

# SIEMENS



## **SAPHIR** **Modbus for ACX32, slave mode** **IV Produkt LB20 Application v3.x**

### **Engineering Guide**



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# 1 About this Document

## 1.1 Foreword

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### Purpose

The purpose of this document is to provide users with a quick and simple means to familiarize themselves with the configuration and use of Modbus on the Saphir.

## 1.2 Notes on Use

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### Target audience

This document is intended for developers who perform commissioning of the Modbus communication.

### Further information

For operation and planning of the SAPHIR OEM primary controller, please refer to additional documents, such as:

- SAPHIR ACX32..., Device Datasheet (Order No: CE2Q3689en)
- SAPHIR ACX51.20, Device Datasheet (Order No: CE2Q3675en)

You can order this and other publications from Siemens Building Technologies, HVAC Products.

## 1.3 Symbols and Abbreviations

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Passages introduced by this symbol indicate a warning to help prevent incorrect operation.



Passages introduced by this symbol indicate that the text must be read with special attention.



Paragraphs with this symbol provide tips.

### Abbreviations

Abbreviation	Description
RTU	Remote Terminal Unit
TCP/IP	Transmission Control Protocol, e.g. Ethernet/Internet
Gateway	A device for transfer data between different kind of networks
LSB	Least Significant Bit
MSB	Most Significant Bit

## 1.4 Revision History

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Revision	Date	Author	Remark
1.0	2006-03-10	Michael Sjöberg	First release
1.1	2006-05-23	Michael Sjöberg	

## 2 General

### 2.1 The Modbus protocol

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The following section provides only a brief overview of the Modbus protocol. For the full specification, refer to "Modicon Modbus Protocol Reference Guide PI-MBUS-300 Rev. J".

#### Master/slave protocol

The Modbus is a master/slave protocol. By definition, this means that a Modbus network contains one, and only one, master and at least one slave.

#### Transactions on the Modbus

The Modbus master starts the transactions on the network with a slave query. The slave either responds positively with the requested service (*response*) or transmits an "exception message". In the remainder of this document, these query/response sequences are also referred to as "Modbus telegrams".

#### Function codes

The type of transaction is defined by the function code transmitted in the Modbus telegrams. A function code defines the following:

- Structure of the telegram, query and response
- Direction of data transmission (master → slave or slave→master)
- Data format of data point (bit or 16-bit register)

#### Transmission modes

The Modbus protocol defines two alternative serial transmission modes: These modes have the following characteristics:

##### RTU (Remote Terminal Unit) mode

- Binary-coded data
- Start and end of telegrams marked by timed pauses (a "silent interval") between the characters transmitted.
- Check sum algorithm: CRC (Cyclic Redundancy Check)

##### ASCII mode

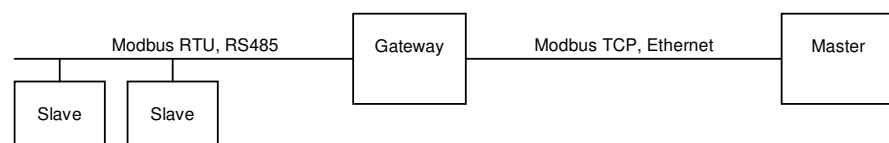
- Data in hexadecimal notation
- Beginning and end of telegrams marked by start and end characters.
- Check sum algorithm: LRC (Longitudinal Redundancy Check)

#### Telegrams with multiple data points

Certain types of Modbus transactions permit the transmission of a variable number of Modbus data points (bit or 16-bit register) in a single telegram.

#### Modbus TCP Ethernet

A Modbus TCP/RTU gateway can be used to connect a Modbus/TCP master to one or several Saphir. The Modbus TCP/RTU gateway will act as a Modbus/TCP slave on a Ethernet network, and transform the queries to the serial Modbus network and back again.



## 2.2 RS485 networks

RS485 is a balanced line, half-duplex transmission system that meets the requirements for a truly multi-point communications network, and the standard specifies up to 32 drivers and 32 receivers on a single (2-wire) bus. Half-duplex data transmission means that data can be transmitted in both directions on a signal carrier, but not at the same time.

### Specifications

#### RS485

Mode of Operation	Differential
Total Number of Drivers and Receivers on One Line (One driver active at a time for RS485 networks)	32 Driver 32 Recvr
Maximum Cable Length	1200 meter
Maximum Data Rate (10m – 1200m)	10Mb/s-100Kb/s
Maximum Driver Output Voltage	-7V to +12V
Driver Output Signal Level (Loaded Min.)	+/-1.5V
Driver Output Signal Level (Unloaded Max)	+/-6V
Driver Load Impedance (Ohms)	54
Max. Driver Current in High Z State, Power On	+/-100uA
Max. Driver Current in High Z State, Power Off	+/-100uA
Slew Rate (Max.)	N/A
Receiver Input Voltage Range	-7V to +12V
Receiver Input Sensitivity	+/-200mV
Receiver Input Resistance (Ohms), (1 Standard Load for RS485)	>=12k

## 2.3 Tools



Modbus slave devices e.g. Saphir can be tested with several Modbus master simulation tools, like “Modbus Poll” or “ModScan”, from a computer. Modbus Poll can be downloaded from [www.modbustools.com](http://www.modbustools.com).

A RS485/RS232 converter or a Modbus RTU/TCP gateway may be needed to connect to a computer.

## 2.4 Troubleshooting, Tips

### Modbus

#### Communication error

- The slave address must be unique in the network, valid addresses are from 1-247.
- Only reference addresses that are generated can be read/write, see chapter 5 for more information about the specific application.

#### RS485 network

- Baudrate, Parity and Stopbits must match the network and the Master.
- The 2-wire bus is NOT interchangeable and must be connected correctly.
- In case of long distance and/or high Baudrate, please consider end of line resistors like 120 Ohm on both sides (according to RS485 rules).

# 3 Connection and Configuration

## 3.1 General

### Connection ways

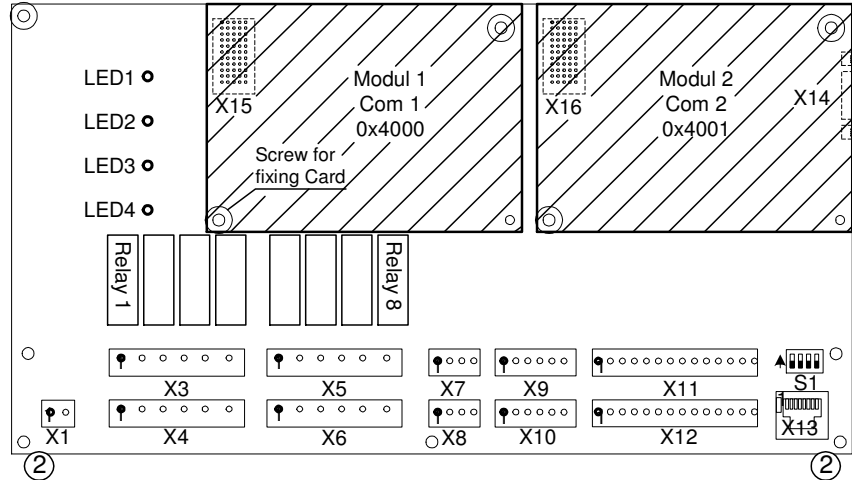


The ACX32 Saphir controller can communicate on RS485 either via the external communication card ACX51.20 QuadCom or the internal comport onboard\* via the 9 pin D-Sub connector on the side of the controller.

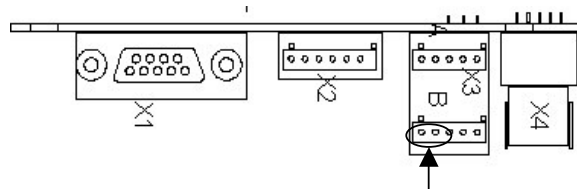
\*The hardware must be marked with RS422/RS485

## 3.2 QuadCom card

Follow the instructions below for mounting the QuadCom card on the Saphir controller.



1. Power off.
2. Dismounting the two forward outside screws on cover with a screw-driver type Torx 10 or a flat chisel.  
**Note!** Connect yourself to earth to avoid static electricity that could seriously damage the circuit card.
3. Mount metal fixing supports.
4. Place the card with belonging cover plate in one of the slots.  
**Note!** ACX51.20 can be connected to any of the two slots.
5. Check that the card is correct connected.
6. Fix card with the screws that are in the kit.
7. Remount the Cover of the controller.
8. Power on.



9. Attach communication cable to connector X3B, pin 1 and 2

### Pin assignment

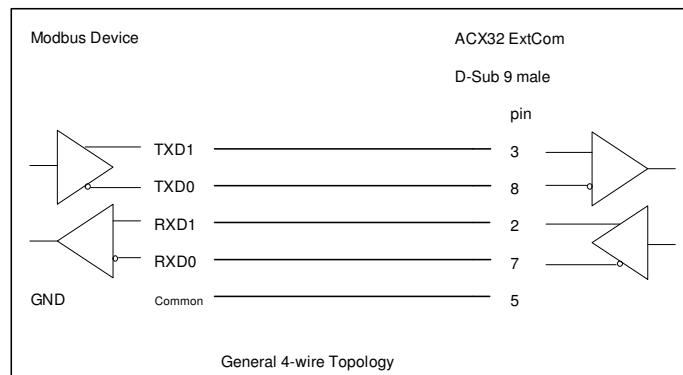
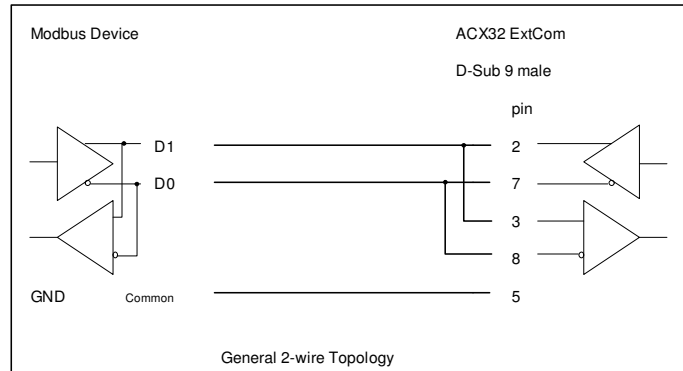
Pin No.	X3B Connector RS485
1	Tx+/Rx+
2	Tx-/Rx-
3	Tx+/Rx+
4	Tx-/Rx-
5	GND

The interface is not galvanically separated, so GND should not be connected.

### 3.3 Onboard 9 pin D-Sub



Follow the instructions below to connect to the internal onboard 9-pin D-Sub interface (female onboard). **The hardware must be marked with RS422/RS485.**



#### Pin assignment

Pin No.	9 pin D-Sub
1	-
2	TxD+
3	RxD+
4	-
5	GND
6	-
7	TxD-
8	RxD-
9	-

### 3.4 Configure

Follow the instructions below to configure RS485 and Modbus.

1. Commissioning unit with all settings before starting to configure Modbus.
2. Log in with password 2000.  
Navigate to menu "Systemparameter – Communication – Modbus configuration".
3. Set communication port (Internal, 4Com)
4. Set the slave address for the device. (1-247, Must be unique).
5. Set Baudrate for RS485 (300-19200)
6. Set Parity for RS485 (None, Even, Odd)
7. Set number of Stopbit for RS485 (1 or 2)
8. Set the "Configuration done" to "Yes", to restart the Saphir.



## 4 Register map and function codes

### 4.1 Register map

Modbus registers are organized into reference types identified by the leading number of the reference address:

The "x" following the leading character represents a four-digit reference address.

#### Modbus Data formats

ModbusType	Reference	Description (refer to a Master device)
Coil Status	0xxxx	<u>Read/Write Discrete Outputs or Coils.</u> A 0x reference address is used to drive output data to a digital 1-bit output channel.
Input Status	1xxxx	<u>Read Discrete Inputs.</u> The 1-bit status of a 1x reference address is controlled by the corresponding digital input channel.
Input Register	3xxxx	<u>Read Input Registers.</u> A 3x reference register contains a 16-bit number received from an external source—e.g. an analog signal.
Holding Register	4xxxx	<u>Read/Write Output or Holding Registers.</u> A 4x register is used to store 16-bits of numerical data (binary or decimal), or to send the data from the CPU to an output channel.

The leading character is generally implied by the function code and omitted from the address specified for a given function. The leading character also identifies the I/O data type.

### 4.2 Function codes

The functions below are used to access the registers outlined in the register map of the module for sending and receiving data.

#### Supported Modbus commands

Function Code	Modbus function	Modbus master application
01	Read Coil Status	Read multiple DOs (0xAdr)
02	Read Input Status	Read multiple DIs (1xAdr)
03	Read Holding Registers	Read multiple AOs (4xAdr)
04	Read Input Registers	Read multiple AIs (3xAdr)
05	Force Single Coil	Write single DO (0xAdr)
06	Preset Single Register	Write single AO (4xAdr)
15	Force Multiple Coils	Write multiple DOs (0xAdr)
16	Preset Multiple Registers	Write multiple AOs (4xAdr)

When the slave device responds to the master, it uses the function code field to indicate either a normal (error-free) response, or that some kind of error has occurred (an exception response).

# 5 Reference addresses

## 5.1 General

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This chapter describes the reference addresses used in the application.

### Used addresses

All reference addresses from 0001-0099 are generated and can be accessed even if they are not in this list. Therefore it is possible to Force/Preset Multiple Coils/Registers even if there is a gap between two reference addresses.



**Do not Read/Write any addresses above 0099. If so there will be an exception response and the communication fails.**

### Presentation

- 16 bit real values are presented in their actual value/unit. E.g. °C, %, Pa, l/s
- 16 bit states are presented as a number, see the reference address description
- 1 bit status are presented as 0=Off and 1=On
- 1 bit alarms are presented as 0=Normal and 1=Alarm

### Example

A real value is 215 and is then presented by a 16 bit register binary as:  
MSB 11010111 LSB

The 16 bit register "BMS override timeprogram" will be used and set binary to state 6:  
MSB 00000110 LSB

### Decimals

When Modbus are using a 16 bit register to handle real values, a factor must be used to have decimals. E.g. a factor 10 for 1 decimal, a factor 100 for 2 decimals...



**All temperature values and setpoints have a factor 10 and must then be divided/multiplied with 10 in the Master device.**

### Example

The actual supply air temperature is 20.6°C and is then multiplied with 10 in the Saphir. It will then be presented as 206 at Modbus and must be divided by 10 in the Master device to have 20.6°C again.

To set the temperature setpoint 21.5°C from the Master device it must be multiplied with 10 to have it presented as 215 at Modbus. The saphir then divide by 10 to have 21.5°C again.

### Setpoints

#### Double reference addr

All setpoints have two reference addresses. The reason for that is that there are no feedback on the Holding register (4xAdr) on startup after power failure or if the setpoint are changed locally in the Saphir from the HMI, the actual setpoint that the Saphir use are therefore presented at the Input register (3xAdr). If the setpoint is changed over Modbus both the Holding register and the Input register are updated.

The Holding register (4xAdr) and the Input register (3xAdr) use the same reference for easier access.

### Example

Heating setpoint comfort	4x0001 and 3x0001
Flow setpoint	4x0010 and 3x0010

## 5.2 Coil Status

Address	Description	Values / Unit	Remark
0x0001	Reset Alarms	0-1	Manually set back to 0

## 5.3 Input Status

Address	Description	Values / Unit	Remark
1x0001	Not used	0	
1x0002	Alarm class A active	0-1	
1x0003	Alarm class B active	0-1	
1x0004	Alarm class C active	0-1	
1x0005	Temperature deviation alarm	0-1	
1x0006	Fire / Smoke alarm	0-1	
1x0007	HRC alarm	0-1	
1x0008	Heating pump / Heating alarm	0-1	
1x0009	Cooling pump / Cooling alarm	0-1	
1x0010	AUX alarm	0-1	
1x0011	Supply fan alarm	0-1	
1x0012	Exhaust fan alarm	0-1	
1x0014	Frost protection alarm	0-1	
1x0015	HRC frost alarm	0-1	
1x0017	HRC efficiency alarm	0-1	
1x0018	Unit override alarm	0-1	
1x0019	Filter alarm	0-1	
1x0021	Room / Exhaust sensor alarm	0-1	
1x0022	Out door sensor alarm	0-1	
1x0023	Supply air sensor alarm	0-1	
1x0024	Frost sensor alarm	0-1	
1x0025	Multifunction sensor 1 alarm	0-1	
1x0026	Multifunction sensor 2 alarm	0-1	
1x0027	Runtime alarm	0-1	
1x0028	Smoke damper alarm	0-1	
1x0033	Heating pump / Electrical heater	0-1	
1x0034	Cooling pump / DX Step 1	0-1	
1x0035	Out door damper	0-1	
1x0036	Alarm class A output	0-1	
1x0037	Alarm class B output	0-1	
1x0038	Smoke damper	0-1	
1x0039	Cooling DX Step 2	0-1	
1x0040	Supply fan Off	0-1	
1x0041	Supply fan Step 1	0-1	
1x0042	Supply fan Step 2	0-1	
1x0043	Exhaust fan Off	0-1	
1x0044	Exhaust fan Step 1	0-1	
1x0045	Exhaust fan Step 2	0-1	
1x0052	Service switch Stop	0-1	
1x0053	Service switch Step 1	0-1	
1x0054	Service switch Step 2	0-1	
1x0055	External Stop	0-1	
1x0056	Control input / Timer input Stop	0-1	
1x0057	Control input / Timer input Step 1	0-1	
1x0058	Control input / Timer input Step 2	0-1	
1x0059	Room control active	0-1	
1x0060	Supply control active	0-1	
1x0061	Exhaust air control active	0-1	

## 5.4 Input Register

Address	Description	Values / Unit	Remark
3x0001	Basic setpoint temperature, Comfort	xx.y °C (fac10)	Feedback for Holding reg
3x0002	Basic setpoint temperature, Economy	xx.y °C (fac10)	Feedback for Holding reg
3x0003	Dead zone cooling, Comfort	xx.y °C (fac10)	Feedback for Holding reg
3x0004	Dead zone cooling, Economy	xx.y °C (fac10)	Feedback for Holding reg
3x0005	Setpoint post-conditioning	xx.y °C (fac10)	Feedback for Holding reg
3x0007	Min setpoint supply air temperature, cascade control	xx.y °C (fac10)	Feedback for Holding reg
3x0008	Max setpoint supply air temperature, cascade control	xx.y °C (fac10)	Feedback for Holding reg
3x0010	Setpoint flow/pressure supply air lowspeed	xxx l/s or Pa	Feedback for Holding reg
3x0011	Setpoint flow/pressure supply air highspeed	xxx l/s or Pa	Feedback for Holding reg
3x0012	Setpoint flow/press exhaust air lowspeed	xxx l/s or Pa	Feedback for Holding reg
3x0013	Setpoint flow/press exhaust air highspeed	xxx l/s or Pa	Feedback for Holding reg
3x0015	Setpoint fixed supply air lowspeed	xxx 0-100%	Feedback for Holding reg
3x0016	Setpoint fixed supply air highspeed	xxx 0-100%	Feedback for Holding reg
3x0017	Setpoint fixed exhaust air lowspeed	xxx 0-100%	Feedback for Holding reg
3x0018	Setpoint fixed exhaust air highspeed	xxx 0-100%	Feedback for Holding reg
3x0020	Actual heating setpoint for temperature control	xx.y °C (fac10)	
3x0021	Actual cooling setpoint for temperature control	xx.y °C (fac10)	
3x0022	Actual heating setpoint for supply air temperature control	xx.y °C (fac10)	When cascade control
3x0023	Actual cooling setpoint for supply air temperature control	xx.y °C (fac10)	When cascade control
3x0024	Presentation remote setpoint	xx.y °C (fac10)	
3x0025	Outdoor temperature	xx.y °C (fac10)	
3x0026	Supply air temperature	xx.y °C (fac10)	
3x0027	Frost temperature	xx.y °C (fac10)	
3x0028	Room/Exhaust air temperature	xx.y °C (fac10)	
3x0029	Multifunction temperature 2	xx.y °C (fac10)	
3x0030	Multifunction temperature 1	xx.y °C (fac10)	
3x0031	Supply air flow/pressure	xxx l/s	
3x0032	Exhaust air flow/pressure	xxx l/s	
3x0033	Supply air pressure	xxx Pa	When fan slave mode
3x0040	Analog output Heating	0-100%	
3x0041	Analog output Cooling	0-100%	
3x0042	Analog output Heat recovery	0-100%	
3x0043	Actual HRC efficiency	0-100%	
3x0044	Frequency converter Supply fan	0-100%	
3x0045	Frequency converter Exhaust fan	0-100%	
3x0046	Air quality	0-2000 ppm	
3x0047	Analog output Extra controller/sequence	0-100%	
3x0050	Actual operation mode 0 = Damperkick, 1 = Testtemp, 2 = Off 3 = Economy, 4 = Comfort, 5 = Startup 6 = Nightpurge, 7 = Unoccupied 8 = Overrun	0-8	
3x0051	Actual fan mode 0 = Off, 1 = Lowspeed, 2 = Highspeed	0-2	

## 5.5 Holding Register

Address	Description	Values / Unit	Remark
4x0001	Basic setpoint temperature, Comfort	xx.y °C (fac10)	
4x0002	Basic setpoint temperature, Economy	xx.y °C (fac10)	
4x0003	Dead zone cooling, Comfort	xx.y °C (fac10)	
4x0004	Dead zone cooling, Economy	xx.y °C (fac10)	
4x0005	Setpoint post-conditioning	xx.y °C (fac10)	
4x0007	Min setpoint supply air temperature, cascade control	xx.y °C (fac10)	
4x0008	Max setpoint supply air temperature, cascade control	xx.y °C (fac10)	
4x0010	Setpoint flow/pressure supply air lowspeed	xxx l/s or Pa	Depends on configuration
4x0011	Setpoint flow/pressure supply air highspeed	xxx l/s or Pa	Depends on configuration
4x0012	Setpoint flow/press exhaust air lowspeed	xxx l/s or Pa	Depends on configuration
4x0013	Setpoint flow/press exhaust air highspeed	xxx l/s or Pa	Depends on configuration
4x0015	Setpoint fixed supply air lowspeed	xxx 0-100%	
4x0016	Setpoint fixed supply air highspeed	xxx 0-100%	
3x0017	Setpoint fixed exhaust air lowspeed	xxx 0-100%	
4x0018	Setpoint fixed exhaust air highspeed	xxx 0-100%	
4x0050	BMS override timeprogram 0 = Internal TSP, 1 = Off, 2 = Eco St1 3 = Eco St2, 4 = Comf St1, 5 = Comf St2	0-5	

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