus:

- MODBUS RTU can be connected point-to-point to the RS-232C input on the front panel. If appropriate a RS-232C/RS-485 (or RS-232C/RS-422) interface is required for connection to the device.
- MODBUS TCP (also known as MODBUS TCP/IP) can be connected to the Ethernet connector on the front panel. This allows the exchange of data between the Field Controller and a PLC, Remote I/O and/or operator panel.

The MODBUS protocol exchanges data in a master-slave relationship. Each slave has a unique address, and the data are identified by their location in the slave address register. Certain characteristics of the MODBUS protocol are fixed, such as the frame format, frame sequences, handling of communications errors, exception conditions and the functions performed. Other characteristics are user selectable; these include transmission medium, baudrate, character parity, number of stop bits, and transmission modes. The contents of the data carried by the protocol are also freely selectable, i.e. nothing is said about strings, integers, floating-point numbers etc.

The MODBUS protocol controls the query and response cycle between master and slave devices. Only the master can initiate a transaction. A query and response may involve only a single slave, or it may be in the form of a broadcast, in which case the slaves do not answer. The query is contained in a frame that includes the address of the intended receiver, what this slave is to do, data needed to perform the action, and a means of checking for errors. The slave checks if errors have occurred and performs the desired action. After the action is performed the slave builds the response and returns it to the master. The master can send another message to any slave as soon as it receives a valid response or after a user-selected time interval. This "time-out" period has to be selected on the master device and depends on the slave response time.

The data can be exchanged in two transmission modes: ASCII (American Standard Code for Information Interchange) and RTU (Remote Terminal Unit). The major differences between them are the type of error check performed on the message and the number of characters used. MODBUS offers several read, write and test functions, each identified by a code number. They are designed as control commands for sensors and actuators, e.g. coils, inputs, input registers, holding or output registers, diagnosis and test reports, programs, polling control and reset. For MODBUS TCP the serial frame is simply inserted into the Ethernet data frame. In addition, not all codes are implemented.

2.2 Using Modbus with ControlCare

When connected to a Modbus device, the ControlCare Field Controller SFC162 or SFC173 can be used as a master or slave, see Section 2.2.1 and 2.2.2. Application Designer has five function blocks that are used to configure the system, whereby up to 16 Master/Slave configuration blocks can be assigned to a Field Controller:

- MBCF (Modbus Configuration Block)
  configures the Field Controller for Modbus operation
- MBSS (Modbus Supervision Slave)
  allows the Field Controller to be used as a Modbus supervision slave, e.g. to a SCADA host
- MBSM (Modbus Supervision Master)
  allows the Field Controller to operate as a Modbus supervision master, e.g. to a SCADA host
- MBCS (Modbus Control Slave)
  allows the Field Controller to be operated as slave, allowing a Modbus controller, e.g. a PLC, access to the PROFIBUS or FOUNDATION Fieldbus, depending on controller type
- MBCM (Modbus Control Master)
  allows the Field Controller to operate as a master and access Modbus slave data, e.g. from controller or device registers

This tutorial describes the use of a Field Controller as a Modbus Control Master or Slave. A description of the Modbus Supervisory Master and Modbus Supervisory Slave blocks is to be found in the Function Block Manual BA022S/047en.

2.2.1 Use as Modbus master

When used in master master mode, the Field Controller can read data from and write data to the Modbus slaves. If Modbus TCP is in use, the numer of slaves is limited to six. Fig 2-1 shows the possible network topology.

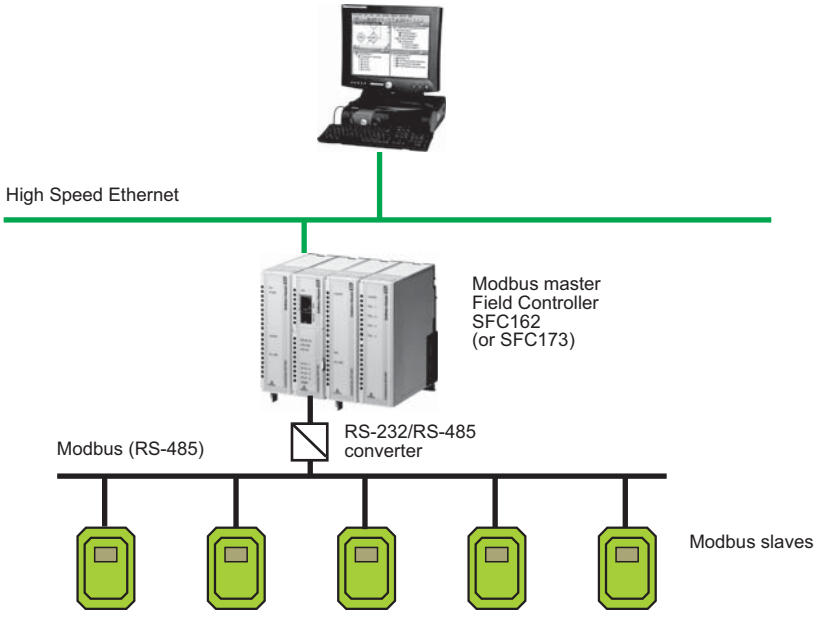


Fig. 2-1 Use of the Field Controller to access parameters on a Modbus line

The Field Controller uses the standard Modbus commands for read and write, making the slave data available for use in the control strategy or for display and trending in the operator workstation. The operator may also actuate Modbus slave devices and perform other supervisory functions. This type of application is described in Chapter 3.

2.2.2 Use as a Modbus slave

Most legacy systems such as DCS or PLC have serial interface modules that support Modbus. This may be used to supervise Fieldbus instruments through a Modbus slave Field Controller acting as a gateway as shown in Fig. 2-2 and 2-3. This allows the existing system to access some of the capabilities provided by Fieldbus devices.

Data in the Field Controller can be read or written by a Modbus master when the Field Controller operates in a Modbus slave mode. The data can be accessed in a binary format (Functions 1, 2, 5 and 15) or through registers (Functions 3, 4, 6 and 16). This application is described in Chapter 4.

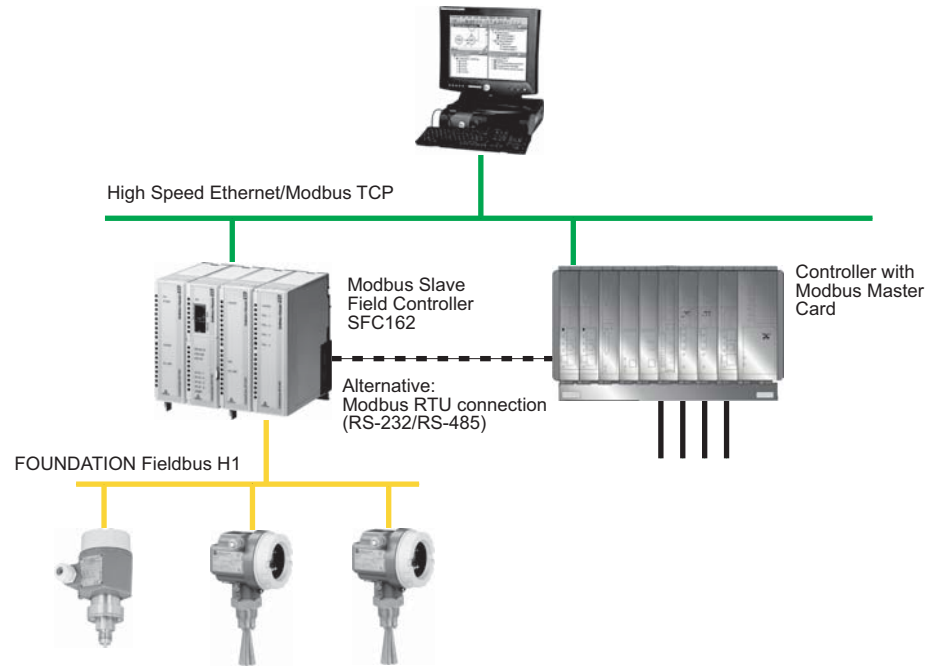


Fig. 2-2 Use of the SFC 162 Field Controller to allow legacy systems access to selected FF parameters

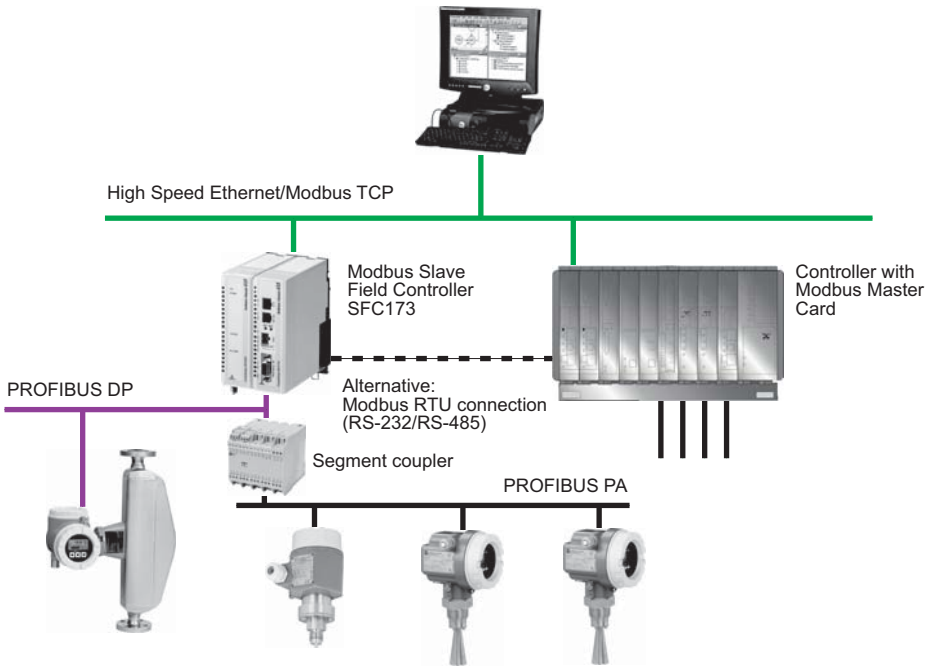


Fig. 2-3 Use of the SFC 173 Field Controller to allow legacy systems access to selected PROFIBUS parameters

3 Field Controller as Modbus Master

3.1 Task Description

This part of the tutorial describes all steps necessary for setting up the Field Controller as a Modbus Control Master. 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. Function block descriptions are to be found in BA022/04/en, Function Block manual.

3.1.1 Application

For this tutorial, the case of cascade control for a heat exchanger will be used, see Fig. 3-1.

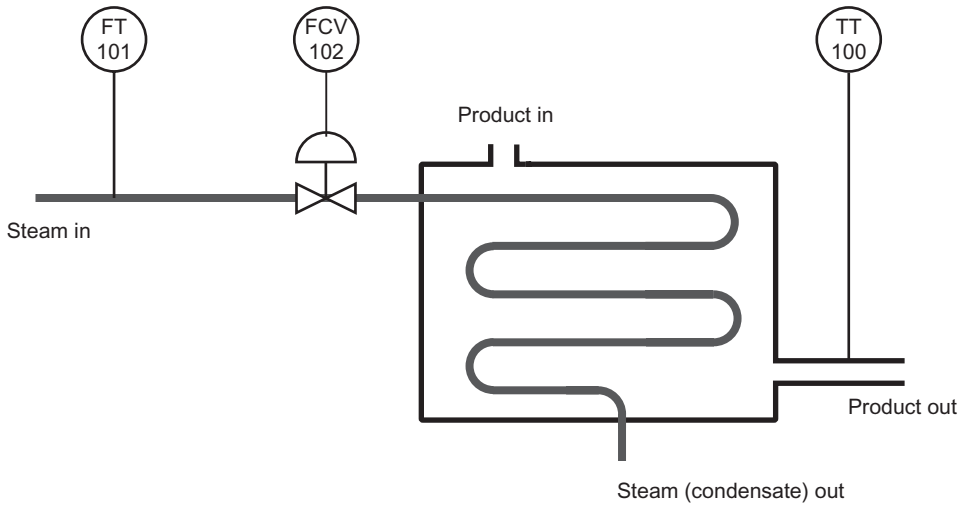


Fig. 3-1: Schematic diagram of heat exchanger application

A liquid flows through the heat exchanger and is heated by condensing steam. The controlled variable is the exit temperature of the liquid flowing through the exchanger. The manipulated variable is the steam flow to the exchanger. The temperature of the product defines the set point of the steam flow, which is controlled by a valve in order to avoid excessive waste of energy (=steam). The flow values are delivered by a Modbus slave (e.g. flowmeter) via the MBCM block in the Field Controller, which acts as Modbus master. The corresponding control strategy is shown in Fig. 3-2.

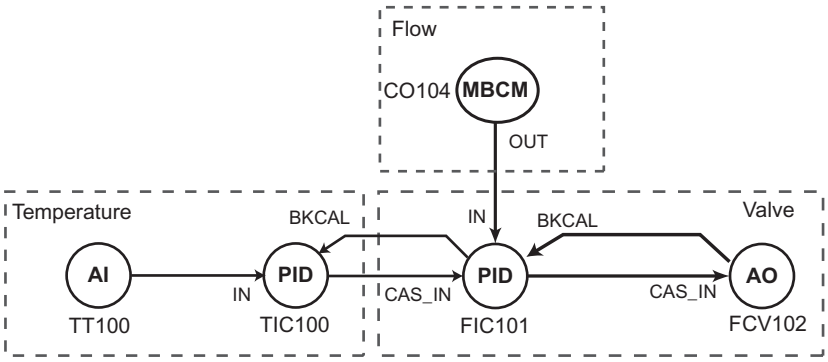


Fig. 3-2 Cascade control strategy for heat exchanger application

3.1.2 Network

The network is assumed to be constructed as shown in Fig. 3-3.

- The flowmeter is a Promass 83F with Modbus RS-485 interface, acting as Modbus slave, suitable for steam measurement
- The valve positioner is a Metso ND9103FN (FOUNDATION fieldbus)
- The temperature transmitter TMT162 (FOUNDATION fieldbus)

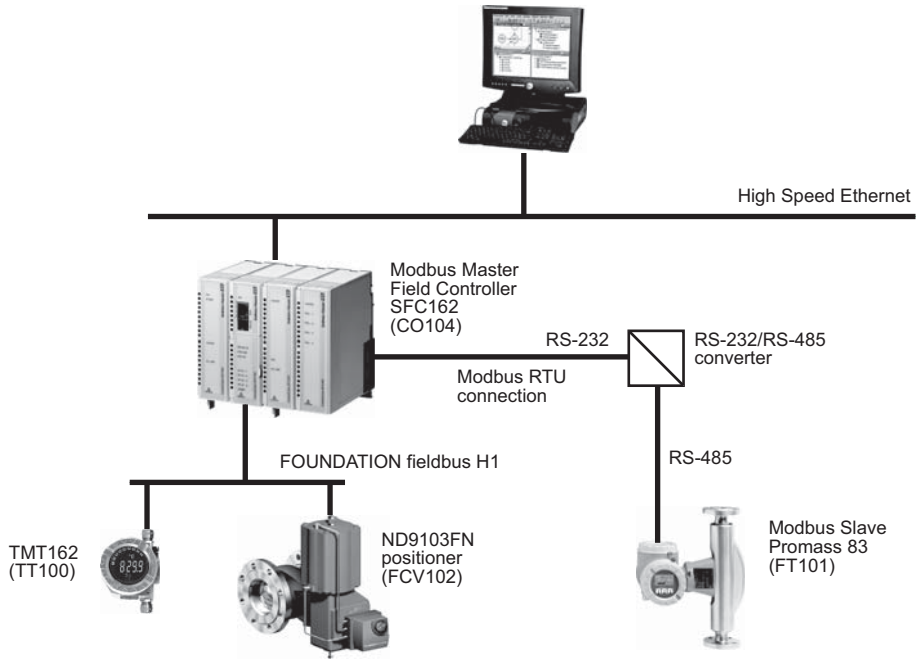


Fig. 3-3 Network for application example

As shown in Figure 3-2, the control will be done in the TMT162 temperature transmitter and the ND99103FN valve positioner. As far as traffic on the bus is concerned, this is the most efficient method. The user has, however, the alternative of performing all control in the controller, should this be preferred.

The Promass 83 delivers the flow measurement for the cascade control. To do this it must be connected to the RS-232 port of controller via a RS-232/RS-485 interface. The both the Field Controller and the flowmeter can be configured as master or slave. In this example, the Field Controller is used as master.

3.1.3 Installation and commissioning

Before you can start this part of the Modbus tutorial, Application Designer must be installed on your computer, the SFC162 FOUNDATION Fieldbus 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

3.1.4 Device ID and tag

For a FOUNDATION Fieldbus system, each device that communicates has a unique bus address and tag. Addresses are assigned automatically during the start-up of the system on the basis of the device ID. The device ID is a unique identifier that is based on a Manufacturer ID and the serial number of the device. When the project goes online, the actual device IDs must be assigned to virtual devices that have been planned in Application Designer by using the Assign Tags procedure.

To aid the offline engineering of the network, it is necessary to keep a record of the measuring point tags (device tags), often as an Excel sheet. Measuring point tags are used in P&I diagrams to indicate the type of measurement or action performed at a particular location in a process. Table 3-1 below provides an example of how this might look for the application at hand.

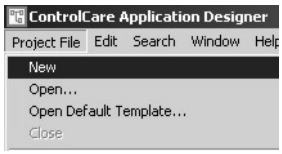
Area	Process Cell	Device	Vendor	Tag	Unit	Task
Pasteurization	Heat Exchanger	TMT162	E+H	TT100 TIC100	°C	Product temperature Temperature PID
Pasteurization	Heat Exchanger	Promass 83F	E+H	FT101	kg/h	Steam flow
Pasteurization	Heat Exchanger	ND9103FN	Metso	FCV102 FIC101	%	Steam valve positioner Flow PID
Pasteurization	Heat Exchanger	SFC162	E+H	CO104		Field Controller acquiring and passing on flow measurement

Tab. 3-1: : Measuring point tag list for tutorial application

3.2 Create a project

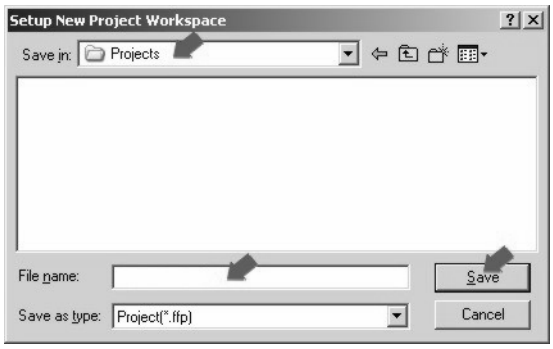
1 Start ControlCare Application Designer by clicking on the icon on your destop or via **Start => Programs => Endress+Hauser => ControlCare => ControlCare Application Designer**

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



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

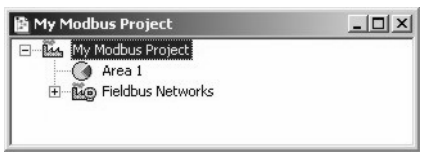
2 The **New Project** dialog box opens:



1. Choose the folder where the project will be saved.
2. Type the name of the project in the File Name box, e.g. My Modbus project.
3. Click **Save**.
   If the new project is not to be created, click **Cancel.**

3 ControlCare Application Designer automatically creates a folder with the entered file name within the selected folder.

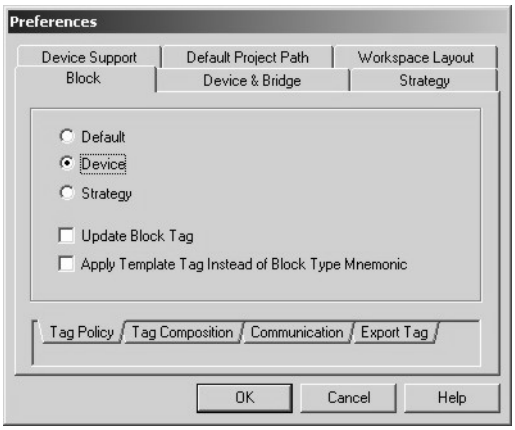
4 The project opens with the first branches of the plant and network view already created:



3.3 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 activate the following (check box)
– **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**:
– Enter a mnemonic separator: for this manual the setting was "-"
Default setting is "_" and mandatory for if flexible 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 or TagName_Block_n.

Export Tag

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

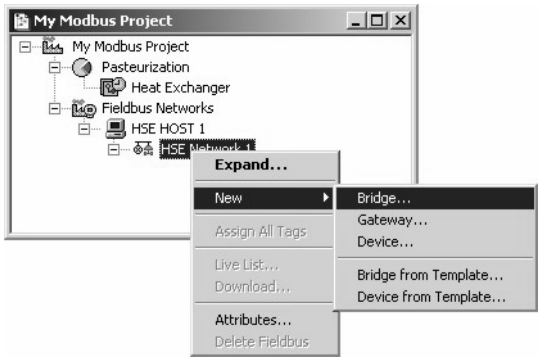
1 Select the subfolder **Export Tag**
– Check the **Automatic** button

2 Press **OK** to confirm your selection

3.4 Create a fieldbus network

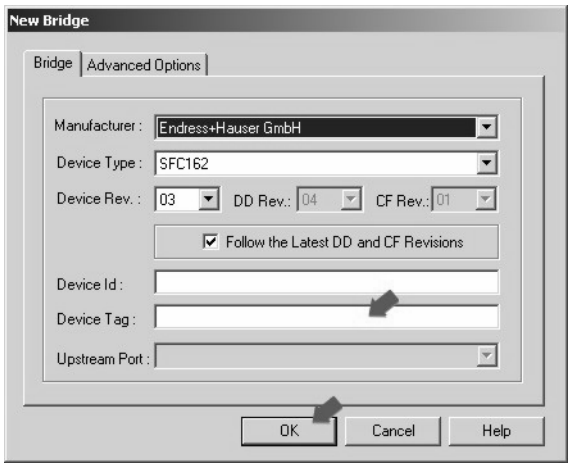
3.4.1 Add the controller

1 Expand the **Fieldbus Networks** branch in the project window and right-click on **HSE Network 1**



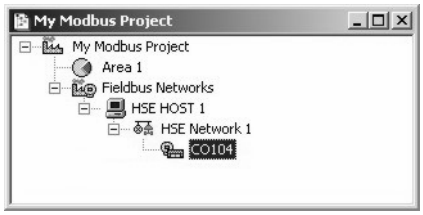
– Select **New => Bridge** to add the Field Controller SFC162
– If the Field Controller SFC173 was to be used, it would be added by **New => Gateway**

2 The **New Bridge** dialog opens



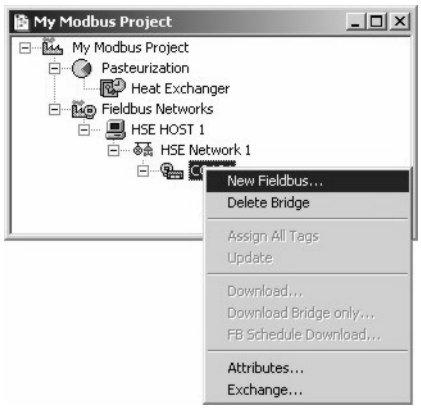
– Enter the **Device Tag**, e.g. CO104
– Press **OK** to create the bridge

3 The Field Controller SFC162 is added to the network



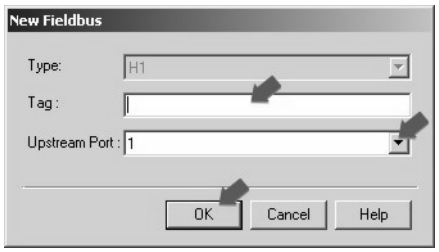
3.4.2 Add a fieldbus segment

1 Right-click on the Field Controller (CO104)



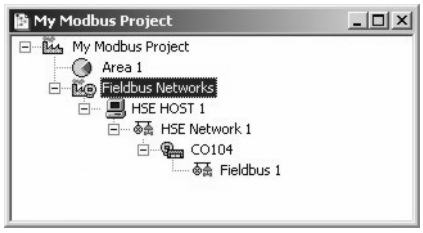
– Select **New Fieldbus**

2 The New Fieldbus dialog opens



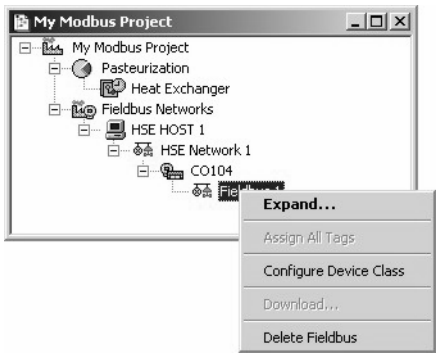
– Press **OK** to create the fieldbus with default settings

3 The fieldbus is created with the default name **Fieldbus 1**

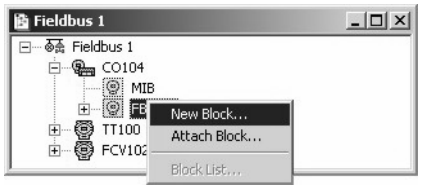


3.4.3 Add the Modbus function blocks

1 Right-click on the **Fieldbus 1** leaf and select **Expand**

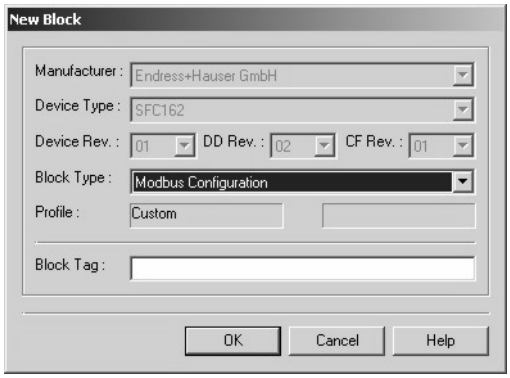


2 A new window opens with the name **Fieldbus 1**
- Expand the tree until all leaves until you see **FBAP** under the Field Controller



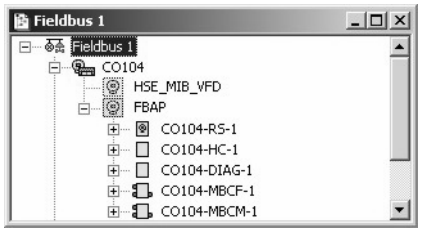
- Right-click on **FBAP** and select **New Block**

3 The **New Block** dialog for the SFC162 Field Controller opens



- In **Block Type**, select the function block **Modbus Configuration**
- Press **OK** to create the block with default values

4 Repeat Step 2 and create a **Modbus Control Master** block
- Depending on the number of inputs or outputs required, up to 16 MBCM blocks can be created)

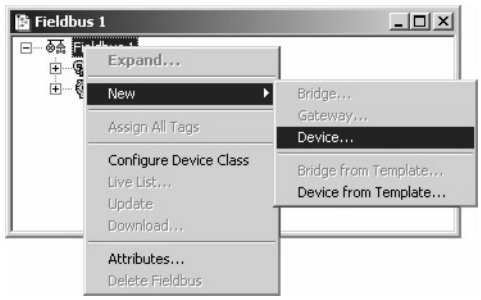


3.4.4 Add the FF field devices

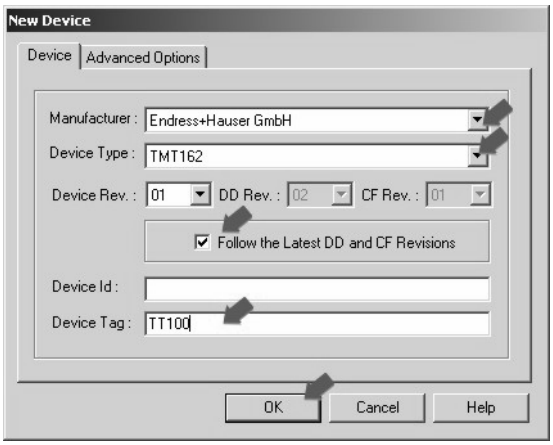
Note!

- Only FOUNDATION Fieldbus devices are added to the Fieldbus network, Modbus devices are not shown in this tool

1 In the Fieldbus 1 window, right-click on the **Fieldbus 1** leaf and select **New => Device**



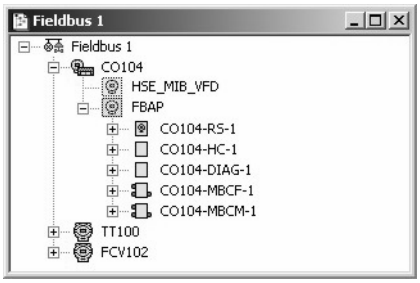
2 The **New Device** dialog appears



- Select **Manufacturer**: Endress+Hauser
- Select **Device Type**: TMT162
- Enter **Device Tag**: TT100
- Press **OK** to create the device

3 Repeat Step 2 to create the Metso positioner
- Select **Manufacturer**: Metso Automation
- Select **Device Type**: Metso FBLK Interface
- Enter **Device Tag**: FCV102
- Press **OK** to create the device

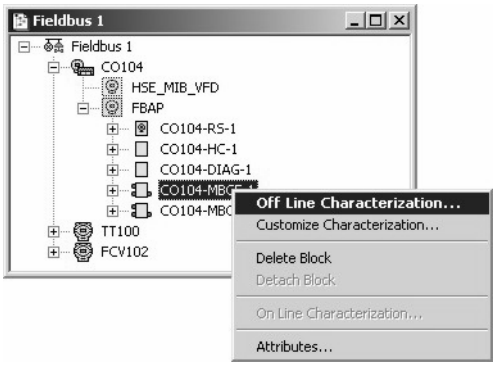
4 Fieldbus 1 now looks like this



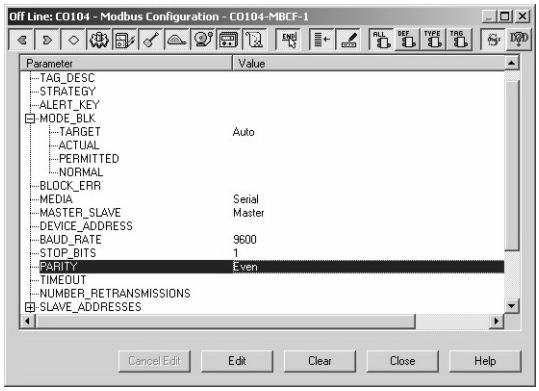
3.5 Configure the devices

3.5.1 MBCF Modbus Configuration block

1 In the Fieldbus 1 window, right-click on the Field Controller function block **CO104-MBCF-1** and select **Off Line Characterization**



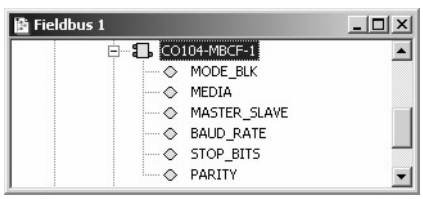
2 The **Off Line Characterization** dialog opens: Press **All** to show all parameters



3 Set the following parameters by double-clicking in the middle of the value space in the parameter line, entering or selecting the parameter from the drop-down menu, and clicking End Edit to register the change (MBCF block parameters are described in Chapter 6.1):

- **MODE_BLK TARGET** = Auto
- **MEDIA** = Serial
- **MASTER_SLAVE** = Master
- **BAUD_RATE** =38400 (default value in Promass 83)
- **STOP_BITS** = 1 (RTU, supported by Promass 83)
- **PARITY** = Even (RTU, supported by Promass 83)

4 Click **Close** to close the dialog: the parameters are added to the MBCF function block



3.5.2 MBCM Modbus Control Master block

The MBCM function block allows 16 Modbus registers to be mapped. Each MBCM block offers:

- Four OUT channels for reading analog values from Modbus device registers
- Four OUT_D channels for reading discrete values from Modbus device registers
- Four IN channels for writing analog values to Modbus device registers
- Four IN_D channels for writing discrete values to Modbus device registers

The SCALE_LOC_XXX parameter allows each channel to be individually configured for scaling, slave address, register and data type. The registers are listed in the operating instructions of the Modbus device. Field Controller uses 5 digit register addresses, so should the slave device instructions show only four digits, a "3" must be prefixed for OUT values and a "4" for IN values. If more than four registers of a particular type are required, up to 16 MBCM blocks can be created. This means that a total of 64 AIs, 64 AOs, 64 DIs and 64 DOs can be mapped from the Modbus network. By default the LOCAL_MOD_MAP = 0, valid range is 0 – 15.

The Promass 83 offers several measured values which can be read from different MODBUS registers, see below. For our example, mass flow (2007 = **3**2007) will be selected.

Measured value	Register 1	Register 2	Data type	Access
Mass flow	2007	247	Float	Read
Volume flow	2009	253	Float	Read
Corrected volume flow	2011	–	Float	Read
Density	2013	249	Float	Read
Reference density	2015	–	Float	Read
Temperature	2017	251	Float	Read
Totalizer 1	2610	259/261	Float	Read
Totalizer 2	2810	–	Float	Read
Totalizer 3	3010	–	Float	Read

Tab. 3-2: Modbus registers for Promass measured values

By default, the Promass 83 sends its float number with the bytes order 1-0-3-2 and not in the sequence 3-2-1-0. For the Field Controller the 1-0-3-2 sequence corresponds to the DATA_TYPE "float".

The values mapped to the Field Controller or sent to a Modbus slave device register can be scaled. The parameters:

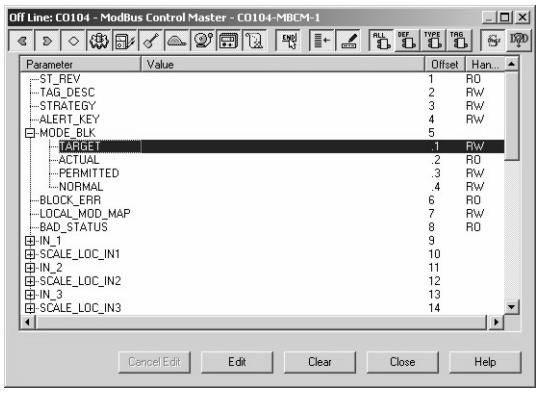
- FROM_EU_0
- FROM_EU_100
- TO_EU_0
- TO_EU_100

allow a conversion from one set of engineering units to a second set of engineering units, by simply entering the lower and upper limit values of each set. In our example, the mass flow value offered by the Promass 83 will be scaled from 0% to 100% by entering the lower and upper range limits of the transmitter in the "FROM" parameters.

Full details of how to parametrize the Promass 83 flow transmitter with Modbus slave interface are to be found Operating Instructions BA107D and BA108D respectively.

Procedure

1 Right-click on the **CO104-MBCM-1** block and open the **Off Line Characterization** dialog

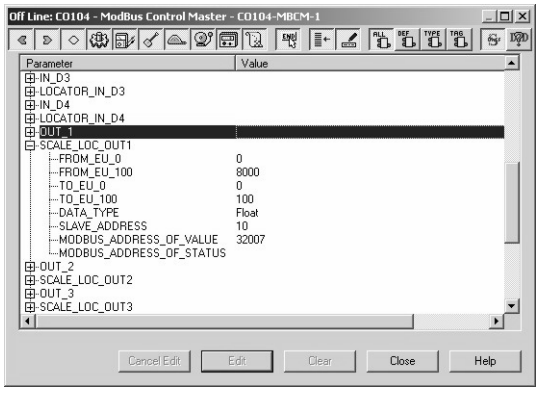


2 Click All to reveal all parameters and enter the following parameters by double-clicking in the middle of the parameter line, entering or selecting the parameter from the drop-down menu, and clicking End Edit to register the change:

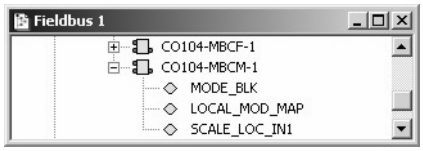
- **MODE_BLK TARGET** = Auto
- **LOCAL_MOD_MAP** = 0 (first MBCM function block)

3 Now set the following **SCALE_LOC_OUT1** parameters for the Modbus read value:

- **FROM_EU_0** = 0
- **FROM_EU_100** = 8000 (Upper range limit for Promass)
- **TO_EU_0** = 0
- **TO_EU_100** = 100 (%)
- **DATA_TYPE** = Float
- **SLAVE_ADDRESS** = 10 (Default address of Promass 83)
- **MODBUS_ADDRESS_OF_VALUE** = 32007 (mass flow)



4 Press **Close** to close the Off Line Characterization dialog. You should now see the parameters attached to the MBCM block:



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

3.5.3 TMT162 transducer block

Full details of how to parametrize the TMT162 temperature transmitter are to be found Operating Instructions BA224REN.

Transducer Block

Table 3-3 shows the parameters that must be set in the TMT162 TEMP_1 transducer block

Parameter	Function	Temperature TT100
MODE BLOCK/TARGET	Normal operating mode of block	Auto
PRIMARY_VALUE_TYPE	Calculation method for primary process value ▪ Process temperature SV1 or SV2 ▪ Average 0.5 (SV1 + SV2) with/without redundancay ▪ Differential (SV1 - SV2) ▪ Conditional (SV1 or SV2), (SV2 if SV1 >T)	Sensor Value 1
SENSOR_TYPE	Type of sensor connected to the transmitter ▪ All types of standardized temperature sensors	Pt 100 IEC 751
SENSOR_CONNECTION	Way in which the sensor is connected ▪ 4-wire (if two sensors are connected only one can be 4-wire) ▪ 3-wire ▪ 2-wire	2-wire

Tab. 3-3: Basic parameters for TMT162 transducer block

Order of parameters

Some block parameters have a write check based on the value of others parameters. It is therefore important to set the parameters in the order shown in Table 3-3 (the same order in which they are displayed in the **Off Line Characterization** dialog. After parametrization of the block, the parameters will appear in the FOUNDATION Fieldbus tree. If you find a parameter in the wrong position, it can be move by dragging and dropping to the correct one.

Parametrize

1 In the Fieldbus network workspace, expand the TT100 tree until the function blocks are visible
   – Right click on the transducer function block **TT100-BLK-1** and select **Off Line Characterization...**

2 The **Off Line Characterization** dialog opens: Press **All** to reveal all parameters.

3 Now set the following parameters to the values in Table 3-3:

   – **MODE_BLK TARGET** = Auto
   – **PRIMARY_VALUE_TYPE** = PV = Sensor value 1 (SV1)
   – **SENSOR_TYPE** = Pt 100 IEC (a=3.85 E-03)
   – **SENSOR_CONNECTION** = 2-wire

   – Double-click on the "Value space" next to the parameter
   – Enter a value or select a parameter from the drop-down menu
   – Press **End Edit** to register your change

4 Press Close to quit the Off Line Characterization dialog

3.5.4 Metso ND9103FN positioner

Full details of how to parametrize the Metso ND9103FN valve positioner are to be found in the ND900F User Guide which can be downloaded from www.metso.com.

Transducer Block

In the tutorial, you have probably only the valve positioner, but not the valve itself. In real life, the positioner must be told what it is driving and certain assembly information must always be entered into the transducer block. Rotary valve parameters are included in Table 3-4.

Parameter	Function	Positioner FCV102
MODE BLOCK/TARGET	Normal operating mode of block	Cas
VALVE_TYPE	Type of valve the positioner is actuating ▪ Select from drop-down menu	Rotary
FINAL_VALUE_RATE_DN	Maximum travel rate in closing direction ▪ 0 = parameter not in use	0
FINAL_VALUE_RATE_UP	Maximum travel rate in opening direction ▪ 0 = parameter no in use	0
POSITIONER_FAIL_ACTION	Action of position on loss of electrical power or reception of an output signal with a bad status ▪ Select from drop-down menu	Close
POS_SENSOR_ROT	Relationship between valve action and position sensor rotation ▪ Select from drop-down menu	Standard: Clockwise to close
DEAD_ANGLE_COMP	Dead angle for segment and rotary valves	0
ACT_TYPE	Type of positioner action ▪ Select from drop-down menu	Double-acting actuator
PERFORMANCE_LEVEL	Target performance level of valve position control Select from drop-down menu	Optimum
CHAR_TYPE	Type of linearization ▪ Select from drop-down menu	No characterization

Tab. 3-4: : Basic parameters for Promass 83F transducer block

Order of parameters

Some block parameters have a write check based on the value of others parameters. It is therefore important to set the parameters in the order shown in Table 3-4 (the same order in which they are displayed in the **Off Line Characterization** dialog. After parametrization of the block, the parameters will appear in the FOUNDATION Fieldbus tree. If you find a parameter in the wrong position, it can be move by dragging and dropping to the correct one.

Parametrize

1 In the Fieldbus network workspace, expand the FCV102 tree to reveal the function blocks.
   – Right click on the transducer function block **FCV102-BLK-2** block and select **Off Line Characterization...**

2 The **Off Line Characterization** dialog opens: Press **All** to reveal all parameters
   – Expand the **Mode Block** parameter tree

3 Now set the parameters to the values in Table 3-4:
   – Double-click on the "Value space" next to the parameter
   – Enter a value or select a parameter from the drop-down menu
   – Press **End Edit** to register your change

4 Press Close to quit the Characterization dialog

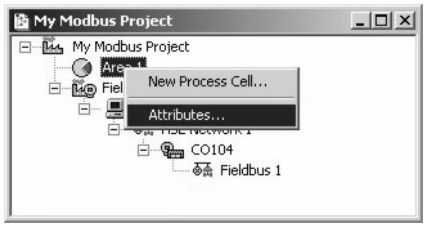
5 Open **Project File**, then press **Save**, to save the project

3.6 Create the Control Strategy

Having created a physical view of the process, 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.

3.6.1 Add a Process Cell

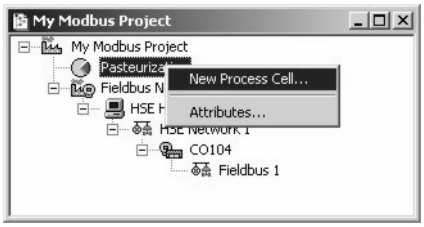
1 Click on the "**Area 1**" leaf in the project and select **Attributes...**



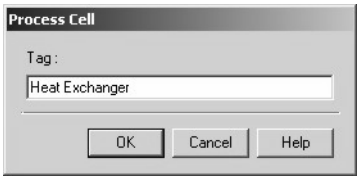
2 The **Attributes** dialog box appears

- Enter a name for the area, e.g. Pasteurization (see Table 3-1, Chapter 3.1)
- 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

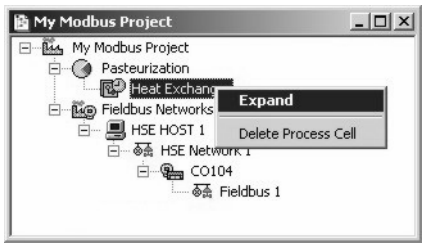


- Enter a name for the process cell, e.g. Heat Exchanger (see Table 3-1, Chapter 3.1.4)
- Click **OK** to store your changes

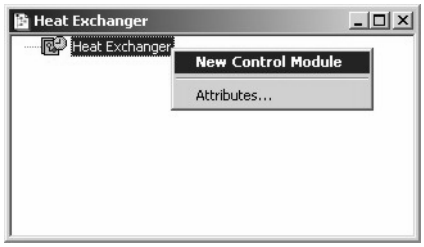
5 Open **Project File**, then press **Save**, to save the project.

3.6.2 Add a Control Module

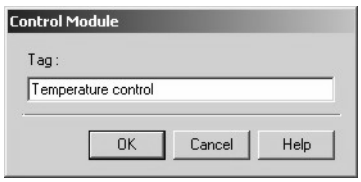
1 Right-click on the Process Cell leaf you just created and select **Expand**



1 A new window with the name of the leaf opens
– Right-click on the top leaf and select **New Control Module**

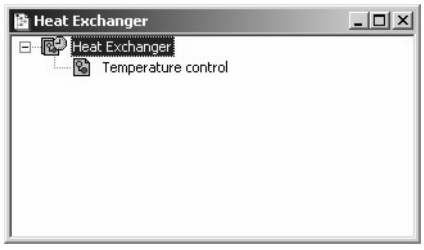


2 The **Control Module** dialog box appears



– Enter a name for the control module, e.g. Temperature Control (see Table 3-1)
– Click **OK** to store your changes

3 The project now looks something like this:

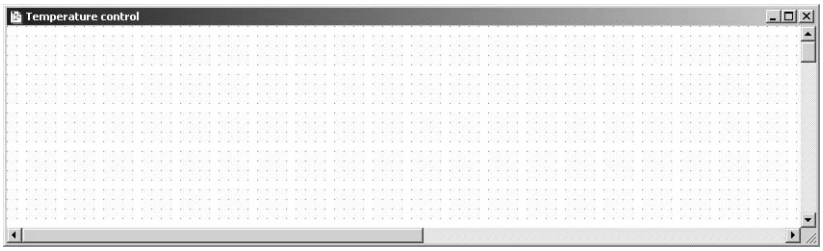


4 For a real project, Step 2 and 3 would be repeated until all the required control modules for a particular process cell have been added.

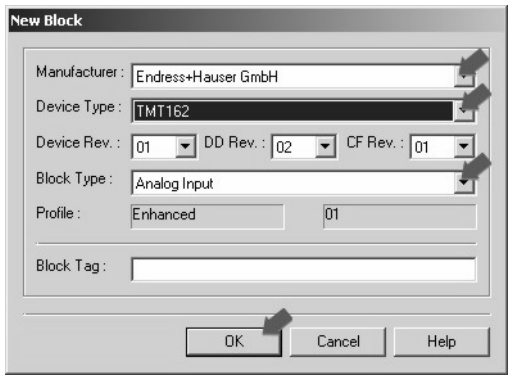
5 Open **Project File**, then press **Save**, to save the project.

3.6.3 Create the function blocks

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

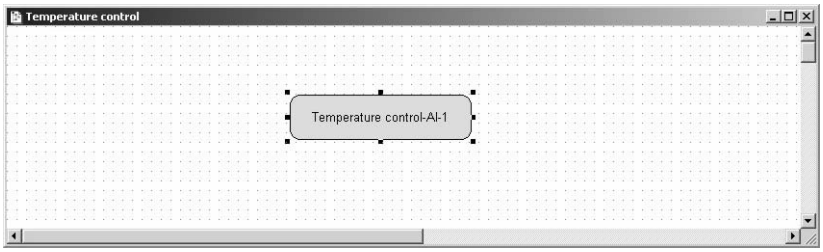


2 Press the Function Block button in the toolbar and click in the workspace
– The **New Block** dialog appears



– Select the **Manufacturer** = Endress+Hauser
– Select the **Device Type** = TMT162
– 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 Temperature PID, Flow PID and Valve AO blocks

- Temperature PID:
  Manufacturer = Endress+Hauser
  Device Type = TMT162
  Block Type = PID Control

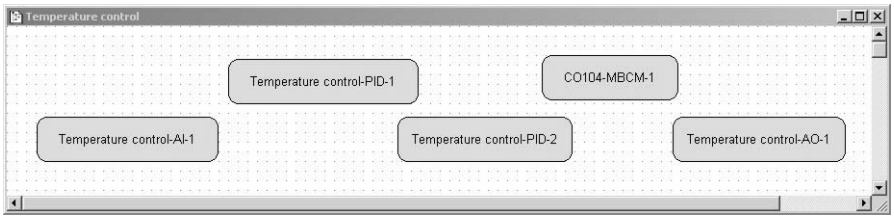
- Flow PID
  Manufacturer = Metso Automation
  Device Type = FBLK Interface
  Block Type = PID Control

- Positioner AO
  Manufacturer = Metso Automation
  Device Type = FBLK Interface
  Block Type = Analog Output

5 The Modbus master/slave data exchange is managed by the MBCM block which you have already created

- In the **Fieldbus 1** window expand the **CO104** leaf and click on **CO104-MBCM-1**
- Drag and drop the block into the control strategy window

6 The control strategy now looks like this



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

Note

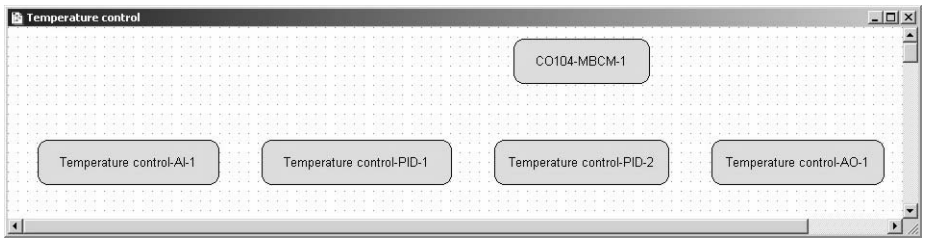
- In the tutorial we created the MBCM block together with the MBCF block. Is is also possible to create the MBCM block in the strategy window as we have done with the PID, AI and AO blocks:

  Modbus Control Master MBCM
  Manufacturer = Metso Automation
  Device Type = SFC162 (or SFC173 with PROFIBUS Field Controller)
  Block Type = Modbus Control Master

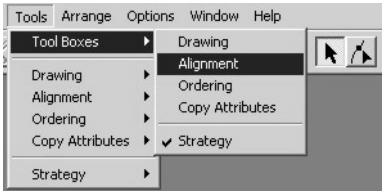
  Then drag and drop it to the Field Controller in the Fieldbus Network view, see Chapter 3.6.7.

3.6.4 Add the Function Block Links

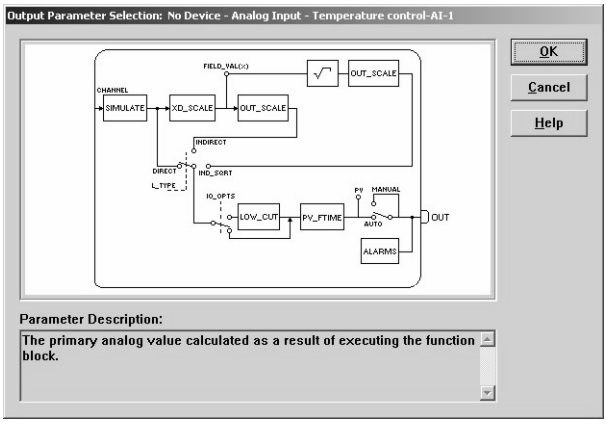
1 In the Control Strategy workspace position the blocks according to your strategy



- 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.



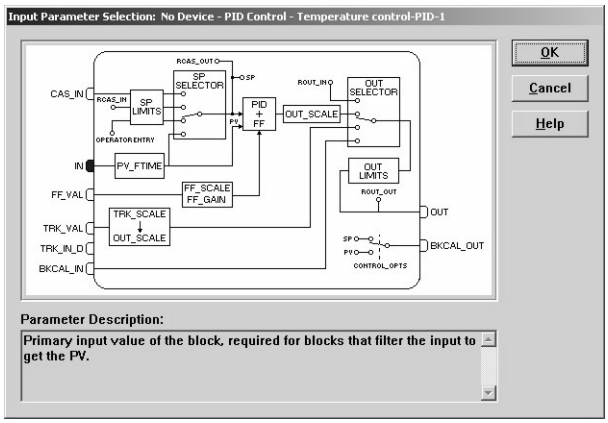
2 Click on **Function Block Link** button in the tool bar, the cursor changes to a cross
- Select the **Temperature AI block** with the cross: the **Output Parameter Selection** dialog appears



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

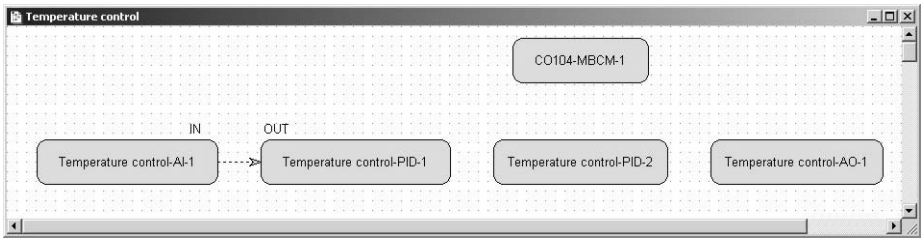
- The **Output Parameter Selection** dialog closes
- The cursor is now connected to a blue dotted line
- Place the Cursor in the Controller PID Block 1 and click to make the link

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



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

5 When the Input Parameter Selection dialog changes, the link is made and appears as below:

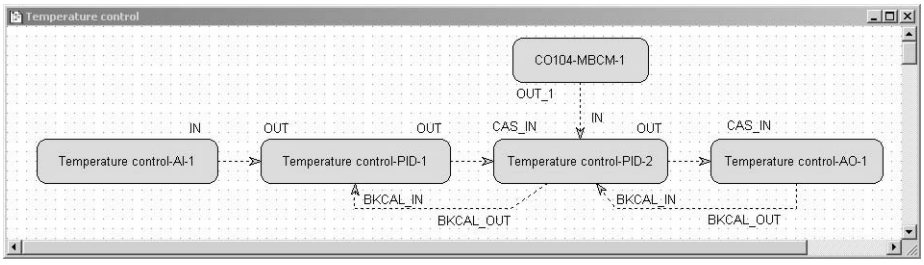


– You may have to move the parameter legends "IN" and "OUT" by selecting and positioning with the left mouse key depressed

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

– PID1 and PID2 = **OUT** to **CAS_IN**
– PID2 and PID1 = **BKCAL_OUT to BKCAL_IN**
– CO104-MBMC-1 to PID2 = **OUT1** to **IN**
– PID2 to Valve AO = **OUT** to **CAS_IN**
– Valve AO to PID2 = **BKCAL_OUT** to **BKCAL_IN**

7 Your Control Strategy now looks something like this



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

3.7 Configure the strategy

FOUNDATION Fieldbus offers the possibility of storing complete control strategies as fully configured generic templates. This is especially useful when particular control strategies occur several times within a project. The strategies are stored independent of device assignment, which is performed as a separate step, see Chapter 3.8.

In this tutorial, the strategy will be configured to receive the incoming process value from the input block as % of full range, and to output a % value to the positioner.

3.7.1 Analog Input parameters

The function block **Temperature control- A1-1** for the TMT162 has to be configured. The basic parameters required are shown in Table 3-5. A full description of the parameters are to be found in the Operating Instructions BA224REN.

Parameter	Function	Temperature TC100
MODE BLOCK/TARGET	Normal operating mode of block	Auto
XD_SCALE/EU_100* XD_SCALE/EU_0 XD_SCALE/UNITS_INDEX	Upper range value for process variable Lower range value for process variable Unit of process variable	150 (max.850) –50 (min. –200) °C
OUT_SCALE/EU_100 OUT_SCALE/EU_0 OUT_SCALE/UNITS_INDEX	Upper range limit for output variable Lower range limit for output variable Unit of output variable	100 0 %
CHANNEL	Output channels of Transducer Block aasigned to Ananlog Input Block. ▪ Primary, RJ or Sensor vlaue 1/2 depending on whether one or two sensors are connected	Sensor Value 1
L_TYPE	Selects the type of linearisation for the input value. ▪ Direct: PV value = OUT value, Identical XD_SCALE and OUT_SCALE ▪ Indirect: PV value scaled to OUT value ▪ Indirect Square Root: as Indirect but scaling with root function	Indirect
PV_FTIME	Output damping constant (in seconds).	1
*The range limits for the TMT162 temperature transmitter are determined by the transducer block parameters SENSOR_TYPE and PRIMARY_OUTPUT_TYPE. For SENSOR_TYPE = Pt100 and PRIMARY_OUTPUT_TYPE = SV_1 the transducer block outputs a temperature signal in the range -200°C to +850°C. The XD_SCALE and OUT_SCALE parameters generate the OUT value of the Anlaog Input block from any part of this range, in our case -50°C to 150°C.		

Tab. 3-5: Basic parameters for Analog Input blocks

Order of parameters

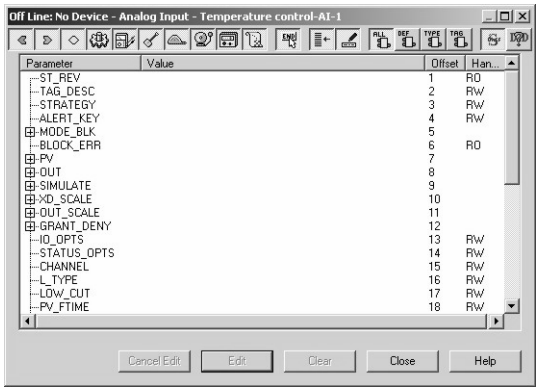
Some block parameters have a write check based on the value of others parameters. It is therefore important to set the parameters in the order shown in Table 3-5 (the same order in which they are displayed in the **Off Line Characterization** dialog. After parametrization of the block, the parameters will appear in the FOUNDATION Fieldbus tree. If you find a parameter in the wrong position, it can be move by dragging and dropping to the correct one.

Note

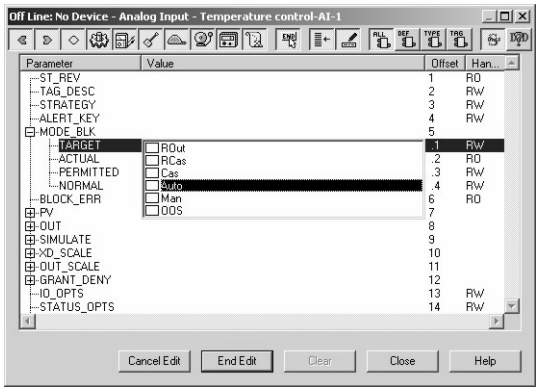
- In the tutorial we configured the MBCM block together with the MBCF block, see Chapter 3.5.2. If the MBCM block had been created in the strategy window as we have done with the PID, AI and AO blocks, it could also be configured in the same manner has described here.

3.7.2 Configuring the Analog Input blocks

1 In the Control strategy workspace, double-click on the **Temperature control AI-1** block
- The **Off Line Characterization** dialog opens
- Press **All** to display all the parameters



2 The Mode Block **Target** must be set to **Auto**.



- Expand the **Mode Block** parameter tree
- Double-click on the "Value space" next to the **Target** parameter
- Select **"Auto"** from the drop-down menu
- Press **End Edit** to register your change

3 Repeat this procedure for the remainder of the Temperature parameters in Table 3-5
- Remember to press **End Edit** after every change
- When all parameters have been entered, press **Close** to quit the Characterization dialog

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

3.7.3 Basic PID parameters

The controller PID blocks must now be parametrized. In practice, the values for the GAIN, RESET and RATE as well as the setpoint value SP for the temperature loop will be known. The other values determine the the way the control is handled when the block moves from auto/cas or a value becomes bad. See also ControlCare Function Block manual BA022S/04/en.

Parameter	Function	Temperature TC100	Flow FC101
MODE BLOCK/TARGET	Normal operating mode of block	Auto	CAS
SP/VALUE	Setpoint for product temperature	40%	–
PV_SCALE/EU_100 PV_SCALE/EU_0 PV_SCALE/UNITS_INDEX	Upper range limit for process variable Lower range limit for process variable Unit of process variable	100 0 %	100 0 %
OUTSCALE/EU_100 OUTSCALE/EU_0 OUTSCALE/UNITS_INDEX	Upper range limit for output variable Lower range limit for output variable Unit of output variable	100 0 %	15 3 psi
CONTROL_OPTS	Sets control options for bad input	Bypass Enable	Bypass Enable
BYPASS	When ON, SP value is transferred to the OUT without the calculation of PID terms.	OFF	OFF
SP_RATE_DN SP_RATE_UP	Rate of change from old to new, higher SP Rate of change from old to new, lower SP	0 0	0 0
GAIN RESET RATE	Tuning constants for the P, I and D terms, of the PID block respectively.	1.5 0.1 0.5	2 0.2 0.6
SHED_OPT	Behaviour when shedding from remote mode	Normal shed, normal return	Normal shed, normal return

Tab. 3-6: Basic parameters for temperature and flow PID blocks

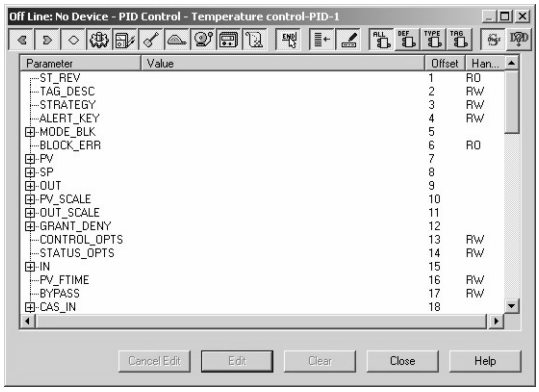
Order of parameters

Some block parameters have a write check based on the value of others parameters. It is therefore important to set the parameters in the order shown in Table 3-6 (the same order in which they are displayed in the **Off Line Characterization** dialog.

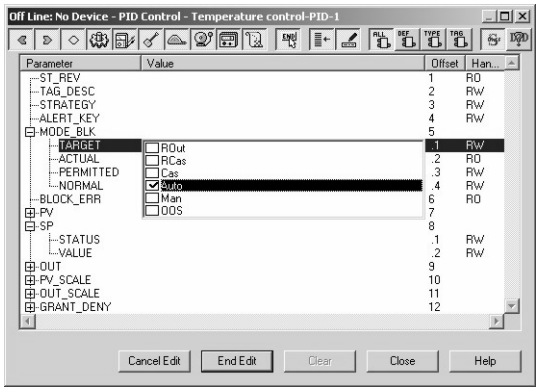
After parametrization of the block, the parameters will appear in the FOUNDATION Fieldbus tree. If you find a parameter in the wrong position, it can be move by dragging and dropping to the correct one.

3.7.4 Configure the PID blocks

1 In the Control strategy workspace, double-click on the **Temperature control PID-1** block
   – The **Off Line Characterization** dialog opens
   – Press **All** to display all the parameters



2 The Mode Block **Target** must be set to **Auto**.



   – Expand the **Mode Block** parameter tree
   – Double-click on the "Value space" next to the **Target** parameter
   – Select **"Auto"** from the drop-down menu
   – Press **End Edit** to register your change

3 Repeat this procedure for the remainder of the Temperature PID parameters in Table 3-6
   – Remember to press **End Edit** after each entry
   – When all parameters have been entered, press Close to quit the Characterization dialog

4 Repeat Steps 1 to 3 for the Flow PID parameters in the **Temperature control-PID-2** block
   – Remember to set the Block Mode **Target** to **CAS**

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

3.7.5 Analog Output parameters

The function block **Temperature control- AO-1** for the ND9103FN now has to be configured. The basic parameters required are shown in Table 3-7. A full description of the parameters are to be found in the Operating Instructions

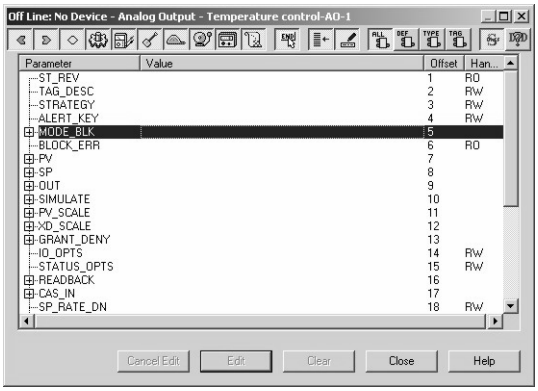
- ND9000F Users Guide, downloadable from www.metso.com

Parameter	Function	Positioner FCV102
MODE BLOCK/TARGET	Normal operating mode of block	Cas
PV_SCALE/EU_100 PV_SCALE/EU_0 PV_SCALE/UNITS_INDEX	Upper range limit for process variable Lower range limit for process variable Unit of process variable	100 0 %
XD_SCALE/EU_100 XD_SCALE/EU_0 XD_SCALE/UNITS_INDEX	Upper range limit for output variable Lower range limit for output variable Unit of output variable	15 3 psi
CHANNEL	Defines the signal configuration between the AO block and transducer block.. ▪ 1 = AO, valve control ▪ 2 = AO, no transducer connected	1 = valve control
SHED_OPT	Behaviour when shedding from remote mode	Normal shed, normal return

Tab. 3-7: Basic parameters for Analog Output block

3.7.6 Configuring the Analog Output block

1 In the Control strategy workspace, double-click on the **Temperature control AO-1** block
  – The **Off Line Characterization** dialog opens
  – Press **All** to display all the parameters



2 The Mode Block **Target** must be set to **Cas**.
  – Expand the **Mode Block** parameter tree
  – Double-click on the "Value space" next to the **Target** parameter
  – Select **"CAS"** from the drop-down menu
  – Press **End Edit** to register your change

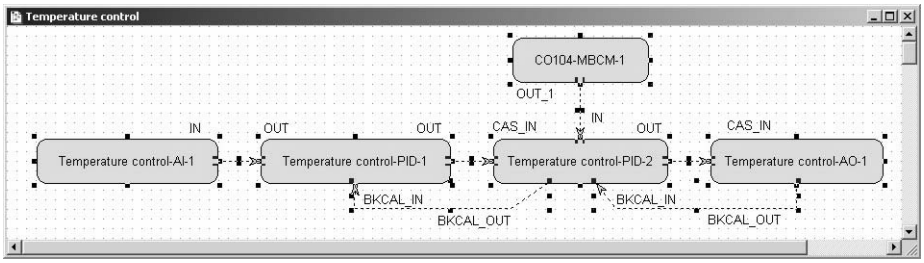
3 Repeat this procedure for the remainder of the Temperature AO parameters in Table 4-3
  – Remember to press **End Edit** after each entry

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

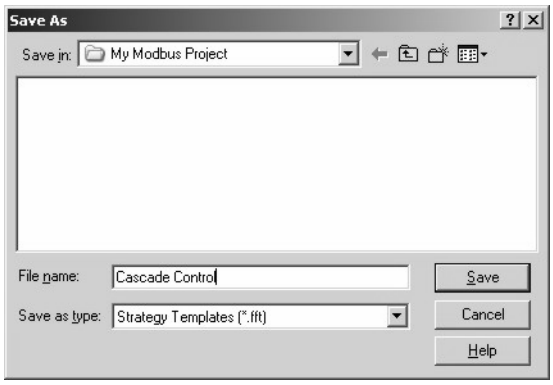
3.7.7 Store the strategy as a template

After configuration, the strategy can be stored as a template for similar applications

1 In the Strategy workspace, drag the mouse across the complete strategy with the lefthand button depressed, until all function blocks are selected



2 Now press the **Strategy Export** button in the toolbar
– The **Save As** dialog appears



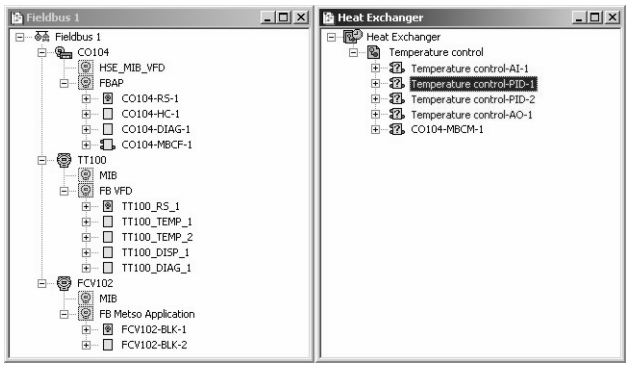
– If appropriate, browse to another folder
– Enter a **File Name**
– Press **Save Entire Configuration** to save the strategy

3 The strategy can be imported again pressing the **Strategy Import** button in the toolbar and double-clicking on the appropriate file name.

3.8 Attach the Function Blocks to the Devices

Now attach the function blocks in the control strategy to the devices where they are to run. The order of assignation determines the order of executions (can be changed by drag&drop).

1 Expand the **Fieldbus** workspace (Fieldbus 1) and the **Process Cell** workspace (Heat exchanger)

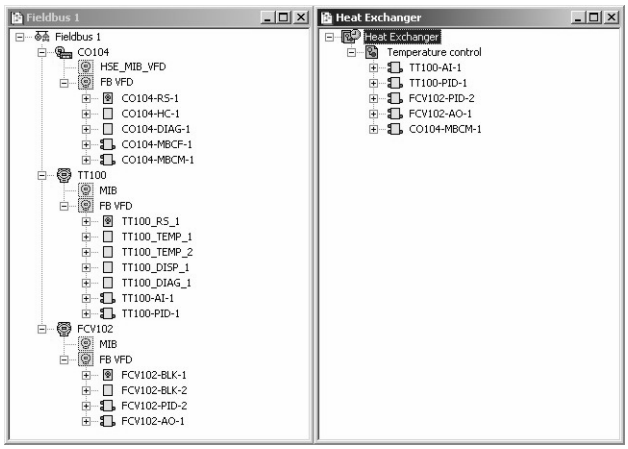


– Note that the Heat Exchanger tree now contains all the function blocks that you created in the Control Strategy workspace

2 Now drag and drop the **Temperature control-AI-1** block to the greyed Function Block Application leaf of the TT100 tree
– When you drop the block, it is attached to tree
– Its name changes to TT100-AI-1 in both views
– The question mark disappears from the block icon in the Process Cell tree
– You have now assigned the Temperature AI block to the temperature transmitter

3 Repeat Step 2 for the other function blocks
– **Temperature control-PID-1** => TT100
– **Temperature control-PID-2** => FCV102
– **Temperature control-AO-1** => FCV102

4 Your project now looks like this



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

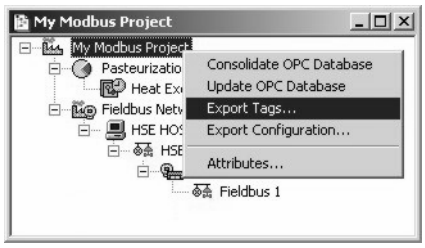
3.9 Export tags

Note!

- You should use the **Export Tags** function everytime you change the configuration of the project, so the the OPC server information is always up-to-date.
- Application Designer will do this automatically everytime you go online, if the corresponding preferences are set, see Chapter 3.3.

1 Active the project view by clicking in its workspace.

2 Right click on the project name, a context menu appears



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

   – Press **OK** to close the dialog

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

3.10 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

3.10.1 Set the IP address of the host computer

SFC162 Field Controllers are delivered with the default IP address:

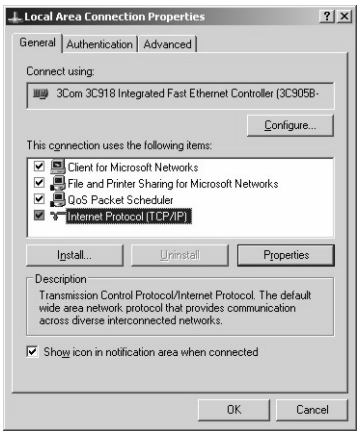
- 192.168.164.100

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**

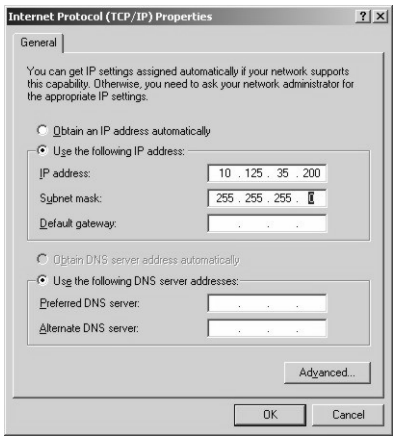


3 Using the left mouse button, double-click **Internet Protocol (TCP/IP)** or click once, then click **Properties**.

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 these are reserved as default addresses for Field Controller SFC162



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

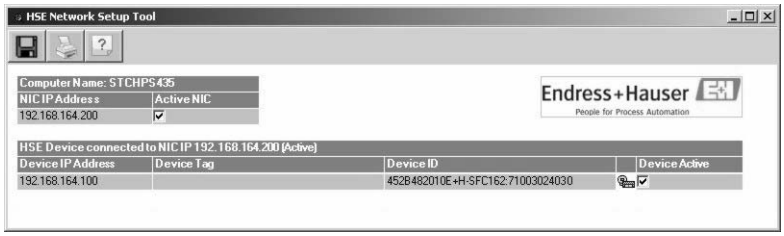
3.10.2 Set the Field Controller IP address

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

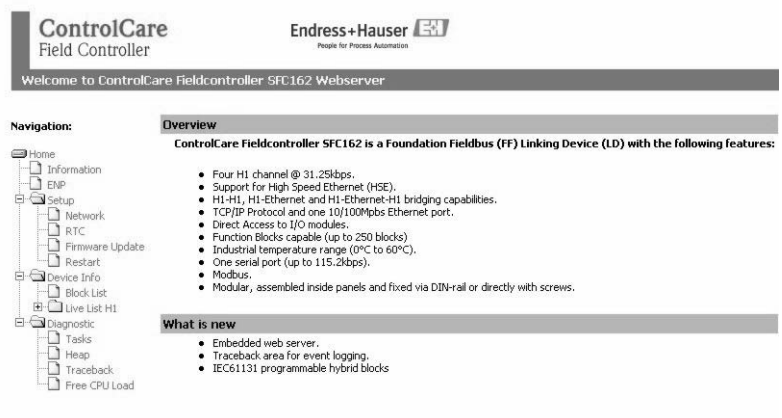
2 HSE Network Setup is launched and searches for Field Controllers in the Ethernet network.



– 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

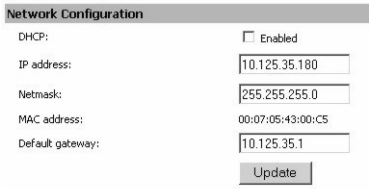
3 If your computer has more than on NIC card, select the one you want to use for communication with the Field Controllers by ticking "Active NIC" and Press .

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



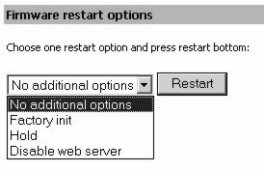
– The Web Server will only open if the host computer and the Field Controller have IP addresses in the same IP domain.

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



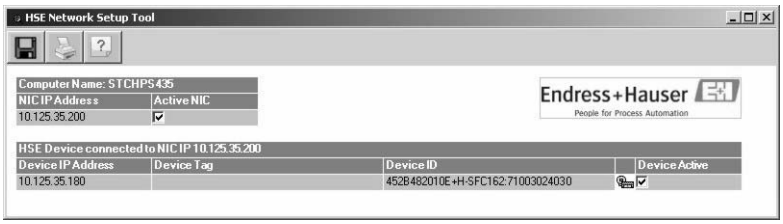
- Enter the required IP address, in our example 10.125.35.180
- Enter a netmask, normally 255.255.255.0
- If required, enter a default gateway, usually address xxx.xxx.xxx.1 in the selected domain

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

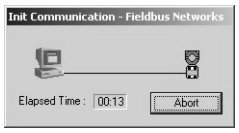
Note!
- If you have more than one Field Controller on the network, Repeat Steps 4 to 6 for all other Field Controllers, introducing them one by one to the network.

3.11 Go online

3.11.1 Create the HSE live list

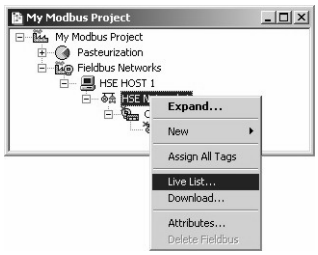
Once the Computer and Field Controller are able to communicate with each other, the connection to the network can be checked by creating a live list.

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

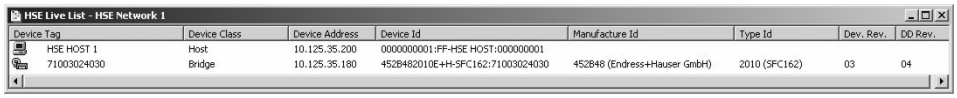


   – Red crosses temporarily appear against the Field Controller and Fieldbus network in the Project workspace

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

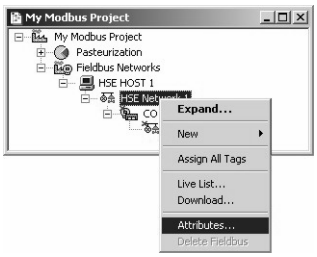


   – A live list is generated of the devices on the HSE network



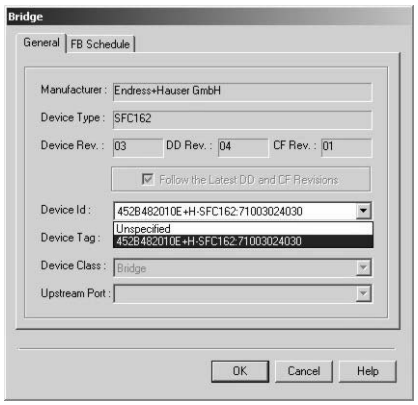
3.11.2 Assign the HSE Device IDs

1 In the project workspace, right click on the **Field Controller** (CO104) and select **Attributes**...

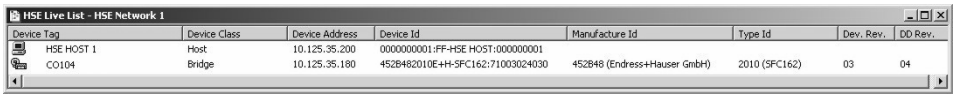


– The **Attributes** dialog opens

2 Open the drop-down menu of the **Device ID** and select the Field Controller that is associated with the displayed TAG (in our case CO104) - 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**



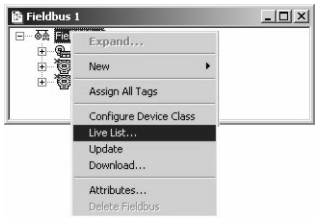
3 In the HSE Live list, the Field Controller icon goes grey, then reappears with the correct tag



4 Click on the **Project View** workspace and **Export Tags**..., see Chapter 3.9
– Open **Project File**, then press **Save Entire Configuration**, to save the project

3.11.3 Create the FOUNDATION Fieldbus live list

1 In the Fieldbus network workspace, right-click on the Field Controller (CO104) and select the option **Live List**

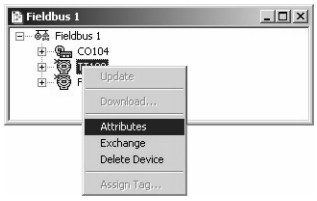


2 The Fieldbus live list is created

- Check that all the devices in the project appear in the live list
- If this is not the case, check connections, power etc.

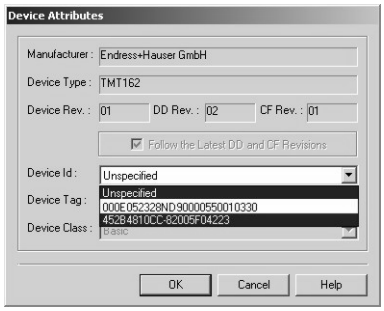
3.11.4 Assign the Fieldbus Device IDs

1 In the fieldbus workspace, right click on **TT100** and select **Attributes**...



- The **Attributes** dialog opens

2 Open the drop-down menu of the **Device ID** and select the Field Controller that is associated with the displayed TAG (in our case TT100) - the serial number is on the nameplatel

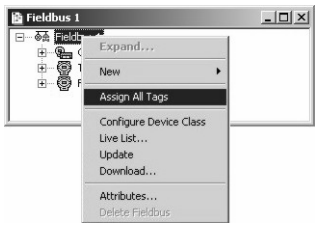


- Confirm your choice with **OK**
- After a short period of time, the red cross disappears from the device in the Fieldbus network

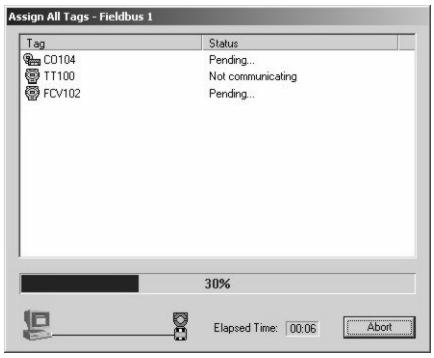
3 Repeat the process for the rest of the devices in the Fieldbus network (FCV102)
- After a period of time, the red cross disappears from the device in the Fieldbus network

3.11.5 Assign All Tags

1 In the Fieldbus workspace, right-click on the Fieldbus node at the top of the tree and select **Assign All Tags**



2 The Assign All Tags dialog appears with the list of device and a progress bar



- On completion, the message "Profile reading done" stands next to the Field Controller and "Tag has been confirmed" next to the devices
- If there are any failures in tag assignment these are logged with reasons at the bottom of the screen.

3 As the assignment proceeds, the Field Controller transmits the change to the device
- The device goes grey in the live list
- The Field Controller initiates a new network scan
- After about 1 - 2 minutes, the device goes black and appears with the new tag

4 At the end of the process the live list looks like this

5 The "bright" dot next to the SFC162 Field Controller indicates that it is the ACTIVE LAS of this segment
- Any devices configured as backup LAS have an ordinary dot next to them, see Chapter 3.12.2

6 Click on the **Project View** workspace and **Export Tags**..., see Chapter 3.9
- Open **Project File**, then press **Save Entire Configuration**, to save the project

3.12 Download the project

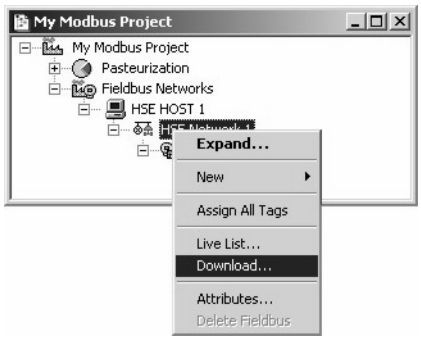
Note!

- 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.

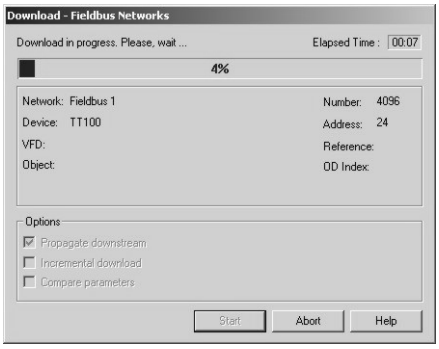
3.12.1 Download

When the devices in the Fieldbus live list correspond to those configured in the project, the download can begin.

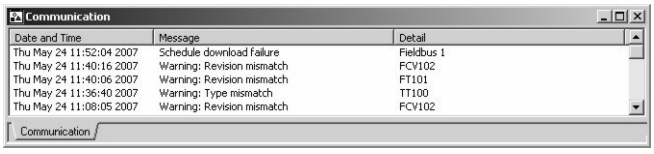
1 In the Project workspace right-click on **HSE Network** and select **Download**



2 The **Download dialog** appears



- Press **Start** to start the download
- A log at the bottom of the screen allows you to identify download problems



3 The download will be interrupted if the project encounters a critial problem, e.g.

- The Project tags are not up-to-date => Chapter 3.10
- The Device IDs have not been assigned correctly => Chapter 6.2.2, Chapter 6.2.4
- The Device Tags have not been assigned => Chapter 6.2.5

4 When the download is successfully completed, the dialog is closed or disappears and you are ready to test the control strategy

3.12.2 Configure device class

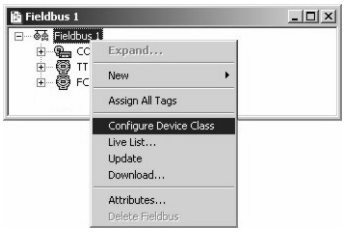
In our project the Field Controller acts as the Link Active Scheduler by default. The FOUNDATION fieldbus protocol allows other devices to take over the this role should the Field Controller fail. This ensures that any control loop not involving function blocks in the controller will continue to function in this event. A device can be setup to be a backup LAS by using the Configure Device Class function. This function is only effective when the device is online.

Note!

- If you are offline, the process finishes at Step 2. The change is registered in the project but is not downloaded with it. The procedure must then be repeated with the device online, otherwise a mismatch when you try to download.

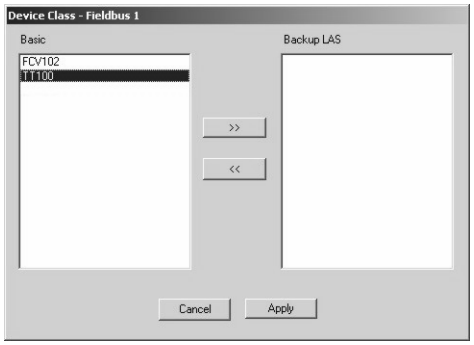
Procedure

1 In the Fieldbus window, right click on the Fieldbus node to open the context menu



– Select the menu **Configure Device Class**

2 The **Device Class** dialog opens



– Select the device(s) you want as backup LAS
(usually one with few FB links, in our case TT100)
– Press >> to transfer the device to the righthand pane
(if the device does not support LAS functionality, an error message appears)
– Press **Apply** to confirm the choice and close the dialog.

3 When online, the **Change Device Class** dialog appears and shows the download progress

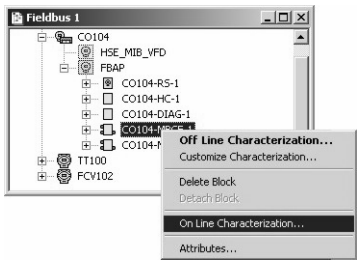
4 On completion the TT100 device appears in the live list with a dot indicating backup LAS functionality

3.13 Make the Modbus Connection

3.13.1 Start the Modbus

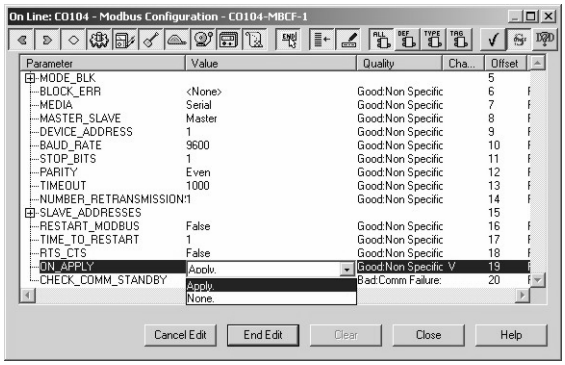
The Modbus must be started after the download (and restarted on every change in the Modbus configuration)

1 In the Fieldbus window, expand the Field Controller tree



– Right-click on the **CO104 -MBCF-1** block and select **On Line Characterization**

2 In the **On Line Characterization** dialog
– Select **All** to display all parameters
– Select the parameter **ON_APPLY**

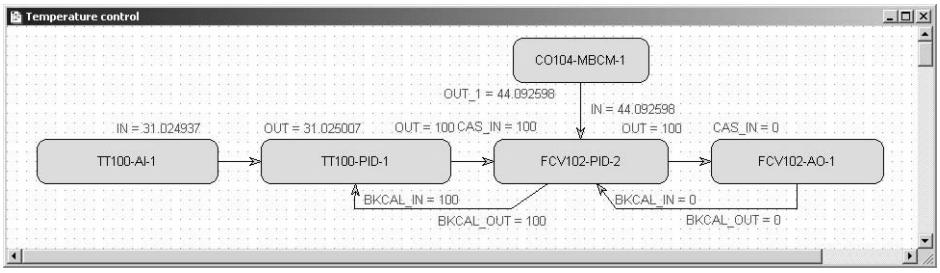


3 Click in the value space at the center of the line and open the drop-down menu
– Select **Apply**
– Click **End Edit** to confirm your choice
– The parameter remains for two or three seconds, then reverts to **None**
– The Modbus starts
– Press **Close** to close the dialog

Note!
- This procedure must be repeated every time the Modbus configuration is changed

3.13.2 Check the control stategy

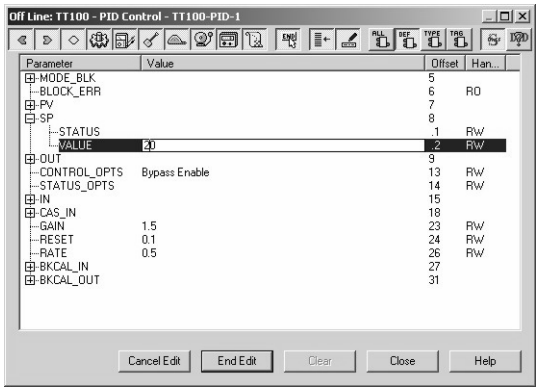
1 Click in the Control Strategy workspace (Temperature control) and press the button in the menu toolbar – the control strategy goes "on-line"



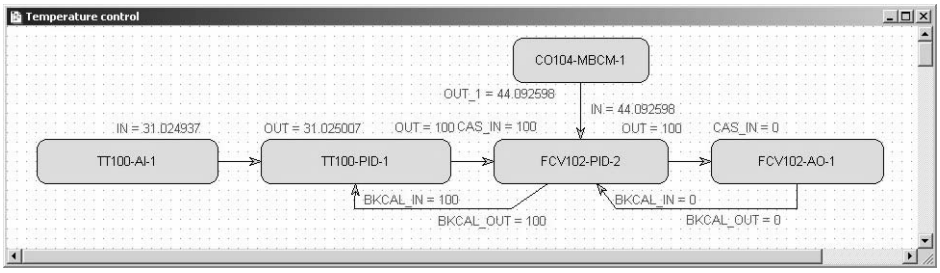
- Values appear in green when the status is good
- Values appear in red if the status is bad - at this stage this is an indication of a Fieldbus configuration, a strategy configuration or a device parametrization error

2 Check that the loop is working by changing the Setpoint parameter in the temperature PID TT100

- Double-click on the **Temperature PID block** TT100-PID-1, the **On-line Characterization** dialog appears
- Press the **All** icon to reveal all parameters
- Open the **SP** leaf and double-click in the space next to **Value**
- Enter a new SP value – for T > SP, set SP < T or vice versa
- Click **End Edit** to set the parameter
- Press **Close** to store the value (if you are prompted - answer with **Yes**)



3 Now check that the control loop has responded properly



3.14 Modify the project

3.14.1 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** (PID block) and **Apply** (MBCF block) parameters, 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 Fieldbus network or Control module workspace, right-click on the function block and select **On-line Characterization**

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

- Press the **All** icon to reveal all parameters
- 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
- If you have modified the Modbus configuration (MBCF or MBCM blocks), start the Modbus again with the ON-APPLY parameter, see Chapter 3.12.1
- 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 3.9
- 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, see Chapter 3.12.2.

3.14.2 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 FOUNDATION Fieldbus 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 3.9
– 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 3.11.6.

6 Start the Modbus with the **ON_APPLY** parameter, see Chapter 3.12.1

7 Put the Control stategy back "on-line" to check the results of your modification, see Chapter 3.12.2.

Note!
- The ON_APPLY parameter must be activated after every download because the Modbus parameters are overwritten during the download process. ON_APPLY confirms the changes and starts the execution of the blocks.

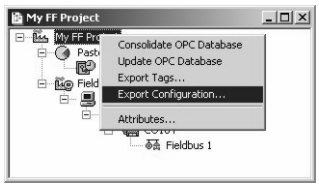
3.15 Export the configuration

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.

3.15.1 File data source folder

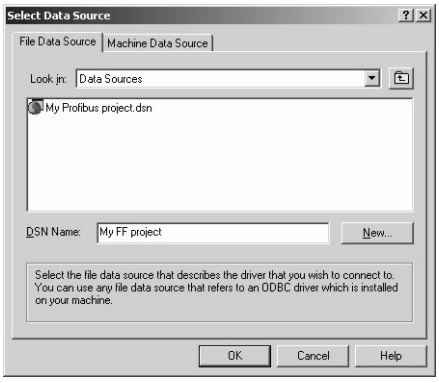
The file data source must have been created before the export.

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:



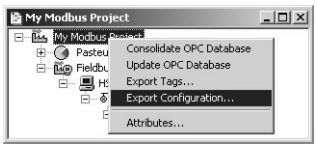
- Press **OK** to make the connection

3.15.2 Machine data source folder

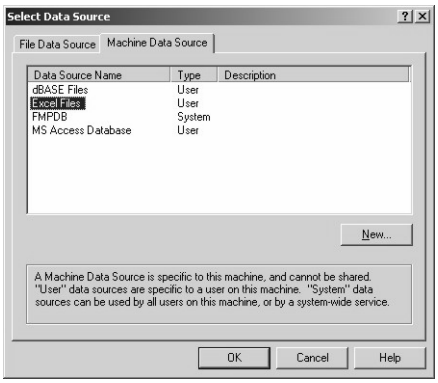
The Machine Data Source is specific to the machine, and cannot be shared. "User" data sources are specific to a user on the machine; "System" data sources can be used by all users on the machine, or by a system-wide service. The Machine Data Source must have been created before export.

Procedure

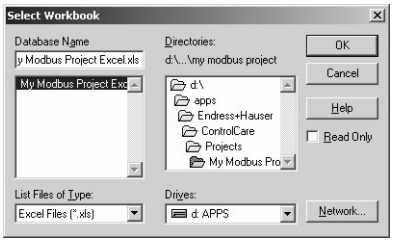
1 In the Project window, right-click on the Project icon and select **Export Configuration**:



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.



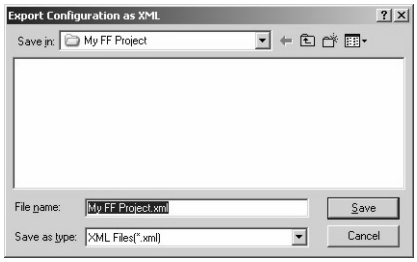
- Your project configuration will be exported to the workbook file.
- A message box appears on completion - press OK

4 Open the Excel file to check the result:

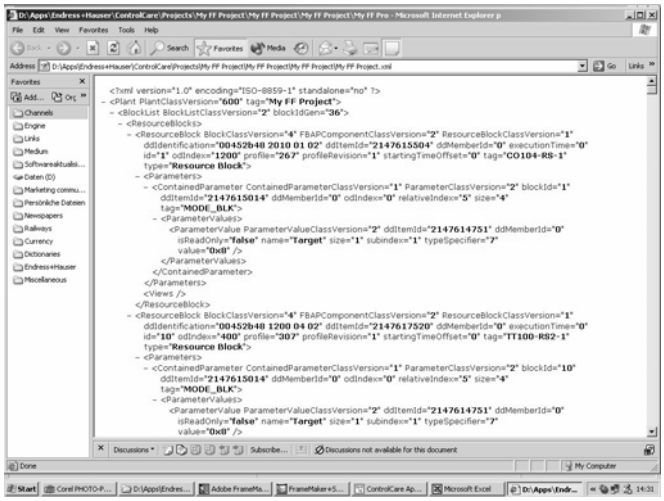
	A	B	C	D	E	F	G	H	I	J	K
1	BlockTag	BlockType	Manufacturer	DeviceType	DeviceRevision	DDRevision	StartingTimeOffset	Execution	ControlModuleTag	DeviceTag	VFDNumber
2	TT100-AI-1	Analog Input	Endress+Hauser GmbH	TMT162	01	02	0	25	Temperature control	TT100	2
3	TT100-PID-1	PID Control	Endress+Hauser GmbH	TMT162	01	02	0	50	Temperature control	TT100	2
4	FCV102-PID-2	PID Control	Metso Automation	METSO FBLK Interface	02	01	0	50	Temperature control	FCV102	2
5	FCV102-AO-1	Analog Output	Metso Automation	METSO FBLK Interface	02	01	0	30	Temperature control	FCV102	2
6	CO104-MBCM-1	ModBus Control Master	Endress+Hauser GmbH	SFC162	03	02	0	4	Temperature control	CO104	2
7	CO104-MBCF-1	Modbus Configuration	Endress+Hauser GmbH	SFC162	03	02	0	4		CO104	2

3.15.3 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



3.16 Close Application Designer

When you have completed your session, close 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 Field Controller, the project remains stored in its memory (back-up switch must be set as described in BA021S/04/en, Field Controller, Hardware Installation)
   – It is initialized and re-executed as soon as the Field Controller is switched on again

3.16.1 Reconnecting

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.

4 Field Controller as Modbus Slave

4.1 Task Description

This part of tutorial describes all steps necessary for setting up the Field Controller as a Modbus Control Slave. 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. Function block descriptions are to be found in BA022/04/en, Function Block manual.

4.1.1 Application

For this part of the tutorial it is assumed that a controller, e.g. PLC, acting as a Modbus master acquires a temperature value from a FOUNDATION Fieldbus device through the Field Controller, which acts as a Modbus slave. The Modbus master returns a control signal to a FOUNDATION Fieldbus positioner, which in turn reports its new position to the Modbus controller. It is assumed that all control is done in the Modbus master, so the FOUNDATION Fieldbus network supplies and receives values only. The corresponding control strategy is shown in Fig. 4-1.

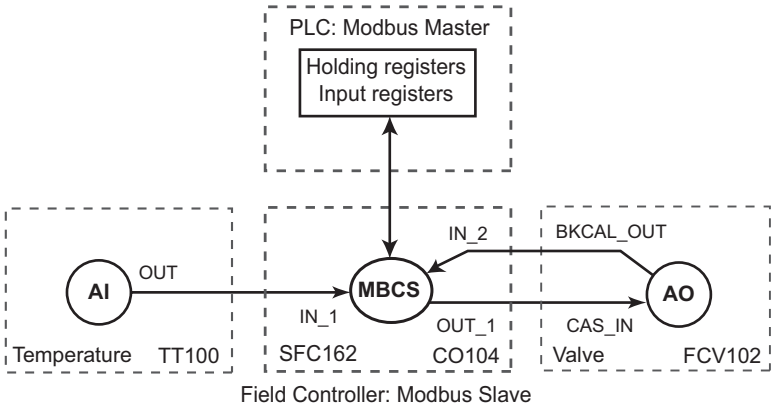


Fig. 4-1 Cascade control strategy for heat exchanger application

Since it is not the object of this tutorial to describe the programming of a Modbus controller, the control function has been simulated by the ModSim32 software. This provides a simple means of testing the application and checking what is being transmitted across the Modbus interface. The simulator operates via Ethernet TCP, but other simulators are available for RS232.

Note!

- The Modbus standard restricts the maximum slave telegram length to 253 bytes, which corresponds to 125 measuring points of two bytes each plus three. This corresponds to a maximum of three control slave blocks, LOCAL_MOD_MAP 1 -3 = address range 40000 – 40120. If more blocks are required, the master must be programmed to send more than one read request per cycle.

4.1.2 Network

The network is assumed to be constructed as shown in Fig. 4-2.

- The Modbus master is simulated by the ModSim32 application
- The valve positioner is a Metso ND9103FN
- The temperature transmitter TMT162

In the example the SFC162 is used as Modbus Slave, but the SFC173 could also be used.

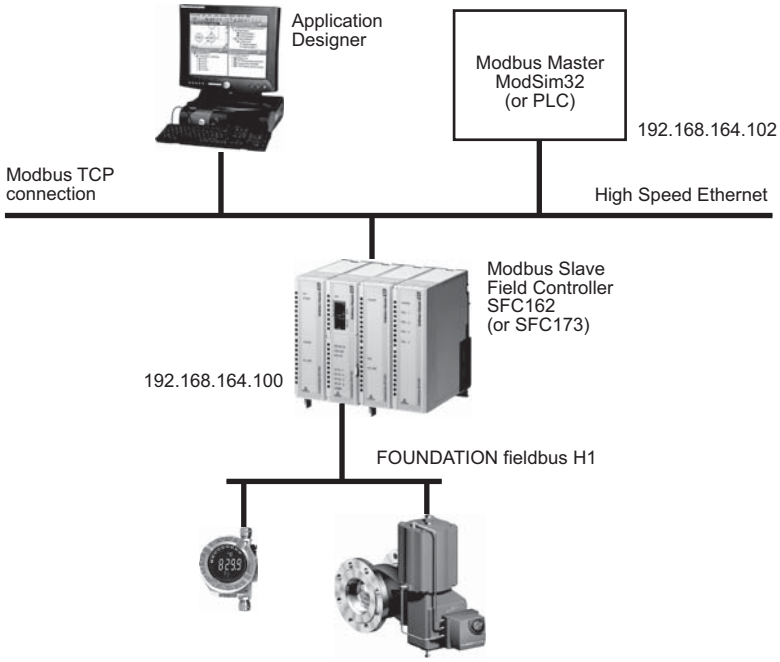


Fig. 4-2 Network for application example

4.1.3 Installation and commissioning

Before you can start this part of the Modbus tutorial, Application Designer must be installed on your computer, the SFC162 FOUNDATION Fieldbus 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

4.1.4 Device ID and tag

For a FOUNDATION Fieldbus system, each device that communicates has a unique bus address and tag. Addresses are assigned automatically during the start-up of the system on the basis of the device ID. The device ID is a unique identifier that is based on a Manufacturer ID and the serial number of the device. When the project goes online, the actual device IDs must be assigned to virtual devices that have been planned in Application Designer by using the Assign Tags procedure.

To aid the offline engineering of the network, it is necessary to keep a record of the measuring point tags (device tags), often as an Excel sheet. Measuring point tags are used in P&I diagrams to indicate the type of measurement or action performed at a particular location in a process. Table 4-1 below provides an example of how this might look for the application at hand.

Area	Process Cell	Device	Vendor	Tag	Unit	Task
Pasteurization	Heat Exchanger	TMT162	E+H	TT100	°C	Product temperature
Pasteurization	Heat Exchanger	ND9103FN	Metso	FCV102	%	Steam valve positioner
Pasteurization	Heat Exchanger	SFC162	E+H	CO104		Field Controller acting as Modbus slave

Tab. 4-1: Measuring point tag list for tutorial application

4.2 Create a project

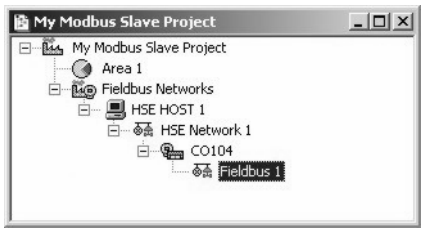
4.2.1 Create the project and add the fieldbus

1 Following the instructions in Chapter 3.2 create a new project, e.g. My Modbus Slave Project

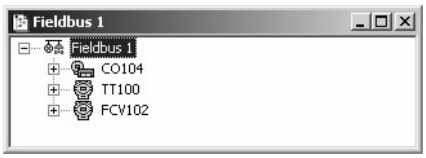
2 Following the instructions in Chapter 3.3, set the preferences

3 Following the instructions in Chapter 3.4, add the bridge, fieldbus and devices
– In this case, do not add the MBCF and MBCM blocks to the controller yet.

4 Your project should now look something like this:



and the fieldbus like this

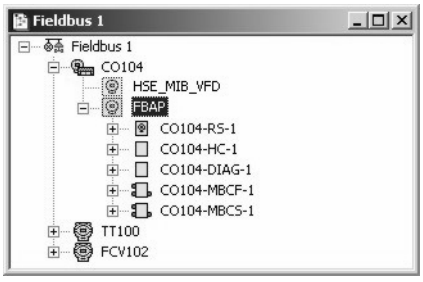


4.2.2 Add the Modbus blocks

1 Expand the Field Controller (CO104) leaf on the Fieldbus tree and add the Modbus blocks MBCF and MBCS

– Right-click on the FBAP leaf and select New Block
– Select the Modbus Configuration block
– Repeat and select the Modbus Control Slave block

2 The Fieldbus tree now looks like this

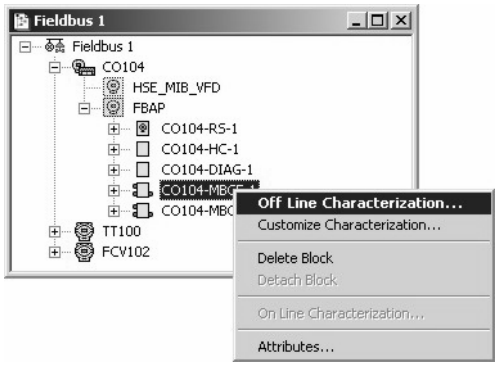


3 Open **Project File**, then press **Save**, to save the project

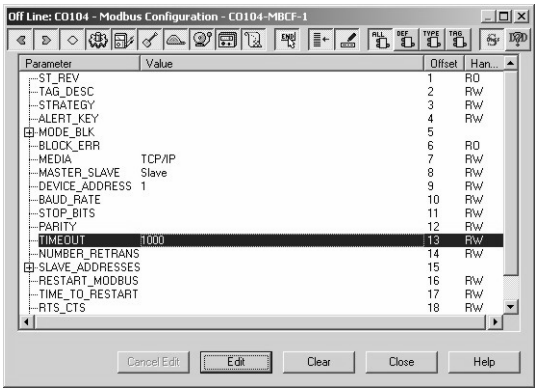
4.3 Configure the devices

4.3.1 MBCF Modbus Configuration block

1 In the Fieldbus 1 window, right-click on the Field Controller function block **CO104-MBCF-1** and select **Off Line Characterization**

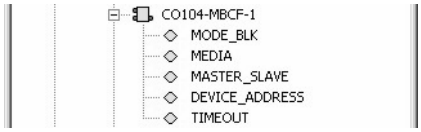


2 The **Offline Characterization** dialog opens: Press **All** to show all parameters



3 Set the following parameters by double-clicking in the middle of the parameter line, entering or selecting the parameter from the drop-down menu, and clicking End Edit to register the change (MBCF block parameters are described in Chapter 6.1):

- **MODE_BLK TARGET** = Auto
- **MEDIA** = TCP/IP
- **MASTER_SLAVE** = Slave
- **DEVICE_ADDRESS** =1
- **TIMEOUT** = e.g. 1000
  The value entered must be greater than the write cycle of the Modbus master
- Click **Close** to close the dialog: the parameters are added to the MBCF function block



4.3.2 MBCS Modbus Control Slave block

The MBCS function block allows fieldbus and Modbus data to be exchanged through 16 Modbus registers: if required, the register addresses in the Field Controller can be calculated from the LOCAL_MOD_MAP table, see Chapter 6.2. Each block offers:

- Four OUT channels for reading analog values from the Field Controller Modbus registers
- Four OUT_D channels for reading discrete values from the Field Controller Modbus registers
- Four IN channels for writing analog values to the Field Controller Modbus registers
- Four IN_D channels for writing discrete values to the Field Controller Modbus registers

The SCALE_CONV_XXX parameter allows each channel to be individually configured for scaling and data type. If more than four registers of a particular type are required, up to 16 MBCM blocks can be created: in this case the various blocks are identified by the parameter LOCAL_MOD_MAP. This means that a total of 64 AIs, 64 AOs, 64 DIs and 64 DOs can be mapped from the Modbus network. By default LOCAL_MOD_MAP = 0, valid range 0 – 15.

For the tutorial we require the IN_1, IN_2 and OUT_1 channels. When LOCAL_MOD_MAP is set to zero, the data will be mapped to the registers in Table 4-2.

Parameter	Channel	Register	Data type	Access
Temperature	IN_1	40001	Float	Write
Status		40017		
Positioner	OUT_1	40009	Float	Read
Status		40021		
Back calculation	IN_2	40003	Float	Write
Status		40018		

Tab. 4-2: Modbus registers for exchange of data

By default, the Field Controller sends its float number with the bytes order 1-0-3-2 and not in the sequence 3-2-1-0. The 1-0-3-2 sequence corresponds to the DATA_TYPE "float"

The values mapped to the Field Controller or sent to a Modbus device register can be scaled. The parameters:

- FROM_EU_0
- FROM_EU_100
- TO_EU_0
- TO_EU_100

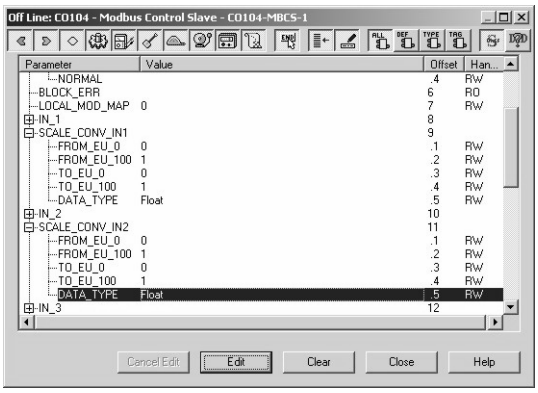
allow a conversion from one set of engineering units to a second set of engineering units, by simply entering the lower and upper limit values of each set. In our example, no scaling will be done and the default parameters 0 and 1 entered for both "TO" and "FROM" parameters.

The STATUS_OUT_Dx and STATUS_OUTPUT elements used in the OUT parameters define the following rules for OUTPUT STATUS parameters:

- If the option "Set by master" is used, the output status will behave exactly as the Fieldbus protocol works, in other words, the status will reflect the value which the master is writing but if after TIMEOUT (defined in MBCF block) the status is not updated, this status will be forced to BAD COMMUNICATION. **For this reason the TIMEOUT parameter in the MBCF block must be set to a value greater than the write cycle of the Modbus master.**
- If the user defines this element with anything other than "Set by master", this value will be reflected in output status, while communication OK, otherwise the status goes to BAD COMMUNICATION..

Procedure

1 Right-click on the **CO104-MBCS-1** block and open the **Off Line Characterization** dialog



2 Click All to reveal all parameters and enter the following parameters by double-clicking in the middle of the parameter line, entering or selecting the parameter from the drop-down menu, and clicking End Edit to register the change:

- **MODE_BLK TARGET** = Auto
- **LOCAL_MOD_MAP** = 0

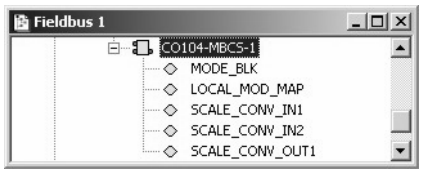
3 Now set the following **SCALE_LOC_CONV1** parameters for the **IN_1** and **IN_2** channels:

- **FROM_EU_0** = 0
- **FROM_EU_100** = 1
- TO_EU_0 = 0
- **TO_EU_100** = 1
- **DATA_TYPE** = Float

4 Set the following **SCALE_LOC_CONV1** parameters for the **OUT_1** channel:

- **FROM_EU_0** = 0
- **FROM_EU_100** = 1
- TO_EU_0 = 0
- **TO_EU_100** = 1
- **DATA_TYPE** = Float
- **STATUS_OUTPUT** = "Good_Cascade::NonSpecific:NotLimited"

5 Press **Close** to close the Off Line Characterization dialog. You should now see the parameters attached to the MBCM block:



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

4.3.3 Configure the Fieldbus devices

1 Configure the devices according to Tables 4-3 and 4-4 as described in Chapter 3.5.3 and 3.5.4 respectively.

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

TMT162

Table 4-3 shows the parameters that must be set in the TMT162 transducer block

Parameter	Function	Temperature TT100
MODE BLOCK/TARGET	Normal operating mode of block	Auto
PRIMARY_VALUE_TYPE	Calculation method for primary process value ▪ Process temperature SV1 or SV2 ▪ Average 0.5 (SV1 + SV2) with/without redundancay ▪ Differential (SV1 - SV2) ▪ Conditional (SV1 or SV2), (SV2 if SV1 >T)	Sensor Value 1
SENSOR_TYPE	Type of sensor connected to the transmitter ▪ All types of standardized temperature sensors	Pt 100 IEC 751
SENSOR_CONNECTION	Way in which the sensor is connected ▪ 4-wire (if two sensors are connected only one can be 4-wire) ▪ 3-wire ▪ 2-wire	2-wire

Tab. 4-3: Basic parameters for TMT162 transducer block

ND9103FN

Rotary valve parameters are included in Table 4-4.

Parameter	Function	Positioner FCV102
MODE BLOCK/TARGET	Normal operating mode of block	Auto
VALVE_TYPE	Type of valve the positioner is actuating ▪ Select from drop-down menu	Rotary
FINAL_VALUE_RATE_DN	Maximum travel rate in closing direction ▪ 0 = parameter not in use	0
FINAL_VALUE_RATE_UP	Maximum travel rate in opening direction ▪ 0 = parameter no in use	0
POSITIONER_FAIL_ACTION	Action of position on loss of electrical power or reception of an output signal with a bad status ▪ Select from drop-down menu	Close
POS_SENSOR_ROT	Relationship between valve action and position sensor rotation ▪ Select from drop-down menu	Standard: Clockwise to close
DEAD_ANGLE_COMP	Dead angle for segment and rotary valves	0
ACT_TYPE	Type of positioner action ▪ Select from drop-down menu	Double-acting actuator
PERFORMANCE_LEVEL	Target performance level of valve position control Select from drop-down menu	Optimum
CHAR_TYPE	Type of linearization ▪ Select from drop-down menu	No characterization

Tab. 4-4: Basic parameters for Metso ND9103FN transducer block

4.4 Create the Control Strategy

Having created a physical view of the process, the next step is to create control strategy. This is done described in Section 3.6.

4.4.1 Add a Process Cell

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

- The **Attributes** dialog box appears
- Enter a name for the area, e.g. Pasteurization (see Table 3-1, Chapter 3.1.4)
- Click **OK** to store your changes

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

- The **Process Cell** dialog box appears
- Enter a name for the process cell, e.g. Heat Exchanger (see Table 3-1)
- Click **OK** to store your changes

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

4.4.2 Add a Control Module

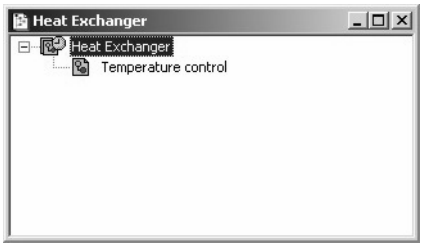
1 Right-click on the Process Cell leaf you just created and select **Expand**

- A new window with the name of the leaf opens

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

- The **Control Module** dialog box appears
- Enter a name for the control module, e.g. Temperature Control (see Table 3-1)
- Click **OK** to store your changes

3 The project looks something like this



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

4.4.3 Create the function blocks

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** = TMT162
- 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

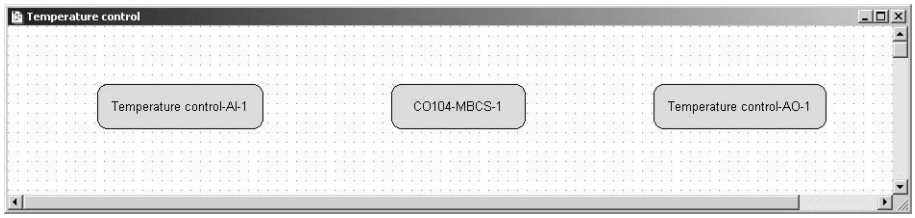
4 Repeat Steps 2 and 3 for the Positioner AO block

- Positioner AO
  Manufacturer = Metso Automation
  Device Type = FBLK Interface
  Block Type = Analog Output

5 The flow value is supplied by the MBCS block which you have already created

- In the **Fieldbus 1** window expand the **CO104** leaf and click on **CO104-MBCS-1**
- Drag and drop the block into the control strategy window

6 The control strategy now looks like this



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

Note

- In the tutorial we created the MBCS block together with the MBCF block. Is is also possible to create the MBCS block in the strategy window as we have done with the AI and AO blocks, and then drag and drop it to the Fieldbus, see Chapter 3.8.

4.4.4 Add the Function Block links

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

2 Click on **Function Block Link** button in the tool bar, the cursor changes to a cross

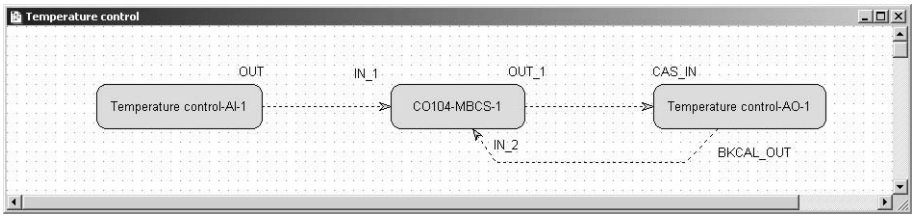
3 Select the **Temperature AI block** with the cross: the **Output Parameter Selection** dialog appears

- 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 **CO104-MBCS-1** block and click to make the link
- When the link is made, the Input Parameter Selection dialog for the PID block appears
- Click the box next to **IN_1** – it changes color – then click on **OK**

4 Repeat steps 2 to 3 and make the following links between the function blocks

- CO104-MBMS-1 to Valve AO = **OUT_1** to **CAS_IN**
- Valve AO to CO104-MBMS-1 = **BKCAL_OUT** to **IN_2**

5 Your Control Strategy now looks something like this



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

4.5 Configure the strategy

4.5.1 Configure the blocks

1 In the Control strategy workspace, double-click on the **Temperature control AI-1** block
Set the parameters in Table 4-5 as described in Chapter 3.7.2

2 In the Control strategy workspace, double-click on the **Temperature control AO-1** block
Set the parameters in Table 4-6 as described in Chapter 3.7.6

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

Analog Input parameters

Parameter	Function	Temperature TC100
MODE BLOCK/TARGET	Normal operating mode of block	Auto
XD_SCALE/EU_100* XD_SCALE/EU_0 XD_SCALE/UNITS_INDEX	Upper range value for process variable Lower range value for process variable Unit of process variable	150 (max.850) –50 (min. –200) °C
OUT_SCALE/EU_100 OUT_SCALE/EU_0 OUT_SCALE/UNITS_INDEX	Upper range limit for output variable Lower range limit for output variable Unit of output variable	100 0 %
CHANNEL	Output channels of Transducer Block aasigned to Ananlog Input Block. ▪ Primary, RJ or Sensor vlaue 1/2 depending on whether one or two sensors are connected	Sensor Value 1
L_TYPE	Selects the type of linearisation for the input value. ▪ Direct: PV value = OUT value, Identical XD_SCALE and OUT_SCALE ▪ Indirect: PV value scaled to OUT value ▪ Indirect Square Root: as Indirect but scaling with root function	Indirect
PV_FTIME	Output damping constant (in seconds).	1

Tab. 4-5: Basic parameters for Analog Input block

Analog Output parameters

Parameter	Function	Positioner FCV102
MODE BLOCK/TARGET	Normal operating mode of block	Cas
PV_SCALE/EU_100 PV_SCALE/EU_0 PV_SCALE/UNITS_INDEX	Upper range limit for process variable Lower range limit for process variable Unit of process variable	100 0 %
XD_SCALE/EU_100 XD_SCALE/EU_0 XD_SCALE/UNITS_INDEX	Upper range limit for output variable Lower range limit for output variable Unit of output variable	15 3 psi
CHANNEL	Defines the signal configuration between the AO block and transducer block.. ▪ 1 = AO, valve control ▪ 2 = AO, no transducer connected	1 = valve control
SHED_OPT	Behaviour when shedding from remote mode	Normal shed, normal return

Tab. 4-6: : Basic parameters for Analog Output block

4.5.2 Attach the Function Blocks to the Devices

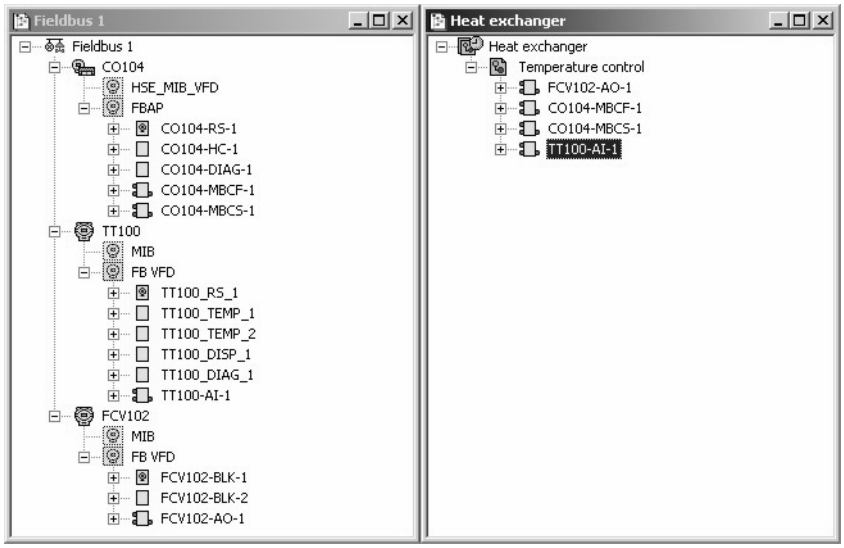
Now attach the function blocks in the control strategy to the devices where they are to run. The order of assignation determines the order of executions (can be changed by drag&drop).

1 Expand the **Fieldbus** workspace (Fieldbus 1) and the **Process Cell** workspace (Heat exchanger)

2 Now drag and drop the **Temperature control-AI-1** block to the greyed Function Block Application leaf of the TT100 tree
- When you drop the block, it is attached to tree
- Its name changes to TT100-AI-1 in both views
- You have now assigned the Temperature AI block to the temperature transmitter

3 Repeat Step 2 for the other function block
- **Temperature control-AO-1** => FCV102

4 Your project now looks like this



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

4.5.3 Export tags

1 Active the project view by clicking in its workspace.

2 Right click on the project name, a context menu appears
- 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**, to save the project

4.6 Go Online

Now go online as described in more detail in Chapter 3.11.

4.6.1 Connect to the Field Controller

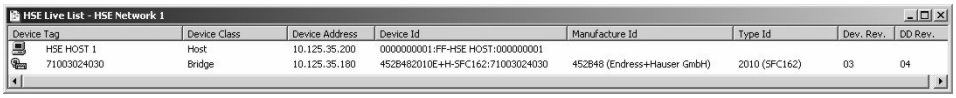
After the Field Controller and other components have been physically installed in the network, connection must be established as described in Chapter 3.10.

4.6.2 Create the 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 as decribed in Chapter 3.11.1

1 Press the **On-Line** button  in the menu toolbar
- The project goes on on-line
- Red crosses appear against the Field Controller and Fieldbus network 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

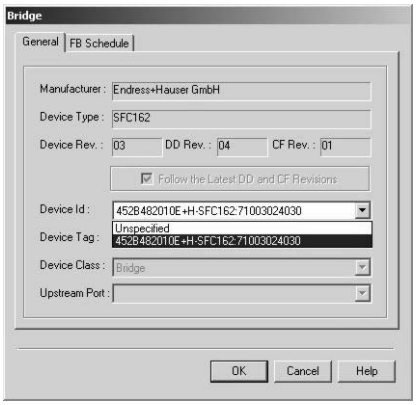


4.6.3 Assign the HSE Device IDs

Assign the HSE Device IDs as decribed in Chapter 3.11.2

1 In the project workspace, right click on the **Field Controller** (CO104) and select **Attributes**...
- The **Attributes** dialog opens

2 Open the drop-down menu of the **Device ID** and select the Field Controller that is associated with the displayed TAG (in our case CO104) - 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 In the HSE Live list, the Controller Icon goes grey, then reappears with the correct tag

4 Click on the **Project View** workspace and **Export Tags**..., see Chapter 3.9
- Open **Project File**, then press **Save Entire Configuration**, to save the project

4.6.4 Create the FOUNDATION Fieldbus live list

Create the Foundation Fieldbus live list as described in Chapter 3.11.3

1 In the Fieldbus network workspace, right-click on the Field Controller (CO104) and select the option **Live List:** The Fieldbus live list is created

Device Tag	Device Class	Device Address	Device Id	Manufacture Id	Type Id	Dev. Rev.	DD Rev.
FCV102	Basic	26 (0x1A)	000E052328ND90000550010330	E05 (Metso Automation)	2328 (METSO FBLK ...	03	01
CO104	Bridge	16 (0x10)	452B482010E+H-SFC162:71003024030	452B48 (Endress+Hauser GmbH)	2010 (SFC162)	03	04
TT100	Link Master	27 (0x1B)	452B4810CC-82005F04223	452B48 (Endress+Hauser GmbH)	10CC (TMT162)	01	01

- Check that all the devices in the project appear in the live list
- If this is not the case, check connections, power etc.

4.6.5 Assign the Fieldbus Device IDs

Assign the Fieldbus Device IDs as decribed in Chapter 3.11.4.

1 In the fieldbus workspace, right click on **TT100** and select **Attributes**...
- The **Attributes** dialog opens

2 Open the drop-down menu of the **Device ID** and select the Field Controller that is associated with the displayed TAG (in our case TT100) - the serial number is on the nameplatel
- Confirm your choice with **OK**
- After a short period of time, the red cross disappears from the device in the Fieldbus network

3 Repeat the process for the rest of the devices in the Fieldbus network (FCV102)
- After a period of time, the red cross disappears from the device in the Fieldbus network

4.6.6 Assign All Tags

1 In the Fieldbus workspace, right-click on the Fieldbus node at the top of the tree and select **Assign All Tags**

2 The Assign All Tags dialog appears with the list of device and a progress bar
- On completion, the message "Profile reading done" stands next to the Field Controller and "Tag has been confirmed" next to the devices

3 As the assignment proceeds, the Field Controller transmits the change to the device
- The device goes grey in the live list
- The Field Controller initiates a new network scan
- After about 1 - 2 minutes, the device goes black and appears with the new tag

4 At the end of the process the live list looks like this

Device Tag	Device Class	Device Address	Device Id	Manufacture Id	Type Id	Dev. Rev.	DD Rev.
FCV102	Basic	26 (0x1A)	000E052328ND90000550010330	E05 (Metso Automation)	2328 (METSO FBLK ...	03	01
CO104	Bridge	16 (0x10)	452B482010E+H-SFC162:71003024030	452B48 (Endress+Hauser GmbH)	2010 (SFC162)	03	04
TT100	Link Master	27 (0x1B)	452B4810CC-82005F04223	452B48 (Endress+Hauser GmbH)	10CC (TMT162)	01	01

5 The "bright" dot next to the SFC162 Field Controller indicates that it is the ACTIVE LAS of this segment

6 Click on the **Project View** workspace and **Export Tags**..., see Chapter 3.9
- Open **Project File**, then press **Save Entire Configuration**, to save the project

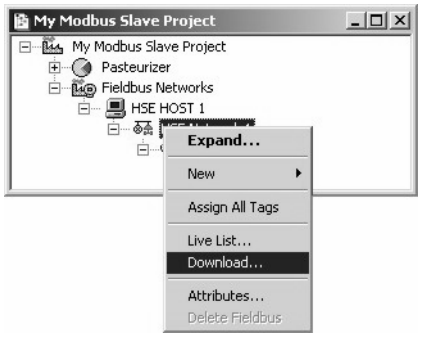
4.7 Download the project

Note!

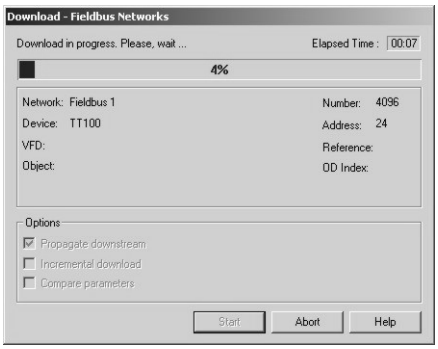
- The procedure below describes the initial download for the entire HSE network.
- Partial downloads can be made later from lower leaves, when changes are confined to this level
- Incremental downloads can be made to a running project by checking the boxes **Incremental Download** and **Compare Parameters**: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

When the devices in the Fieldbus live list correspond to those configured in the project, the download can begin.

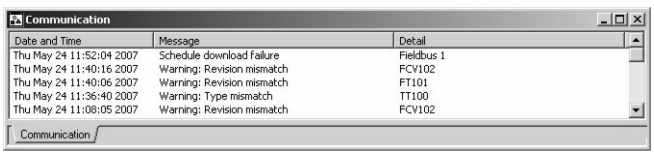
1 In the Project workspace right-click on **HSE Network** and select **Download**



2 The **Download dialog** appears



- Press **Start** to start the download
- A log at the bottom of the screen allows you to identify and non-critical download problems



3 The download will be interrupted if the project encounters a critial problem, e.g.

- The Project tags are not up-to-date => Chapter 3.10
- The Device IDs have not been assigned correctly => Chapter 6.2.2, Chapter 6.2.4
- The Device Tags have not been assigned => Chapter 6.2.5

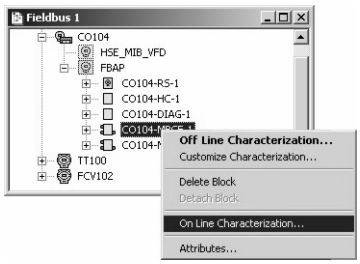
4 When the download is successfully completed, the dialog is closed, and you are ready to test the control strategy

4.8 Make the Modbus Connection

4.8.1 Start the Modbus

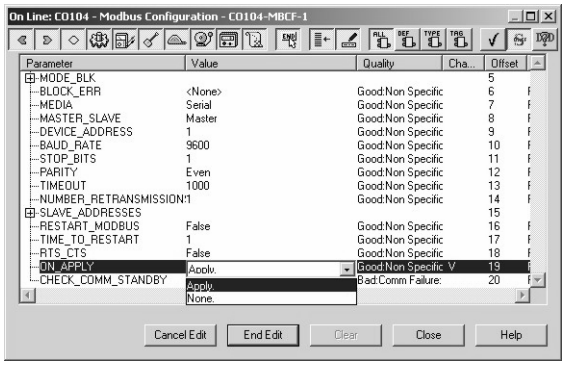
The Modbus must be started after the download (and restarted on every change in the Modbus configuration)

1 In the Fieldbus window, expand the Field Controller tree



– Right-click on the **CO104 -MBCF-1** block and select **On Line Characterization**

2 In the **On Line Characterization** dialog
– Select **All** to display all parameters
– Select the parameter **ON_APPLY**



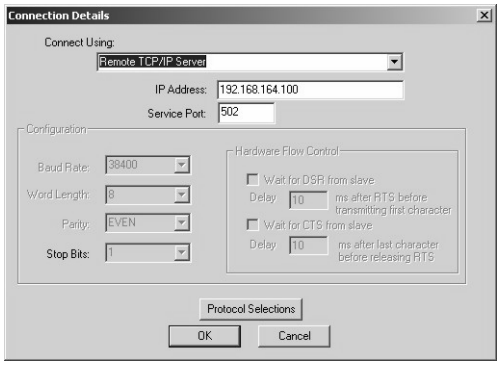
3 Click in the value space at the center of the line and open the drop-down menu
– Select **Apply**
– Click **End Edit** to confirm your choice
– The parameter remains for two or three seconds, then reverts to **None**
– The Modbus starts
– Press **Close** to close the dialog

Note!
- This procedure must be repeated every time the Modbus configuration is changed, including project download.

4.8.2 Start the Modbus simulator

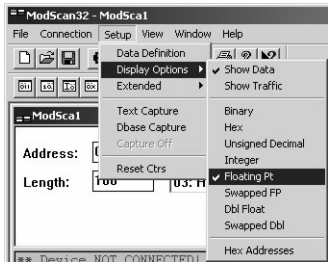
1 Start the ModSim32 or other Modbus simulator as master from the desktop or through the Explorer

2 Set up the communication by selecting **Connections => Connect**



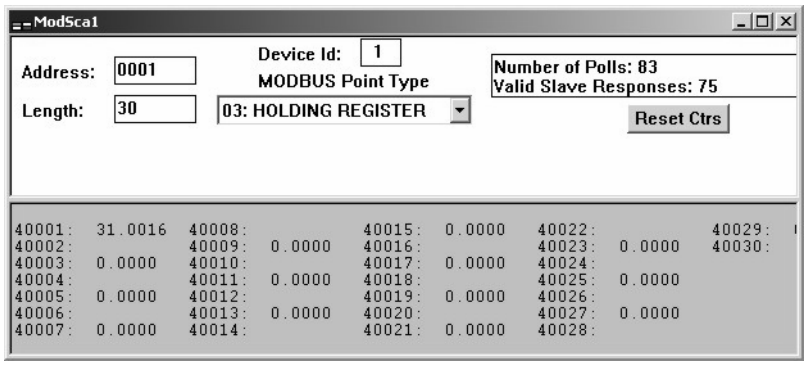
- Set the **Connect Using** to **Remote TCP/IP** Server
- Enter the **IP Address** of the Field Controller (here default 192.168.164.100)
- Press **OK** to confirm the settings

3 Set up the data display by selection **Setup => Display Options**



- Select **Show Data**
- Select **Floating Pt**

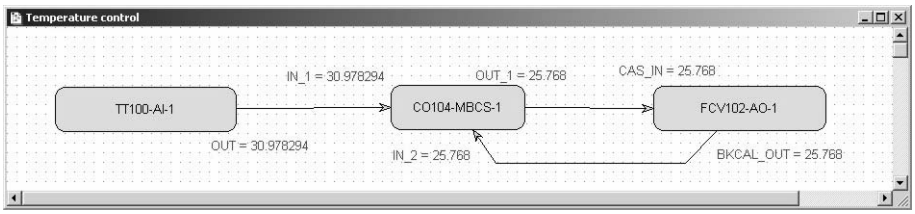
4 Select the view **Holding Registers** from the drop-down menu in the user interface.
- Set the **Address** to 0001 and **Length** to 50
- You should now be able to see **IN_1** and **IN_2** in registers **40001** and **40003**



5 Double-click on register **40009** and enter a value to simulate the **OUT_1** value.

4.8.3 Check the control stategy

1 Click in the Control Strategy workspace (Temperature control) and press the button  in the menu toolbar – the control strategy 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 Fieldbus configuration, a strategy configuration or a device parametrization error

4.8.4 Modify, export and close the project

See Chapters 3.13 to 3.15.

5 Trouble-Shooting

5.1 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.

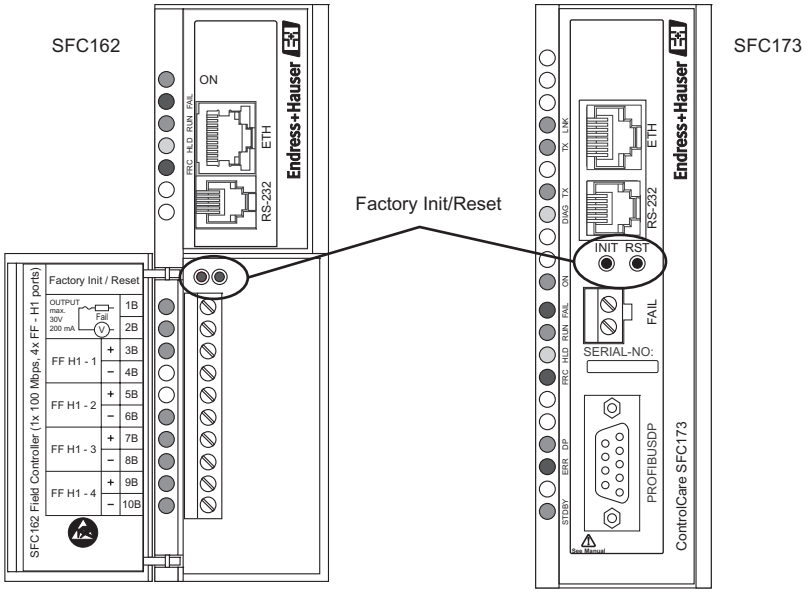


Fig. 5-1: Front panels of SFC162 and SFC173 Field Controllers

Two pushbuttons, located in the Field Controller module 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).
- Once started, any mode (Factory Init or HOLD Mode) can be exited by keeping the right pushbutton pressed and releasing the left pushbutton.
- If you loose the count of the times that the right pushbutton was pressed, check the rate at which the **FORCE** LED is flashing. It will return to a rate of once a second after the fourth touch (the function is rotative).

Function	Effect
Reset	Click the right pushbutton (see details in Fig. 5.1) and the system will execute the **RESET**, taking some seconds for correct system initialization. In accordance with the procedure via FC Tools, a new IP will be attributed automatically or the last configured IP will be accepted for the system. Verify that the **RUN** and **ETH LNK** LEDs remain lit.
Factory Init	Keep the left pushbutton pressed and then click the right pushbutton, checking that the **FORCE** LED flashes once a second. Release the left push button and the system will execute the **RESET**, deleting the previous configurations.
HOLD mode	Keep the left pushbutton pressed and then double click the right pushbutton, checking that the assuring that **FORCE** LED flashes twice a second.Release the left pushbutton and the system will execute the **RESET** and then enter the **HOLD** mode. Verify that the **HOLD** and **ETH LNK** LEDs remain lit. With the Field Controller in this mode, you can use the FC Tools Wizard to update the firmware or change the IP address. Use the **Reset** again, case you want to return to the execution mode (**RUN**).

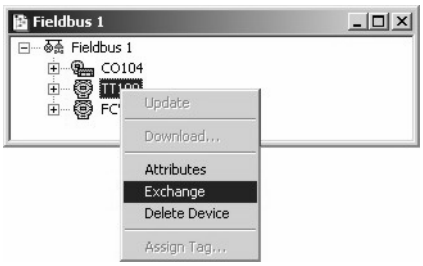
5.2 Exchanging devices

It may be that during Device ID assignment, see Chapters 6.2.2 and 6.2.4, Application Designer detects a revision mismatch. If this occurs, the device revision must be changed in the project and the project downloaded as described below.

Note!
- For exchange of controllers, see Chapter 7.3, Updating the Firmware, in BA035S/04/en
- The process also applies to exchange of devices of the same type but different device revision
- In the case of devices from different manufacturers, manually check the incompatibilities (press **NO** at Step 3). Additional adjustments to the strategy may also be required.
- Device revisions not supported by Application Designer can be downloaded from www.fieldbus.org and integrated using the Import Device Support function

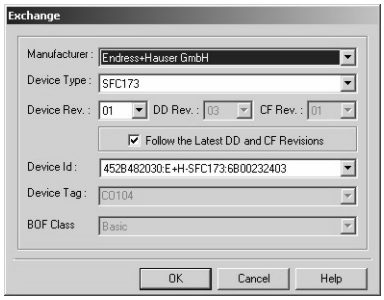
Procedure

1 Open the project in Application Designer and select the device to be updated, here SFC162



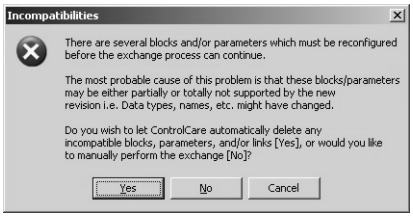
– Right-click on the node and select **Exchange...**

2 The **Exchange** dialog for the device appears



– Open the **Device Rev** menu and select the correct revision
– Press **OK** to confirm the change and close the dialog.

3 The **Incompatibilities** dialog may now appear



– Press **OK** to automatically update all links
– Close the successful exchange dialog by pressing **OK**.

4 Export the tags, press  to go on-line and download the project as described in Chapter 3.12.

5.3 Trouble-shooting tables

5.3.1 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: ▪ SFC954 - Cable Standard. To be used in a network between the Field Controller and a Switch/Hub. (preferred configuration) ▪ SFC955 - 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)

5.3.2 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 7.3.1 ▪ 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
5	Red cross appears on field device	No communication with fieldbus device ▪ No communicaton with Field Controller, see above ▪ No communicaton with fieldbus, see above ▪ No Device ID set (Attributes) ▪ Tag not assigned (Assign Tag)
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 and download again
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

5.3.3 Modbus

Problem	Remedy
No communication via Modbus RS-232	▪ If you have changed the configuration of a Modbus block, check that you have restarted the bus by using the ON_APPLY parameter, Chapter 3.17 ▪ Check that the MEDIA parameter is correct, TCP or serial, Chapter 3.5.1 ▪ Check that the Field Controller and Modbus device are using the same communication settings: RTU/ASCII, Data bytes, Stop bits, Parity, Baudrate, Chapter 3.5.1 ▪ Check that you are using the correct Modbus Block, Chapter 3.5.2, Chapter 4.3.2 ▪ Check that you are using the correct Modbus addresses ▪ Check that the Controller connector, all cables and any interfaces, e.g. RS-232/RS-485 are correctly wired
No communication via Modbus TCP	▪ Check that the IP addresses are in the same domain ▪ Check that any slave IP addresses have been property entered, Chapter 6.2 ▪ Check that the correct cables have been used, see Chapter 5.2, **ETH LNK** LED and any switches etc. are powered ▪ If you have changed the configuration of a Modbus block, check that you have restarted the bus by using the ON_APPLY parameter, Chapter 3.17
A Modbus block does not switch to "Auto" but remains "OOS"	▪ Check the the Mode Block target is set to "Auto" ▪ Check that the Local Mod Map of each Modbus Block has a unique identifier between 0 and 15 ▪ Check that the Modbus has been started by using the ON_APPLY parameter, Chapter 3.17
Local Mod Map identifier is not accepted	▪ Check that value is between 0 and 15 ▪ Check that no other Modbus block of the sdame time is using the value you entered
A static value in the Modbus Block was changed, but the value does not update.	▪ Put the block out of service (OOS) before editing the parameter. ▪ After the edit, put the block back to "Auto" and restart the bus with ON_APPLY
The Modbus parameters cannot be found or displayed	▪ Check that you are looking at the correct registers ▪ Check that the data format has been set correctly Chapter 6.
Status of Modbus value alsways bad	▪ Check TIMEOUT parameter is greater than Modbus master write cycle, see Chapter 4.3.1

6 Function Block Descriptions

A more detailed description of the blocks MBSC and MBSS are to be found in the Function Block manual BA022S/04/en.

6.1 MBCF Modbus Configuration Block

The MBCF allows the Field Controller to be configured for Modbus TCP or RTU operation.

- The parameters MEDIA and MASTER_SLAVE determine the medium and mode of Modbus communication
- The Modbus address of Field Controller is entered in DEVICE_ADDRESS. It is 1 by default and must only be entered if the Field Controller is to be a slave
- For Modbus RTU, the communication parameters BAUD_RATE, STOP_BITS, PARITY must be set. For Field Controllers operating as Modbus Master via Modbus TCP, the IP and Modbus addresses of up to six slaves can be defined in the SLAVE_ADDRESSES parameter
- The ON_APPLY parameter starts Modbus after download or change in Modbus configuration

Details of these and other parameters can be taken fron the table below.

MBCF parameters

Parameter	Valid range/ Options	Default value	Description/Action
ST_VER		0	Increments on every static parameter change
TAG_DESC		blanks	User specific text of 32-characters to uniquely identify the block
STRATEGY	0 to 255	0	User specific value that may be used in configuration and diagnositics as a key in sorting block information
ALERT_KEY	1 to 255	1	User specific value that may be used in sorting the alarms and events generated by the block
MODE_BLK	TARGET	O/S	Set to AUTO
BLOCK_ERR	0 to 15		Error status of hardware and software components associated with the block
MEDIA	0: Serial 1: TCP/IP	Serial	Define the type of Modbus channel.
MASTER_SLAVE	0: Master 1: Slave	Slave	Define if Field Controller is master or slave
DEVICE_ADDRESS	0 - 247	1	Define the Field Controller Modbus address (only when used as slave).
BAUD_RATE	0 - 10	19200	Define the baud rate (only for media serial) 0:110, 1:300, 2: 600, 3:1200, 4:2400, 5:4800, 6:9600, 7:19200, 8:38400, 9:57600, 10:115200
STOP_BITS	0: 1, 1: 2	1	Define the number of stop bits (only for media serial).
PARITY	0: None, 1: Even, 2: Odd	Even	Define the parity (only for media serial)
TIMEOUT	0 - 65535	1000	Time to wait a response from a slave (for Field Controller master) or time to wait the OUTs be updated (for Field Controller slave). Value 0 is used to disable. In the case of a slave, the TIMEOUT must be set to a value greater than the write cycle of the Modbus master, otherwise the status of the mapped values is BAD.

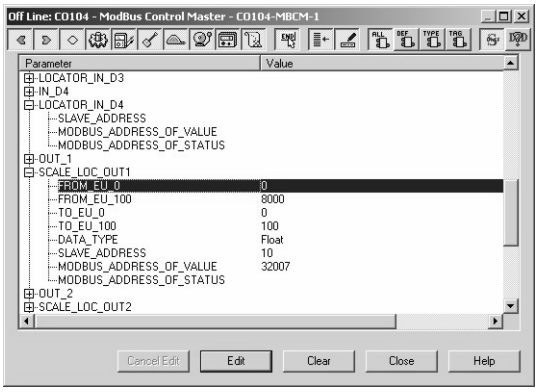
Parameter	Valid range/ Options	Default value	Description/Action
NUMBER_ RETRANSMISSIONS	0 - 255	1	Number of retransmission if the Field Controller does not receive a response from a slave
SLAVE_ADDRESSES			IP number and Modbus addresses of slaves (only for Field Controller master using TCP/IP media)
RESTART_MODBUS		FALSE	Indicate if after communication failure with slave, there will be a new transmission after the time defined in TIME_TO_RESTART (only for Field Controller master).
TIME_TO_RESTART	1 - 65535	1	Time to restart communication with slave
RTS_CTS		FALSE	Enable or disable handshaking
ON_APPLY	0: None 1: Apply	None	Apply the changes made in the Modbus blocks
UPDATE_EVT			This alert is generated by any change to the static data
BLOCK_ALM			The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

6.2 MBCM Modbus Control Master Block

6.2.1 Block description

The Modbus Control Master block allows the Field Controller to read or write to Modbus registers in a slave application, e.g. a controller or field device. The values are mapped into a FOUNDATION Fieldbus function block, with four sets of analog and discrete I/O channels, allowing connection to other function blocks in a control strategy.

- Up to 16 MBCM blocks can be created in a project, the blocks being managed via the LOCAL_MOD_MAP parameter (0 to 15). Each block must be assigned a different LOCAL_MOD_MAP address.
- The SCALE_LOC_XXX and LOCATOR_XXX parameters allow the configuration of the analog and discrete I/O channels



- Each input or output channel is assigned to a Modbus slave through the SLAVE_ADDRESS parameter. The register address is entered in the MODBUS_ADDRESS_OF_XXX parameter. Read Values (IN) are taken from registers with 4xxxx addresses, write values (OUT) are sent to registers with 3xxxx addresses.
- Analog inputs and outputs scale the slave values with the FROM_EU_XX and TO_EU_XX parameters and the data format is set with the DATA_TYPE parameter.

Details of these and other parameters can be taken fron the table in Chapter 6.2.2.

MODBUS_ADDRESS_OF_STATUS

The MODBUS_ADDRESS_OF_STATUS elements define the following rules regarding OUTPUT STATUS parameters:

- If this element is set with a value that is not ZERO, the output status will behave exactly as the fieldbus protocol, in other words, the status will reflect the value which the master is reading but if after TIMEOUT (defined in MBCF block) the status is not updated, this status will be forced to BAD COMMUNICATION.
- If this element is set with a value equal to ZERO, the output status will be set automatically to GOOD and will also accept a characterization via the ControlCare Application Designer (e.g GOOD CASCADE, etc). But, if after TIMEOUT (defined in MBCF block) the communication with the Modbus Device is not running properly, the status will be forced to BAD COMMUNICATION.

6.2.2 MBCM parameters

Parameter	Valid range/ Options	Default value	Description/Action
ST_VER		0	Increments on every static parameter change
TAG_DESC		blanks	User specific text of 32-characters to uniquely identify the block
STRATEGY	0 to 255	0	User specific value that may be used in configuration and diagnositics as a key in sorting block information
ALERT_KEY	1 to 255	1	User specific value that may be used in sorting the alarms and events generated by the block
MODE_BLK	TARGET	O/S	Set to AUTO
BLOCK_ERR	0 to 15		Error status of hardware and software components associated with the block
LOCAL_MOD_MAP	0 to 15	0	Define the modbus addresses
BAD_STATUS		0	Indicates if communication from slave is good or not (each bit corresponds to a Modbus variable
IN_1			Analog input 1
SCALE_LOC_IN1			Scaling, data format and register addresses for input signal
IN_2			Analog input 2
SCALE_LOC_IN2			Scaling, data format and register addresses for input signal
IN_3			Analog input 3
SCALE_LOC_IN3			Scaling, data format and register addresses for input signall
IN_4			Analog input 4
SCALE_LOC_IN4			Scaling, data format and register addresses for input signal
IN_D1			Discrete input 1
LOCATOR_IN_D1			Register addresses for input signal
IN_D2			Discrete input 2
LOCATOR_IN_D2			Register addresses for input signale
IN_D3			Discrete input 3
LOCATOR_IN_D3			Register addresses for input signal
IN_D4			Discrete input 4
LOCATOR_IN_D4			Register addresses for input signal
OUT1			Analog output 1
SCALE_ LOC_OUT1			Scaling, data format and register addresses for output signal
OUT2			Analog output 2
SCALE_ LOC_OUT2			Scaling, data format and register addresses for output signal
OUT3			Analog output 3
SCALE_ LOC_OUT3			Scaling, data format and register addresses for output signal
OUT4			Analog output 4
SCALE_ LOC_OUT4			Scaling, data format and register addresses for output signal
OUT_D1			Discrete output 1

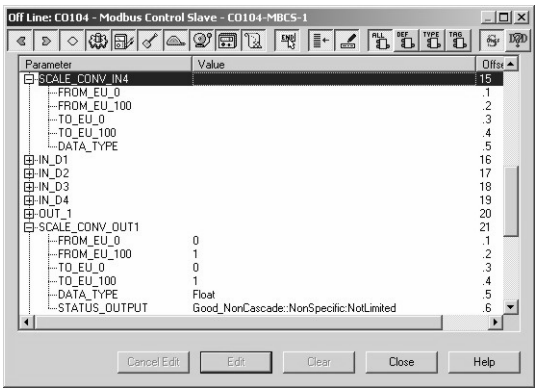
Parameter	Valid range/ Options	Default value	Description/Action
LOCATOR_OUT_D1			Register addresses for output signal
OUT_D2			Discrete output 2
LOCATOR_OUT_D2			Register addresses for output signal
OUT_D3			Discrete output 3
LOCATOR_OUT_D3			Register addresses for output signal
OUT_D4			Discrete output 4
LOCATOR_OUT_D4			Register addresses for output signal
UPDATE_EVT			This alert is generated by any change to the static data
BLOCK_ALM			The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

6.3 MBCS Modbus Control Slave Block

6.3.1 Block description

The Modbus Control Slave block allows a Modbus master to read or write to values in the Field Controller Modbus registers. The values are mapped from a FOUNDATION Fieldbus function block, with four sets of analog and discrete I/O channels, into fixed registers, allowing connection to other function blocks in a control strategy.

- Up to 16 MBCF blocks can be created in a project, the blocks being managed via the LOCAL_MOD_MAP parameter (0 to 15).
- The SCALE_CONV_XXX parameters allow the configuration of the analog channels



- Each input or output channel is assigned to a Modbus slave register through its I/O parameter and an OFFSET value which is 40 x LOCAL_MOD_MAP parameter. The basic addresses are listed in the table in Section 6.3.3. All registers are Read/Write.
- Analog inputs and outputs scale the slave values with the FROM_EU_XX and TO_EU_XX parameters and the data format is set with the DATA_TYPE parameter.

Details of these and other parameters can be taken fron the table on Chapter 6.3.2.

STATUS_OUT_Dx and STATUS_OUTPUT

The STATUS_OUT_Dx and STATUS_OUTPUT elements used in the OUT parameters define the following rules for OUTPUT STATUS parameters:

- If the option "Set by master" is used, the output status will behave exactly as the Fieldbus protocol works, in other words, the status will reflect the value which the master is writing but if after TIMEOUT (defined in MBCF block) the status is not updated, this status will be forced to BAD COMMUNICATION.
- If the user defines this element with anything other than "Set by master", this value will be reflected in output status, while communication OK, otherwise the status goes to BAD COMMUNICATION..

6.3.2 MBCS parameters

Parameter	Valid range/ Options	Default value	Description/Action
ST_VER		0	Increments on every static parameter change
TAG_DESC		blanks	User specific text of 32-characters to uniquely identify the block
STRATEGY	0 to 255	0	User specific value that may be used in configuration and diagnositics as a key in sorting block information
ALERT_KEY	1 to 255	1	User specific value that may be used in sorting the alarms and events generated by the block
MODE_BLK	TARGET	O/S	Set to AUTO
BLOCK_ERR	0 to 15		Error status of hardware and software components associated with the block
LOCAL_MOD_MAP	0 to 15	0	Define the modbus addresses
IN1			Analog input 1
SCALE_CONV_IN1			Information to generate constants A and B em equation Y=A*X+B
IN2			Analog input 2
SCALE_CONV_IN2			Information to generate constants A and B em equation Y=A*X+B
IN3			Analog input 3
SCALE_CONV_IN3			Information to generate constants A and B em equation Y=A*X+B
IN4			Analog input 4
SCALE_CONV_IN4			Information to generate constants A and B em equation Y=A*X+B
IN_D1			Discrete input 1
IN_D2			Discrete input 2
IN_D3			Discrete input 3
IN_D4			Discrete input 4
OUT1			Analog output 1
SCALE_CONV_OUT1			Information to generate constants the A and B and equation Y=A*X+B plus output status
OUT2			Analog output 2
SCALE_CONV_OUT2			Information to generate constants the A and B and equation Y=A*X+B plus output status
OUT3			Analog output 3
SCALE_CONV_OUT3			Information to generate constants the A and B and equation Y=A*X+B plus output status
OUT4			Analog output 4
SCALE_CONV_OUT4			Information to generate constants the A and B and equation Y=A*X+B plus output status
OUT_D1			Discrete output 1
STATUS_OUT_D1			Status to OUT_D1 if master will not update

Parameter	Valid range/ Options	Default value	Description/Action
OUT_D2			Discrete output 2
STATUS_OUT_D2			Status to OUT_D2 if master will not update
OUT_D3			Discrete output 3
STATUS_OUT_D3			Status to OUT_D3 if master will not update
OUT_D4			Discrete output 4
STATUS_OUT_D4			Status to OUT_D4 if master will not update
UPDATE_EVT			This alert is generated by any change to the static data
BLOCK_ALM			The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

6.3.3 LOCAL_MOD_MAP

MBCS			MBSS		
Parameter	LOCAL_MOD_MAP = x OFFSET = 40 * x x = 0 ~ 15	e.g. LOCAL_ MOD_MAP	Parameter	LOCAL_MOD_MAP = x OFFSET = 40 * x x = 0 ~ 15	e.g. LOCAL_ MOD_MAP
IN1-Value	40001+ OFFSET 40002+ OFFSET	40041 40042	FBLOCK_TAG1	42601+ OFFSET 42602+ OFFSET	42641 42642
IN2-Value	40003+ OFFSET 40004+ OFFSET	40043 40044	FBLOCK_TAG2	42603+ OFFSET 42604+ OFFSET	42643 42644
IN3-Value	40005+ OFFSET 40006+ OFFSET	40045 40046	FBLOCK_TAG3	42605+ OFFSET 42606+ OFFSET	42645 42646
IN4-Value	40007+ OFFSET 40008+ OFFSET	40047 40048	FBLOCK_TAG4	42607+ OFFSET 42608+ OFFSET	42647 42648
OUT1-Value	40009+ OFFSET 40010+ OFFSET	40049 40050	FBLOCK_TAG5	42609+ OFFSET 42610+ OFFSET	42649 42650
OUT2-Value	40011+ OFFSET 40012+ OFFSET	40051 40052	FBLOCK_TAG6	42611+ OFFSET 42612+ OFFSET	42651 42652
OUT3-Value	40013+ OFFSET 40014+ OFFSET	40053 40054	FBLOCK_TAG7	42613+ OFFSET 42614+ OFFSET	42653 42654
OUT4-Value	40015+ OFFSET 40016+ OFFSET	40055 40056	FBLOCK_TAG8	42615+ OFFSET 42616+ OFFSET	42655 42656
IN1-Status	40017+ OFFSET	40057	IBLOCK_TAG1	42617+ OFFSET 42618+ OFFSET	42657 42658
IN2-Status	40018+ OFFSET	40058	IBLOCK_TAG2	42619+ OFFSET 42620+ OFFSET	42659 42660
IN3-Status	40019+ OFFSET	40059	IBLOCK_TAG3	42621+ OFFSET 42622+ OFFSET	42661 42662
IN4-Status	40020+ OFFSET	40060	IBLOCK_TAG4	42623+ OFFSET 42624+ OFFSET	42663 42664
OUT1-Status	40021+ OFFSET	40061	BBLOCK_TAG1	2601+ OFFSET	2641
OUT2-Status	40022+ OFFSET	40062	BBLOCK_TAG1	2602+ OFFSET	2642
OUT3-Status	40023+ OFFSET	40063	BBLOCK_TAG1	2603+ OFFSET	2643
OUT4-Status	40024+ OFFSET	40064	BBLOCK_TAG1	2604+ OFFSET	2644
IN_D1-Status	40025+ OFFSET	40065			
IN_D2-Status	40026+ OFFSET	40066			
IN_D3-Status	40027+ OFFSET	40067			
IN_D4-Status	40028+ OFFSET	40068			
OUT_D1-Status	40029+ OFFSET	40069			
OUT_D1-Status	40030+ OFFSET	40070			
OUT_D1-Status	40031+ OFFSET	40071			
OUT_D1-Status	40032+ OFFSET	40072			
IN_D1-Value	1+ OFFSET	41			
IN_D2-Value	2+ OFFSET	42			
IN_D3-Value	3+ OFFSET	43			
IN_D4-Value	4+ OFFSET	44			
OUT_D1-Value	5+ OFFSET	45			
OUT_D1-Value	6+ OFFSET	46			
OUT_D1-Value	7+ OFFSET	47			
OUT_D1-Value	8+ OFFSET	48			

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