

# Application description

## Communication

Siemens PLC – Studer Innotec devices  
via "Modbus RTU" protocol



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## 1 Introduction

The purpose of this document is to provide support if you want to use the "Modbus\_RTU\_Master" application. This application performs a communication via the Modbus RTU (Remote Terminal Unit) protocol between a Siemens PLC and an Xcom-485i interface that communicates with an Xtender inverter-charger and a Studer Innotec BSP battery module.

All data that are transferred between the PLC and the Studer Innotec devices are displayed on a Siemens Human-Machine Interface (HMI).

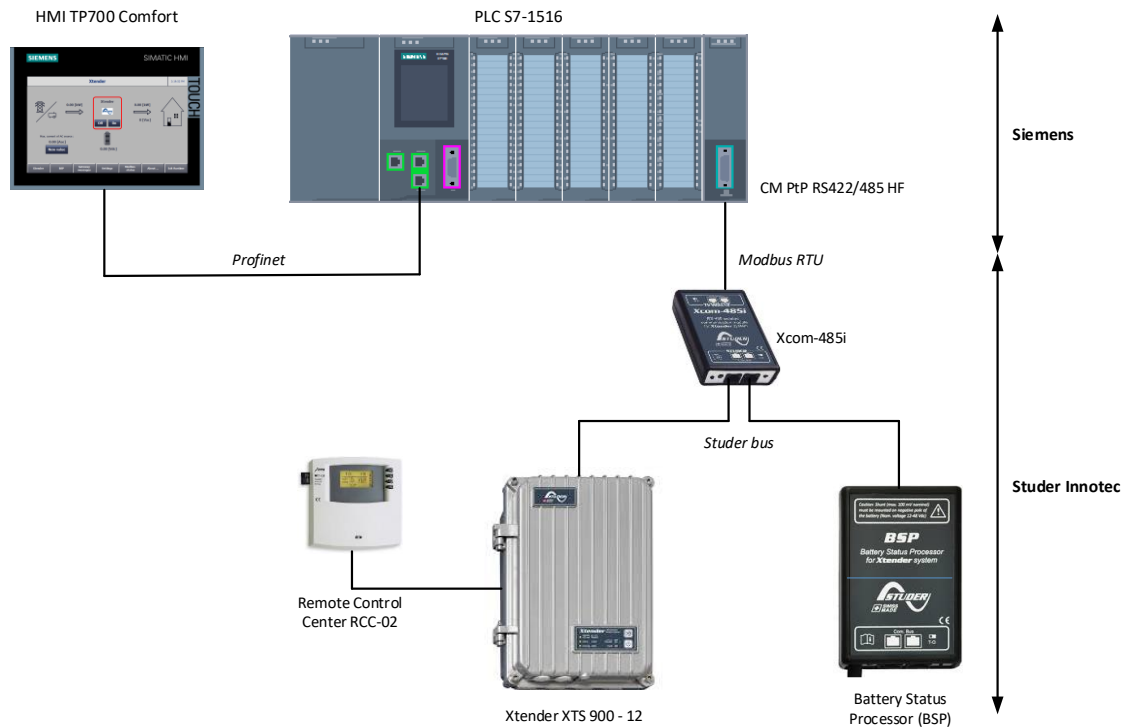


Figure 1 : Overview

The Modbus RTU protocol uses a master/slave network where all communications are initiated by the master. In our application, the Studer Innotec devices are the slaves and they reply to the requests sent by the PLC which is the master.

The Profinet protocol allows the communication between the PLC and the Human-Machine Interface (HMI).

## 2 Required hardware

### 2.1.1 Siemens Programmable Logic Controller

Module	Article number	Comment
PM 190W 120/230VAC	6EP1333-4BA00	
CPU 1516-3 PN/DP	6ES7 516-3AN01-0AB0	Firmware : V2.5
DI 32x24VDC HF	6ES7 521-1BL00-0AB0	<i>Module not used in this application</i>
DQ 32x24VDC/0.5A HF	6ES7 522-1BL01-0AB0	<i>Module not used in this application</i>
AI 8xU/I/RTD/TC ST	6ES7 531-7KF00-0AB0	<i>Module not used in this application</i>
AQ 8xU/I HS	6ES7 532-5HF00-0AB0	<i>Module not used in this application</i>
TM Count 2x24V	6ES7 550-1AA00-0AB0	<i>Module not used in this application</i>
CM PtP RS422/485 HF	6ES7 541-1AB00-0AB0	

### 2.1.2 Siemens Human-Machine Interface

Module	Article number	Comment
TP700 Comfort	6AV2 124-0GC01-0AX0	Version 15.0.0.0
Micro SD Memory	8 GB	
Micro SD memory adapter		

## 2.2 Studer Innotec devices

Module	Article number	Comment
Interface RS 485 <-> bus Studer Innotec	Xcom-485i	
Inverter-Charger	Xtender XTS 900 - 12	
Battery module	Battery Status Processor (BSP)	
Remote Control Center	Remote Control Center RCC-02	

## 3 Required Siemens software

Software	Version
Totally Integrated Automation Portal	V15, update 4
STEP 7 Professional	V15, update 4
WinCC Advanced	V15, update 4

## 4 Modbus RTU communication parameters

The configuration parameters of the Modbus RTU network as well as the different addresses used by the Studer Innotec devices are described below.

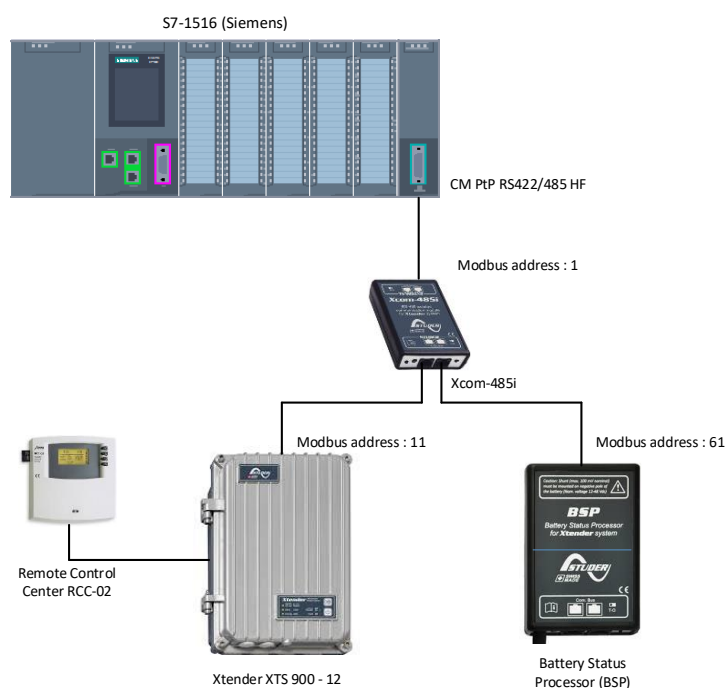


Figure 2 : Modbus RTU network

### Communication Parameters :

Parameter	Default value
Baud rate	9'600 bps
Parity	Even
Frame format	1 start bit 8 data bits 1 parity bit 1 stop bit
Electrical interface	RS 485 with 2 wires (half-duplex)

Most of these parameters can be modified on the Human-Machine Interface.

The Xcom-485i module is used as communication interface between the Studer Innotec devices and the PLC. This module has two "RJ45" connectors that communicate with the Modbus RTU protocol and two "RJ45" connectors that communicate with Studer Innotec's protocol.



1. External switch position  
The switch for the communication line ending must be in position O (open).
2. Jumper positions as shown in the figure below.



- 
- Version 1.0

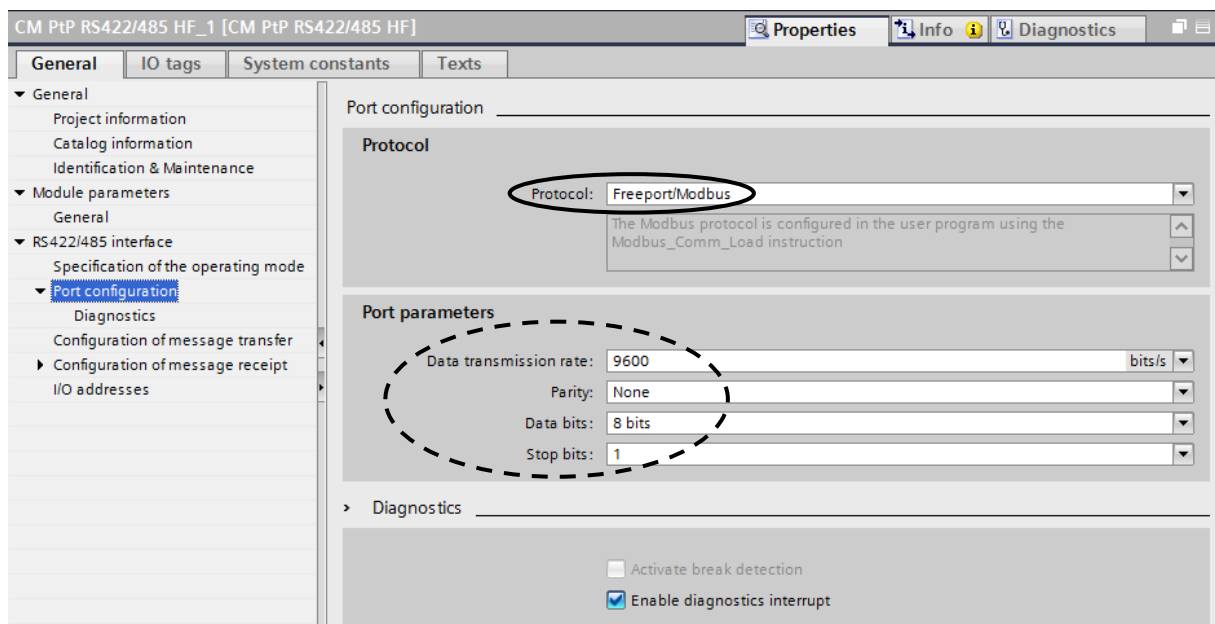
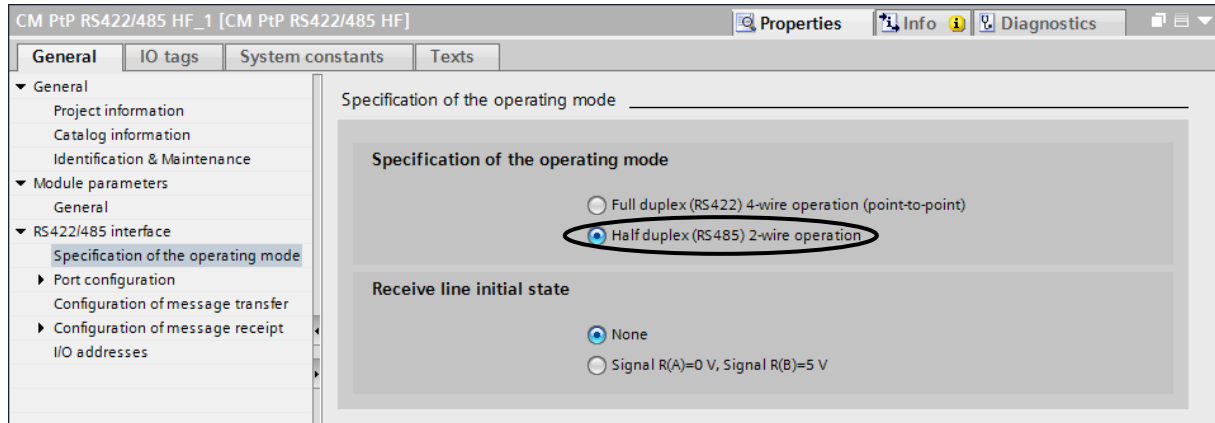
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## 6 CM PtP RS422/485 HF module settings

This module allows the PLC to communicate as a master within the Modbus RTU network.

Its configuration is as follows:



The different values under "Port parameters" are not relevant in this configuration. The values of these parameters are assigned via the function block "Modbus\_Comm\_Load" programmed on the PLC.

The other parameters retain their default values.

## 7 Cable RS422/485 HF PtP CM module - Xcom-485i interface

Module CM PtP RS422/485 HF (15-pin Sub-D connector)		Interface Xcom-485i (RJ 45 connector)	Description
Pin 4	↔	Pin 4	D-
Pin 8	↔	Pin 8	Gnd
Pin 11	↔	Pin 5	D+

## 8 Profinet communication parameters

The Profinet network allows the data transfer between the PLC and the HMI.

The required IP addresses are :

Programmable Logic Controller : 192.168.0.1

Human-Machine Interface : 192.168.0.2

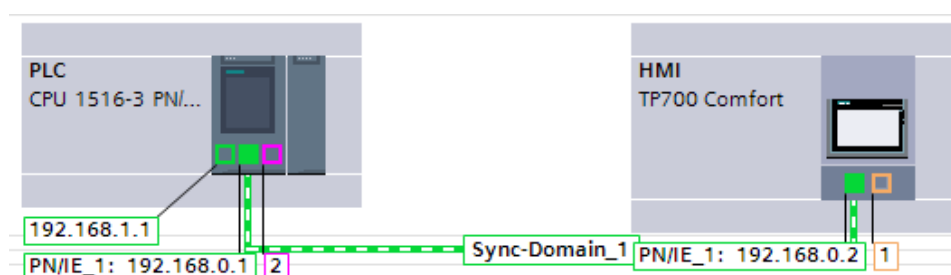


Figure 5 : Profinet Network



## 9 Programmable logic controller program

### 9.1 Program blocks

The main program blocks used to read or write on Studer Innotec devices are as follows :



Figure 6 : Read/Write program blocks

### 9.2 Program structure

The program is composed of different function blocks that allow to structure the application. Each function block performs a well-defined task so that the entire program can perform reading and writing operations with the Studer Innotec devices.

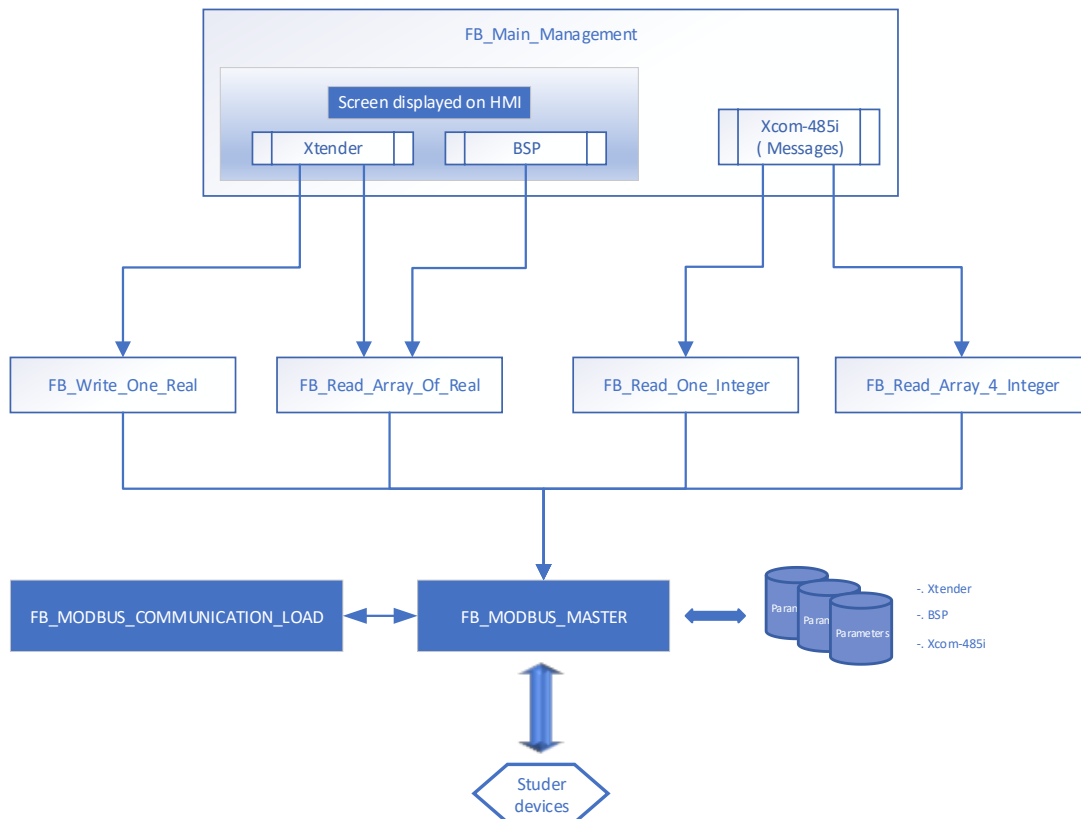


Figure 7 : Structure of the program

### 9.2.1 Management of reading and writing operations

The function block "FB\_Main\_Management" manages reading and writing operations at regular intervals with the Studer Innotec devices. The period (T) is set by default to 1 [sec.].

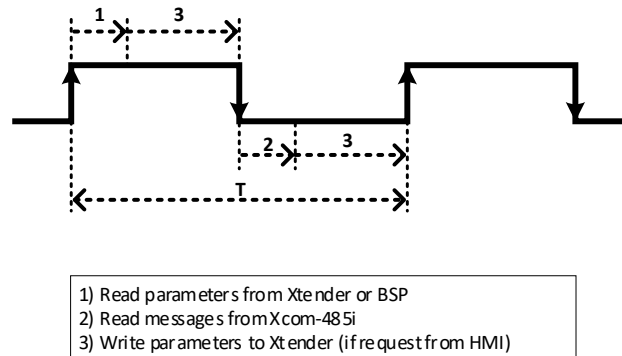


Figure 8 : Reading and writing cycle

### 9.2.2 Parameters reading sequence from the Xtender and BSP

The reading sequence of the parameters on the Xtender or the BSP is carried out periodically by the function block "FB\_Read\_Array\_Of\_Real".

Only the parameters displayed on the HMI screen are read.

### 9.2.3 Parameters writing sequence to the Xtender

The modification of a parameter value on the Xtender is initiated by the operator via the HMI. The function block "FB\_Write\_One\_Real" is called from the function block "FB\_Main\_Management" in order to write the parameter value. This block is processed if no read operation is in progress. If this is not the case, the write operation waits for the end of the read operation.

### 9.2.4 Message reading sequence from the Xcom-485i

The Xcom-485i interface software saves all the messages in its memory which are sent by the Xtender and the BSP.

The reading sequence of the parameters on the Xcom-485i interface is performed periodically by the function blocks "FB\_Read\_One\_Integer" and "FB\_Read\_Array\_4\_Integer".

The function block "FB\_Read\_One\_Integer" is used to read the number of messages present on the interface and the function block "FB\_Read\_Array\_4\_Integer" is used to read the messages. These messages are then displayed on the HMI.

#### 9.2.4.1 Sequence programming concept

The programmed sequences in function blocks FB\_Read\_xxx and FB\_Write\_xxx are relatively similar. They differ mainly from each other by the types of data to be read or written.

As an example, the function block "FB\_Read\_Array\_Of\_Real" is implemented with the following sequence.

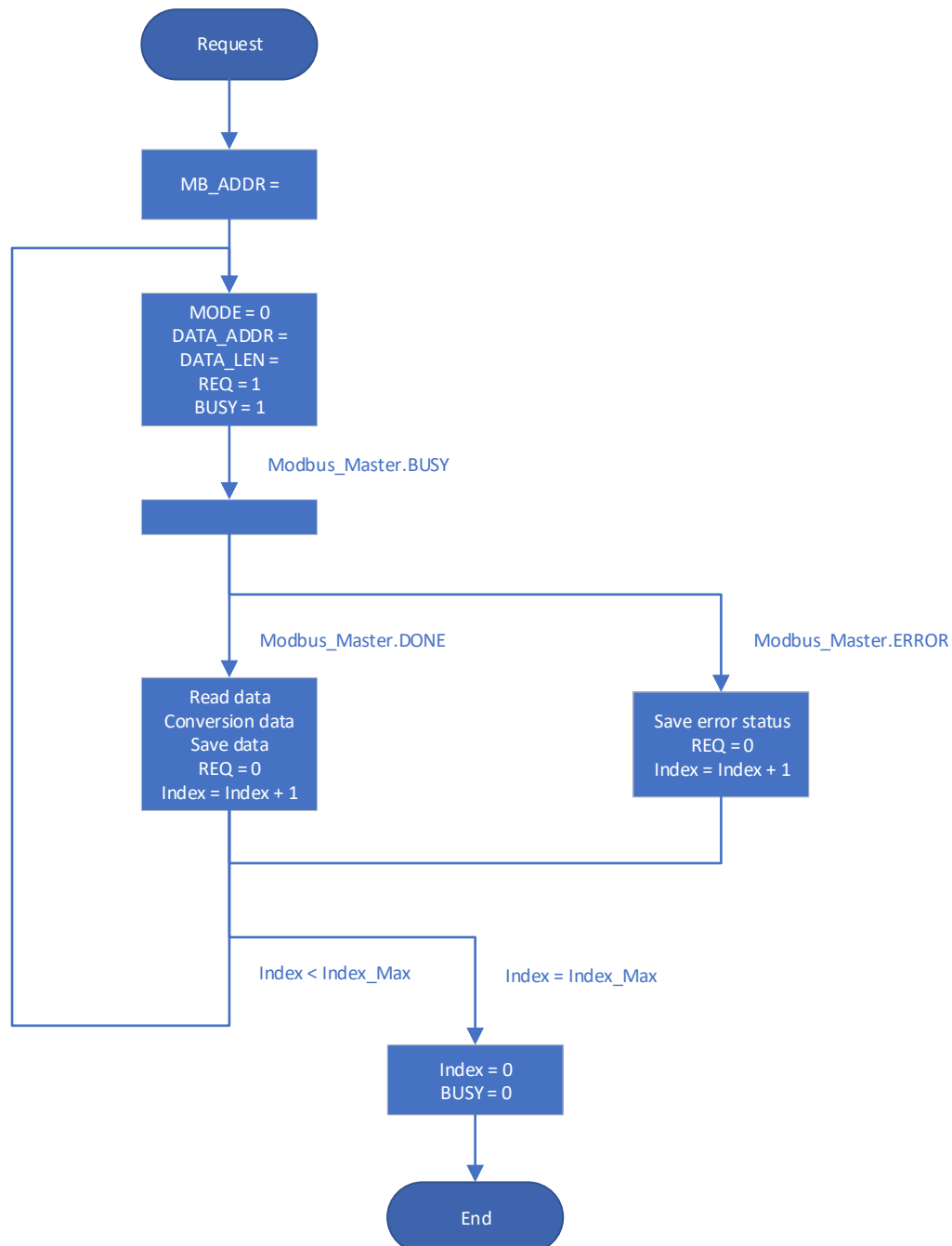


Figure 9 : FB\_Read\_Array\_Of\_Real" function block sequence

### 9.2.5 Modbus RTU read and write functions

The reading and writing of parameters to Studer Innotec devices via Modbus RTU is carried out with the function blocks "FB\_MODBUS\_COMMUNICATION\_LOAD" and "FB\_MODBUS\_MASTER".

Both of these blocks use the following function blocks from the TIA-Portal library :

- Modbus\_Comm\_Load
- Modbus\_Master

These blocks can be found in the library under Communication → Communication Processor → MODBUS (RTU).

Communication	
Name	Version
▶ S7 communication	V1.3
▶ Open user communication	<a href="#">V6.0</a>
▶ OPC UA	
▶ WEB Server	V1.1
▶ Others	
▼ Communication processor	
▶ PtP Communication	<a href="#">V3.1</a>
▶ USS communication	<a href="#">V4.1</a>
▼ MODBUS (RTU)	<a href="#">V4.2</a>
- Modbus_Comm_Load	V3.1
- Modbus_Master	<a href="#">V3.1</a>
- Modbus_Slave	<a href="#">V4.2</a>
▶ ET200S serial interface	V2.7
▶ SIMATIC NET CP	<a href="#">V4.1</a>

Figure 10 : Modbus RTU function blocks

### 9.2.5.1 Modbus\_Comm\_Load

The function block "Modbus\_Comm\_Load" is used to select the communication module and to define the communication parameters of the Modbus RTU network.

It is called only once during the first cycle of the OB1 or when a communication parameter has been changed on the HMI.

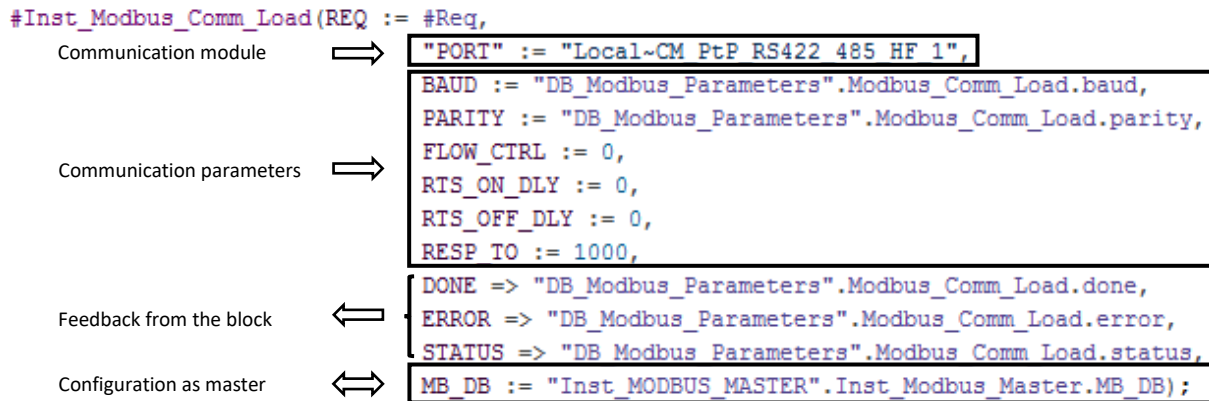


Figure 11 : Instance of the function block "Modbus\_Comm\_Load"

#### 9.2.5.1.1 Configuration

After inserting the CM PtP RS422/485 HF communication module in the hardware configuration, the symbolic name of the communication module can be selected in the PORT parameter. The symbolic name is accessible in the system constants which are listed in the PLC variables.

The communication parameters BAUD (baud rate) and PARITY (parity) must be identical to the other devices in the network (slaves).

The parameter "MB\_DB" of the instance data block of the "Modbus\_Master" master block (see chapter 9.2.5.2) must be transferred to the parameter MB\_DB of the "Modbus\_Comm\_Load" function block. This parameter defines the communication module (parameter PORT) as Modbus master.

In addition, the static parameter MODE in the instance data of "Modbus\_Comm\_Load" must be set with the value 4, which corresponds to half-duplex RS 485 communication in 2-wire mode.

Static		
Inst_Modbus_Comm_Load	Modbus_Comm_Load	
Input		
Output		
InOut		
Static		
ICHAR_GAP	Word	16#0
RETRIES	Word	16#0
MODE	USInt	4
LINE_PRE	USInt	16#00

Figure 12 : DB instance of the function block "Modbus\_Comm\_Load"

### 9.2.5.2 Modbus\_Master

The function block "Modbus\_Master" is used to read or write parameters to the Studer Innotec devices (slaves) via Modbus RTU using the port configured in the "PORT" parameter of the function block "Modbus\_Comm\_Load".

#### Reading of parameters :

Depending on the screen displayed on the HMI, the parameters of the Xtender module or the BSP battery module are read alternately with the messages contained in the Xcom-485i interface if no parameter writing is in progress (cf chapter 9.2.1).

#### Writing of parameters :

The function block "Modbus\_Master" is called when a request to change a parameter has been triggered by the operator on the HMI and if no parameter reading is in progress (cf chapter 9.2.1).

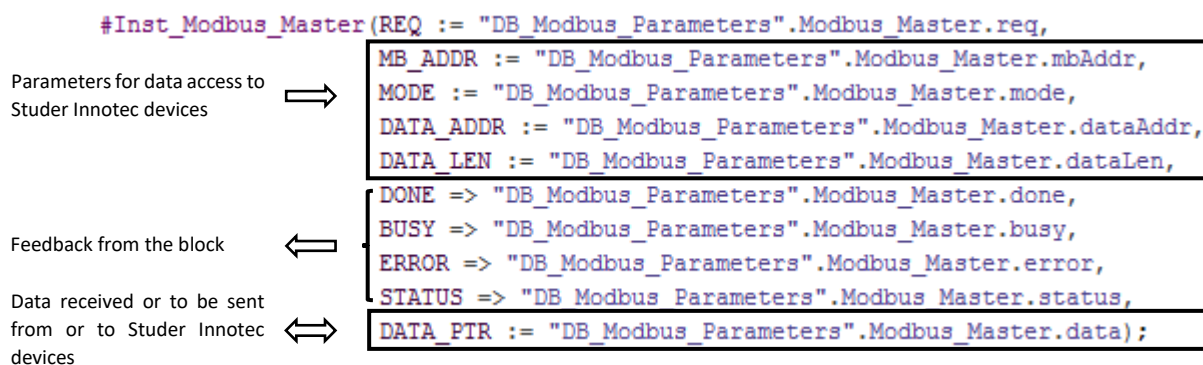


Figure 13 : Instance of the "Modbus\_Master" function block

#### 9.2.5.2.1 Configuration

The parameters of the function block are used to select the Modbus address of the Studer Innotec device, to define the Modbus function code and the local parameter storage area (registers).

The Modbus function code which is used in the Modbus telegram is determined automatically by the function block "Modbus\_Master" based on the parameters MODE and DATA\_ADDR.

The table below describes the parameters.

Parameter	Description
MB_ADDR	Modbus address of the Studer Innotec device
MODE	Direction of transmission (read or write)
DATA_ADDR	Address of the first register to be accessed in the Studer Innotec device
DATA_LEN	Number of registers to be accessed in the Studer Innotec device
DATA_PTR	Area of the read data or to be sent from or to the Studer Innotec device

### 9.3 Data Structure

All parameters or messages which have to be read (or written) on the Studer Innotec devices are contained in the following data blocks :

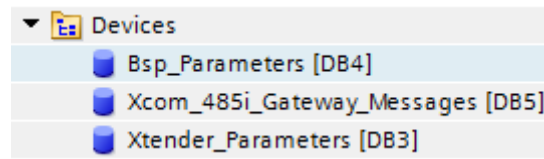


Figure 14 : Data blocks containing parameters and messages

Each data block contains the Modbus address of the device concerned as well as a structure containing the parameters to be read or written.

Xtender_Parameters			
	Name	Data type	Start value
1	▼ Static		
2	■ Modbus_Address	UInt	11
3	▼ Read_Parameters	Array[0..*XTENDER_UPPER_INDEX_ARRAY_READ...	
4	■ ▼ Read_Parameters[0]	"UDT_Read_1_Real_Register"	
5	■ Description	String	'Battery voltage'
6	■ Data_Address	UDInt	30001
7	■ Data	Real	0.0
8	■ Unit	String	'[Vdc]'
9	■ ▼ Read_Parameters[1]	"UDT_Read_1_Real_Register"	
10	■ Description	String	'Output voltage'
11	■ Data_Address	UDInt	30043
12	■ Data	Real	0.0
13	■ Unit	String	'[Vac]'
14	■ ▶ Read_Parameters[2]	"UDT_Read_1_Real_Register"	
15	■ ▶ Read_Parameters[3]	"UDT_Read_1_Real_Register"	
16	■ ▶ Read_Parameters[4]	"UDT_Read_1_Real_Register"	
17	■ ▶ Read_Parameters[5]	"UDT_Read_1_Real_Register"	
18	▼ Parameters_To_Write	Array[0..*XTENDER_UPPER_INDEX_ARRAY_PARA...	
19	■ ▼ Parameters_To_Write[0]	"UDT_Write_1_Real_Register"	
20	■ Description	String	'Maximum current ...
21	■ Data_Address	UDInt	40015
22	■ Data	Real	2.0
23	■ Unit	String	'[Aac]'
24	■ Min	Real	2.0
25	■ Max	Real	50.0
26	■ ▶ Parameters_To_Write[1]	"UDT_Write_1_Real_Register"	
27	■ ▶ Parameters_To_Write[2]	"UDT_Write_1_Real_Register"	
28	■ Reading_In_Progress	Bool	false
29	■ Writing_In_Progress	Bool	false

Figure 15 : Data block of the Xtender

The data types of the variables in the tables are defined as PLC data types.

UDT_Read_1_Real_Register				
	Name	Data type	Default value	
1	Description	String	"	
2	Data_Address	UDInt	0	
3	Data	Real	0.0	
4	Unit	String	"	

Figure 16 : PLC data type "UDT\_Read\_1\_Real\_Register"

The number of parameters in the data tables can be adjusted by changing the value of the user constants defined in the variable table.

Modbus_RTU_Master ▶ PLC [CPU 1516-3 PN/DP] ▶ PLC tags ▶ Table de variables standard [66]				
			Tags	User constants
Table de variables standard				
	Name	Data type	Value	Comment
1	XCOM_485_UPPER_INDEX_ARRAY_MESSAGES_ARCHIVE	UInt	126	Number of archives -1
2	XTENDER_UPPER_INDEX_ARRAY_READ_PARAMETERS	UInt	5	Number of parameters -1
3	XTENDER_UPPER_INDEX_ARRAY_PARAMETERS_TO_WRITE	UInt	2	Number of parameters -1
4	BSP_UPPER_INDEX_ARRAY_READ_PARAMETERS	UInt	4	Number of parameters -1

Figure 17 : Constants defining the number of parameters contained in the tables



## 10 Human-Machine Interface (HMI) Program

The Human-Machine Interface (HMI) allows to :

- visualize some Xtender and BSP parameters
- modify some Xtender parameters
- view messages contained in the Xcom-485i interface
- change some Modbus RTU communication parameters
- view an information message for each data transfer
- view the program version

The HMI displays the following screens :

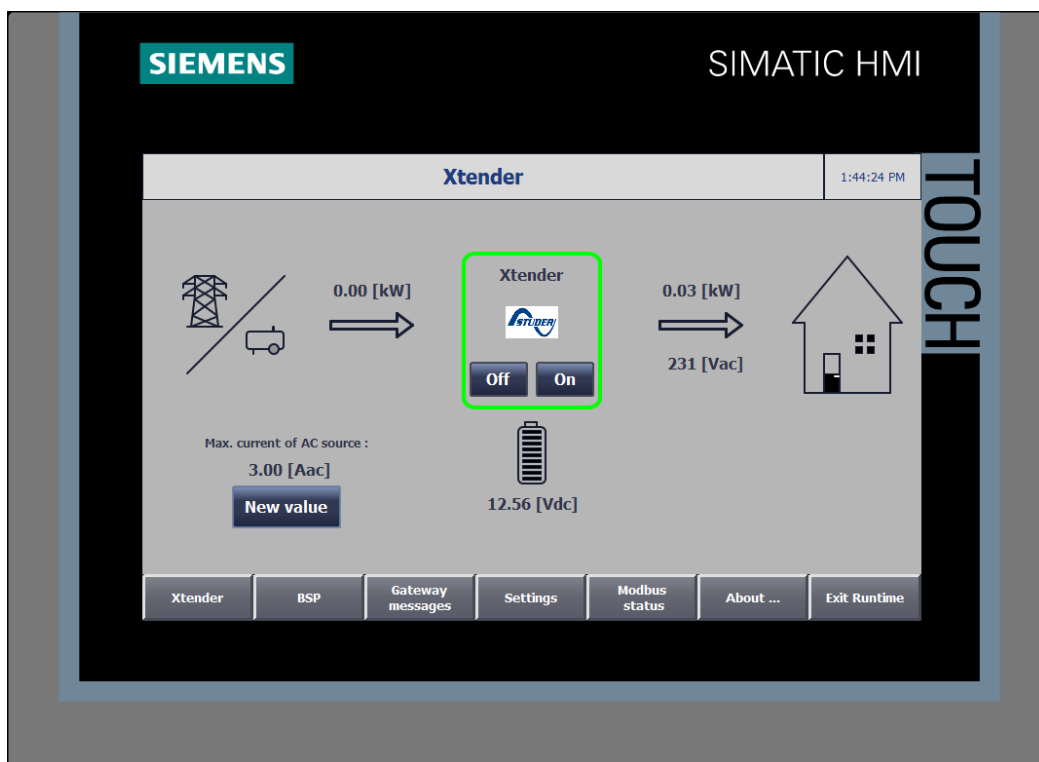


Figure 18 : Screen "Xtender"

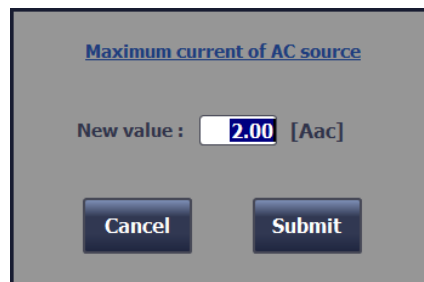


Figure 19 : Modifying the maximum value of the current of the AC source on the "Xtender"

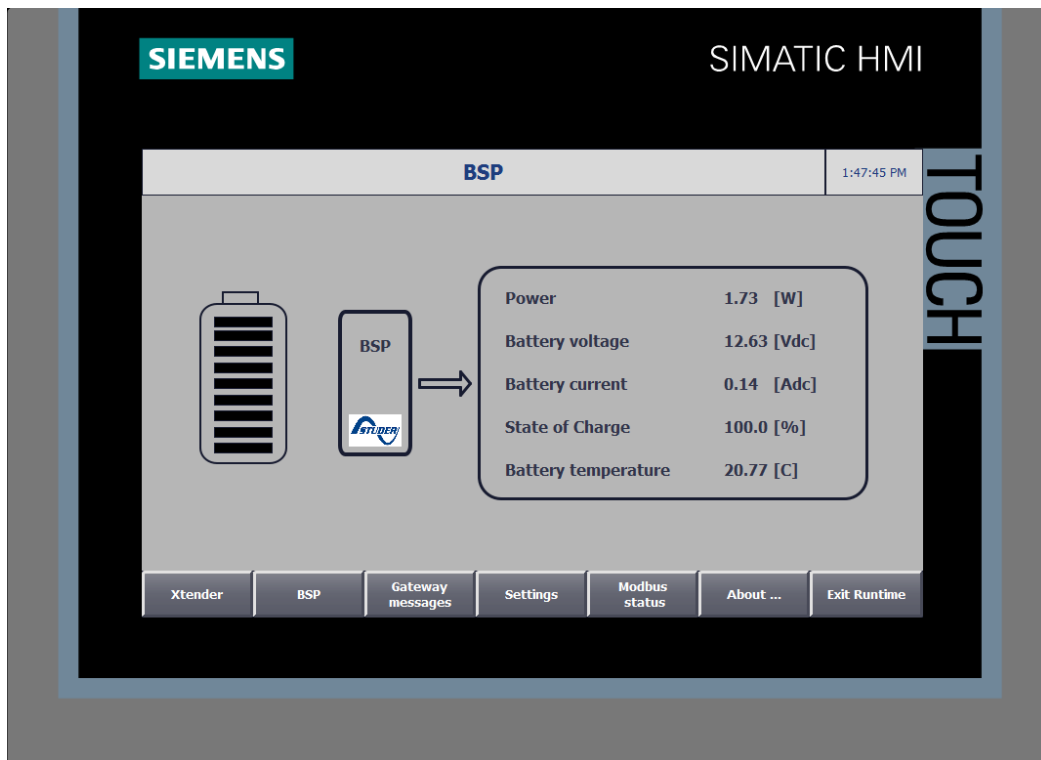


Figure 20 : Screen "BSP"

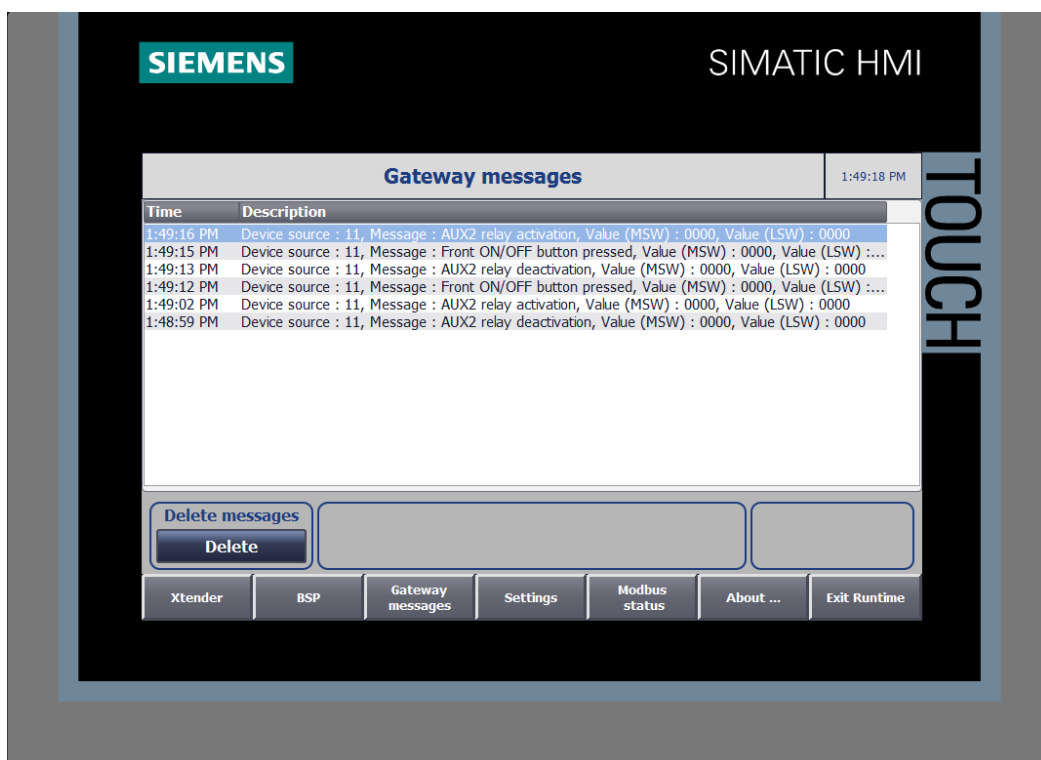


Figure 21 : Screen "Gateway Messages"

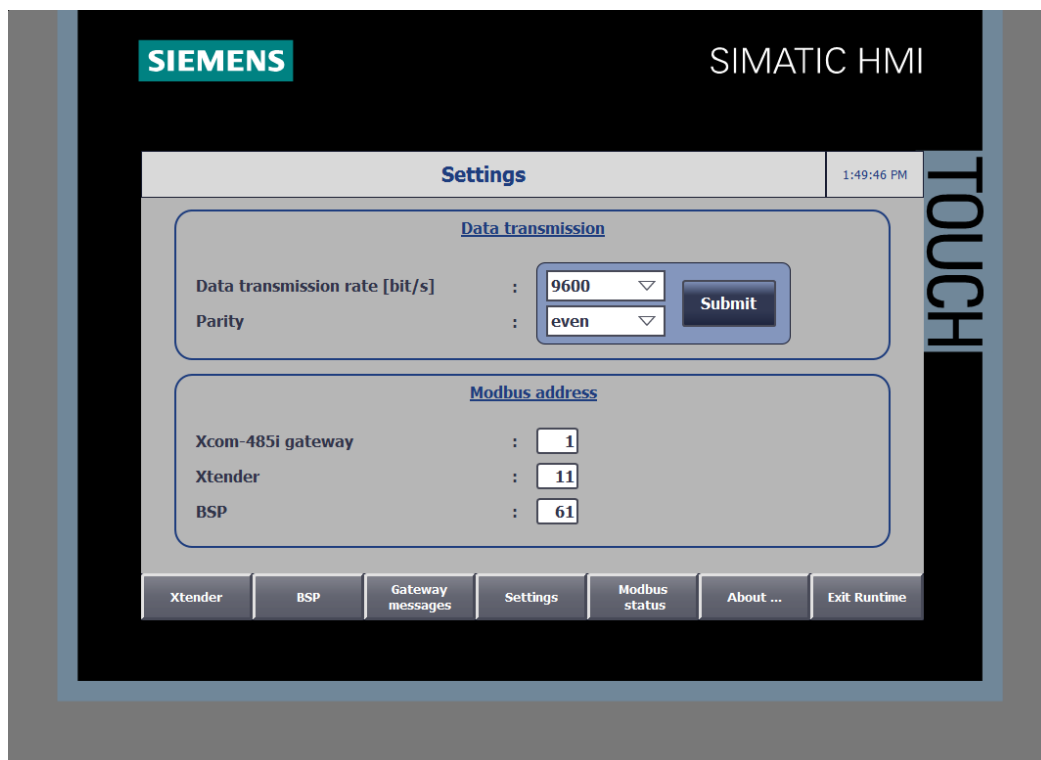


Figure 22 : Screen "Settings"

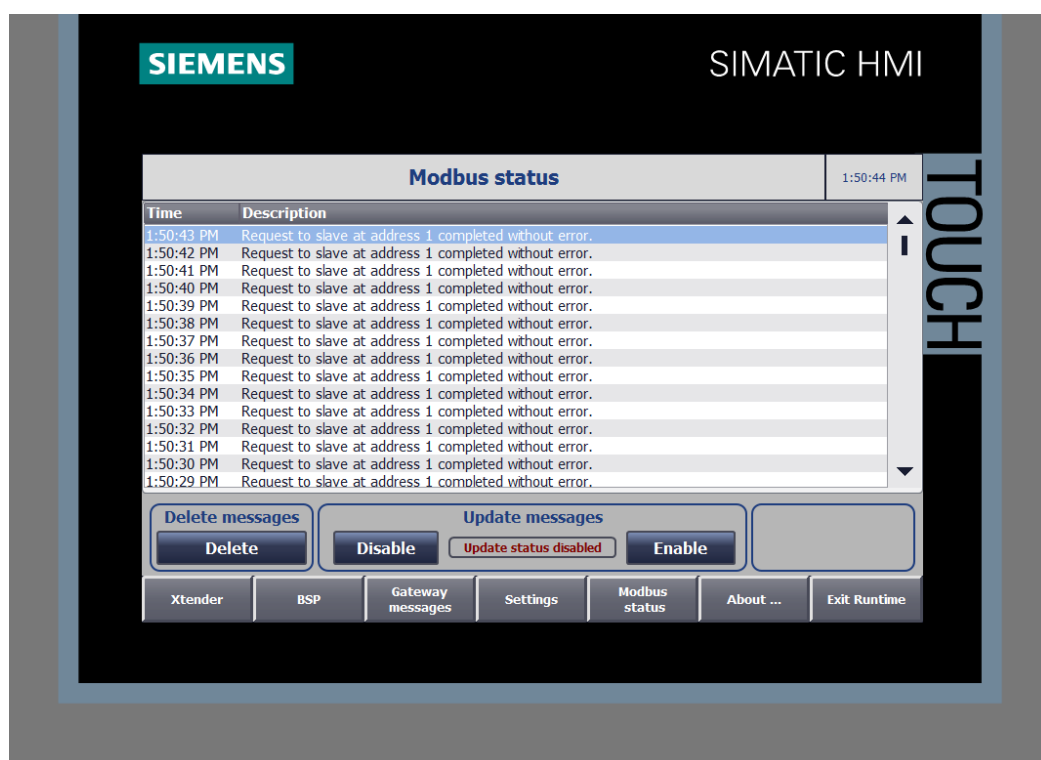


Figure 23 : Screen "Modbus Status"

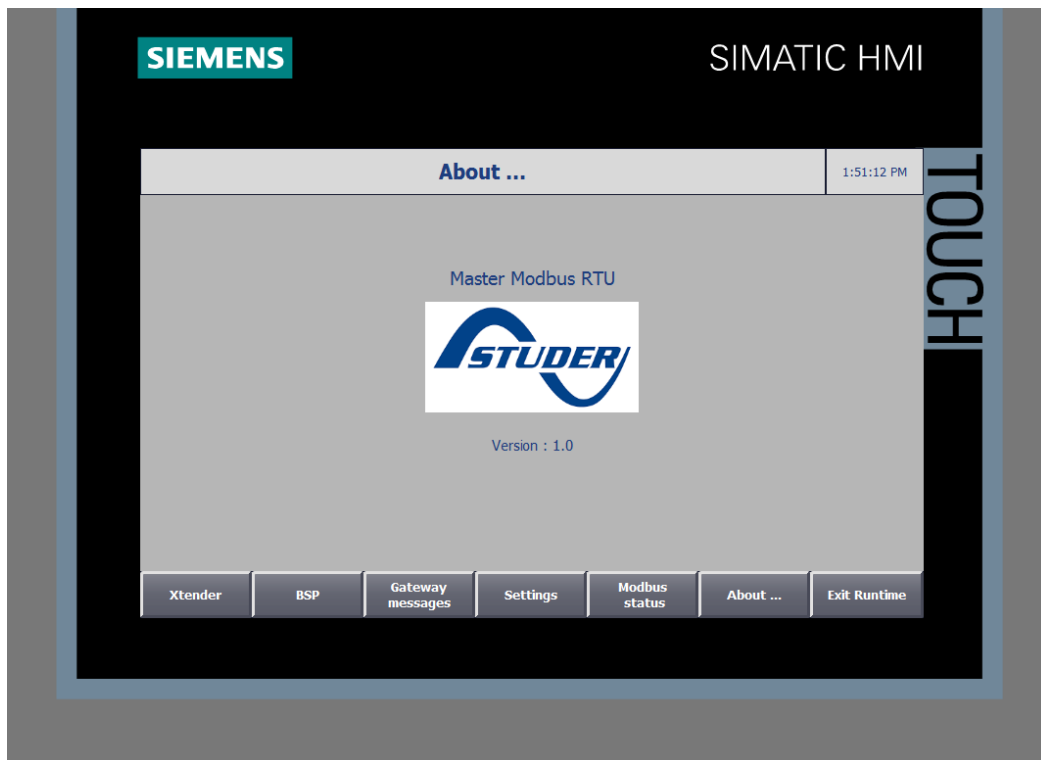


Figure 24 : Screen "About"

Remark :

Messages that are read in the Xcom-485i interface as well as information messages generated during data transfers are saved in a flash memory inserted in the HMI.