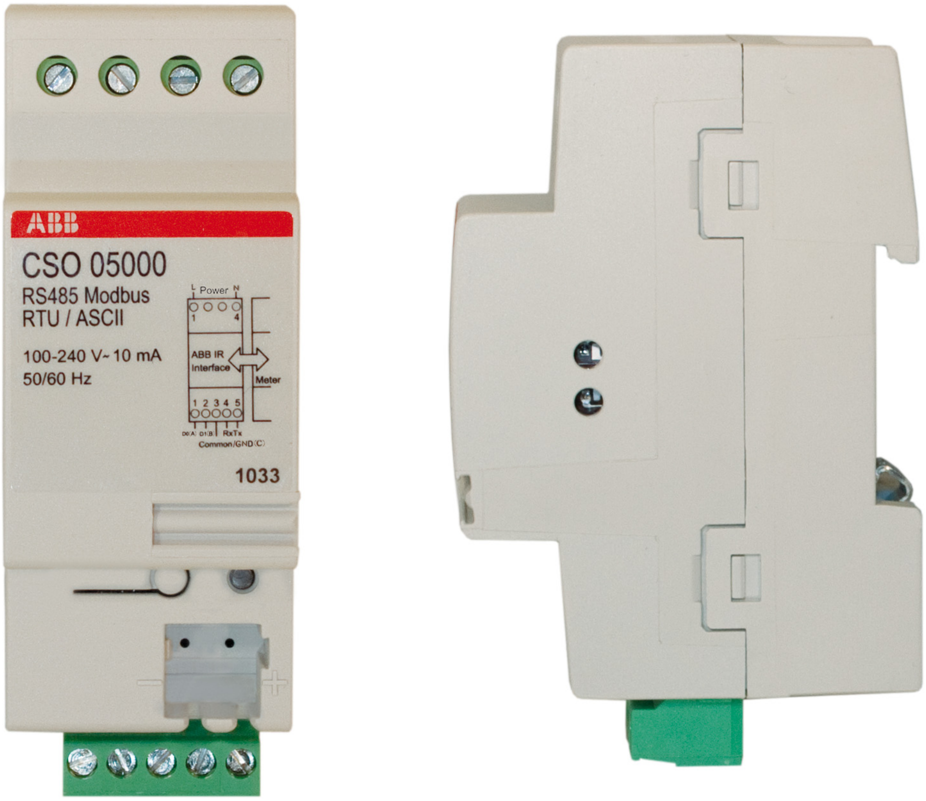
CSO 05000 RS-485 Modbus RTU/ASCII

Serial Communication Adapter

User Manual



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CSO05000 RS-485 Modbus RTU/ASCII SCA

User Manual

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Contact

ABB AB
P.O. BOX 1005
SE-611 29 NYKÖPING
SWEDEN
Tel: +46 155 295000
Fax: +46 155 288110

1 About This manual

1.1 Overview

Introduction

This chapter describes the conventions used in this document. In this chapter you will also find explanations and definitions of terms and abbreviations that are used in the document.

In this chapter

This chapter covers the following topics.

1.2 Conventions used in this document

Symbols

This document contains warning, caution, and note icons that point out safety related conditions or other important information.

The meaning of the symbols

The following table explains the meaning of the symbols used in this document.

Symbol	Description
⚠	The electrical warning icon indicates the presence of a hazard which could result in electrical shock.
❗	The caution icon indicates important information or a warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.
ℹ	The information icon alerts the reader to important facts and conditions.

1.3 Terminology

List of terms

The following table explains the term used in this document.

Term	Definition
DIN-rail mount	Mounting of industrial control equipment on a standardized rail.
ABB System Pro M	ABB’s modular system for DIN-rail mounting.
M-Bus	Industrial communication protocol for remote reading of consumption meters.
Modbus	Industrial communication protocol for connecting industrial electronic devices.
Bit-rate	Data transmission rate

List of abbreviations

The following table explains the abbreviations and acronyms used in this docuument

Abbreviation	Explanation
SCA	Serial communication adapter
EMC	Electromagnetic compatibility
LED	Light emitting diod
LVD	Low voltage directive
AMR	Automatic meter reading
RTU	Remote terminal unit
ASCII	American standard code for information interchange

2 About the CSO 05000

2.1 Overview

Introduction

This chapter describes the parts of the CSO 05000 and its technical specifications.

In this chapter

This chapter covers the following topics.

2.2 Product overview

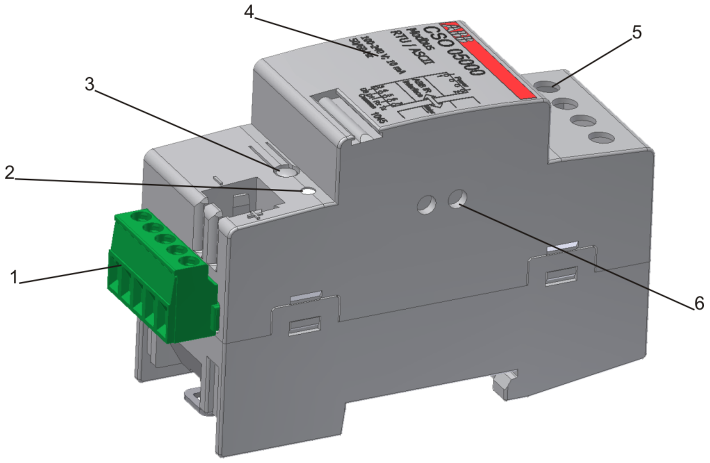
Description

The CSO 05000 is a DIN-rail mount serial communication adapter (SCA) for automatic meter reading (AMR) in Modbus RTU/ASCII networks. The SCA converts the M-bus protocol from the electricity meter to Modbus entities thus making it possible to use data from M-Bus meters in a Modbus RTU/ASCII network.

The SCA has the size of two Din modules and follows ABB's Pro M standard, which defines mechanical dimensions, way of mounting and design.

Illustration

The parts of the CSO 05000 is shown in the picture below.



Parts

The following table describes the parts of the CSO 05000.

Part	Description
1	Terminal for communication and PC connections (RS-485 and RS-232)
2	Status LED
3	Reset button
4	Type designation label and wiring diagram
5	Terminal for power connection
6	Infra-red communication port

2.3 Technical specifications

Electrical

The following table shows the electrical specifications

Nominal voltage	100-240 V~
Voltage range	-20% to +15% of nominal voltage
Frequency	50/60 Hz ± 5%
Power consumption in standby	0.54 VA, 0.13 W at 230 V~
Power consumption in operation	0.61 VA, 0.17 W at 230 V~
Terminal wire area	0-2.5mm^2
Recommended tightening torque	0.5 Nm
Max. fuse before the SCA	16A

Mechanical

The following table shows the mechanical specifications

Casing material	Polyamide
Weight	102 g (without packing) 141 g (with packing)
Protection class	IP 20

Environmental

The following table shows the environmental specifications

Operating temperature range	-25° to +70°
Storage temperature range	-25° to +70°
Humidity	75% yearly average, 95% for 30 days/year

Interface

The following table shows the interface specifications.

Terminal wire area solid	0-2.5 mm^2 (IMQ) 12 AWG (UL)
Terminal wire area stranded	0-1.5 mm^2 (VDE) 12 AWG (UL)
Communication interface	RS-485
Protocol	Modbus RTU/ASCII
Bit-rate	600 - 115200 bit/s (Default: 19200 bit/s)
Configuration interface	RS-232

Standards

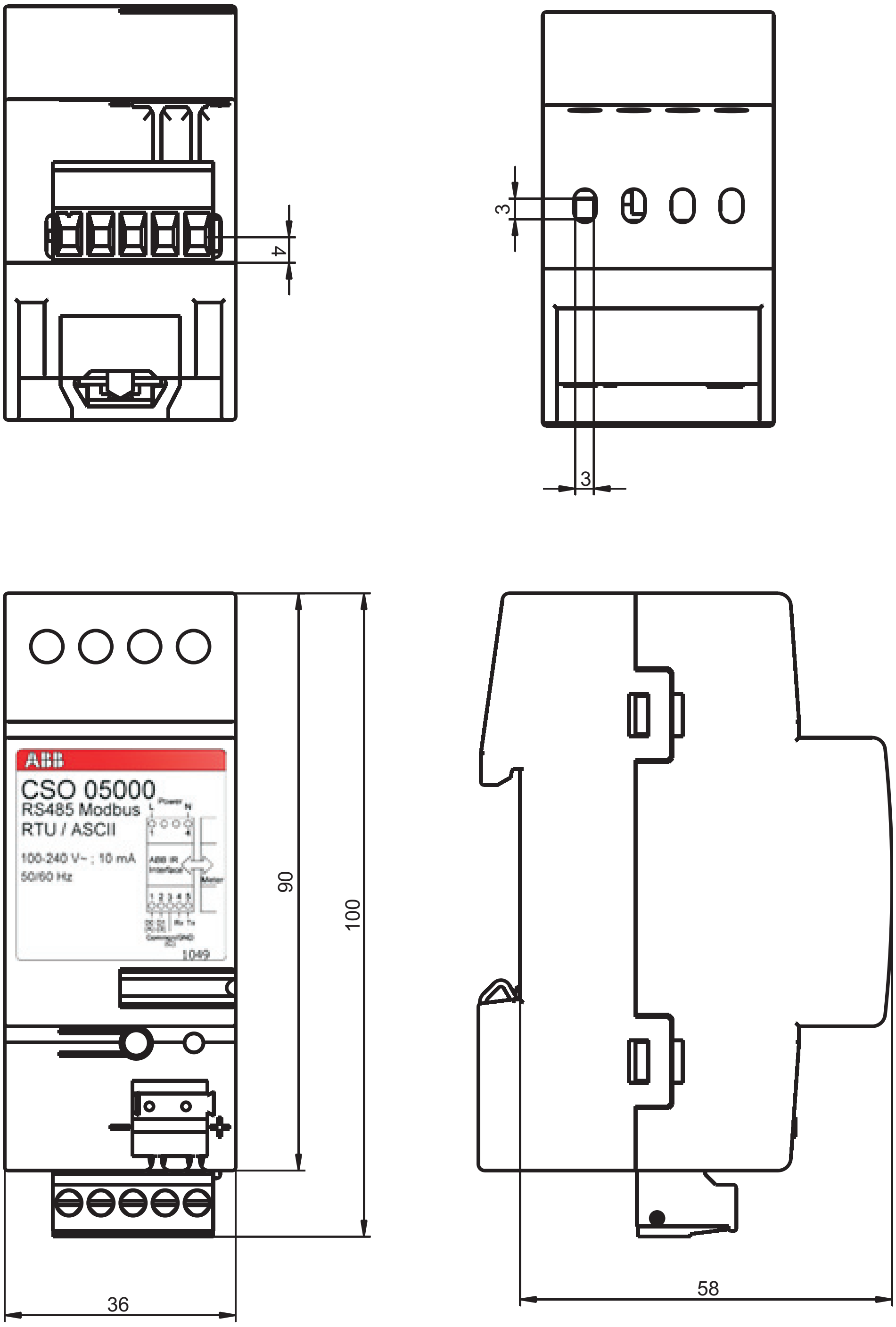
The following table shows

LVD	2006/95 EEC
EMC	2004/108 EEC IEC 61000-6-2 and IEC 61000-6-3
Protection class	IP 20 according to IEC 60529 with the terminal for Modbus communication attached to the SCA.

2.4 Physical dimensions

Drawing

The drawing below shows the physical dimensions of the CSO 05000.



3 Installing the CSO 05000

3.1 Overview

Introduction

This chapter gives you the information you need to install and to verify the installation of the CSO 05000.

In this chapter

This chapter covers the following topics

3.2 Installation

⚠ Electrical equipment should only be installed, accessed, serviced and maintained by qualified electrical personnel.Working with high voltage is potentially lethal. Persons subjected to high voltage may suffer cardiac arrest, burn injuries, or other severe injuries. To avoid such injuries, make sure to disconnect the power supply before you start the installation.

The CSO 05000 is intended for installation in a Restricted Access Location. For safety reasons it is recommended that the CSO 05000 is installed in a way that makes it impossible to reach or touch the terminal blocks by accident.The best way to make a safe installation is to install the unit in an enclosure. Further, access to the CSO 05000 should be limited through use of lock and key, controlled by qualified electrical personnel.

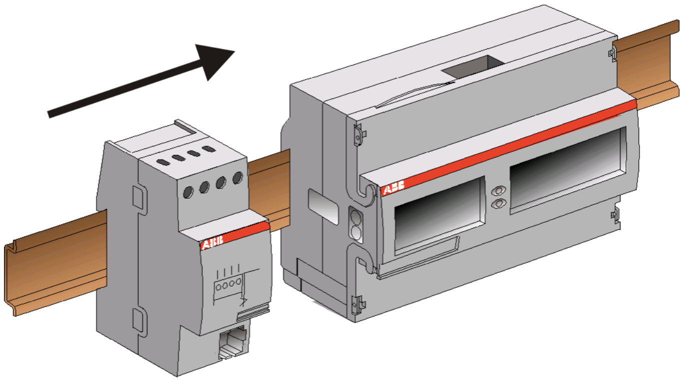
General

The CSO 05000 is intended for permanent installation on the mains power supply. The unit is powered by 100-240 V~ between terminals 1 and 4. For communication the SCA can be connected to an AMR system that supports Modbus RTU/ASCII on RS-485, or it can be connected directly to a PC for configuration via the RS-232 configuration interface. For further information about how to configure the SCA, refer to “Configuring the CSO 05000” on page - 19.

⚠ For a permanently connected SCA, a readily accessible disconnect device shall be incorporated external to the equipment.

How to install the CSO 05000.

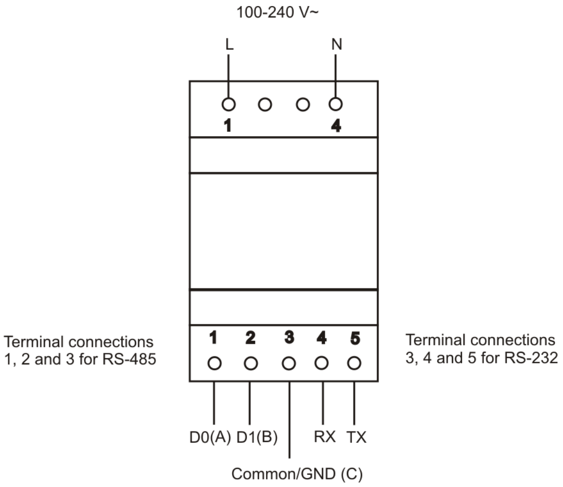
Follow the steps in the table to install the SCA.

Step	Action
1	Disconnect the mains power supply
2	Place the SCA to the left of the meter and snap it onto the DIN-rail. 
3	Strip the power wires and connect them to terminal 1 and 4 at the top of the SCA, see the wiring diagram below. (Recommended tightening torque 0.5 Nm)

Step	Action
4	Strip the communication and configuration wires and connect them to the terminals at the bottom of the SCA, see the wiring diagram below. (Recommended tightening torque 0.5 Nm)
5	Reconnect the mains power supply.
8	Verify that the LED shines with a steady green light.

Wiring diagram

The illustration below shows how to connect the power and the communication wires to the terminals on the SCA.


100-240 V~
L
N
1
4
Terminal connections 1, 2 and 3 for RS-485
1
2
3
4
5
Terminal connections 3, 4 and 5 for RS-232
D0(A) D1(B)
RX TX
Common/GND (C)

LED behavior

The following table describes the LED behavior and the status of the CSO 05000.

LED behavior	SCA status
Steady green	Power is on.
Blinking green	During start up of SCA
Blinking yellow	SCA is sending/receiving over the Modbus protocol.
Blinking red	Firmware is being updated or a soft reset has been initiated.
Blinking red and green	Factory reset. The reset button has been pressed for more than 10 seconds.
Steady red	Fatal error

4 Configuring the CSO 05000

4.1 Overview

Introduction

This chapter describes the different configuration settings for the CSO 05000 and how to change them. It also contains information about how to set up the terminal software that is required to perform the configuration.

In this chapter

This chapter covers the following topics.

4.2 Configuring the Modbus settings

Preparations

To configure the CSO 05000, the SCA must be connected to the RS-232 port of a pc and you need a terminal software to perform the necessary settings.

Terminal software

ABB recommends using Hyperterminal or TeraTerm.

On Windows XP machines Hyperterminal is included in the OS and is ready to run.

On Windows Vista and Windows 7 machines no terminal software is included in the OS. However, both Hyperterminal and TeraTerm are available for download from the Internet. It is also possible to copy the Hyperterminal from an XP machine and install on a Windows 7 or Vista machine. If you choose to copy Hyperterminal, make sure to copy the files hypertrm.exe and hypertrm.dll.

For detailed information about how to set up the terminal software, see “Setting up Hyperterminal and logging on” on page 21. or “Setting up TeraTerm and logging on” on page 24.

Modbus settings

Some Modbus settings can be configured by the user. Depending on what transmission mode is chosen, some settings are automatically set by the SCA and cannot be changed by the user.

Configurable settings

The settings in the following table can be configured by the user.

Configurable setting	Default setting	Setting range
Modbus address	1	1-247
Bit-rate	19200	600 -115200
Transmission mode	RTU	RTU/ASCII
Parity	Even	Even/Odd/No parity

Non-configurable settings

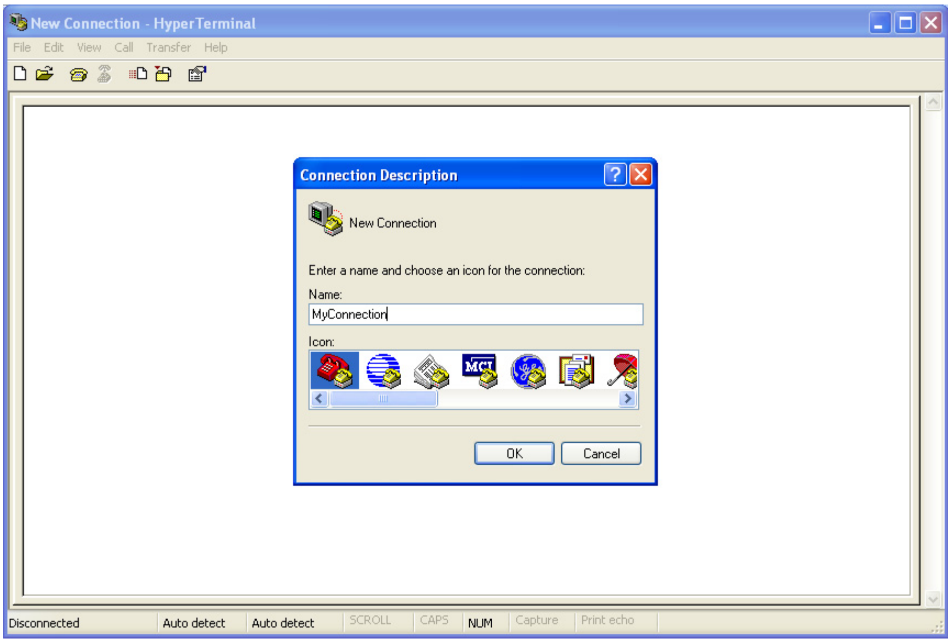
The settings in the following table are set by the SCA and cannot be configured manually.

Non-configurable settings	RTU	ASCII
Data bits	8	7
Stop bits	1 (2 if no parity)	1 (2 if no parity)
ASCII Inter-character Time out	N/A	1s

4.3 Setting up Hyperterminal and logging on

New connection

Start Hyperterminal and give a name to the new connection and click **OK**.



Connection Description

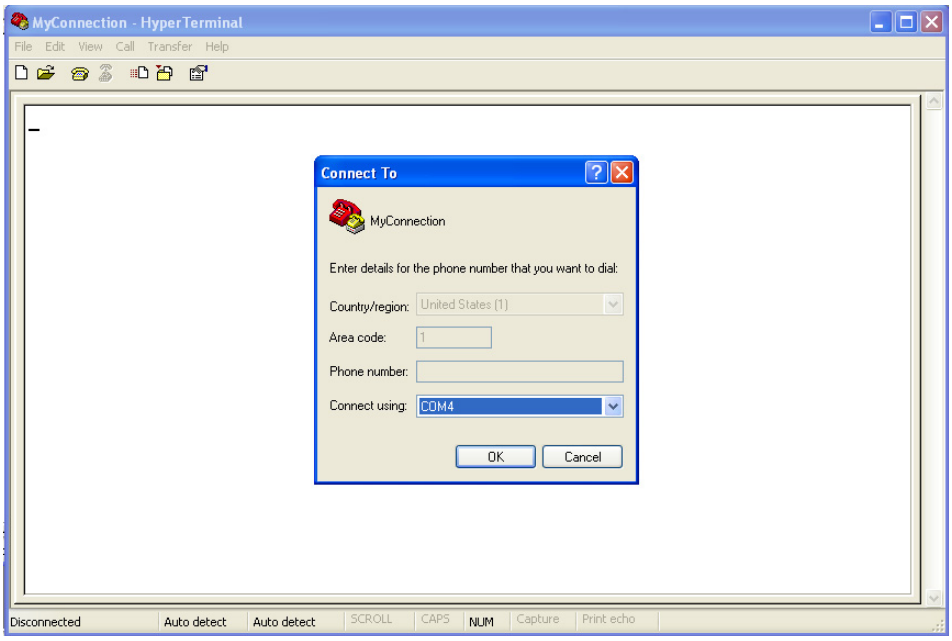
New Connection

Enter a name and choose an icon for the connection:

Name: MyConnection

Select COM-port

Select a COM-port and click **OK**



Connect To

MyConnection

Enter details for the phone number that you want to dial:

Country/region: United States (1)

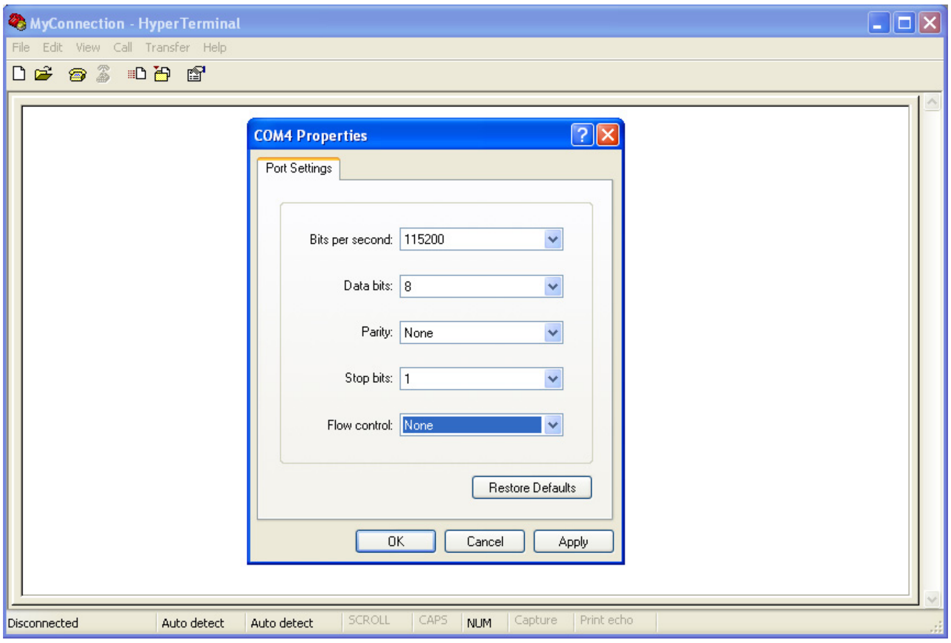
Area code: 1

Phone number:

Connect using: COM4

Set COM-port properties

Set the COM-port properties according to the image below and click **OK**



MyConnection - HyperTerminal
File Edit View Call Transfer Help
COM4 Properties
Port Settings

Bits per second: 115200

Data bits: 8

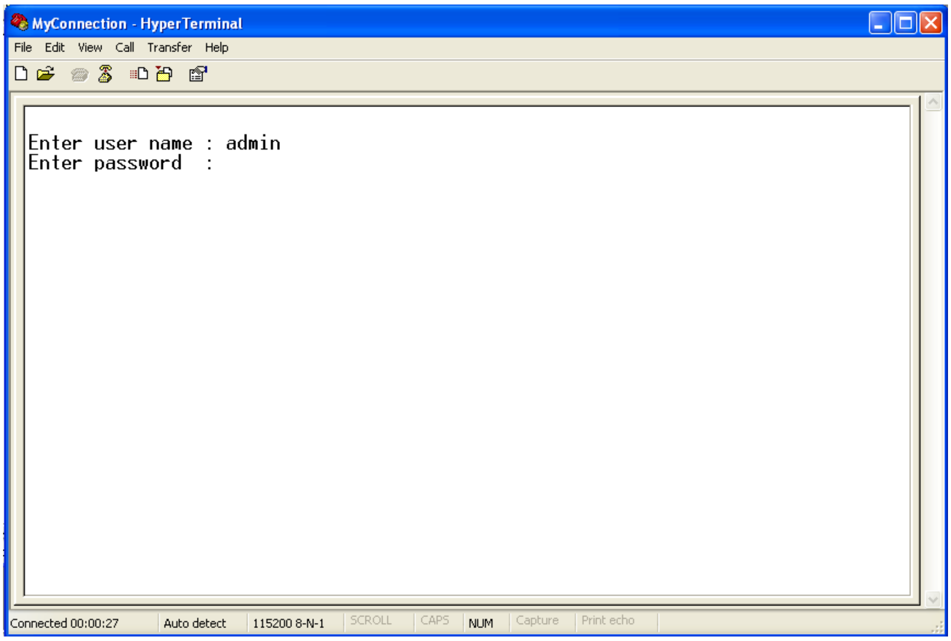
Parity: None

Stop bits: 1

Flow control: None

Login to the SCA

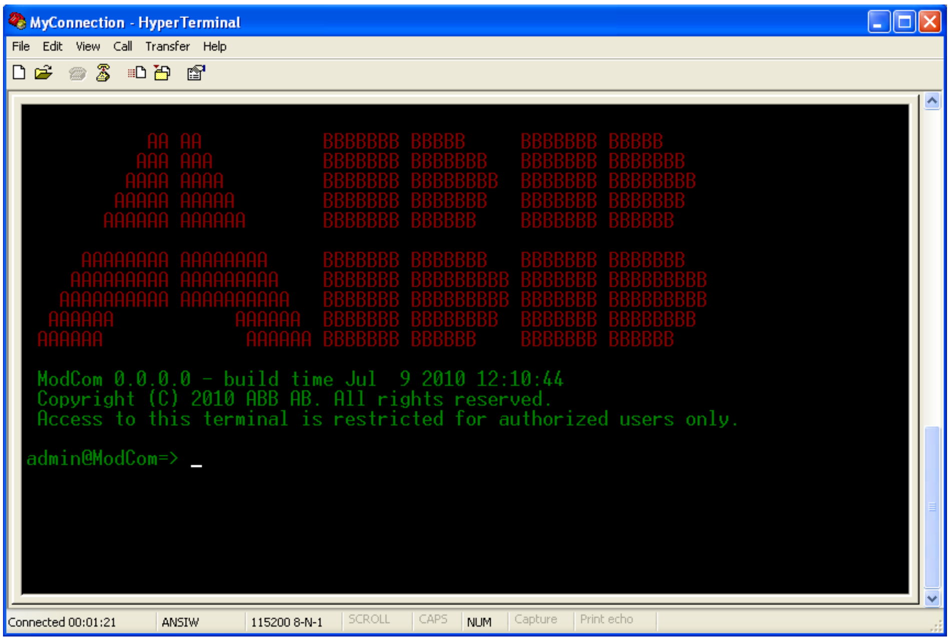
To login, use the default user name: *admin* and the default password: *123456*. Press **Enter** between each entry. The first time you log in you are required to change the password. The new password should be at least 6 characters long.



MyConnection - HyperTerminal
File Edit View Call Transfer Help

```
Enter user name : admin
Enter password  :
```

Once you are logged in, this view should appear on your screen.

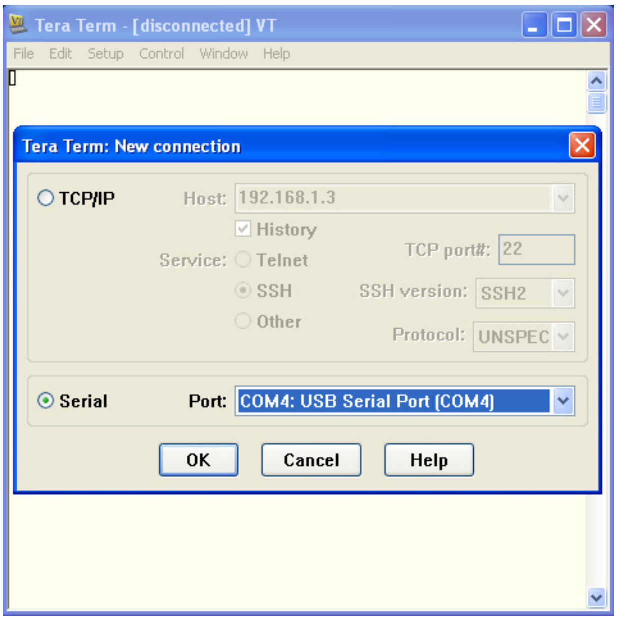


```
           AA AA           BBBBBBB BBBBB     BBBBBBB BBBBB
          AAA AAA          BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
         AAAA AAAA         BBBBBBB BBBBBBBB  BBBBBBB BBBBBBBB
        AAAAA AAAAA        BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
       AAAAAA AAAAAA       BBBBBBB BBBBBB    BBBBBBB BBBBBB

     AAAAAAAA AAAAAAAA     BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
    AAAAAAAAA AAAAAAAAA    BBBBBBB BBBBBBBBB BBBBBBB BBBBBBBBB
   AAAAAAAAAA AAAAAAAAAA   BBBBBBB BBBBBBBBB BBBBBBB BBBBBBBBB
  AAAAAA           AAAAAA  BBBBBBB BBBBBBBB  BBBBBBB BBBBBBBB
 AAAAAA             AAAAAA BBBBBBB BBBBBB    BBBBBBB BBBBBB

 ModCom 0.0.0.0 - build time Jul  9 2010 12:10:44
 Copyright (C) 2010 ABB AB. All rights reserved.
 Access to this terminal is restricted for authorized users only.

admin@ModCom=> _
```

4.4 Setting up TeraTerm and logging on

New connection

Start TeraTerm and select a COM-port and then click **OK**.



Tera Term - [disconnected] VT

Tera Term: New connection

○ TCP/IP Host: 192.168.1.3

☑ History

Service: ○ Telnet TCP port#: 22

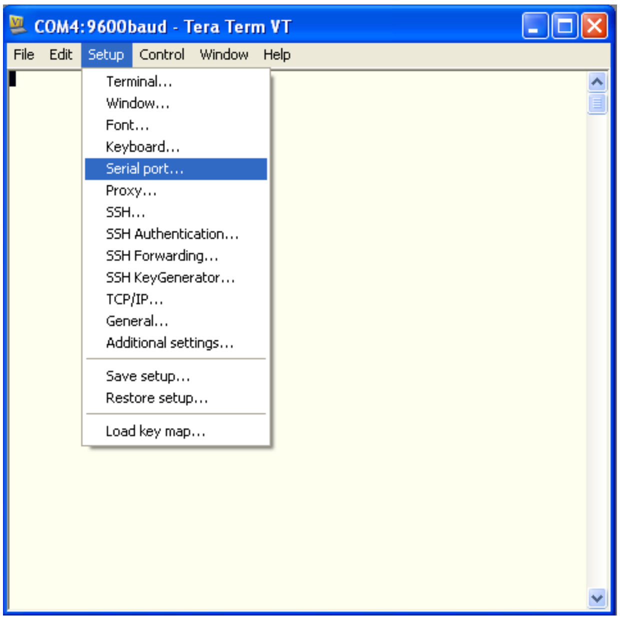
● SSH SSH version: SSH2

○ Other Protocol: UNSPEC

● Serial Port: COM4: USB Serial Port (COM4)

Select serial port

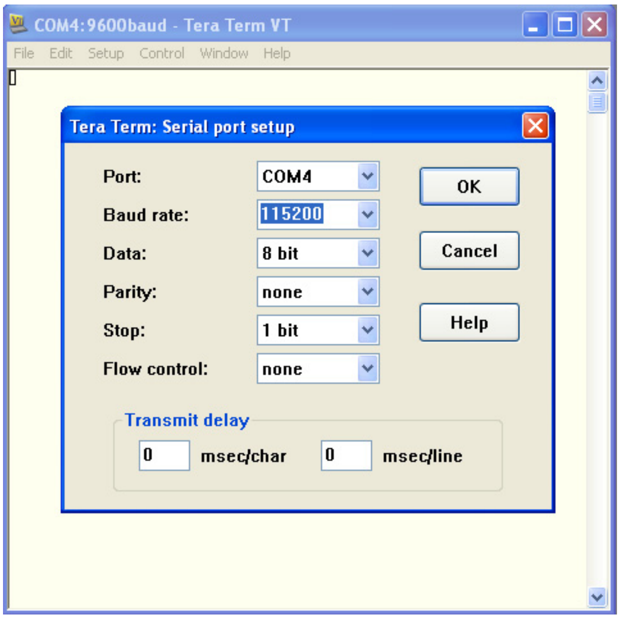
Open the *Setup menu* and select *Serial port.*



COM4:9600baud - Tera Term VT

Set COM-port properties

Set the COM-port properties according to the image below and click **OK**

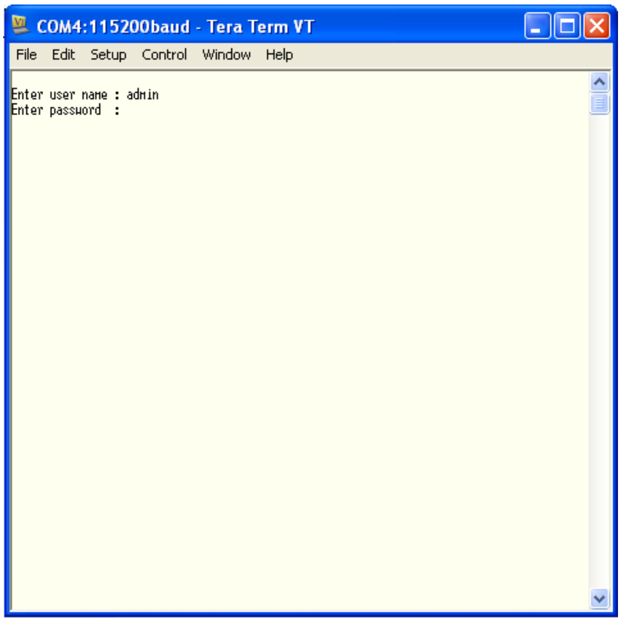

COM4:9600baud - Tera Term VT
File Edit Setup Control Window Help
Tera Term: Serial port setup
OK
Cancel
Help

Port: COM4
Baud rate: 115200
Data: 8 bit
Parity: none
Stop: 1 bit
Flow control: none

Transmit delay
0 msec/char 0 msec/line

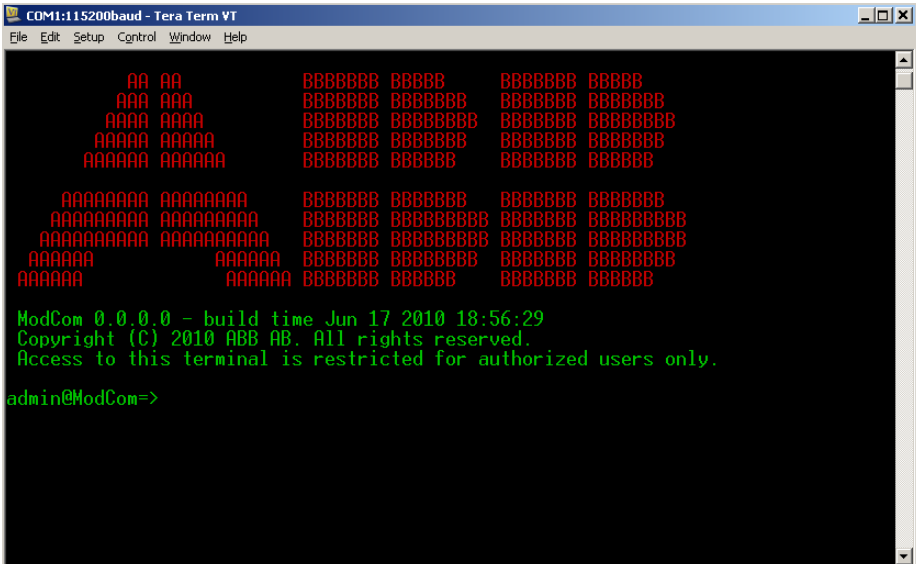
Login to the SCA

To login, use the default user name: *admin* and the default password: *123456.* Press **Enter** after each entry. The first time you log in you are required to change the password. The new password should be at least 6 characters long


COM4:115200baud - Tera Term VT
File Edit Setup Control Window Help

```
Enter user name : admin
Enter password  :
```

Once you are logged in, this view should appear on your screen.


COM1:115200baud - Tera Term VT
File Edit Setup Control Window Help

```
           AA AA           BBBBBBB BBBBB     BBBBBBB BBBBB
          AAA AAA          BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
         AAAA AAAA         BBBBBBB BBBBBBBB  BBBBBBB BBBBBBBB
        AAAAA AAAAA        BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
       AAAAAA AAAAAA       BBBBBBB BBBBBB    BBBBBBB BBBBBB

     AAAAAAAA AAAAAAAA     BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
    AAAAAAAAA AAAAAAAAA    BBBBBBB BBBBBBBBB BBBBBBB BBBBBBBBB
   AAAAAAAAAA AAAAAAAAAA   BBBBBBB BBBBBBBBB BBBBBBB BBBBBBBBB
  AAAAAA           AAAAAA  BBBBBBB BBBBBBBB  BBBBBBB BBBBBBBB
 AAAAAA             AAAAAA BBBBBBB BBBBBB    BBBBBBB BBBBBB

 ModCom 0.0.0.0 - build time Jun 17 2010 18:56:29
 Copyright (C) 2010 ABB AB. All rights reserved.
 Access to this terminal is restricted for authorized users only.

admin@ModCom=>
```

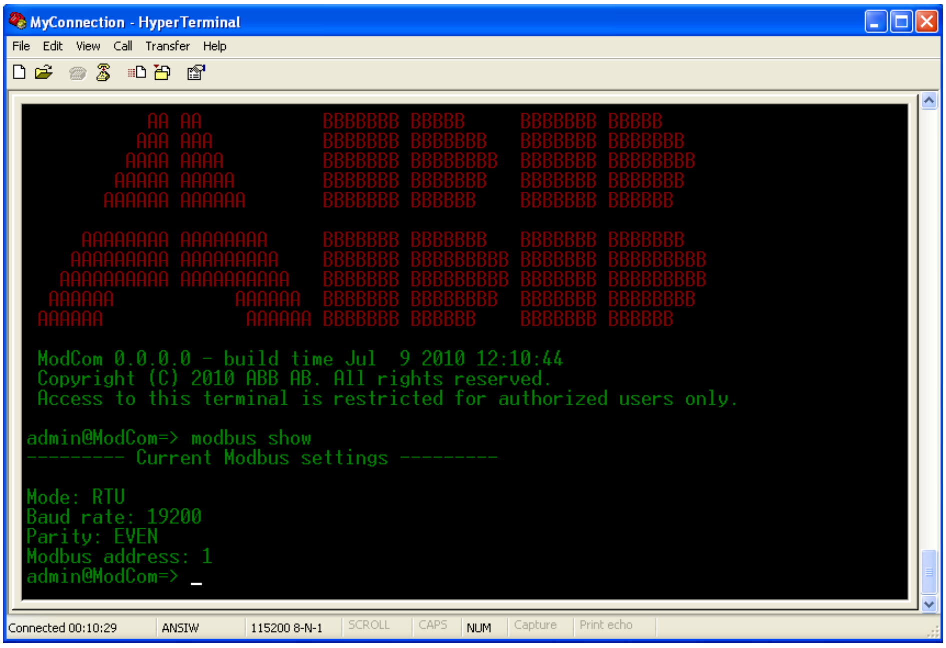
4.5 Modbus commands

Introduction

This section will briefly describe the most basic commands that are needed to configure the CSO 05000. More information about other commands are available in the terminal software. The commands are the same for both Hyperterminal and TeraTerm.

Modbus show

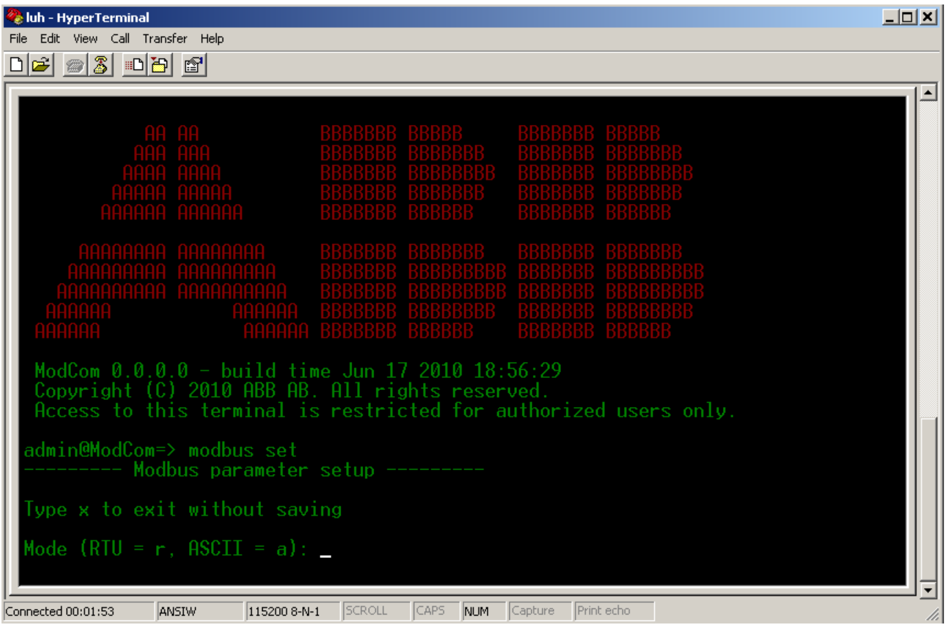
To display the current Modbus settings, type `modbus show`.



```
           AA AA           BBBBBBB BBBBB     BBBBBBB BBBBB
          AAA AAA          BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
         AAAA AAAA         BBBBBBB BBBBBBBB  BBBBBBB BBBBBBBB
        AAAAA AAAAA        BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
       AAAAAA AAAAAA       BBBBBBB BBBBBB    BBBBBBB BBBBBB

     AAAAAAAA AAAAAAAA     BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
    AAAAAAAAA AAAAAAAAA    BBBBBBB BBBBBBBBB BBBBBBB BBBBBBBBB
   AAAAAAAAAA AAAAAAAAAA   BBBBBBB BBBBBBBBB BBBBBBB BBBBBBBBB
  AAAAAA           AAAAAA  BBBBBBB BBBBBBBB  BBBBBBB BBBBBBBB
 AAAAAA             AAAAAA BBBBBBB BBBBBB    BBBBBBB BBBBBB

 ModCom 0.0.0.0 - build time Jul  9 2010 12:10:44
 Copyright (C) 2010 ABB AB. All rights reserved.
 Access to this terminal is restricted for authorized users only.

admin@ModCom=> modbus show
--------- Current Modbus settings ---------

Mode: RTU
Baud rate: 19200
Parity: EVEN
Modbus address: 1
admin@ModCom=> _
```

Modbus set

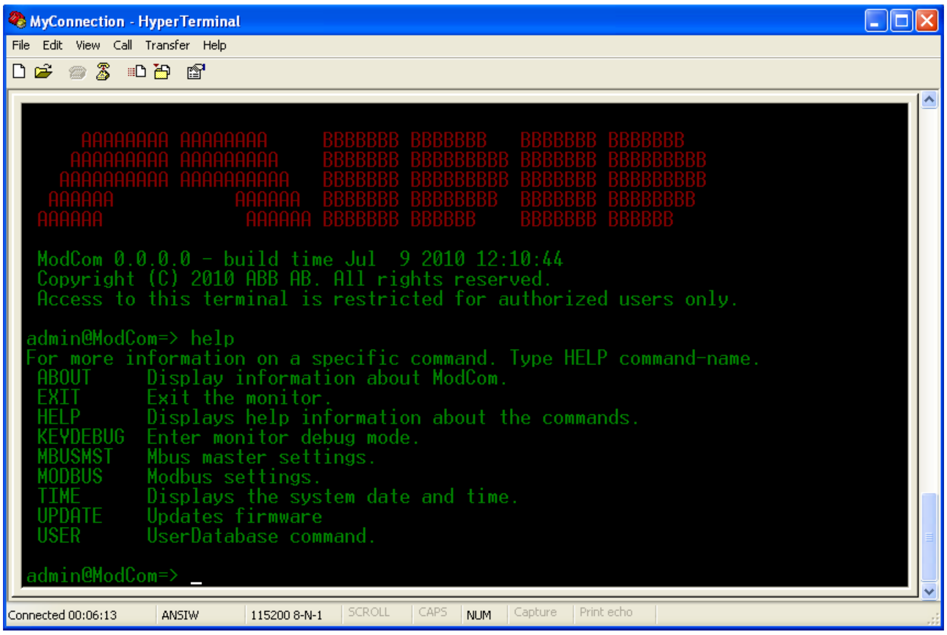
To change the current settings, type `modbus set`.



```
           AA AA           BBBBBBB BBBBB     BBBBBBB BBBBB
          AAA AAA          BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
         AAAA AAAA         BBBBBBB BBBBBBBB  BBBBBBB BBBBBBBB
        AAAAA AAAAA        BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
       AAAAAA AAAAAA       BBBBBBB BBBBBB    BBBBBBB BBBBBB

     AAAAAAAA AAAAAAAA     BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
    AAAAAAAAA AAAAAAAAA    BBBBBBB BBBBBBBBB BBBBBBB BBBBBBBBB
   AAAAAAAAAA AAAAAAAAAA   BBBBBBB BBBBBBBBB BBBBBBB BBBBBBBBB
  AAAAAA           AAAAAA  BBBBBBB BBBBBBBB  BBBBBBB BBBBBBBB
 AAAAAA             AAAAAA BBBBBBB BBBBBB    BBBBBBB BBBBBB

 ModCom 0.0.0.0 - build time Jun 17 2010 18:56:29
 Copyright (C) 2010 ABB AB. All rights reserved.
 Access to this terminal is restricted for authorized users only.

admin@ModCom=> modbus set
--------- Modbus parameter setup ---------

Type x to exit without saving

Mode (RTU = r, ASCII = a): _
```

Help

The `help` command displays all available commands.'



```
     AAAAAAAA AAAAAAAA     BBBBBBB BBBBBBB   BBBBBBB BBBBBBB
    AAAAAAAAA AAAAAAAAA    BBBBBBB BBBBBBBBB BBBBBBB BBBBBBBBB
   AAAAAAAAAA AAAAAAAAAA   BBBBBBB BBBBBBBBB BBBBBBB BBBBBBBBB
  AAAAAA           AAAAAA  BBBBBBB BBBBBBBB  BBBBBBB BBBBBBBB
 AAAAAA             AAAAAA BBBBBBB BBBBBB    BBBBBBB BBBBBB

 ModCom 0.0.0.0 - build time Jul  9 2010 12:10:44
 Copyright (C) 2010 ABB AB. All rights reserved.
 Access to this terminal is restricted for authorized users only.

admin@ModCom=> help
For more information on a specific command, Type HELP command-name.
 ABOUT     Display information about ModCom.
 EXIT      Exit the monitor.
 HELP      Displays help information about the commands.
 KEYDEBUG  Enter monitor debug mode.
 MBUSMST   Mbus master settings.
 MODBUS    Modbus settings.
 TIME      Displays the system date and time.
 UPDATE    Updates firmware
 USER      UserDatabase command.

admin@ModCom=> _
```

To find out more about a specific command, type `help` and the name of the command, i.e., `help modbus`.

It is also possible to get information about the different subcommands. `Set` and `show` are subcommands of `Modbus`. To get the information about these two subcommands, type `help modbus set` and `help modbus show`.

4.6 Resetting the CSO 05000

Soft reset and factory reset

The following table describes the reset functions and how they affect the SCA.

Reset function	Result
Soft reset	Restarts the SCA without affecting any user defined settings.
Factory reset	Restores the SCA to the default settings it had when it came from the factory. Performing a factory reset will erase all user defined settings including the user database.

To perform a reset

The following table describes how to perform a reset of the SCA.

To perform a...	Press the reset button for...
Soft reset	< 10 seconds
Factory reset	> 10 seconds

5 The Modbus Protocol

5.1 Overview

Introduction

This chapter describes the mapping from M-Bus to Modbus and how to read and write to registers. You will also find information about previous values and how to read previous values.

In this chapter

This chapter covers the following topics

5.2 About the Modbus Protocol and Function Codes

General

Modbus is a master-slave communication protocol that can support up to 247 slaves organized as a multidrop bus. The communication is half duplex. Services on Modbus are specified by function codes.

The function codes are used to read or write 16 bit registers. All metering data, such as active energy, voltage or firmware version, is represented by one or more such registers. For further information about the relation between register number and metering data, see the chapter “Mapping tables” on page - 41.

The Modbus protocol is specified in its entirety in *Modbus Application Protocol Specification V1.1b*. The document is available at *http://www.modbus.org*

Supported function codes

The CSO 05000 supports the following function codes:

- Function code 3 (Read holding registers)
- Function code 16 (Write single register)
- Function code 6 (Write multiple registers)

All examples of function codes that appear in this chapter are shown as Modbus RTU frames. For detailed information about Modbus RTU and Modbus ASCII transmission modes, please refer to *Modbus over Serial Line Specification and Implementation Guide, V1.02*. The document is available at *http://www.Modbus.org*

Modbus request frame

A modbus request frame generally has the following structure.

Slave Address	Function Code	Data	Error Check

Slave address	Modbus slave address, 1 byte
Function code	Decides the service to be performed, 1 byte
Data	Dependent on the function code. The length varies.
Error check	CRC, 2 bytes

Message types

The network messages can be query-response or broadcast type. The query-response command sends a query from the master to an individual slave and is generally followed by a response.

The broadcast command sends a message to all slaves and is never followed by a response. Broadcast is supported by function code 6 and 16.

5.3 Function code 3 (Read holding registers)

General

Function code 3 is used to read measurement values or other information from the electricity meter. It is possible to read up to 125 consecutive registers at a time. This means that multiple values can be read in one request.

Request frame

A request frame has the following structure.

Slave Address	Function Code	Address	No. of Registers	Error Check

Example of a request

The following is an example of a request.(Modbus RTU, read total energy import, etc...)

Slave address	0x01
Function code	0x03
Start address, high byte	0x50
Start address, low byte	0x00
No. of registers, high byte	0x00
No. of registers, low byte	0x18
Error check (CRC), high byte	0x54
Error check (CRC), low byte	0xC0

In this example the master sends a read request to the slave that has the Modbus address 1. The first register read is 0x5000 and the number of registers to read is 0x18. This means that registers 0x5000 to 0x5017 have been requested.

Response frame

A response frame has the following structure.

Slave Address	Function Code	Byte Count	Register Values	Error Check

Example of a response

The following is an example of a response (Modbus RTU)

Slave address	0x01
Function code	0x03
Byte count	0x30
Value of register 0x5000, high byte	0x00
Value of register 0x5000, low byte	0x15
...	...
Value of register 0x5017, high byte	0xFF
Value of register 0x5017, low byte	0xFF
Error check (CRC) high byte	0xXX
Error check (CRC) low byte	0xXX

In this example, the slave with the Modbus address 1 responds to a read request. The number of data bytes is 0x30. The first register (0x5000) has the value 0x0015 and the last (0x5017) has the value 0xFFFF.

5.4 Function Code 16 (Write multiple registers)

General

Function code 16 is used to modify settings in the meter, such as date/time, to control output and to reset values, such as power fail counter. It is possible to write up to 123 consecutive registers in a single request. This means that several settings can be modified and/or several reset operations can be performed in a single request.

Request frame

A request frame has the following structure.

Slave Address	Function Code	Start Address	No. of Registers	Byte Count	Register Values	Error Check

Example of a request

The following is an example of a request (Modbus RTU, set Date/Time to November 11, 2010, 12:13:14):

Slave address	0x01
Function Code	0x10
Start Address, high byte	0x8A
Start Address, low byte	0x00
No. of registers, high byte	0x00
No. of registers, low byte	0x03
Byte count	0x06
Value of register 0x8A00, high byte	0x0A
Value of register 0x8A00, low byte	0x0B
Value of register 0x8A01, high byte	0x0B
Value of register 0x8A01, low byte	0x0C
Value of register 0x8A02, high byte	0x0D
Value of register 0x8A02, low byte	0x0E
Error check (CRC), high byte	0x8C
Error check (CRC), low byte	0x82

In this example the master sends a write request to the slave that has the Modbus address 1. The first register to write is 0x8A00 and the number of registers to write is 0x03. This means that the registers 0x8A00 to 0x8A02 are written. Register 0x8A00 is set to the value 0x0A0B, and so on.

Response frame

A response frame has the following structure.

Slave Address	Function code	Start Address	No. of Registers	Error Check

Example of a response

The following is an example of a response (modbus RTU):

Slave address	0x01
Function code	0x10
Register address, high byte	0x8A
Register address, low byte	0x00
No. of registers, high byte	0x00
No. of registers, low byte	0x03
Error check (CRC), high byte	0xAA
Error check (CRC), low byte	0x10

In the example above the slave with the Modbus address 1 responds to a write request. The first register is 0x8A00 and 0x03 registers have been successfully written to.

5.5 Function Code 6 (Write single register)

general

Function code 6 can be used as an alternative to function code 16 if there is only one register to be written. It can, for example be used to reset the power fail counter.

Request frame

A request frame has the following structure:

Slave Address	Function Code	Register Address	Register Value	Error Check

Example of a request

The following is an example of a request (Modbus RTU, reset power fail counter):

Slave address	0x01
Function code	0x06
Register address, high byte	0x8F
Register address, low byte	0x00
Value of register 0x8F00, high byte	0x00
Value of register 0x8F00, low byte	0x01
Error check (CRC) high byte	0x62
Error check (CRC), low byte	0xDE

Response frame

Using function code 6, the response frame is an echo of the request frame.

5.6 Exception Responses

General

If an error should occur while processing a request, the CSO 05000 gives an exception response that contains an exception code.

Exception frame

An exception frame has the following structure:

Slave Address	Function Code	Exception Code	Error Check

In the exception response the function code is set to the function code of the request plus 0x80.

Exception codes

The exception codes that are used by the CSO 05000 are listed in the following table:

Exception code	Exception name	Definition
01	Illegal function	A function code that is not supported has been sent.
02	Illegal data address	The requested register is out of the allowed range, or there is no contact between the CSO 05000 and the electricity meter.
03	Illegal data value	The structure of a received request is incorrect.
04	Slave device failure	Processing the request failed due to an internal error in the CSO 05000.

5.7 Reading and writing to registers

Readable registers

The readable range in the modbus mapping are registers 1000-8EFF (hexadecimal). Reading any registers within this range will result in a normal Modbus response. It is possible to read any number of registers between 1 and 125, i.e., it is not necessary to read all registers of a quantity listed onone line in the mapping tables. Any attempt to read outside this range will result in an illegal data address exception (Modbus exception code 2).

Multi-register values

For quantities that are represented as more than 1 register, the most significant byte is found in the high byte of the first (lowest) register. The least significant byte is found in the low byte of the last (highest) register.

Unused registers

Unused registers within the mapping range, for example missing quantities in the connected meter, will result in a normal Modbus response but the value of the register will be set to “invalid”.

For quantities with data type “unsigned”, the value will be FFFF in all registers.

For quantities with data type “signed”, the value is the highest value possible to express. That means that a quantity that is represented by only one register will have the value 7FFF. A quantity that is represented by 2 registers will have the value 7FFFFFFF, and so on.

Writing to registers

Writing to registers is only permitted to the registers listed as writable in the mapping tables. Attempting to write to a register that is listed as writable but that is not supported by the meter will not result in an error indication.

Note that it is not possible to modify parts of a setting, e.g. to set only the year and month of the Date/time setting.

Confirm set values

After you set a value in the meter, it is recommended that you read the value to confirm the result, since it is not possible to confirm if a write was successful from the Modbus response. Note that it may take a few seconds before the updated value can be seen in Modbus.

No contact between SCA and meter

If there is no contact between the SCA and the meter over the IR interface, any attempt to read or to write to Modbus registers will result in an illegal data address exception.

However, the Modbus mapping version and the SCA firmware version are always readable.

Limitation of write requests

Due to the limited communication speed over the IR interface, write requests might be queued in the SCA. The number of queued write requests is limited to

3. If many write requests are sent within a short period of time, there is a risk that some requests might be lost.

5.8 Mapping tables

Introduction

The purpose with this section is to explain the relation between register number and metering data.

Contents of the mapping tables

The following table explains the content of the mapping tables.

Quantity	Name of the meter quantity or other information available in the meter.
Details	Refinement of the Quantity column.
Start Reg (Hex)	Hexadecimal number for the first (lowest) Modbus Register for this quantity. *
Size	Number of Modbus registers for the meter Quantity. A Modbus Register is 16 bits long.
Res.	Resolution of the value for this Quantity (if applicable).
Unit	Unit for the Quantity (if applicable).
Data type	Data type for this Quantity, i.e. how the value in the Modbus registers should be interpreted.

'*It is expressed exactly as it is sent on the bus. That is, it should not be subtracted by 40 000 or decremented by 1 as is common for Modbus products.

Total energy accumulators

All registers in the following table are read only.

Quantity	Details	Start Reg (Hex)	Size	Res.	Unit	Data type
Active import	kWh	5000	4	0,01	kWh	unsigned
Active export	kWh	5004	4	0,01	kWh	unsigned
Reactive import	kvarh	500C	4	0,01	kvarh	unsigned
Reactive export	kvarh	5010	4	0,01	kvarh	unsigned

Energy accumulators divided into tariffs

The following table show read only registers.

Quantity	Details	Start Reg (Hex	Size	Res.	Unit	Data type
Active import	Tariff 1	5170	4	0,01	kWh	unsigned
Active import	Tariff 2	5174	4	0,01	kWh	unsigned
Active import	Tariff 3	5178	4	0,01	kWh	unsigned
Active import	Tariff 4	517C	4	0,01	kWh	unsigned
Reactive import	Tariff 1	51B0	4	0,01	kvarh	unsigned
Reactive import	Tariff 2	51B4	4	0,01	kvarh	unsigned
Reactive import	Tariff 3	51B8	4	0,01	kvarh	unsigned
Reactive import	Tariff 4	51BC	4	0,01	kvarh	unsigned

Instantaneous values

The following table shows read only registers.

Quantity	Details	Start Reg (Hex)	Size	Res.	Unit	Value range	Data type
Voltage	L1-N	5B00	2	0,1	V		Unsigned
Voltage	L2-N	5B02	2	0,1	V		Unsigned
Voltage	L3-N	5B04	2	0,1	V		Unsigned
Voltage	L1-L2	5B06	2	0,1	V		Unsigned
Voltage	L3-L2	5B08	2	0,1	V		Unsigned
Current	L1	5B0C	2	0,01	A		Unsigned
Current	L2	5B0E	2	0,01	A		Unsigned
Current	L3	5B10	2	0,01	A		Unsigned
Active power	Total	5B14	2	0,01	W		Signed
Active power	L1	5B16	2	0,01	W		Signed
Active power	L2	5B18	2	0,01	W		Signed
Active power	L3	5B1A	2	0,01	W		Signed
Reactive Power	Total	5B1C	2	0,01	var		Signed
Reactive Power	L1	5B1E	2	0,01	var		Signed
Reactive Power	L2	5B20	2	0,01	var		Signed
Reactive Power	L3	5B22	2	0,01	var		Signed
Apparent Power	Total	5B24	2	0,01	VA		Signed
Apparent Power	L1	5B26	2	0,01	VA		Signed
Apparent Power	L2	5B28	2	0,01	VA		Signed
Apparent Power	L3	5B2A	2	0,01	VA		Signed
Frequency		5B2C	1	0,01	Hz		Unsigned
Phase angle power	Total	5B2D	1	0,1	°	-180° - +180°	Signed
Phase angle power	L1	5B2E	1	0,1	°	-180° - +180°	Signed
Phase angle power	L2	5B2F	1	0,1	°	-180° - +180°	Signed
Phase angle power	L3	5B30	1	0,1	°	-180° - +180°	Signed
Phase angle voltage	L1	5B31	1	0,1	°	-180° - +180°	Signed
Phase angle voltage	L2	5B32	1	0,1	°	-180° - +180°	Signed
Phase angle voltage	L3	5B33	1	0,1	°	-180° - +180°	Signed
Phase angle current	L1	5B37	1	0,1	°	-180° - +180°	Signed
Phase angle current	L2	5B38	1	0,1	°	-180° - +180°	Signed
Phase angle current	L3	5B39	1	0,1	°	-180° - +180°	Signed
Power factor	Total	5B3A	1	0,001	-	-1,000 - +1,000	Signed
Power factor	L1	5B3B	1	0,001	-	-1,000 - +1,000	Signed
Power factor	L2	5B3C	1	0,001	-	-1,000 - +1,000	Signed
Power factor	L3	5B3D	1	0,001	-	-1,000 - +1,000	Signed
Current quadrant	Total	5B3E	1		-	1-4	Unsigned
Current quadrant	L1	5B3F	1		-	1-4	Unsigned
Current quadrant	L2	5B40	1		-	1-4	Unsigned
Current quadrant	L3	5B41	1		-	1-4	Unsigned

Inputs and outputs

Quantity	Details	Start Reg (Hex)	Size	Possible values	Data type	Read/Write
Output 1		6300	1	ON=1, OFF=0	Unsigned	RW
Output 2		6301	1	ON=1, OFF=0	Unsigned	RW
Input 1	Current state	6308	1	ON=1, OFF=0	Unsigned	R
Input 2	Current state	6309	1	ON=1, OFF=0	Unsigned	R
Input 1	Stored state	6310	1	ON=1, OFF=0	Unsigned	R
Input 2	Stored state	6311	1	ON=1, OFF=0	Unsigned	R
Input 1	Counter	6318	4		Unsigned	R
Input 2	Counter	631C	4		Unsigned	R

Production data and identification

All registers in this table are read only.

Quantity	Start Reg (Hex)	Size	Data type
Serial number	8900	2	Unsigned
Meter firmware version	8908	8	ASCII string (up to 16 characters)
Modbus mapping version	8910	1	2 bytes
Adapter firmware version	8911	8	ASCII string (up to 16 characters)

Meter firmware version is expressed as a number of ASCII characters, either as "Xabc-def" or "Xabc". X stands for the type of meter, for example O for Odin. "abc" is the total firmware version (for example "317" for version 3.17) and "def" is the metrological version (for example "100" for version 1.00), which is the part of the firmware that handles the basic metrological functions.

In the **Modbus mapping version** register the high byte corresponds to the Major version (1-255), and the low byte corresponds to the Minor version (0-255).

Adapter firmware version is expressed as a string of 4 digits separated by periods, e.g. 1.0.0.0. Any unused bytes at the end is set to 0

Miscellaneous

In this table Date/Time is writable. All other registers are read only.

Quantity	Start Reg (Hex)	Description	Size	Data type	Read/Write
Date/Time	8A00	Byte 0: year* Byte 1: month Byte 2: day Byte 3: hour Byte 4: minute Byte 5: second	3	Date/Time	RW
Day of week	8A03	Weekdays (1-7, Mo=1).	1	Unsigned	R

Quantity	Start Reg (Hex)	Description	Size	Data type	Read/Write
DST active	8A04	1=DST active, 0=DST inactive	1	Unsigned	R
Day type	8A05	Value 0-3 correspond to Day type 1-4	1	Unsigned	R
Season	8A06	Value 0-3 correspond to season 1-4	1	Unsigned	R
Current tariff	8A07	Tariff, 1-4	1	Unsigned	R
Error register	8A0F		4	Bit string	R
Power fail counter	8A2F		1	Unsigned	R
Power outage time	8A39	Byte 0-2: days* Byte 3: hours Byte 4: minutes Byte 5: seconds	3	Days/Time	R
Reset counter	8A48		4	Unsigned	R

The **reset counter register** shows the number of resets that has been performed on the resettable energy accumulator. This register is only available for meters that have resettable energy, i.e, ODINsingle.

*Byte 0 is the highest byte of the lowest register.

Settings

All registers in the following table are read only.

Quantity	Start Reg (Hex)	Size	Data type
Current transformer ratio	8C00	1	Unsigned
Voltage transformer ratio	8C01	1	Unsigned
Total transformer ratio	8C02	2	Unsigned

Operations

All registers in the following table are write only.

Quantity	Details	Start Reg (Hex)	Size	Action	Data type
Reset power fail counter		8F00	1	Write 1 to perform a reset	Unsigned
Reset outage time		8F05	1	Write 1 to perform a reset	Unsigned
Reset energy		8F0A	1	Write 1 to perform a reset	Unsigned
Reset counter	Input 1	8F0B	1	Write 1 to perform a reset	Unsigned
Reset counter	Input 2	8F0C	1	Write 1 to perform a reset	Unsigned
Reset stored state	Input 1	8F13	1	Write 1 to perform a reset	Unsigned
Reset stored state	Input 2	8F14	1	Write 1 to perform a reset	Unsigned

DMTME Multimeters

Parts of the Modbus mapping of the CSO 05000 is compatible with the ABB DMTME multimeters. All registers in the following table are read only

Quantity	Start Reg (Hex)	Size	Unit	Data type
Phase Voltage L1-N	1002	2	Volt	Unsigned
Phase Voltage L2-N	1004	2	Volt	Unsigned
Phase Voltage L3-N	1006	2	Volt	Unsigned
Line Voltage L1-2	1008	2	Volt	Unsigned
Line Voltage L2-3	100A	2	Volt	Unsigned
Line Current L1	1010	2	mA	Unsigned
Line Current L2	1012	2	mA	Unsigned
Line Current L3	1014	2	mA	Unsigned
3-Phase Sys. Power Factor	1016	2	*1000	Signed
Power Factor L1	1018	2	*1000	Signed
Power Factor L2	101A	2	*1000	Signed
Power Factor L3	101C	2	*1000	Signed
3-Phase S. Apparent Power	1026	2	VA	Unsigned
Apparent Power L1	1028	2	VA	Unsigned
Apparent Power L2	102A	2	VA	Unsigned
Apparent Power L3	102C	2	VA	Unsigned
3-Phase Sys. Active Power	102E	2	Watt	Unsigned
Active Power L1	1030	2	Watt	Unsigned
Active Power L2	1032	2	Watt	Unsigned
Active Power L3	1034	2	Watt	Unsigned
3-Phase S. Reactive Power	1036	2	VAr	Unsigned
Reactive Power L1	1038	2	VAr	Unsigned
Reactive Power L2	103A	2	VAr	Unsigned
Reactive Power L3	103C	2	VAr	Unsigned
3-Phase Sys Active Energy	103E	2	Wh*100	Unsigned
3-Phase Sys Reactive Energy	1040	2	VArh*100	Unsigned
Frequency	1046	2	mHz	Unsigned
Current Transformer Ratio	11A0	2	1-999999	Unsigned
Voltage Transformer Ratio	11A2	2	1-9999	Unsigned

5.9 Previous values

General

Previous values is a log of energy and input counter values that are stored in the meter on a monthly or daily basis. The following sections will explain how previous values are represented in the Modbus mapping.

Representation of previous values

In the Modbus mapping previous values are represented as a number of channels. Each channel stores the history of one quantity.

A meter that stores Total imported active energy, 4 tariffs for active energy, Total imported reactive energy, 4 tariffs for reactive energy and the pulse counters for 2 inputs will consequently have 12 channels.

The stored values for each channel is organized as entries. Entry 1 contains the values of the last month, entry 2 contains the values from the month before, and so on. Entry 0 is not used.

Mapping table

The following table shows an overview of the mapping table.

Quantity	Details	Start Reg (Hex)	Size	Data type
Previous values	Header	8000	16	
Previous values	Data block 1	8010	83	Variable
Previous values	Data block 2	8070	83	Variable

Header

The following table describes the header.

Function	Start Reg (hex)	Size	Description	Read/ Write
Get next entry	8000	1	Write value 1 to this register to load the next block of values and timestamp.	R/W
Entry number	8001	1	Write to this register to choose an entry.	R/W

Data block 1 and 2

Data block 1 and 2 have the same structure. Each block can contain up to 8 channels. For example, a meter with 12 channels will show 8 channels in data block 1 and 4 channels in data block 2.

For entry numbers that have no stored values, all registers except *Entry number* are set to 0xFFFF.

Structure of the data block

The following table describes the structure of the two data blocks.

Channel	Contents	Start Reg (Hex)	Size	Description
Common for all channels	Timestamp	8010	3	YYMMDD:HHMMSS. The year is stored in the highest byte of the lowest register
Channel 1	Quantity	8013	3	OBIS code for the quantity stored in channel 1.
Channel 1	Data type	8016	1	Data type for quantity stored in channel 1.
Channel 1	Scaler	8017	1	Scaler for quantity stored in channel 1.
Channel 1	Status	8018	1	Status for quantity stored in channel 1.
Channel 1	Value	8019	4	Value for quantity stored in channel 1.
...				
...				
Channel 8	Quantity	8059	3	OBIS code for the quantity stored in channel 8.
Channel 8	Data type	805C	1	Data type for quantity stored in channel 8.
Channel 8	Scaler	805D	1	Scaler for quantity stored in channel 8.
Channel 8	Status	805E	1	Status for quantity stored in channel 8
Channel 8	Value	805F	4	Value for quantity stored in channel 8.

Example of data block 1

The following table shows the relation between stored values and channels in data block 1.

Entry	Date	Channel 1	Channel 2	Channel..	Channel 7	Channel 8
		Total imported active energy	Active energy tariff 1		Reactive energy tariff 1	Reactive energy tariff 2
1	100601	307 kWh	148 kWh		10kvarh	10kvarh
2	100501	300 kWh	141 kWh		8 kvarh	8 kvarh
3	100401	295 kWh	137 kWh		6 kvarh	6 kvarh

Example of data block 2

The following table shows the relation between stored values and channels in data block 2.

Entry	Date	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5-8 not used
		Reactive energy tariff 3	Reactive energy tariff 4	Pulse counter input 1	Pulse counter input 2	
1	100601	20 kvarh	18 kvarh	10	10	
2	100501	13 kvarh	9 kvarh	8	8	
3	100401	5 kvarh	3 kvarh	6	6	

Quantity registers

The quantity that is stored in a specific channel is identified by its OBIS code. The OBIS code is a 6 byte identifier.

Quantity	OBIS code
Active energy import total	1.0.1.8.0.255
Active energy import tariff 1	1.0.1.8.1.255
Active energy import tariff 2	1.0.1.8.2.255
Active energy import tariff 3	1.0.1.8.3.255
Active energy import tariff 4	1.0.1.8.4.255
Active energy export total	1.0.2.8.0.255
Reactive energy import total	1.0.3.8.0.255
Reactive energy import tariff 1	1.0.3.8.1.255
Reactive energy import tariff 2	1.0.3.8.2.255
Reactive energy import tariff 3	1.0.3.8.3.255
Reactive energy import tariff 4	1.0.3.8.4.255
Reactive energy export total	1.0.4.8.0.255
Input 1 counter	1.128.82.8.0.255
Input 2 counter	1.129.82.8.0.255

Data type register

The data type register contains a data type identifier that is a value between 0 and 255. In the CSO 05000 only 1 identifier is currently used for previous values. The identifier for 64 bit unsigned integer is 21.

Status register

The status register shows the status for a value stored at a given timestamp. Possible values are shown in the table below.

Status	Description
0	OK
1	Not available
2	Data error

Scaler register

The scaler register shows the resolution of the value. The measured value in the Value register should be interpreted as value*10^{scaler}. For example, the prefix kilo is represented by scaler 3 while milli is -3. An energy accumulator with the resolution 0,01 kWh consequently has scaler 1.

Reading previous values

Readout of previous values is controlled by the Entry number register. After writing to the Entry number register, the values of all channels for the given entry number are available in the registers of data block 1 and 2,together with status and timestamp information.

In the data blocks, the registers Quantity, Data type and Scaler provide further information about the data stored in each channel. Instead of writing the entry number directly to the Entry number register, it is also possible to get the next block of previous values by writing 1 to the Get next entry register, and then read again from the registers in the data blocks. The value in the Entry number register is automatically incremented by 1 when you write the value 1 to the Get next entry register.

Read the most recent

Follow the steps in the table below to read the most recent previous values entry:

Step	Action
1	Write the value 1 to the Entry number register.
2	Read data block 1 and, if applicable, data block 2.

Read the entire history

Follow the steps in the table below to read the entire history of previous values:

Step	Action
1	Write the value 0 to the Entry number register to make sure the reading starts from the most recent entry.
2	Write the value 1 to the Get next entry register.
3	Read data block 1 and, if applicable, data block 2.
4	Repeat steps 2 and 3 until there are no more entries stored. When all entries have been read, the SCA sets all registers, except Entry number, to 0xFFFF.

Note that the Entry number register is reset to 0 after a restart of the SCA

6 Troubleshooting

6.1 Overview

Introduction

In this chapter are listed some of the most common error indications together with explantations and suggested solutions.

In this chapter

This chapter covers the following topics.

6.2 Troubleshooting Guide

Troubleshooting

The following table lists symptoms, possible causes and suggested remedies.

Symptom	Cause	Remedy
Modbus requests inside the mapping give Illegal data address exception responses.	• The SCA has not yet read all values from the meter. • There is no contact between the SCA and the meter.	1. Wait and see if a normal response is received. It may take a few seconds for a meter without previous values and up to 20 seconds for a meter with 16 stored values the first time the SCA is connected to a meter. 2. Make sure that the meter and the SCA are properly mounted and sitting closely together.
No response to Modbus requests and LED not flashing yellow.	• Faulty Modbus settings (bit-rate, parity or transmission mode) • Connection problems	1. Check the Modbus configuration and make sure that the settings match those of the meter readout program. 2. Check the physical connection on the RS-485 bus.
No response to Modbus requests and LED flashing yellow.	Faulty Modbus slave address in the SCA	Check the Modbus address and make sure it matches the address expected by the meter readout program.
Modbus write requests don’t take effect even though a normal response is received.	More than 3 requests have been performed within a too short period of time.	Wait a few seconds and then repeat the write request.
A request to reset metering data, e.g., input counter, don’t take effect even though a normal response is received.	The value written to the register is not equal to 1.	Repeat the write request with the value set to 1.