SIEMENS

# SAPHIR
# Modbus for ACX36, slave mode
# Siemens LB10 Application v2.0x

## Engineering Guide

CE2Y3226en/Siemens
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Siemens Building Technologies
**HVAC Products**

# Contents

# 1 About this Document

## 1.1 Foreword

**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

**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 ACX36..., Device Datasheet (Order No: CE2Q3226en)
- SAPHIR ACX36…, Basic Documentation (No: CE2P3226en)

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

## 1.3 Symbols and Abbreviations

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

| Revision | Date | Author | Remark |
|---|---|---|---|
| 1.0 | 2006-04-18 | Michael Sjöberg | First release |
| 1.1 | 2007-04-18 | Michael Sjöberg | New addresses |
| 2.0 | 2008-04-28 | Michael Sjöberg | New addresses |

# 2 General

## 2.1 The Modbus protocol

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**

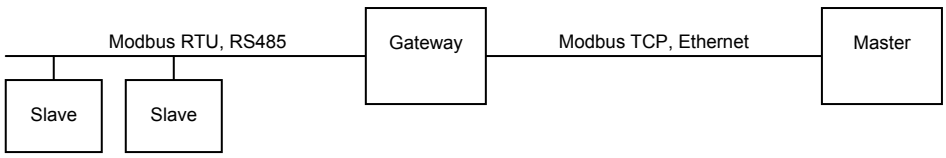
- Data in hexadecimal notation
- Beginning and end of telegrams marked by start and end characters.
- Check sum algorithm: LRC (Longitudinal Redundancy Check)

**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 salve 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<br>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 .
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 from1-247.
- 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

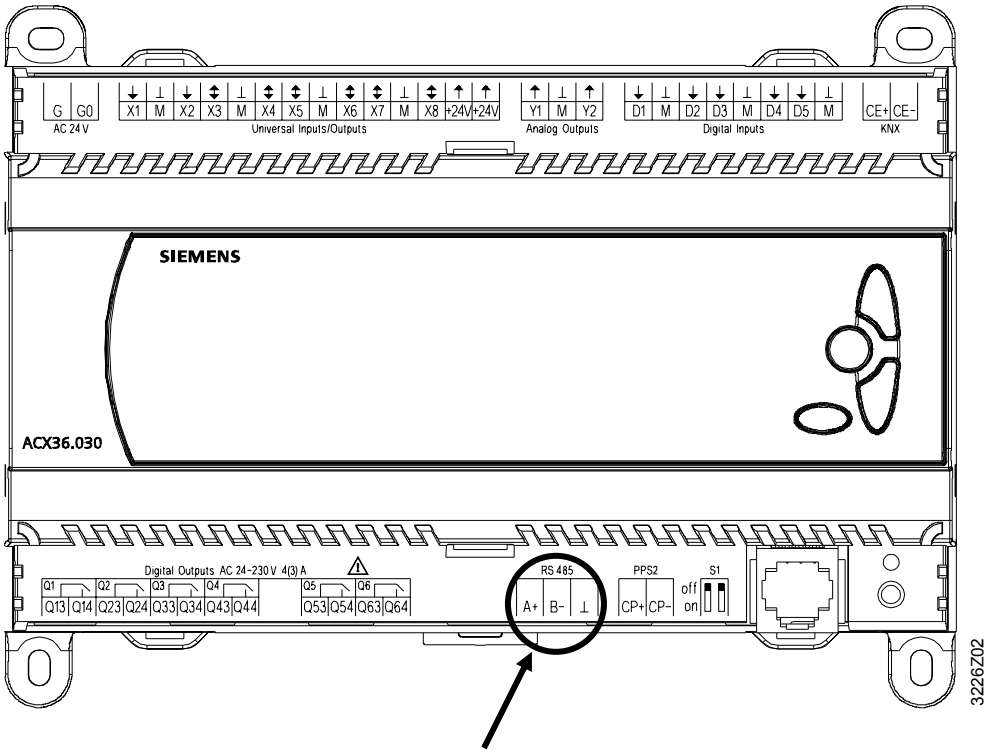
## 3.1 General

The RS485 interface is present on all device types of ACX36.

## 3.2 Connection

Follow the instructions below to connect to the RS485 interface.

⚠ DO NOT use the Saphir power supply to other external Modbus devices.




1. Attach communication cable to connector A+ and B-

**Technical data**

| RS485 / Modbus RTU | Data |
|---|---|
| 2-wire bus connection, twisted pair | A+, B-, NOT interchangeable |
| Bus connection / electronics | Non-floating |
| Bus termination (internal jumper) | 390/220/390 Ohm |

## 3.3 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 the slave address for the device. (1-247, Must be unique).
4. Set Baudrate for RS485 (300-19200)
5. Set Parity for RS485 (None, Even, Odd)
6. Set number of Stopbit for RS485 (1 or 2)
7. 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 | Read/Write Discrete Outputs or Coils.<br>A 0x reference address is used to drive output data to a digital 1-bit output channel. |
| Input Status | 1xxxx | Read Discrete Inputs.<br>The 1-bit status of a 1x reference address is controlled by the corresponding digital input channel. |
| Input Register | 3xxxx | Read Input Registers.<br>A 3x reference register contains a 16-bit number received from an external source—e.g. an analog signal. |
| Holding Register | 4xxxx | Read/Write Output or Holding Registers.<br>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

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.**

**All address types starts with 1, and due to that some Master devices starts with 0 it's in that case necessary to subtract all addresses in this manual with 1.**

**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 16bit 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 |
| 0x0002 | Emergency stop | 0-1 | |
| 0x0003 | Communication test, pulse | 0-1 | |
| | | | |

## 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 | |
| 1x0016 | HRC pressure guard alarm | 0-1 | |
| 1x0017 | HRC efficiency alarm | 0-1 | |
| 1x0018 | Unit override alarm | 0-1 | |
| 1x0019 | Filter alarm | 0-1 | |
| 1x0020 | Room unit 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 | |
| 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 | |
| 1x0064 | Emergency stop | 0-1 | |
| | | | |

## 5.4 Input Register

| Address | Description | Values / Unit | Remark |
|---|---|---|---|
| 3x0001 | Basic setpoint temperature | xx.y °C (fac10) | Feedback for Holding reg |
| 3x0003 | Dead zone cooling | 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 |
| | | | |
| 3x0015 | Setpoint fixed supply air lowspeed | 0-100% | Feedback for Holding reg |
| 3x0016 | Setpoint fixed supply air highspeed | 0-100% | Feedback for Holding reg |
| 3x0017 | Setpoint fixed exhaust air lowspeed | 0-100% | Feedback for Holding reg |
| 3x0018 | Setpoint fixed exhaust air highspeed | 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) | |
| 3x0039 | Room unit temperature | xx.y °C (fac10) | |
| | | | |
| 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% | |
| | | | |
| 3x0050 | Actual operation mode<br>0 = Off, 1 = Step 1, 2 = Step 2<br>3 = Undefined,<br>4 = Testtemp, 5 = Nightpurge<br>6 = Unoccupied, 7 = Startup, 8 = Overrun<br>9 = Damper kick | 0-9 | |
| 3x0051 | Actual fan mode<br>0 = Off, 1 = Step 1, 2 = Step 2 | 0-2 | |
| 3x0052 | Actual external switch / timer mode<br>0 = Auto, 1 = Off, 2 = Step 1, 3 = Step 2 | 0-3 | |
| | | | |

## 5.5 Holding Register

| Address | Description | Values / Unit | Remark |
|---|---|---|---|
| 4x0001 | Basic setpoint temperature | xx.y °C (fac10) | |
| 4x0003 | Dead zone cooling | 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) | |
| | | | |
| 4x0015 | Setpoint fixed supply air lowspeed | 0-100% | |
| 4x0016 | Setpoint fixed supply air highspeed | 0-100% | |
| 3x0017 | Setpoint fixed exhaust air lowspeed | 0-100% | |
| 4x0018 | Setpoint fixed exhaust air highspeed | 0-100% | |
| | | | |
| 4x0025 | Outdoor temperature from communication | xx.y °C (fac10) | |
| | | | |
| 4x0050 | BMS override timeprogram<br>0 = Internal TSP, 1= Off, 2 = Step 1<br>3 = Step 2 | 0-3 | |
| | | | |

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