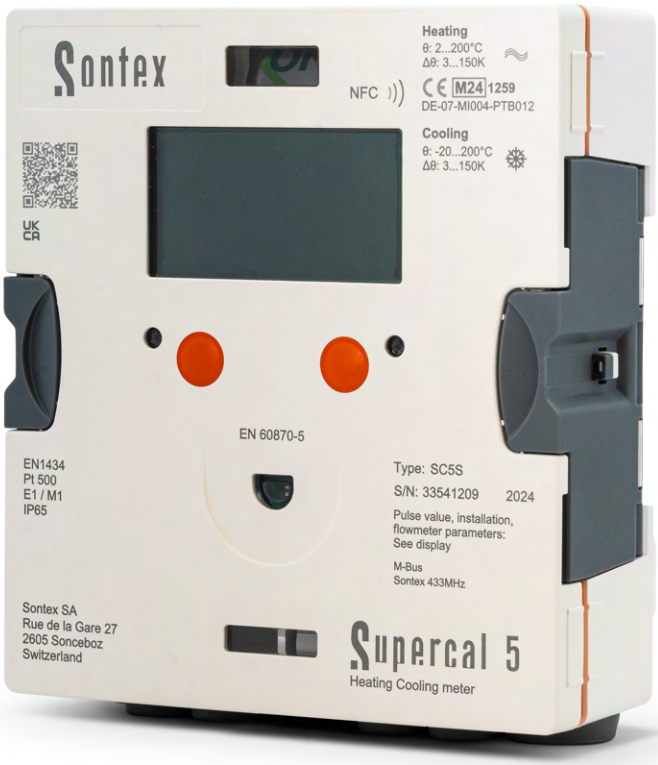
Modbus EIA-485 Module

for Supercal 5





Instruction for use

Table of contents

1. Notes on This Document
    - 1.1 Scope of Validity
    - 1.2 Target Groups
    - 1.3 Storage of Document
    - 1.4 Further Information
    - 1.5 Symbols
2. Safety Information
    - 2.1 Personnel Qualification
    - 2.2 Intended Use
    - 2.3 Safety Instructions
        - 2.3.1 Occupational Safety
        - 2.3.2 Operational safety
        - 2.3.3 Product Safety
3. Retrofittable BACnet / Modbus Module
    - 3.1 Application
    - 3.2 Modbus Application
    - 3.3 Features
    - 3.4 Activate the Modbus Mode
4. General Remarks
    - 4.1 Introduction
    - 4.2 Delivery of the Module
    - 4.3 The Register List
5. Modbus Module Configuration
    - 5.1 Settings – Normal Mode / Test Mode
        - 5.1.1 Default Settings – Normal Mode
        - 5.1.2 Test Mode
    - 5.2 Modbus Connection
    - 5.3 Communication Speed / Mode
    - 5.4 Installing the Modbus Module
    - 5.5 Detection of the Modbus Module with the Superprog Software
    - 5.6 Procedure to Use When Changing Parameters by Modbus Command
        - 5.6.1 Communication Parameters
        - 5.6.2 Changing the Communication Parameters by Modbus Command
    - 5.7 Setting of the Line Terminating Resistor and the Bias Resistors with the DIP Switch
    - 5.8 Modbus Module Addressing
6. Technical Data Modbus EIA-485 Module
    - 6.1 Reliability
    - 6.2 Precautions – Safety Instructions
7. Power Supply for Modbus Modules
    - 7.1 Mains - Power Supply Modules
    - 7.2 Two-Wires Bus Connections
        - 7.2.1 Two-Wires Bus with a Gateway with Galvanic Isolation
        - 7.2.2 Two-Wires Bus with a Gateway WITHOUT a Galvanic Isolation
    - 7.3 Three-Wire Bus Connections
        - 7.3.1 Three-Wires Bus with a Gateway with a Galvanic Isolation
        - 7.3.2 Three-Wires Bus with a Gateway WITHOUT a Galvanic Isolation
8. General Bus Considerations
    - 8.1 Wire Routing
    - 8.2 Cable Specifications

8.3 Electrical Noise
8.3.1 Earth, Shield
8.3.2 Building Crossing
9. Troubelshooting procedure
10. Maintenance Instructions
11. Legal and Compliance Information
12. Support & Warranty Information
13. Disposal
ANNEX A
A.1 Mapping Register for Supercal 5
A.2 Product Description
A.3 Data Model Mapping
A.3.1 Group (A): Settings
A.3.2 Group (B): Information
A.3.3 Group (C): Actual Values
A.3.4 GROUP (D): ST1 Values
A.3.5 GROUP (E): ST2 Values
Annex B
B.1 Example for Energy/Flow Coding with Mod-Scan64 Software
B.1.1 Long Data Points
B.1.2 IEEE745 Single Float Values
B.2 Example for Energy Coding with Modbus Pool Software
B.2.1 Long data points
B.2.2 IEEE745 Single Float Values
Annex C
C.1 RS485 Lines
C.2 Termination or Line Terminating
C.3 Line Polarization or Bias Resistors
C.4 General Explanation if DIP Switch
C.5 Cable & Length
Annex D
D.1 Examples of Modbus EIA-485 Network with Line Terminating and Bias Resistors
D.1.1 Example 1
D.1.2 Example 2
D.1.3 Example 3
Annex E
E.1 Voltage control
E.1.1 Voltage control during the Modbus communication
E.1.2 Voltage control WITHOUT any Modbus communication
Annex F
F.1 Modbus Specification

1. Notes on This Document

This manual provides all the information required for the correct use of the equipment: From product identification, installation and commissioning to troubleshooting, maintenance and disposal.

1.1 Scope of Validity

This instrument documentation is valid for the module Mobdus from Sontex.
The production version can be read off the nameplate.

1.2 Target Groups

This device documentation is intended for the system operator and the installer of the module.

1.3 Storage of Document

The system operator must ensure that this documentation is accessible to the responsible persons at all times. If the original document is lost, you can download an up-to-date version of this document from our extranet (https://extranet.sontex.ch/index/).

1.4 Further Information

Links to further information can be found at http://www.sontex.ch.

1.5 Symbols

Symbol	Significance
DANGER	**DANGER!** Failure to observe these warnings leads to fatal or serious injury.
WARNING	**WARNING!** Failure to observe these warnings may lead to death or serious injury.
NOTICE	**NOTICE!** Failure to observe these warnings may result in damage to property.
	**Information** Information that is important for a specific topic or goal, but not relevant to security.
	**Disposal** This symbol indicates that electrical and electronic equipment must be disposed separately. Do not dispose of the calculator with household waste.

2. Safety Information

Safe and harmless operation of the calculator can only be guaranteed if the operating instructions have been read and the safety instructions contained therein have been observed.
Further information and data can be found in the products' catalogues and data sheets, through your local representative, and on the Sontex homepage at http://www.sontex.ch.

- All technical data without guarantee.
- Subject to technical changes at any time.
- In case of doubt, the text of the English Instructions for Use applies.

2.1 Personnel Qualification

The personnel responsible for installation, commissioning, diagnosis and maintenance must meet the following conditions:

- Trained personnel: Qualified to perform this function and activity.
- Authorized by the plant operator.

- Knowledge of the relevant standards and directives and familiar with national regulations
- Before starting work: Read and understand instructions and additional documentation as well as certificates (depending on application).
- Follow instructions and general conditions.
- Training in the handling of hazards and risks during the installation and operation of electrical devices and systems.

The operating personnel must meet the following conditions:

- Instructed and authorized by the plant operator in accordance with the task requirements.
- Follow the instructions in this document.

2.2 Intended Use

The manufacturer is not liable for damage resulting from improper or improper use. Modifications and changes to the device must not be made.
The Modbus EIA-485 module may only be operated under the conditions stated in the technical specification.

2.3 Safety Instructions

2.3.1 Occupational Safety

When working on and with an electronic device:

- Wear the necessary personal protective equipment under national regulation.

2.3.2 Operational safety

Risk of injury!

- Operate the device only in a technically perfect and safe condition.
- The operator is responsible for the trouble-free operation of the device.

Modifications to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseable dangers:

- If modifications are nevertheless necessary: Consult your local representative or Sontex SA.

Repair

To ensure continued operational safety:

- Only if repair is expressly permitted, carry it out on the electronic device.
- Observe the national regulations concerning the repair of an electrical, electronic devices.
- Only use original Sontex spare parts and accessories.

Environmental requirements

If the plastic housing of the *Supercal 5* is permanently exposed to certain vapour-air mixtures, the housing may be damaged.

- Contact your Sontex sales office for assistance.
- For use in areas subject to approval: See the information on the nameplate.

2.3.3 Product Safety

The Modbus EIA-485 module is built and tested according to the state of the art and good engineering practice and has left the factory in perfect safety condition.

It meets the general safety requirements and legal requirements.

3. Retrofittable BACnet / Modbus Module

3.1 Application

The optional communication module BACnet/Modbus enables the *Supercal 5* calculator to communicate via BACnet/Modbus system.

This allows to readout metrological data from the heat meter and transfer then via BACnet or Modbus to a billing management system.

3.2 Modbus Application

Modbus is a communication protocol for the exchange of information for optimum building automation between devices from different manufacturers.

The Modbus EIA-485 module is used with the *Supercal 5*. The module is suitable for various applications; in public and commercial buildings, but also in residential buildings where intelligent building automation is required.

3.3 Features

This module combines BACnet and Modbus functions

- Switch between BACnet and Modbus
- Switch between Normal and Test Mode

3.4 Activate the Modbus Mode

Please put the DIP Switch on the position Modbus to activate the module in Modbus mode 

4. General Remarks

4.1 Introduction

Additional information on *Supercal 5* as well as *Superprog* Software can be found in the instruction for use of those devices. The documents can be found on our extranet at: https://extranet.sontex.
Only authorised users have access to the extranet. Information and access rights for the Sontex extranet can be obtained from your local Sontex representative.

This instruction for use describes the installation procedure of the Modbus EIA-485 module in the *Supercal 5* calculator as standalone product or in combination with the *Superstatic 440*.
The Modbus module communicates as a slave device on RS-485. The Modbus module transfers a number of both actual data as well as accumulated data.

The technical data, the register list and the specifications of the Modbus EIA-485 module are described in this document. It addresses the questions of both users and engineers.

4.2 Delivery of the Module

Before installing the BACnet MS/TP module check the items delivered.

Included in the delivery are:

- The Modbus EIA-485 module
- A fixing clamp for strain relief

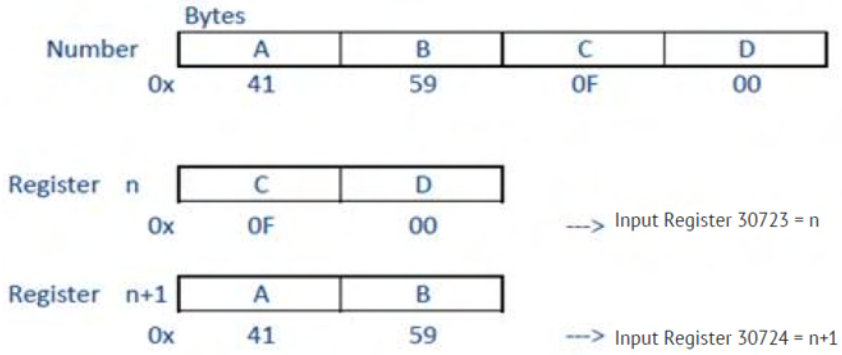
4.3 The Register List

The registers list is available at the end of this document, see Annex A.
These registers allow to access (or to read) to the values supported by the *Supercal 5 I* and the *Supercal 5 S*.

Word Swapping:

Sontex uses the Register Little Endian (the low-order byte is stored first, followed by the high-order byte) to sort binary data. This means float or long data type are sorted in the form of l – h, whereby h (A+B) and l (C+D) are int16.

Example below: The High temperature (IEEE745 single float value) is 0x4159'0F00 in hex.



The converted value of the high temperature is 13,566132 [°C]

5. Modbus Module Configuration

The device address, the serial transmission mode (RTU or ASCII) and the parity can be changed via Modbus command. The parameters can then be checked over the optical interface by the *Superprog* configuration software supplied by Sontex.

5.1 Settings – Normal Mode / Test Mode

5.1.1 Default Settings – Normal Mode

When the Modbus module is delivered, the DIP Switch is set on the position Normal Mode and the default setting of the module is:

- RTU mode using 8 bit data, even parity, 1 stop bit, 19'200 bit/s.
- By default, the Modbus module is addressed with MAC address (or Modbus address) corresponding to the last 2 digits of *Supercal 5* serial number. If the last 2 digits are equal to 00, the MAC address will be set to 100.

5.1.2 Test Mode

If the Test Mode is selected, connection parameters for Modbus should be the setup as follow:
The optional Modbus module comprises:

- 19'200 bds
- Parity Even
- 1 Stop
- RTU
- MAC Address = 1

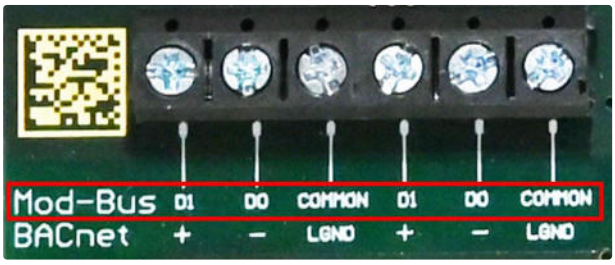


5.2 Modbus Connection

- 2x3 screw terminals (D1/D0/Common terminals for the RS-485 twisted pair connection).

Terminal connection:

- Terminal D0 : RS-485 Tx/Rx (-)
- Terminal D1 : RS-485 Tx/Rx (+)



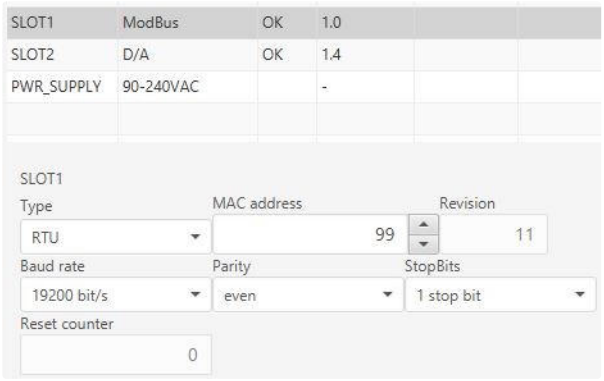
To implement a Daisy Chain, there is an internal connection between the two D0 connections. The same applies for the two D1 and the two Common connections.
The name of the third terminal is called "Common" for the Modbus module and "LGND" for the BACnet module. The properties and functionalities are exactly the same, only the name is different.

5.3 Communication Speed / Mode

The module supports baud rates from 1'200 to 115'200 bit/s. The setting of the communication speed is set with the *Superprog* software. Default speed is set to 19'200 bit/s.

The parity and stop bits are to be selected as one of the following for:

- RTU mode (RTU using 8 bit data)
  - no parity 1 stop bit
  - no parity 2 stop bits
  - even parity 1 stop bit
  - even parity 2 stop bits
  - odd parity 1 stop bit
  - odd parity 2 stop bits
- ASCII mode (ASCII using 7 bit data)
  - no parity 2 stop bits
  - even parity 1 stop bit
  - even parity 2 stop bits
  - odd parity 1 stop bit
  - odd parity 2 stop bits



5.4 Installing the Modbus Module

DANGER

Danger to life from electrical voltage!
If the equipment has not previously been isolated from the mains supply, live components may be exposed when the cover is opened.
If module replacement whilst the equipment is open and live is unavoidable, then this should only be undertaken by specialist technicians who are familiar with the associated hazards and the applicable regulations.

WARNING

Removal of the module must only be carried out with the equipment isolated from the electrical supply!
Removal of the module or insertion of the module must be done when there is no current present.
Avoid electrostatic discharges!
Avoid electrostatic discharges during installation or handling while manipulating the Modbus module. For this purpose, before touching the calculator or the Modbus module, you are advised to touch a grounded conductor (for example a water pipe or hot water pipe) to discharge electricity.

For a Modbus application, the DIP Switch must be set on the Modbust position to activate the Modbus mode.

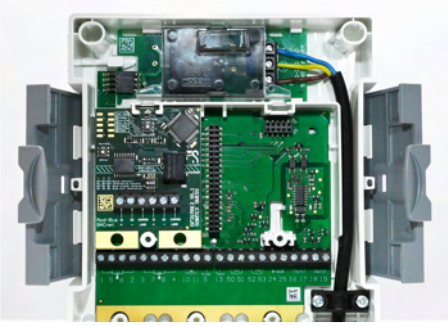
The Modbus module, as all other modules to retrofit to the *Supercal 5* calculator, is mounted in one of the two module slots on the mother board of the *Supercal 5* calculator.

The following procedure must be respected:

- Disconnect the power supply of the calculator.
- Separate the cover (MET) from the housing (MIO).
- Place the Modbus module in one of the module slots of the calculator.
- Connect - the Modbus EIA-485 network (D0, D1 and Common, the latter if available) with the Modbus module.
- Close the calculator carefully.
- Reconnect the power supply cable.

The calculator *Supercal 5* will automatically detect and recognize the new module. No other action is required. The *Supercal 5 I* / *Supercal 5 S* are now ready to communicate via the Modbus module.

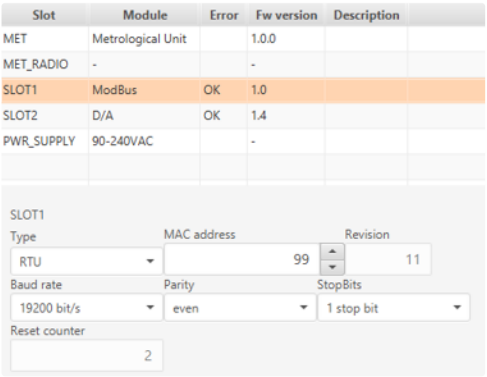
The default setting is: RTU mode using 8 bit data, even parity, 1 stop bit, 19'200 Bds, MAC address (or Modbus address) corresponding to the last 2 digits of *Supercal 5* serial number. If the last 2 digits are equal to 00, the MAC address will be set to 100.



5.5 Detection of the Modbus Module with the *Superprog* Software

The *Superprog* software allows to detect the Modbus module and to see its configuration:

- The firmware release of the Modbus module.
- The Module revision (11 corresponds to the revision of the Modbus protocol).
- The FW version of the Modbus Module.
- The Baudrate
- The serial transmission mode (RTU or ASCII)
- The MAC Address (or Modbus Address)
- The Parity
- Stop bit number



The *Superprog* software allows to change the following parameters, though this approach is not recommended:

- The serial transmission mode (RTU or ASCII)
- The MAC Address (or Modbus Address)
- The Baudrate
- The Parity
- The Stop bit number

Other parameters can be set with the DIP Switch:

- The bias resistors and the terminating resistor

NOTICE

The Modbus module is compatible with *Supercal 5* calculators with firmware release FW 01.00.00 or higher.

Changing the Communication Parameters by *Superprog* Software:

In case you have programmed new communication parameters with the optical probe via the *Superprog* software, it's not necessary to restart the Modbus module.

After programming the new communication parameters with the optical probe via the *Superprog* software, it's necessary to wait a refreshment period before the new communication parameters are activated.The refreshment period can last up to 10 seconds. During this period, the module will not communicate and not answer to the Modbus commands.

5.6 Procedure to Use When Changing Parameters by Modbus Command

5.6.1 Communication Parameters

Device communication is available as holding registers. Setting a new configuration is best done through one telegram to the registers starting from index 40017 and the following ones.
If you want to change only the Parity, it's necessary to address at least the indexes 40017/40018 up to 40019. It is not necessary to send to the other registers such as 40020...

ModBus Registers	Index	Type	remarks
Password "Configuration"	40017	uint16	„1234"
ModBus adress	40018	uint16	1-247
Parity	40019	uint16	MB_PAR_NONE=0, MB_PAR_ODD=1, MB_PAR_EVEN=2
Flow control	40020	uint16	MB_RTU=0, MB_RTU=1
StopBits	40021	uint16	1,2
Config Reserve	40022	uint16	NIL
Custom ID	40023,24	long	OEM serial number

5.6.2 Changing the Communication Parameters by Modbus Command

After sending the Modbus command to change the communication parameters, the Modbus module will not communicate and not answer to the Modbus commands.

The Modbus module will reboot automatically and change the communication parameters. As long as the module has not finished restarting, the module will not communicate.
The restarting period can last up to 10 seconds. During this period, the module will not communicate and not answer to the Modbus commands.

5.7 Setting of the Line Terminating Resistor and the Bias Resistors with the DIP Switch

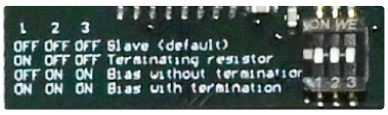
To correctly set up an RS-485 line is of utmost importance to avoid disturbances and failures on the bus and lack of required data altogether.

At delivery the default position of the DIP Switch is: [0 0 0], this indicates that there is a light polarisation induced by 247 kΩ resistors.

If the Modbus module is at the end of the bus line, it is necessary to terminate the line, by adding a terminating resistor 120 Ω. This can be done either by means of the DIP Switch on the module itself or by adding an external resistor between D0 and D1 to close the line.

Additionally it might be necessary to add a bias resistor to further stabilise the line, also this can be done by means of the DIP Switch as shows the table hereafter.

Settings with DIP Switch:



Pos. 1	Pos. 2	Pos. 3	
OFF	OFF	OFF	No Line Terminating resistor LT and no Bias resistor, only a polarisation with 2x 47 kΩ (default)
ON	OFF	OFF	Line Terminating resistor: LT = 120 Ω + 1nF
OFF	ON	ON	Bias resistors (2x510 Ω) without termination (120 Ω)
ON	ON	ON	Bias resistors (2x510 Ω) with LT termination (120 Ω + 1 nF)

0 = OFF; 1 = ON

For DIP Switch, the position is defined as follows: Pos.1 Pos. 2 Pos. 3

5.8 Modbus Module Addressing

The Modbus module distinguishes the master devices and the slave peripherals.
The Modbus module can be addressed as slave in the range 1-247.
At the delivery, by default the Modbus module is addressed with MAC address (or Modbus address) corresponding to the last 2 digits of *Supercal 5* serial number. If the last 2 digits are equal to 00, the MAC address will be set to 100 and the transmission mode is RTU.

6. Technical Data Modbus EIA-485 Module

See datasheet available on our website.

6.1 Reliability

The RS-485 port of the Modbus module is galvanically separated from the meter's voltage potential, thereby improving the security for smooth operation. At the same time, the risk of influencing the meter due to influences of the RS485 port is reduced to a minimum.

6.2 Precautions – Safety Instructions

General notes: the Modbus module works with the specific characteristics described in this document. The manufacturer declines all liability if they are not respected. The manufacturer is not responsible if the Modbus module is incorrectly installed or used. The electrical connection must be established by an authorized person acting in compliance with the international and national stand-ards in force and in conformity with local safety regulations. On the installation side, the main power supply must be protected by a 1A circuit-breaker device. The power supply cable for the *Supercal 5* calculator must be installed in such a way that no hot parts (e.g. pipes, conduits at over 70°C) come into contact with the cable and no cable insulation will be damaged. The power supply con-nection terminals are designed for the connection of wires with a cross-section of between 0.75 mm2 and 1.5 mm2.

7. Power Supply for Modbus Modules

⚠ DANGER

Danger to life from electrical voltage!
If the equipment has not previously been isolated from the mains supply, live components may be exposed when the cover is opened.
If module replacement whilst the equipment is open and live is unavoidable, then this should only be undertaken by specialist technicians who are familiar with the associated hazards and the applicable regulations.

⚠ WARNING

Removal of the module must only be carried out with the equipment isolated from the electrical supply!
Removal of the module or insertion of the module must be done when there is no current present.
Avoid electrostatic discharges!
Avoid electrostatic discharges during installation or handling while manipulating the Modbus module.
For this purpose, before touching the calculator or the Modbus module, you are advised to touch a grounded conductor (for example a water pipe or hot water pipe) to discharge electricity.

7.1 Mains - Power Supply Modules

Two types of main power supply modules are available for the calculator *Supercal 5*:

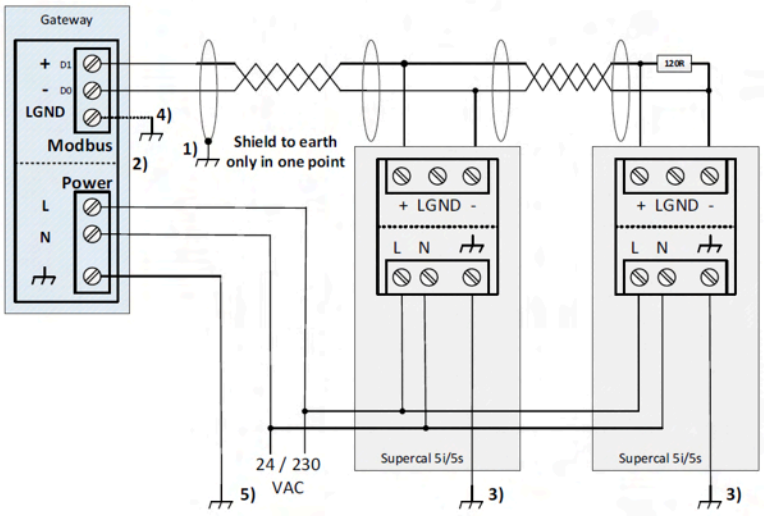
- Power Supply Module for 230 VAC – 50/60 Hz (range 110-240VAC), Art N°: SC5X00012
- Power Supply Module for 24 VDC / 24 VAC (range 12 to 42 VDC / 12 to 36 VAC), Art N°: SC5X00011

Those two models of power supply are completely electrically isolated and can be used for any communication module of the calculator *Supercal 5*.

7.2 Two-Wires Bus Connections

The BACnet module has a terminal called "LGND", the Modbus module one that is called "Common". The properties and functionalities are exactly the same for both, only the name is different.

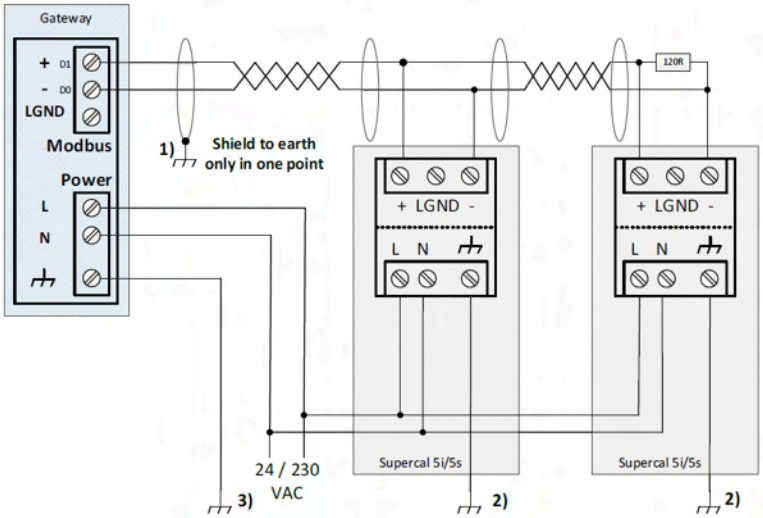
7.2.1 Two-Wires Bus with a Gateway with Galvanic Isolation



- The screen (shield) of the complete cable must be connected to earth (or) in one point only.
- As the gateway is built with a galvanic isolation, the earth (or) of the gateway 5) can, but does not need to, be connected to the earth. In general, the gateway is earthed by an earth cable.
- Connect each power supply module to the earth (or).
- Check if the voltage between the LGND (Common) and the electrical earth is in the range of -7 and +12VDC, as per specified in the EIA-485 requirements. Then connect the LGND (Common) terminal to the earth (or).

Remarks:
In the case where others devices are connected on the BUS, these others devices must be built with a galvanic isolation to ensure proper working of the bus.
In the case where others devices are connected on the BUS, these others devices are built without a galvanic isolation, don't connect the LGND (Common) terminal to the earth (or), point 4).
The resistor 120 Ohm in drawing is built into the module and can be set via a dip switch.

7.2.2 Two-Wires Bus with a Gateway WITHOUT a Galvanic Isolation



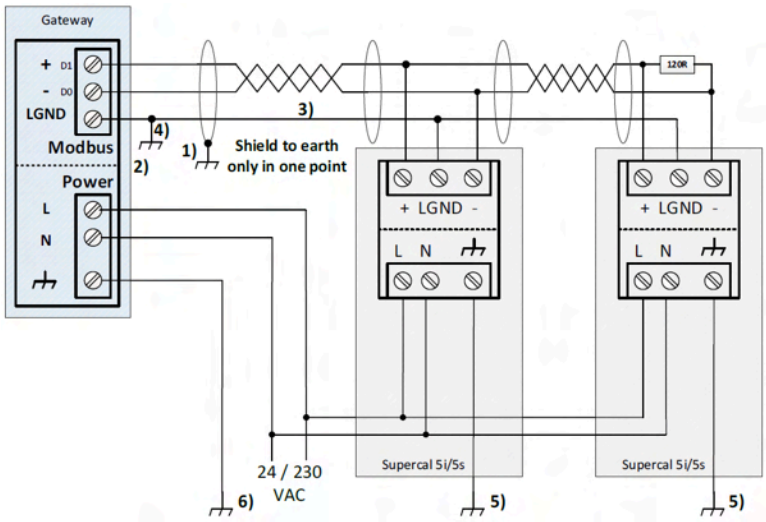
- The screen (shield) of the complete cable must be connected to earth (or) in one point only.
- Connect each power supply module to the earth (or).

Remarks:
As the gateway is built without a galvanic isolation, DON'T CONNECT the LGND to earth (or).

The resistor 120 Ohm in drawing is built into the module and can be set via a dip switch.

7.3 Three-Wire Bus Connections

7.3.1 Three-Wires Bus with a Gateway with a Galvanic Isolation



- The screen (shield) of the complete cable must be connected to earth (or) in one point.
- As the gateway is built with a full isolation 2), the earth (or) of the gateway 6) can, but does not need to, be connected to the earth. In general, the gateway is earthed by an earth cable.
- The line LGND is used to connect all modules mounted on the Bus with the gateway.
- Check if the voltage between the LGND (Common) and the electrical earth is in the range of -7 and +12VDC, as per specIfied in the EIA-485 requirements. Then connect the LGND (Common) terminal to the earth (or).

Remarks:
In the case where others devices are connected on the BUS, these others devices must be built with a galvanic isolation to ensure proper working of the bus.
In the case where others devices are connected on the BUS, these others devices are built without a galvanic isolation, don't connect the LGND (Common) terminal to the earth (or), point 4).

- Connect each power supply module to the earth (or).

The resistor 120 Ohm in drawing is built into the module and can be set via a DIP Switch.

7.3.2 Three-Wires Bus with a Gateway WITHOUT a Galvanic Isolation

- The screen (shield) of the complete cable must be connected to earth (or) in one point.
- The line LGND is used to connect all modules mounted on the Bus with the gateway.
  Do not connect this line to earth when there is no galvanic isolation.
- Connect each power supply module to the earth (or).
- As the gateway is built without a galvanic isolation, the earth (or) of the gateway 4) must be connected to the earth.

Remark:
As the gateway is built without a galvanic isolation, DON'T CONNECT the LGND to earth (or).
The resistor 120 Ohm in drawing is built into the module and can be set via a DIP Switch.

8. General Bus Considerations

8.1 Wire Routing

BACnet MS/TP or Modbus EIA-485 networks must be wired in a daisy chain configuration. A daisy chain means that there is only one main cable, and every network device is connected directly along its path. This type of network is low bandwidth, but reliable and good for long distance multi-drop runs.
Other methods of wiring a MS/TP BACnet or EIA-485 Modbus network may give unreliable and unpredictable results. DO

NOT use Star, Bus, "T", or any other type of network configuration. Any of these other network configurations will result in an unreliable network, and make troubleshooting almost impossible.

8.2 Cable Specifications

A Modbus or BACnet over Serial Line Cable must be shielded, typically either one or two twisted pair.
Please refer to Annex F, chapter 3.6 for all technical specifications.

8.3 Electrical Noise

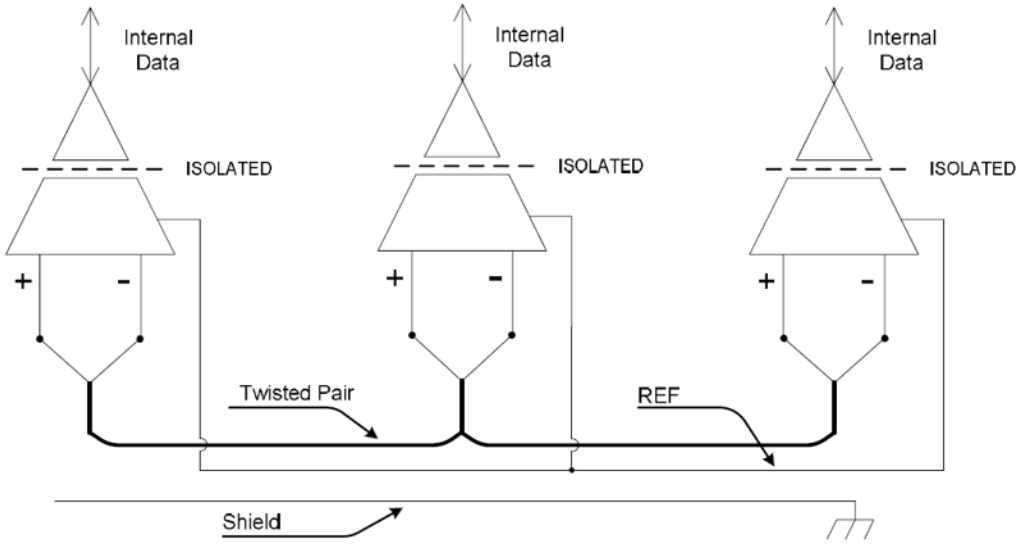
Electrical noise can affect both analogue signal and digital communications such as BACnet or Modbus. Therefore do not route high voltage lines next to the BACnet / Modbus network! Avoid noisy electrical sources such as:

- Variable Frequency Drives
- High current power lines (main panel feeds)
- Fluorescent light fixtures

If you must pass near noisy electrical lines cross at right angles. This will help reduce the amount of noise coupled to the network wires.

8.3.1 Earth, Shield

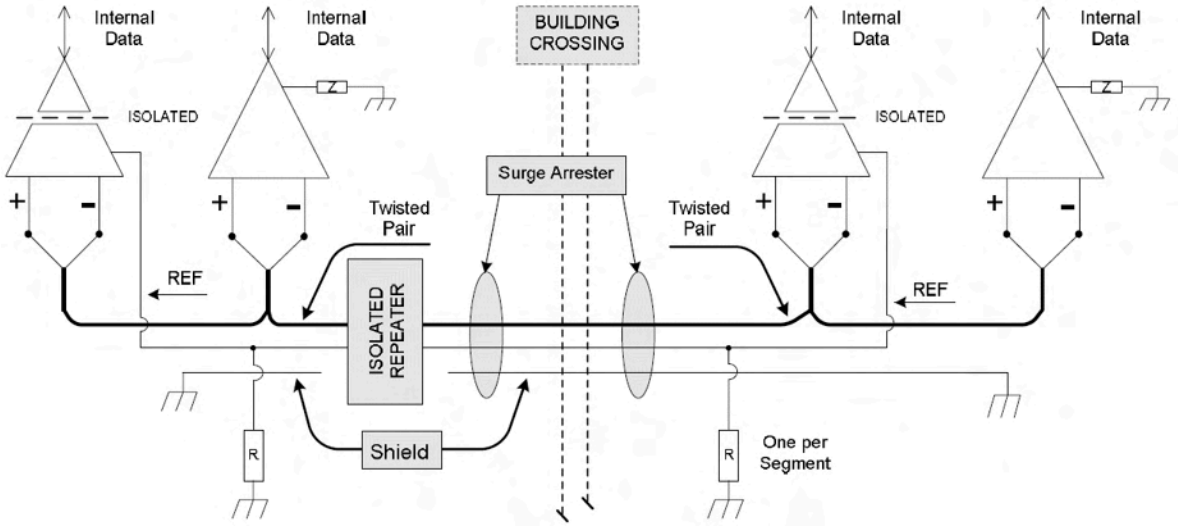
If the installation exclusively uses EIA-485 devices with third-wire reference connections, electrical noise rejection is best if a third conductor in the same cable is used to connect all of the reference connections together as shown in Figure below:



This nearly eliminates earth-ground voltage differences and allows the differential input of each EIA-485 device to float with the electrical noise and stray fields picked up by the signal cable, resulting in better noise rejection. If there are more than three wires in the cable chosen, the third conduc-tor shall be made up of all of the extra wires (outside of the twisted pair used for signaling) connected together. If desired, the third-wire reference conductor may be tied to earth ground at one point where electrical noise is low through a 100-ohm current-limiting resistor in order to limit voltage excursions and to simplify adding two-wire devices in the future.

8.3.2 Building Crossing

If the installation includes a mixture of three-wire isolated and two-wire non-isolated devices in each of two buildings on a single communications line, it is possible to connect the buildings using an iso-lated repeater so that each building is electrically isolated from the other building as shown in Figure below.



The isolated repeater must provide complete three-way electrical isolation between the wiring on either side and ground. In this case, the communication wiring within each building is configured like that of a single building since the isolated repeater provides the required 1500-volt electrical isola-tion. The cable connecting the buildings is an extension of the cable in one of the buildings and shall be electrically isolated from the other building by the isolated repeater and shall not have any connections to other devices or to ground within the other building.
An isolated repeater may also be used on both sides of the cable connecting the buildings. This may be needed for extra isolation or for cable length. In this case the cable connecting the buildings shall be separately shielded, terminated, and biased and shall not have any connections to other devices within either building. If the pair of isolated repeaters provides a reference connection, the two ref-erence connections shall be joined by a third conductor within the cable connecting the buildings and shall not be connected to any other device or to ground.
The use of surge arrestors near each building's cable entrance to protect all of the conductors is recommended.

9. Troubelshooting procedure

- Ensure all MAC addresses (or Modbus addresses) are unique for that Modbus segment. If you have 2 addresses that are the same that means 2 devices are
  talking at the same time.
- Ensure all devices are running at the same baud rate. Confirm this someone may have changed it.
- Ensure all devices are running at the same communication parameters. Confirm this someone may have changed it.
- Ensure the communication parameters are the same on Master and on the devices Slaves.
- Check wiring and power.
- Bad ground connection between Master and Slaves.
- Check for reversed polarity on RS485 lines. If uncertain, just try swapping them.
- With RS485, check termination. Ensure only 2 devices in total are terminated for that Modbus segment.
- With RS485, check if the bias resistors are used on the Modbus segment.
- Chop network in half. Does it start to work? Keep chopping until network comes online. This will help narrow down the problem.
- Have more than 32 Modbus devices on one segment? Not recommended. Break up that segment into separate ones.
- Do you have other Modbus devices on the network? Remove them while troubleshooting. If they are causing issues put them on a separate Modbus segment.

10. Maintenance Instructions

No specific maintenance is required for the electronic device.

11. Legal and Compliance Information

Hereby, Sontex declares that the product is in compliance with Directive 2014/53/EU, 2014/32/EU and 2011/65/EU.

The full text of the CE Declaration of Conformity can be found on our website.

12. Support & Warranty Information

- For technical support, please contact your local agent.
- Warranty and guarantee claims are only valid if the device has been used in accordance with their intended use and if the technical requirements and any applicable technical regulations have been observed.
- Links to online documentation, declaration of conformity, manuals, or support forums:

13. Disposal



For the purposes of disposal, the device is considered a used electronics device in the sense of the European Guideline 2012/19/EU (WEEE). It must not be disposed of with household waste. Dispose only at authorized collection points.

ANNEX A

A.1 Mapping Register for *Supercal 5*

A.2 Product Description

The calculator *Supercal 5 I* / *Supercal 5 S* can be used in various commercial building and apartments, mainly for cooling and heating applications. The system based on signal inputs of two matched temperature sensors and any of e.g. Sontex flow meters.
Supercal 5 provide high accuracy e.g. energy, volume, power, flow, and temperature data via the local LCD display and various communication protocols, like Modbus, BACnet MS/TP, LON FFT-10A and M-Bus.

The Modbus uses a register start address of 1 (meaning physical address 0 in the telegram).
Either RTU or ASCII mode are supported. Byte length strictly follows V 1.1 specification with mode RTU using 8 bit data and ASCII mode 7 bit data.
For ASCII mode, if no parity is set, the number of stop bits is set automatically to 2.

A.3 Data Model Mapping

- Modbus Application Specific Controller (B-ASC)

A.3.1 Group (A): Settings

Holding Register	M-Bus data Individual description Group (A) : settings (read/write)	Data type	Read/Write	Remarks
Managing actual date and time (IEEE745 single float values)				
40011	Actual date: year	16 Bit Integer	R/W	
40012	Actual date: month	16 Bit Integer	R/W	
40013	Actual date: day	16 Bit Integer	R/W	
40014	Actual time: hour	16 Bit Integer	R/W	
40015	Actual time: minute	16 Bit Integer	R/W	
40016	Actual time: second	16 Bit Integer	R/W	
Communication parameters				
40017	Password „Communication“	16 Bit Integer	R/W	„1234“
40018	MAC Address (or Modbus Address)	16 Bit Integer	R/W	1-247
40019	Parity	16 Bit Integer	R/W	MB_PAR_NONE=0, MB_PAR_ODD=1, MB_PAR_EVEN=2
40020	Flow Control	16 Bit Integer	R/W	MB_RTU=0, MB_RTU=1
40021	Stop Bits	16 Bit Integer	R/W	1, 2
40022 - 40023	Baudrate	32 Bit Integer (h-l)	R/W	1200, 2400, 9600, 19200, 38400, 57600, or 115200 bits/s
Setting date for next Set day (IEEE745 single float values)				
40025	Password „Set Day“	16 Bit Integer	R/W	
40026	Set-Day1: month	16 Bit Integer	R/W	

40027	Set-Day1: day	16 Bit Integer	R/W	
40028	Set-Day2: month	16 Bit Integer	R/W	
40029	Set-Day2: day	16 Bit Integer	R/W	

A.3.2 Group (B): Information

Input Register	M-Bus data Individual description Group (B) : Informations (read)	Data type	Read/Write	Remarks
Device information				
30001 - 30002	Fabrication number MET	32 Bit Integer (h-l)	R	
30003	Firmware version	16 Bit Integer	R	
30004 - 30005	Baudrate	32 Bit Integer (h-l)	R	
30006 - 30007	Running hours	32 Bit Integer (h-l)	R	
Error flags				
10001	AD ref1 error	1 Bit	R	
10002	AD ref2 error	1 Bit	R	
10003	AD Pt sensor 1	1 Bit	R	
10004	AD Pt sensor 2	1 Bit	R	
10005	Temperature 1 below min	1 Bit	R	
10006	Temperature 1 above max	1 Bit	R	
10007	Temperature 2 below min	1 Bit	R	
10008	Temperature 2 above max	1 Bit	R	
10009	Sum of all temperatures and AD errors	1 Bit	R	
10010	Flow in saturation	1 Bit	R	
10011	Case is open	1 Bit	R	
10012	Main power cut	1 Bit	R	
10013	Module 1 error	1 Bit	R	
10014	Module 2 error	1 Bit	R	
10015	Firmware checksum error	1 Bit	R	
10016	Radio error	1 Bit	R	

(h-l) = high – low register. This indication means that we are working with 2 registers, 1x register High (h) and 1 register Low (l).
For the words of 32 bit registers, Sontex uses the l – h ordering.

A.3.3 Group (C): Actual Values

Input Register	M-Bus data Individual description Group (C) : Actual values (read)	Data type	Read/Write	Remarks
Energy data (IEEE745 single float values)				
30101	Energy Unit	16 Bit Integer	R	KWh=19, MWh=146, MJ=126, GJ=226, KBtu=147, MBtu=148, Mcal=227, Gcal=228
30102	Reserved			
30103 - 30104	Energy totalizer heating	IEEE745 Single (h-l)	R	Actual value
30105 - 30106	Energy totalizer Tariff 1	IEEE745 Single (h-l)	R	Actual value
30107 - 30108	Energy totalizer Tariff 2	IEEE745 Single (h-l)	R	Actual value
30109 - 30110	Energy – stored ST1	IEEE745 Single (h-l)	R	
30111 - 30112	Energy Tariff 1 – stored ST1	IEEE745 Single (h-l)	R	
30113 - 30114	Energy Tariff 2 – stored ST1	IEEE745 Single (h-l)	R	
30115 - 30116	Energy – stored ST2	IEEE745 Single (h-l)	R	
30117 - 30118	Energy Tariff 1 – stored ST2	IEEE745 Single (h-l)	R	
30119 - 30120	Energy Tariff 2 – stored ST2	IEEE745 Single (h-l)	R	
Energy data (long data points)				
30201	Energy Unit	16 Bit Integer	R	KWh=19, MWh=146, MJ=126, GJ=226, KBtu=147, MBtu=148, Mcal=227, Gcal=228
30202	Energy Decimals	16 Bit Integer	R	Decimals: 0, 1 2 3
30203 - 30204	Energy totalizer heating	32 bits integer (h-l)	R	Actual value
30205 - 30206	Energy totalizer Tariff 1	32 bits integer (h-l)	R	Actual value
30207 - 30208	Energy totalizer Tariff 2	32 bits integer (h-l)	R	Actual value
30209 - 30210	Energy – stored ST1	32 bits integer (h-l)	R	
30211 - 30212	Energy Tariff 1 – stored ST1	32 bits integer (h-l)	R	
30214 - 30213	Energy Tariff 2 – stored ST1	32 bits integer (h-l)	R	
30215 - 30216	Energy – stored ST2	32 bits integer (h-l)	R	
30217 - 30218	Energy Tariff 1 – stored ST2	32 bits integer (h-l)	R	
30219 - 30220	Energy Tariff 2 – stored ST2	32 bits integer (h-l)	R	

(h-l) = high – low register. This indication means that we are working with 2 registers, 1x register High (h) and 1 register Low (l).
For the words of 32 bit registers, Sontex uses the l – h ordering.

Volume data (IEEE745 single float values)				
30301	Volume Unit	16 Bit Integer	R	L=82, m3=80, USGallon=83, KUSGallon=229
30302	Reserved			
30303 - 30304	Volume	IEEE745 Single (h-l)	R	Actual value
30305 - 30306	Volume Tariff 1	IEEE745 Single (h-l)	R	Actual value
30307 - 30308	Volume Tariff 2	IEEE745 Single (h-l)	R	Actual value
30309 - 30310	Volume – stored ST1	IEEE745 Single (h-l)	R	
30311 - 30312	Volume Tariff 1 – stored ST1	IEEE745 Single (h-l)	R	
30313 - 30314	Volume Tariff 2 – stored ST1	IEEE745 Single (h-l)	R	
30315 - 30316	Volume – stored ST2	IEEE745 Single (h-l)	R	
30317 - 30318	Volume Tariff 1 – stored ST2	IEEE745 Single (h-l)	R	
30319 - 30320	Volume Tariff 2 – stored ST2	IEEE745 Single (h-l)	R	
Volume data (long data points)				
30401	Volume Unit	16 Bit Integer	R	L=82, m3=80, USGallon=83, KUSGallon=229
30402	Volume decimals	16 Bit Integer	R	Decimals: 0,1,2,3
30403 - 30404	Volume	32 bits integer (h-l)	R	Actual value
30405 - 30406	Volume Tariff 1	32 bits integer (h-l)	R	Actual value
30407 - 30408	Volume Tariff 2	32 bits integer (h-l)	R	Actual value
30409 - 30410	Volume – stored ST1	32 bits integer (h-l)	R	
30411 - 30412	Volume Tariff 1 – stored ST1	32 bits integer (h-l)	R	
30413 - 30414	Volume Tariff 2 – stored ST1	32 bits integer (h-l)	R	
30415 - 30416	Volume – stored ST2	32 bits integer (h-l)	R	
30417 - 30418	Volume Tariff 1 – stored ST2	32 bits integer (h-l)	R	
30419 - 30420	Volume Tariff 2 – stored ST2	32 bits integer (h-l)	R	

(h-l) = high – low register. This indication means that we are working with 2 registers, 1x register High (h) and 1 register Low (l).
For the words of 32 bit registers, Sontex uses the l – h ordering.

Auxiliary A1 data or complementary counter A1 totalizer (IEEE745 single float values)				
30501	Auxiliary-A1 Unit	16 Bit Integer	R	KWh=19, MWh=146, MJ=126, GJ=226, KBtu=147, MBtu=148, Mcal=227, Gcal=228, no unit=95, L=82, m3=80, USGallon=83, KUS-Gallon= 229
30502	Reserved			
30503 - 30504	Auxiliary-A1	IEEE745 Single (h-l)	R	Actual value
30505 - 30506	Auxiliary-A1 – stored ST1	IEEE745 Single (h-l)	R	
30507 - 30508	Auxiliary-A1 – stored ST2	IEEE745 Single (h-l)	R	
30509 - 30510	Volume Tariff 1 – stored ST1	IEEE745 Single (h-l)	R	
30511 - 30512	Volume Tariff 2 – stored ST1	IEEE745 Single (h-l)	R	
Auxiliary A1 data or complementary counter A1 totalizer (long data points)				
30601	Auxiliary-A1 Unit	16 Bit Integer	R	KWh=19, MWh=146, MJ=126, GJ=226, KBtu=147, MBtu=148, Mcal=227, Gcal=228, no unit=95, L=82, m3=80, USGallon=83, KUS-Gallon=229
30602	Decimals	16 Bit Integer	R	Decimals: 0,1,2,3
30603 - 30604	Auxiliary-A1	32 bits integer (h-l)	R	Actual value
30605 - 30606	Auxiliary-A1 – stored ST1	32 bits integer (h-l)	R	
30607 - 30608	Auxiliary-A1 – stored ST2	32 bits integer (h-l)	R	
Auxiliary A2 data or complementary counter A2 totalizer (IEEE745 single float values)				
30511	Auxiliary-A2 Unit	16 Bit Integer	R	KWh=19, MWh=146, MJ=126, GJ=226, KBtu=147, MBtu=148, Mcal=227, Gcal=228, no unit=95, L=82, m3=80, USGallon=83, KUS-Gallon=229
30512	Reserved			
30513 - 30514	Auxiliary-A2	IEEE745 Single (h-l)	R	Actual value
30515 - 30516	Auxiliary-A2 – stored ST1	IEEE745 Single (h-l)	R	
30517 - 30518	Auxiliary-A2 – stored ST2	IEEE745 Single (h-l)	R	
Auxiliary A2 data or complementary counter A2 totalizer (long data points)				
30611	Auxiliary-A2 Unit	16 Bit Integer	R	KWh=19, MWh=146, MJ=126, GJ=226, KBtu=147, MBtu=148, Mcal=227, Gcal=228, no unit=95, L=82, m3=80, USGallon=83, KUS-Gallon=229
30612	Decimals	16 Bit Integer	R	Decimals: 0,1,2,3
30613 - 30614	Auxiliary-A2	32 bits integer (h-l)	R	Actual value

30615 - 30616	Auxiliary-A2 – stored ST1	32 bits integer (h-l)	R	
30617 - 30618	Auxiliary-A2 – stored ST2	32 bits integer (h-l)	R	
Power (IEEE745 single float values)				
30701	Power Unit	16 Bit Integer	R	W=47-
30702	Reserved			
30703 - 30704	Power	IEEE745 Single (h-l)	R	Actual value
Power (long data points)				
30801	Power Unit	16 Bit Integer	R	W=47-
30802	Decimals	16 Bit Integer	R	Decimals: 0,1,2,3
30803 - 30804	Power	32 bits integer (h-l)	R	Actual value, signed

(h-l) = high – low register. This indication means that we are working with 2 registers, 1x register High (h) and 1 register Low (l).
For the words of 32 bit registers, Sontex uses the l – h ordering.

Flow (IEEE745 single float values)				
30711	Flow Unit	16 Bit Integer	R	m3/h=135
30712	Reserved			
30713 - 30714	Flow	IEEE745 Single (h-l)	R	Actual value
Flow (long data points)				
30811	Flow Unit	16 Bit Integer	R	m3/h=135
30812	Decimals	16 Bit Integer	R	Decimals: 0,1,2,3
30813 - 30814	Flow	32 bits integer (h-l)	R	Actual value signed
High temperature (IEEE745 single float values)				
30721	Temperature Unit	16 Bit Integer	R	°C=62
30722	Reserved			
30723 - 30724	High temperature	IEEE745 Single (h-l)	R	Actual value
High temperature (long data points)				
30821	Temperature Unit	16 Bit Integer	R	°C=62
30822	Decimals	16 Bit Integer	R	Decimals: 0,1,2,3
30823 - 30824	High temperature	32 bits integer (h-l)	R	Actual value, signed
Low temperature (IEEE745 single float values)				
30721	Temperature Unit	16 Bit Integer	R	°C=62
30722	Reserved			
30725 - 30726	Low temperature	IEEE745 Single (h-l)	R	Actual value,
Low temperature (long data points)				
30821	Temperature Unit	16 Bit Integer	R	°C=62
30822	Decimals	16 Bit Integer	R	Decimals: 0,1,2,3
30825 - 30826	Low temperature	32 bits integer (h-l)	R	Actual value, signed
Temperature difference (IEEE745 single float values)				
30731	Delta Temperature Unit	16 Bit Integer	R	K=63
30732	Reserved		R	
30733 - 30734	Delta Temperature	IEEE745 Single (h-l)	R	
Temperature difference (long data points)				
30831	Delta Temperature Unit	16 Bit Integer	R	32 bits integer (h-l)
30832	Decimals	16 Bit Integer	R	Decimals: 0,1,2,3
30833 - 30834	Delta Temperature	32 bits integer (h-l)	R	Signed

(h-l) = high – low register. This indication means that we are working with 2 registers, 1x register High (h) and 1 register Low (l).
For the words of 32 bit registers, Sontex uses the l – h ordering.

A.3.4 GROUP (D): ST1 Values

Input Register	M-Bus data Individual description Group (D) : ST1 values (read)	Data type	Read/Write	Remarks
ST1 values (IEEE745 single float values)				
30008	Last Set-Day1: month	16 Bit Integer	R	
30009	Last Set-Day1: day	16 Bit Integer	R	
30109 - 30110	Energy – stored ST1	IEEE745 Single (h-l)	R	
30111 - 30112	Energy Tariff 1 – stored ST1	IEEE745 Single (h-l)	R	
30113 - 30114	Energy Tariff 2 – stored ST1	IEEE745 Single (h-l)	R	
30309 - 30310	Volume – stored ST1	IEEE745 Single (h-l)	R	
30311 - 30312	Volume Tariff 1 – stored ST1	IEEE745 Single (h-l)	R	
30313 - 30314	Volume Tariff 2 – stored ST1	IEEE745 Single (h-l)	R	
30505 - 30506	Auxiliary-A1 – stored ST1	IEEE745 Single (h-l)	R	
30515 - 30516	Auxiliary-A2 – stored ST1	IEEE745 Single (h-l)	R	
ST1 values (long data points)				
30008	Last Set-Day1: month	16 Bit Integer	R	
30009	Last Set-Day1: day	16 Bit Integer	R	
30209 - 30210	Energy – stored ST1	32 bits integer (h-l)	R	
30211 - 30212	Energy Tariff 1 – stored ST1	32 bits integer (h-l)	R	
30213 - 30214	Energy Tariff 2 – stored ST1	32 bits integer (h-l)	R	
30409 - 30410	Volume – stored ST1	32 bits integer (h-l)	R	
30411 - 30412	Volume Tariff 1 – stored ST1	32 bits integer (h-l)	R	
30413 - 30414	Volume Tariff 2 – stored ST1	32 bits integer (h-l)	R	
30605 - 30606	Auxiliary-A1 – stored ST1	32 bits integer (h-l)	R	
30615 - 30616	Auxiliary-A2 – stored ST1	32 bits integer (h-l)	R	

(h-l) = high – low register. This indication means that we are working with 2 registers, 1x register High (h) and 1 register Low (l).
For the words of 32 bit registers, Sontex uses the l – h ordering.

A.3.5 GROUP (E): ST2 Values

Input Register	M-Bus data Individual description Group (E) : ST2 values (read)	Data type	Read/Write	Remarks
ST2 values (IEEE745 single float values)				
30010	Last Set-Day2: month	16 Bit Integer	R	
30011	Last Set-Day2: day	16 Bit Integer	R	
30115 - 30116	Energy – stored ST2	IEEE745 Single (h-l)	R	
30117 - 30118	Energy Tariff 1 – stored ST2	IEEE745 Single (h-l)	R	
30119 - 30120	Energy Tariff 2 – stored ST2	IEEE745 Single (h-l)	R	
30315 - 30316	Volume – stored ST2	IEEE745 Single (h-l)	R	
30317 - 30318	Volume Tariff 1 – stored ST2	IEEE745 Single (h-l)	R	
30319 - 30320	Volume Tariff 2 – stored ST2	IEEE745 Single (h-l)	R	
30507 - 30508	Auxiliary-A1 – stored ST2	IEEE745 Single (h-l)	R	
30517 - 30518	Auxiliary-A2 – stored ST2	IEEE745 Single (h-l)	R	
ST2 values (long data points)				
30010	Last Set-Day2: month	16 Bit Integer	R	
30011	Last Set-Day2: day	16 Bit Integer	R	
30215 - 30216	Energy – stored ST2	32 bits integer (h-l)	R	
30217 - 30218	Energy Tariff 1 – stored ST2	32 bits integer (h-l)	R	
30219 - 30220	Energy Tariff 2 – stored ST2	32 bits integer (h-l)	R	
30415 - 30416	Volume – stored ST2	32 bits integer (h-l)	R	
30417 - 30418	Volume Tariff 1 – stored ST2	32 bits integer (h-l)	R	
30419 - 30420	Volume Tariff 2 – stored ST2	32 bits integer (h-l)	R	
30607 - 30608	Auxiliary-A1 – stored ST2	32 bits integer (h-l)	R	
30617 - 30618	Auxiliary-A2 – stored ST2	32 bits integer (h-l)	R	

(h-l) = high – low register. This indication means that we are working with 2 registers, 1x register High (h) and 1 register Low (l).
For the words of 32 bit registers, Sontex uses the l – h ordering.

Annex B

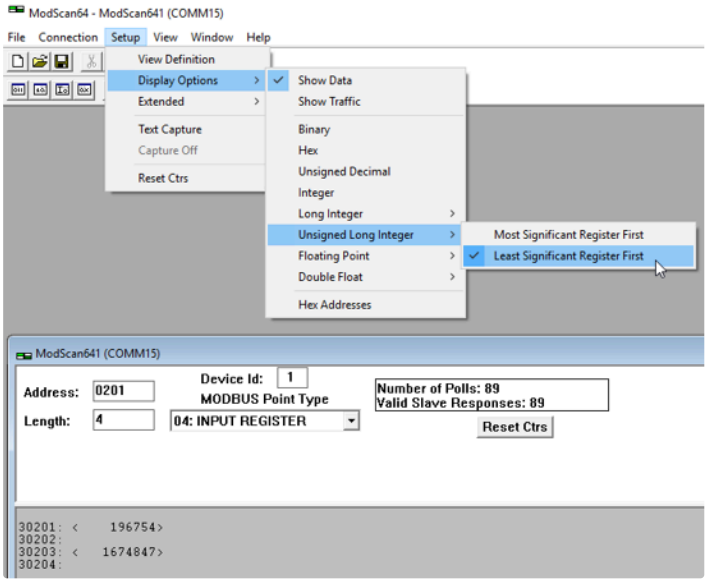
B.1 Example for Energy/Flow Coding with Mod-Scan64 Software

The following tests have been realized with the ModScan64 (Version 1.A00-12) software. The software can be found on the website: https://www.win-tech.com/

B.1.1 Long Data Points

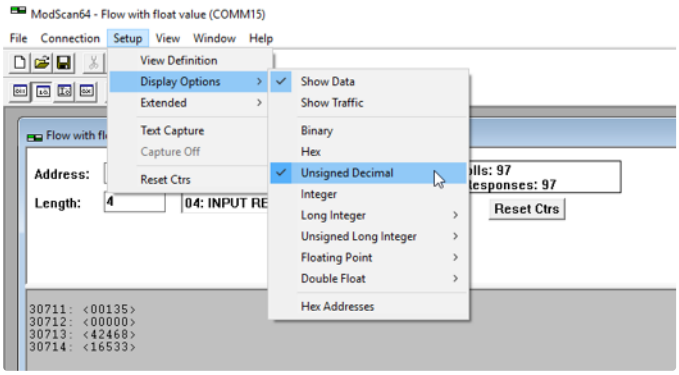
Energy data (long data points)				
30201	Energy Unit	16 Bit Integer	R	Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20
30202	Energy Decimals	16 Bit Integer	R	Decimals: 0, 1 2 3
30203 - 30204	Energy totalizer heating	32 bits integer (h-l)	R	Actual value

The stored energy value is 1674,847 MWh.
The following setting must be set to read the register 30203-30204 (32 bits integer (h-l)) of the energy value.
The Device ID is the address of the module.

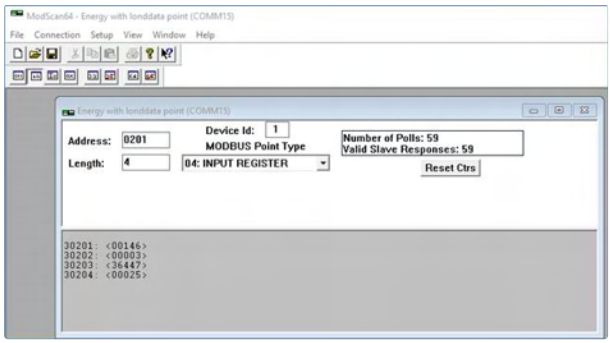


Only value displayed on address 30203 must be taken into consideration.
-> Value displayed = 1674847

To see the real value of the line 30201 and 30202 (16 bit integer), it's necessary to select the setting "Unsigned Decimal":



And the following result is:



Energy Unit: 30201 = <00146>
Energy Decimals: 30202 = <00003>
The signification of these values 146 and 3 are indicated in this technical document, chapter A.3.3:

Energy data (long data points)				
30201	Energy Unit	16 Bit Integer	R	Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20
30202	Energy Decimals	16 Bit Integer	R	Decimals: 0, 1 2 3
30203 - 30204	Energy totalizer heating	32 bits integer (h-l)	R	Actual value

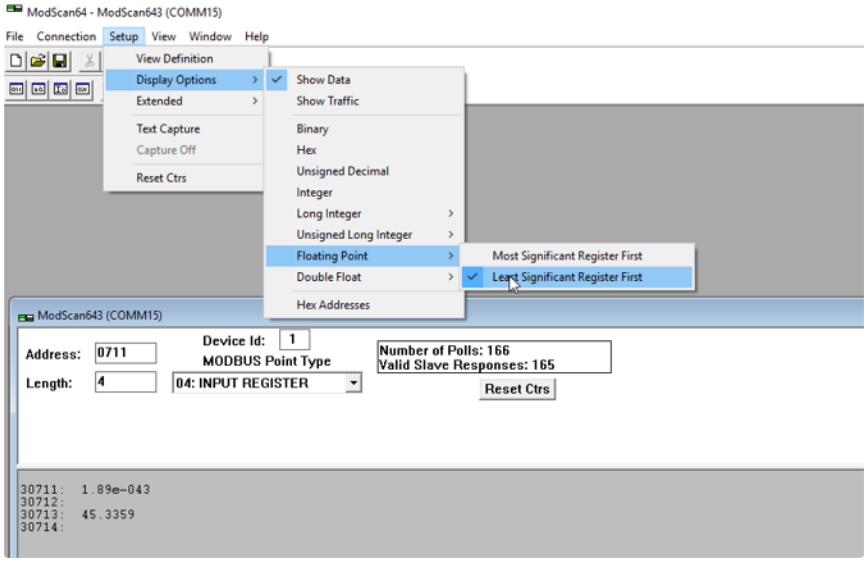
- MWh = 146
- Decimals=3

--> Thus, the real energy value is : 1674,847 MWh

B.1.2 IEEE745 Single Float Values

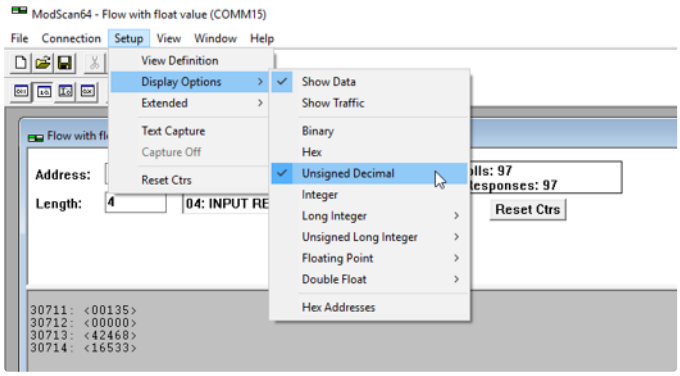
Flow (IEEE745 single float values)				
30711	Flow Unit	16 Bit Integer	R	m3/h=135
30712	Reserved			
30713 - 30714	Flow	IEEE754 Single (h-l)	R	Actual value

The following setting must be set to read the registers IEEE745 Single (h-l).
Example for the Flow:

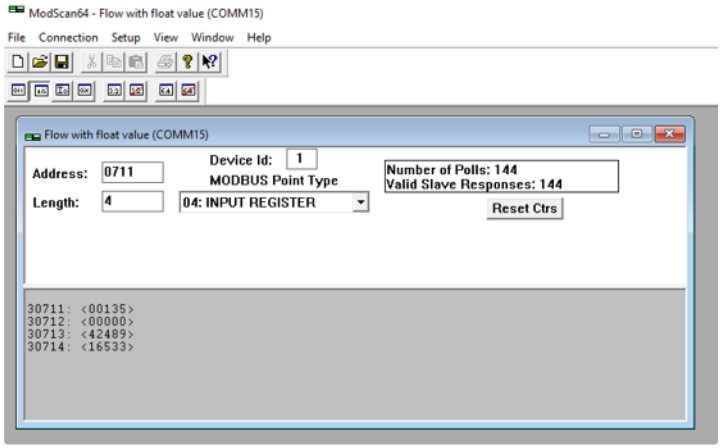


Only value displayed on address 30713 must be taken into consideration.
--> Value of the flow displayed = 45.3359

To see the real value of the line 30711, it's necessary to select the setting "Unsigned Decimal":



And the following result is:



Flow Unit: 30711 = <00135>
The signification of this value 135 is indicated in in this technical document, chapter A.3.3:

Energy data (long data points)				
30201	Energy Unit	16 Bit Integer	R	Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20
30202	Energy Decimals	16 Bit Integer	R	Decimals: 0, 1 2 3
30203 - 30204	Energy totalizer heating	32 bits integer (h-l)	R	Actual value

- MWh = 146
- Decimals=3

--> Thus, the real energy value is : 1674,847 MWh

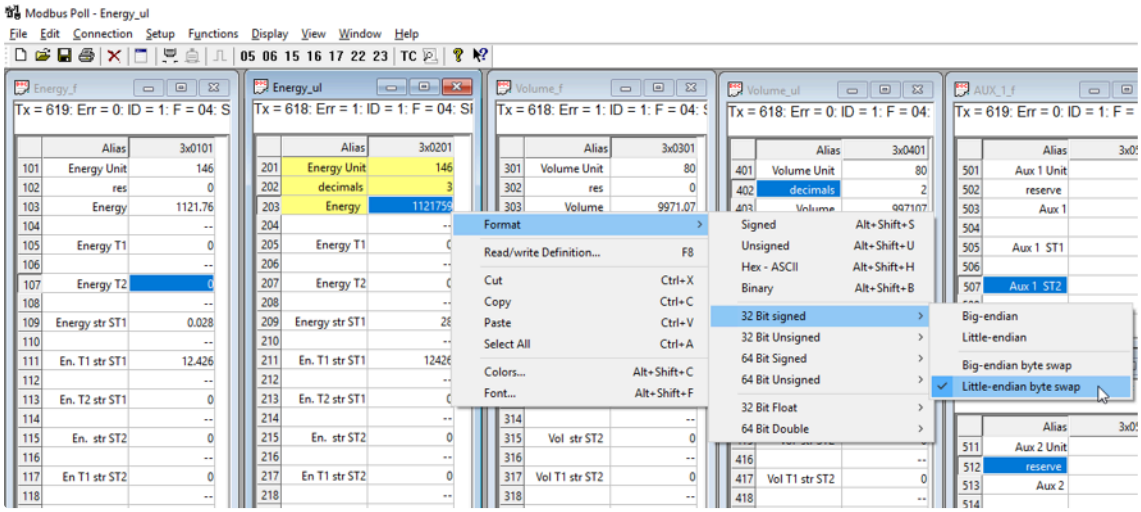
B.2 Example for Energy Coding with Modbus Pool Software

The following tests have been realized with the Modbus Poll – 64 Bit Version 7.2.1 Build 1131 software. The software can be found on the website: http://www.modbustools.com/download.html

B.2.1 Long data points

Energy data (long data points)				
30201	Energy Unit	16 Bit Integer	R	Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20
30202	Energy Decimals	16 Bit Integer	R	Decimals: 0, 1 2 3
30203 - 30204	Energy totalizer heating	32 bits integer (h-l)	R	Actual value

The stored energy value is 1121,759 MWh.
The following setting must be set to read the register 30203-30204 (32 bits integer (h-l)) of the energy value.
The Device ID is the address of the module.



Only value displayed on address 30203 must be taken into consideration.
--> Value displayed = 1121759

To see the real value of the line 30201 and 30202 (16 bit integer), it's necessary to select the setting "Unsigned".
And the following values are:
Energy Unit: 30201 = 146
Energy Decimals: 30202 = 3
The signification of these values 146 and 3 are indicated in this technical document, chapter A.3.3:

Energy data (long data points)				
30201	Energy Unit	16 Bit Integer	R	Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20
30202	Energy Decimals	16 Bit Integer	R	Decimals: 0, 1, 2, 3
30203 - 30204	Energy totalizer heating	32 bits integer (h-l)	R	Actual value

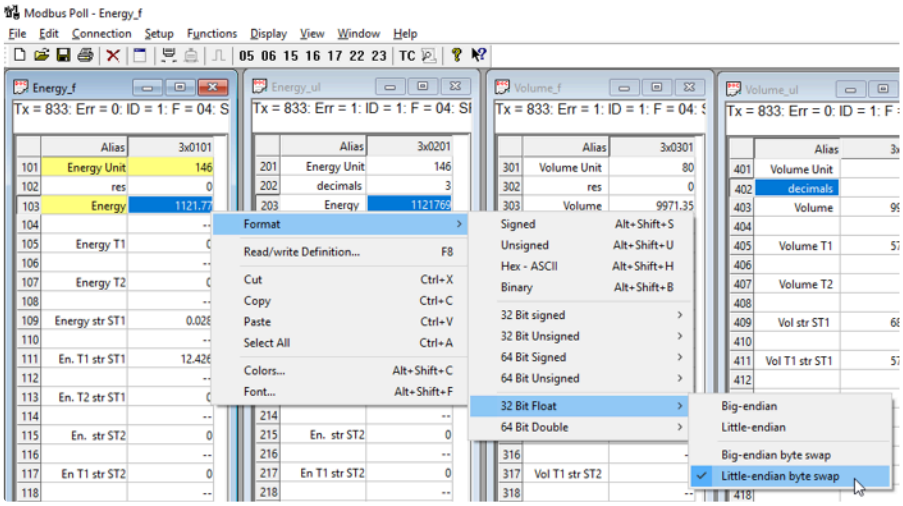
- MWh = 146
- Decimals=3

--> Thus, the real energy value is : 1121,759 MWh

B.2.2 IEEE745 Single Float Values

Energy data (IEEE745 single float values)				
30101	Energy Unit	16 Bit Integer	R	Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20
30102	Reserved			
30103 - 30104	Energy totalizer heating	IEEE754 Single (h-l)	R	Actual value

The following setting must be set to read the registers IEEE745 Single (h-l).
Example for the Energy:



Only value displayed on address 30103 must be taken into consideration.
--> Value of the energy displayed = 1121,77
To see the real value of the line 30101, it's necessary to select the setting "Unsigned":
Energy Unit: 30101 = 146
The signification of this value 146 is indicated in in this technical document, chapter A.3.3:

Energy data (IEEE745 single float values)				
30101	Energy Unit	16 Bit Integer	R	Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20

- MWh = 146

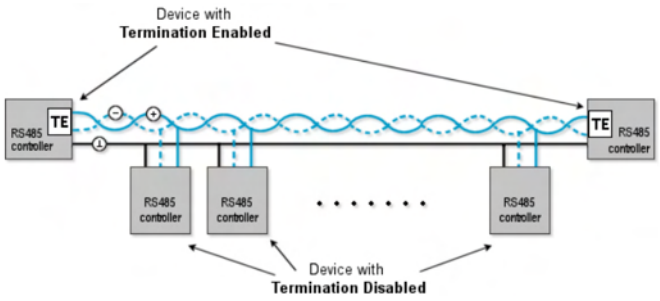
--> Thus, the real energy is: 1121,77 MWh

Annex C

C.1 RS485 Lines

C.2 Termination or Line Terminating

BACnet MS/TP or Modbus EIA-485 networks must be terminated to ensure proper operation. A network should be terminated twice, once at the beginning and once at the end.



Termination helps reduce reflections and noise. The terminating can be done with a 120 ohm resistor across the terminals + and – (BACnet) or D0 and D1 (Modbus) and lines. The BACnet and Modbus modules have the option for enabling termination via a DIP Switch.
If the gateway/router has built in termination and it is enabled by default (since the gateway / router is typically the beginning of the entire BACnet MS/TP or Modbus EIA-485 network, now you only have to go and find/terminate that last device.

C.3 Line Polarization or Bias Resistors

When there is no data activity on an RS-485 balanced pair, the lines are not driven and, thus susceptible to external noise or interference. To insure that its receiver stays in a constant state, when no data signal is present, some devices need to bias the network.
In this case, a polarization of the pair must be implemented at one location for the whole Serial Bus. Generally this point is to choose on the master device or on its Tap. Other devices must not implement any polarization.
The BACnet and Modbus modules have the option for enabling polarization via a DIP Switch.
See Annex F chapter 3.4.6 Line Polarization and chapter 5.7 Setting of the Line Terminating Resistor and the Bias Resistors with the DIP Switch for explanations.

C.4 General Explanation if DIP Switch

A 510 Ω polarization of the pair must be implemented at one location for the whole bus.
By default, BACnet and Modbus module are built with 2x47K polarization resistors (DIP Switch position: OFF – OFF – OFF), there is no termination and no bias resistors activated by default.

These following features are only enabled with the DIP Switch:

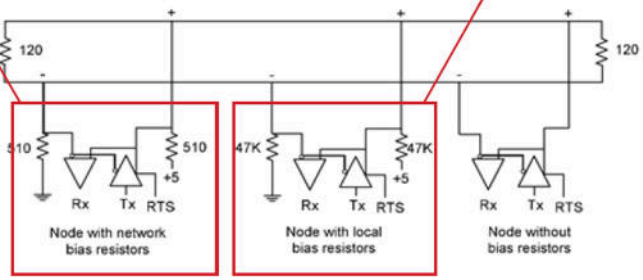
Pos. 1	Pos. 2	Pos. 3	
OFF	OFF	OFF	No Line Terminating resistor LT and no Bias resistor, only a polarisation with 2x 47 kΩ (default)
ON	OFF	OFF	Line Terminating resistor: LT = 120 Ω + 1nF
OFF	ON	ON	Bias resistors (2x510 Ω) without termination (120 Ω)
ON	ON	ON	Bias resistors (2x510 Ω) with LT termination (120 Ω + 1 nF)

OFF OFF OFF



OFF ON ON

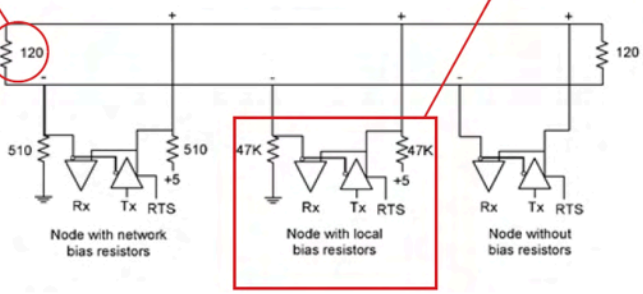




Pos. 1	Pos. 2	Pos. 3	
OFF	OFF	OFF	No Line Terminating resistor LT and no Bias resistor, only a polarisation with 2x 47 kΩ (default)
ON	OFF	OFF	Line Terminating resistor: LT = 120 Ω + 1nF
OFF	ON	ON	Bias resistors (2x510 Ω) without termination (120 Ω)
ON	ON	ON	Bias resistors (2x510 Ω) with LT termination (120 Ω + 1 nF)

ON OFF OFF



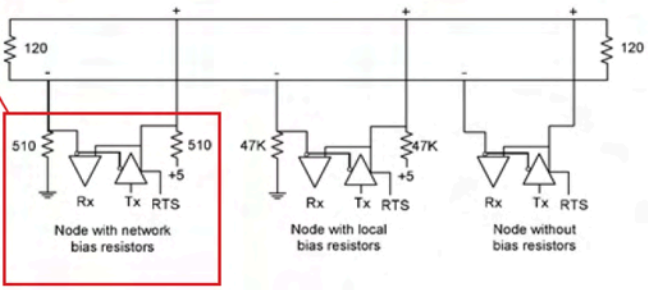


For DIP Switch, the position is defined as follows: Pos.1 Pos. 2 Pos. 3

Pos. 1	Pos. 2	Pos. 3	
OFF	OFF	OFF	No Line Terminating resistor LT and no Bias resistor, only a polarisation with 2x 47 kΩ (default)
ON	OFF	OFF	Line Terminating resistor: LT = 120 Ω + 1nF
OFF	ON	ON	Bias resistors (2x510 Ω) without termination (120 Ω)
ON	ON	ON	Bias resistors (2x510 Ω) with LT termination (120 Ω + 1 nF)

ON ON ON





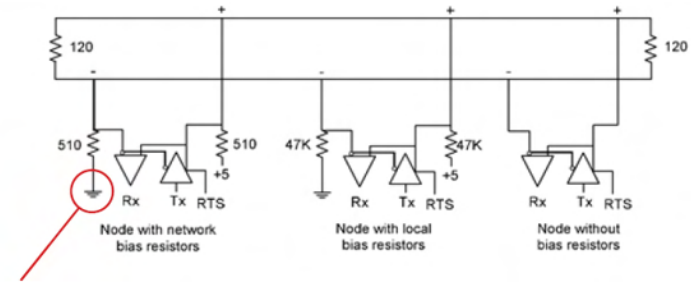
For DIP Switch, the position is defined as follows: Pos.1 Pos. 2 Pos. 3

Summary:

	Modbus	BACnet
Line termination	120 Ω + 1nF	120 Ω only
Bias resistors	2x 510 Ω	2x 510 Ω
Default	2x 47 kΩ, no termination	2x 47 kΩ, no termination

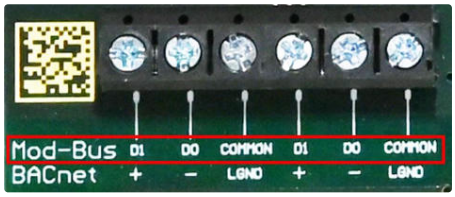
C.5 Cable & Length

A Modbus or BACnet over Serial Line Cable must be shielded.
A figure of 32 devices is always authorized on any EIA-485 system without repeater.
The maximum number of devices authorized on such a Modbus/BACnet Serial Line is reduced by 4 without a 510 Ω polarization!
Characteristic Impedance with a value higher than 100 Ohm may be preferred, especially for 19200 and higher baud rates.
AWG 24 is always sufficient for the EIA-485 data.

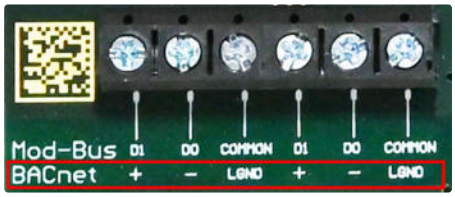


These points are described as “Common” (for Modbus) or “LGND” (for BACnet) on the modules and on the gateway interface.

Modbus:



BACnet:



Remark:

- If a fully isolation is performed from all devices (*Supercal 5* and Gateway) connected on the Bus, only one point of this line must be connected to earth (or)!

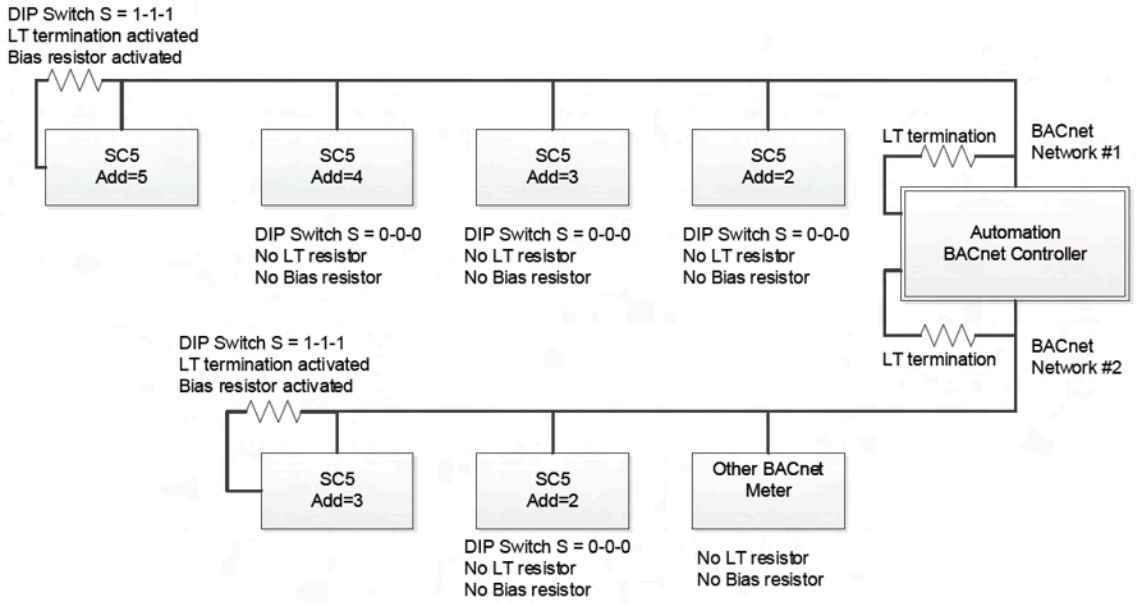
- If a fully isolation is not performed, in case where the gateway/router or another is not isolated, this line must not be connected to earth!!

Please refer to chapter 7.2 and chapter 7.3 for more explanations.

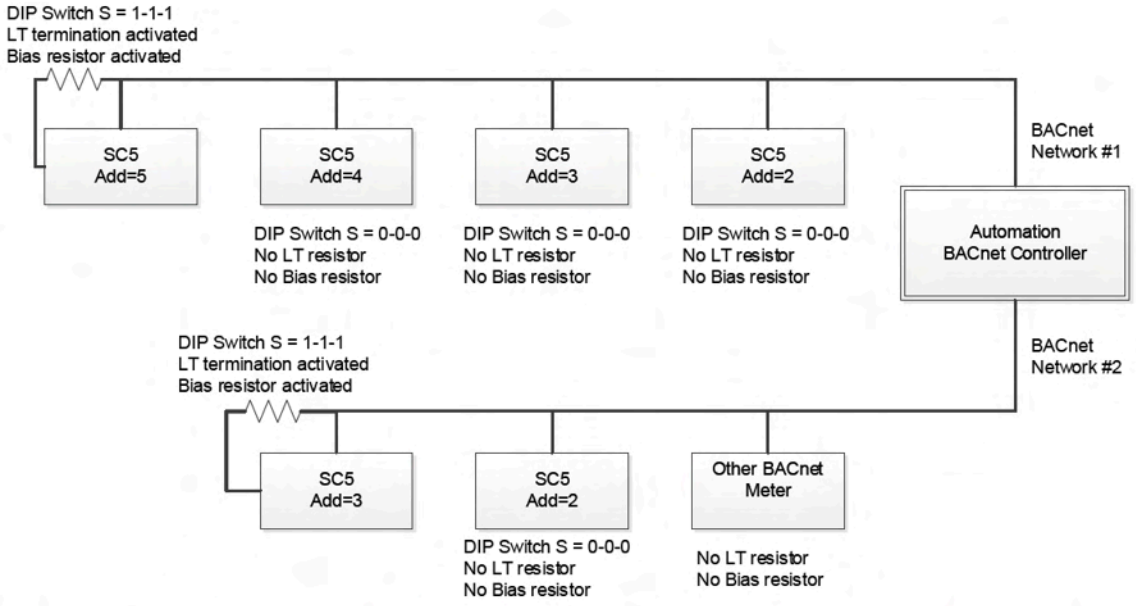
Annex D

D.1 Examples of Modbus EIA-485 Network with Line Terminating and Bias Resistors

D.1.1 Example 1

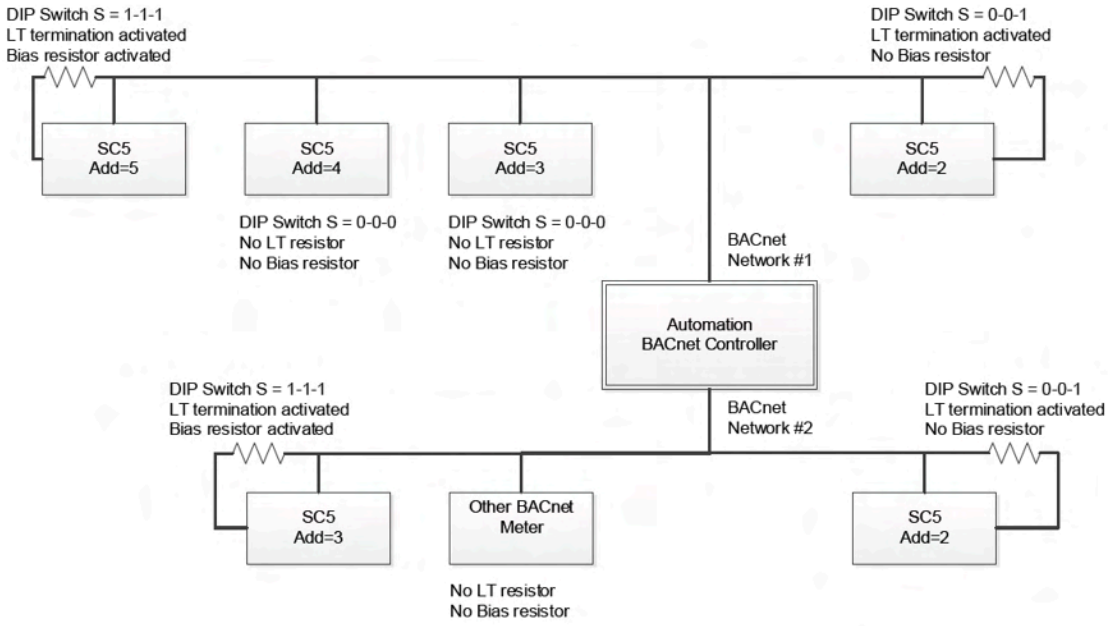


This setting is correct

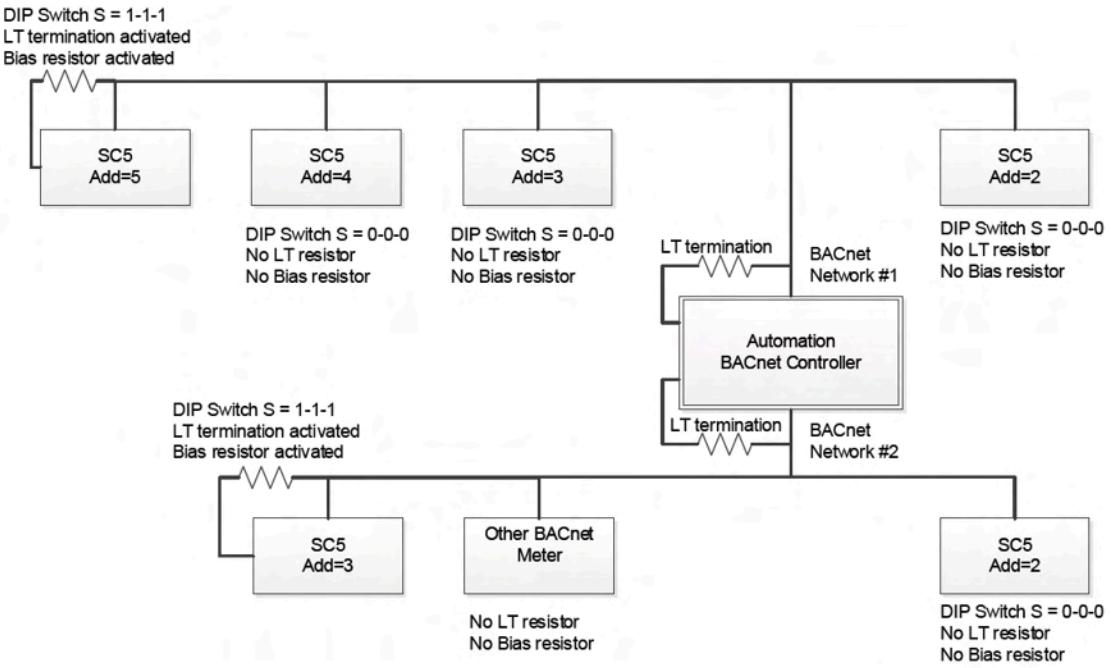


This setting isn't correct. The line termination isn't connected on the Modbus Controller

D.1.2 Example 2



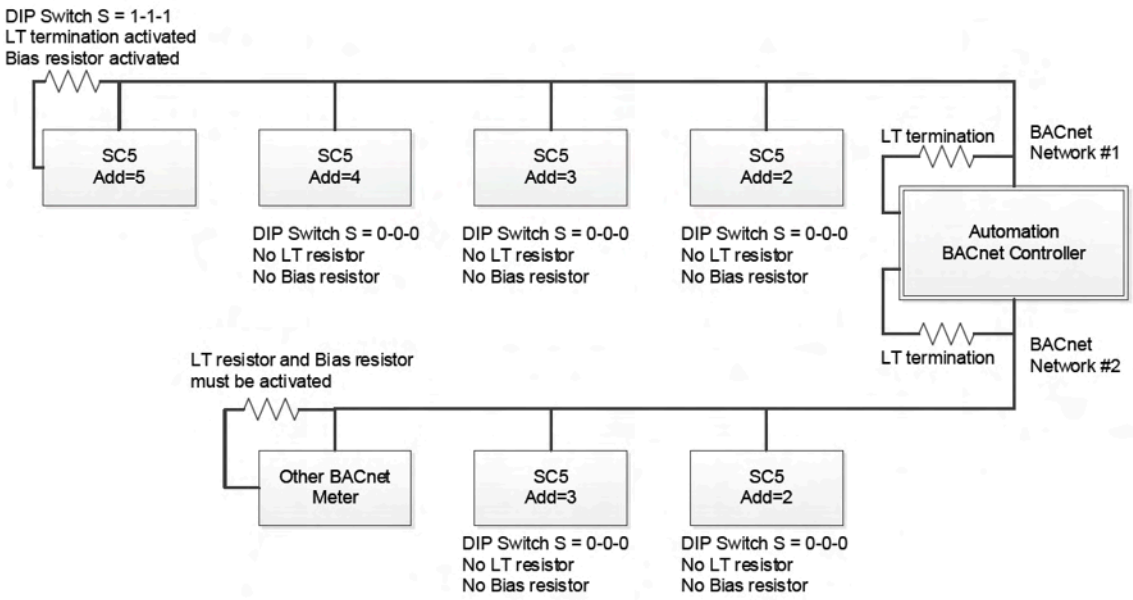
This setting is correct. The LT termination is mounted twice, once at the beginning and once at the end of the EIA-485 network.



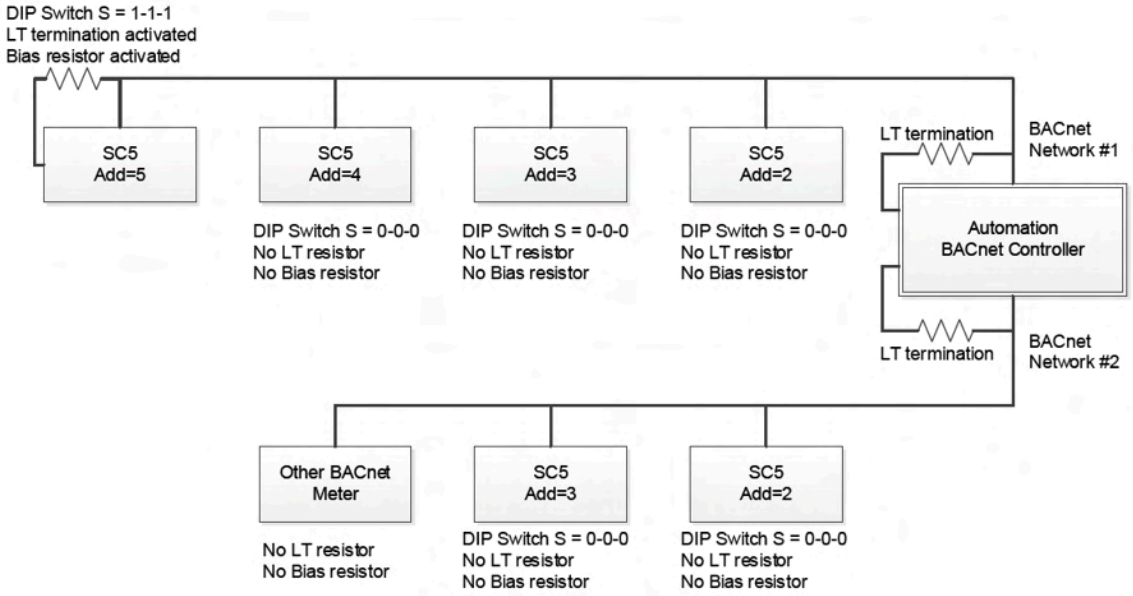
This setting is not correct. The LT termination should be mounted at the end of each side of the EIA-485 network and not directly on the Modbus Controller.

D.1.3 Example 3

Other Modbus Meter connected at the end of the EIA-485 Network



This setting is correct. The LT termination is mounted twice, once at the beginning and once at the end of the EIA-485 network.

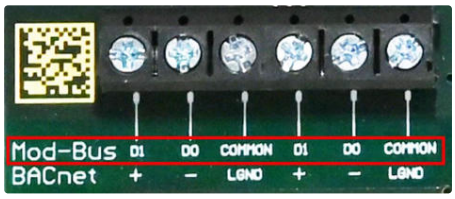


This setting is not correct for the Network #2. The LT termination and the Bias resistors are not mounted on the last Modbus meter.

Annex E

E.1 Voltage control

E.1.1 Voltage control during the Modbus communication



Between terminals :		Measured voltage	Remark
Common	D1	0,2 – 4,8 VDC	Positive value
Common	D0	0,2 – 4,8 VDC	Negative value
Common	Electrical earth or ground	0 ± 0,2 VDC	

Depending on the Modbus communication, the measured voltage can fluctuate between 0,2 VDC and 4,8 VDC (positive and negative value).

E.1.2 Voltage control WITHOUT any Modbus communication

Between terminals :		Measured voltage	Remark
D1	D0	0 VDC	Difference must be higher than 0 VDC

Without any Modbus communication, the measured voltage must be higher than 0 VDC.
If negative it means it has been a wrongly installed, D1 and D0 need to be exchanged.

Annex F

F.1 Modbus Specification

The following explanations are available on the website http://Modbus.org

Technical document:

- Modbus_over_serial_line_V1.02.pdf http://www.modbus.org/docs/Modbus_over_serial_line_V1_02.pdf

1.3 Conventions

In this document, the following words are used to define the significance of each particular **requirement**.

- **"MUST" / "REQUIRED"**

All requirements containing the word **"MUST"** are mandatory. The word **MUST**, or the adjective **"REQUIRED"**, means that the item is an absolute requirement of the implementation. These words are underlined.

- **"SHOULD" / "RECOMMENDED"**

All recommendations containing the word **"SHOULD"**, or the adjective "**RECOMMENDED**", are considered desired behavior. These recommendations should be used as a guideline when choosing between different options to implement functionality. There may be valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course. These words are underlined.

- **"MAY" / "OPTIONAL"**

The word "**MAY**", or the adjective **"OPTIONAL"**, means that this item is truly optional. One designer may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another designer may omit the same item.

1.5 Glossary

Definition of particular words, symbols, and abbreviations used in this document.

2W	The Two-Wire configuration defined in the "Electrical Interface" chapter, or one of its interfaces.
4W	The Four-Wire configuration defined in the "Electrical Interface" chapter, or one of its interfaces.
AUI	Attachment Unit Interface
AWG	American Wire Gauge, a standard method denoting wire diameter; please see Appendix E - References.
Common	The Signal Common in EIA/TIA Standards. In a 2W-or 4W-RS485 MODBUS Network, Signal and optional Power Supply Common
DCE	a MODBUS Device, for example a programmable controller adapter, which implements an RS232 Data Circuit-terminating Equipment, also named Data Communication Equipment.
Device	or "MODBUS device" : see this definition.
Driver	Generator, or Transmitter.
DTE	a MODBUS Device, for example a programming panel or a PC, which implements an RS232 Data Terminal Equipment.
ITr	Physical bus Interface on Trunk side.
IDv	Physical bus Interface on Derivation (or tap or device drop) side.
LT	Line Termination.
MODBUS Device	a Device that implements MODBUS over Serial Line and respects this Technical Note.
RS232	EIA/ TIA -232 Standard.
RS485	EIA/ TIA -485 Standard.
RS485-MODBUS	A 2W-or 4W-Network in accordance with this Technical Note.
Transceiver	a **Trans**mitter and a **Receiver** (or Driver and Receiver).

2.4.3 Master / Slave communication time diagram

This following figure shows the time diagram of 3 typical scenarios of Master / Slave communications.

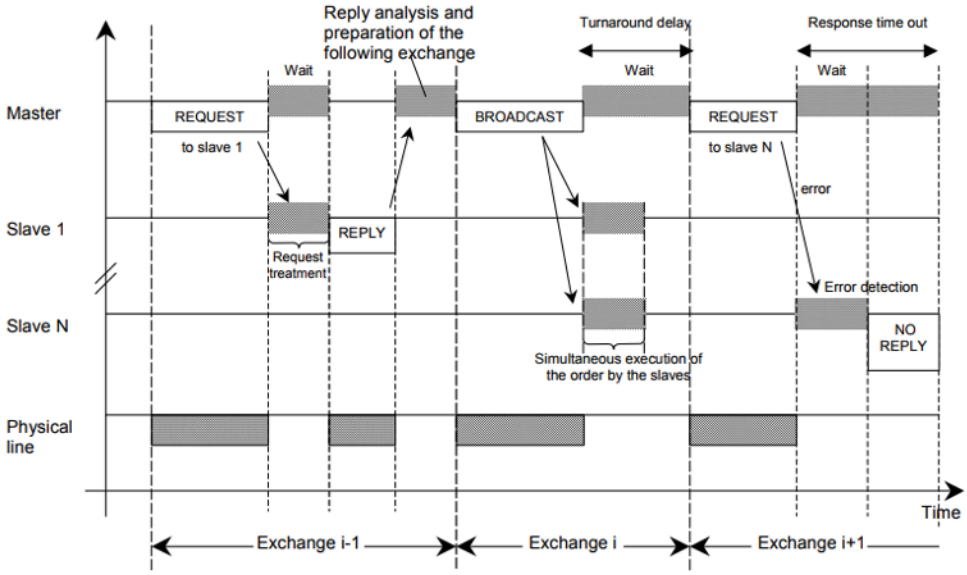


Figure 9: Master / Slave scenario time diagram

Remarks :

- the duration of the REQUEST, REPLY, BROACAST phases depends on the communication features (frame length and throughput).
- the duration of the WAIT and TREATMENT phases depends on the request processing time needed for the slave application.

2.5 The two serial Transmission Modes

Two different serial transmission modes are defined : The RTU mode and the ASCII mode.

It defines the bit contents of message fields transmitted serially on the line. It determines how information is packed into the message fields and decoded.

The transmission mode (and serial port parameters) must be the same for all devices on a MODBUS Serial Line.

Although the ASCII mode is required in some specific applications, interoperability between MODBUS devices can be reached only if each device has the same transmission mode : **All devices must implement the RTU Mode.** The ASCII transmission mode is an option.

Devices should be set up by the users to the desired transmission mode, RTU or ASCII. Default setup must be the RTU mode.

3.2 Data Signaling Rates

9600 bps and 19.2 Kbps are required and 19.2 is the required default

Other baud rates may optionally be implemented : 1200, 2400, 4800, … 38400 bps, 56 Kbps, 115 Kbps, …

Every implemented baud rate must be respected better than 1% in transmission situation, and must accept an error of 2% in reception situation.

3.3.2 Two-Wire MODBUS Definition

A MODBUS solution over serial line should implement a "Two-Wire" electrical interface in accordance with EIA/TIA-485 standard.

On such a 2W-bus, at any time one driver only has the right for transmitting.

In fact a third conductor must also interconnect all the devices of the bus : the common.

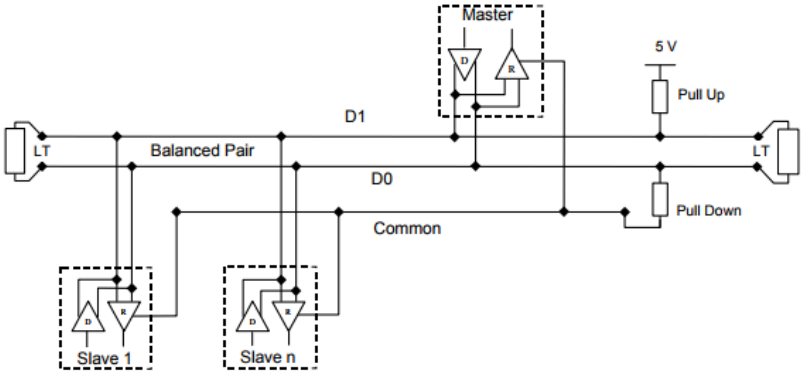


Figure 20: General 2-Wire Topology

2W-MODBUS Circuits Definition

Required Circuits		For device	Required on device	EIA/TIA-485 name	Description
on ITr	on IDv				
D1	D1	I/O	**X**	B/B'	**Transceiver terminal 1, V1 Voltage** (V1 > V0 for binary 1 [OFF] state)
D0	D0	I/O	**X**	A/A'	**Transceiver terminal 0, V0 Voltage** (V0 > V1 for binary 0 [ON] state)
Common	Common	--	**X**	C/C'	Signal and optional Power Supply Common

Notes :

- For Line Termination (LT), Pull Up and Pull Down resistors, please refer to section "Multipoint System requirements".
- D0, D1, and Common circuit names must be used in the documentation related to the device and the Tap (User Guide, Cabling Guide, …) to facilitate interoperability.
- Optional electrical interfaces may be added, for example :
  - **Power Supply :** 5..24 V D.C.
  - **Port mode control :** PMC circuit (TTL compatible). When needed, port mode may be controlled either by this external circuit and/or by another way (a switch on the device for example). In the first case while an open circuit PMC will ask for the 2W-MODBUS mode, a Low level on PMC will switch the port into 4W-MODBUS or RS232-MODBUS Mode, depending on the implementation.

3.4 Multipoint System requirements

For any EIA/ TIA-485 multipoint system, in either 2-wire or 4-wire configuration, the following requirements all apply.

3.4.1 Maximum number of devices without repeater

A figure of **32 devices** is always authorized on any RS485-MODBUS system without repeater.

Depending of :

- all the possible addresses,
- the figure of RS485 Unit Load used by the devices,
- and the line polarization in need be,

A RS485 system may implement a larger number of devices. Some devices allow the implementation of a RS485-MODBUS serial line with more than 32 devices, without repeater.

In this case these MODBUS devices must be documented to say how many of such devices are authorized without repeater.

The use of a **repeater** between two heavy loaded RS485-MODBUS is also possible.

3.4.2 Topology

An RS485-MODBUS configuration without repeater has one trunk cable, along which devices are connected, directly (daisy chaining) or by short derivation cables.

The trunk cable, also named "Bus", can be long (see hereafter). Its two ends must be connected on Line Terminations.

The use of repeaters between several RS485-MODBUS is also possible.

3.4.3 Length

The end to end length of the **trunk cable** must be limited. The maximum length depends on the baud rate, the cable (Gauge, Capacitance or Characteristic Impedance), the number of loads on the daisy chain, and the network configuration *(2-wire or 4-wire)*.

For a maximum 9600 Baud Rate and AWG26 (or wider) gauge, the maximum length is 1000m. In the specific case shown in the figure 22 (4 Wire cabling used as a 2 Wire cabling system) the maximum length must be divided by two.

The **derivations** must be short, never more than 20m. If a multi-port tap is used with n derivations, each one must respect a maximum length of 40m divided by n.

3.4.4 Grounding Arrangements

The « Common » circuit (Signal and optional Power Supply Common) must be connected directly to protective ground, preferably at **one point only** for the entire bus. Generally this point is to choose on the master device or on its Tap.

3.4.5 Line Termination

A reflection in a transmission line is the result of an impedance discontinuity that a travelling wave sees as it propagates down the line. To minimize the reflections from the end of the RS485-cable it is required to place a Line Termination **near each of the 2 Ends** of the Bus.

It is important that the line be terminated at **both** ends since the propagation is bi-directional, but it is not allowed to place more than 2 LT on one passive D0-D1 balanced pair . Never place any LT on a derivation cable.

Each line termination must be connected between the two conductors of the balanced line : D0 and D1.

Line termination may be a 150 ohms value (0.5 W) resistor.

A serial capacitor (1 nF, 10 V minimum) with a 120 Ohms (0.25 W) resistor is a better choice when a polarization of the pair must be implemented (see here after).

In a 4W-system, each pair must be terminated at each end of the bus.

In an RS232 interconnections, no termination should be wired.

3.4.6 Line Polarization

When there is no data activity on an RS-485 balanced pair, the lines are not driven and, thus susceptible to external noise or interference. To insure that its receiver stays in a constant state, when no data signal is present, some devices need to bias the network.

Each MODBUS device must be documented to say :

- if the device needs a line polarization,
- if the device implements, or can implement, such a line polarization.

If one or several devices need polarization, **one** pair of resistors must be connected on the RS-485 balanced pair :

- a Pull-Up Resistor to a 5V Voltage on D1 circuit,
- a Pull-Down Resistor to the common circuit on D0 circuit.

The value of those resistors must be between 450 Ohms and 650 Ohms. 650 Ohms resistors value may allow a higher number of devices on the serial line bus.

In this case, a polarization of the pair must be implemented **at one location for the whole Serial Bus**. Generally this point is to choose on the master device or on its Tap. Other devices must not implement any polarization.

The maximum number of devices authorized on such a MODBUS Serial Line is reduced by 4 from a MODBUS without polarization.

3.6 Cables

A MODBUS over Serial Line Cable **must be shielded**. At one end of each cable its shield must be connected to protective ground. If a connector is used at this end, the shell of the connector is connected to the shield of the cable.

An RS485-MODBUS must use **a balanced pair** (for D0-D1) **and a third wire** (for the Common). In addition to that a second balanced pair must be used in a 4W-MODBUS system (for RXD0-RXD1).

If a connectorized 4 pairs Category 5 Cable is used, please remember to the user in the User Guides :

"Connection of a crossed cable in a 2-wire MODBUS system may cause damages".

To minimize errors in cabling, a Color Code is recommended for the wires in the RS485-MODBUS Cables :

	Signal Names	Recommended Color
	D1-*TXD1*	**yellow**
	D0-*TXD0*	**brown**
	Common	**grey**
4W (Optional)	*RXD0*	*white*
4W (Optional)	*RXD1*	*blue*

Figure 28: Color code for RS485-MODBUS wires

Note : Category 5 Cables use other colors.

For RS485-MODBUS, Wire Gauge must be chosen sufficiently wide to permit the maximum length (1000 m). AWG 24 is always sufficient for the MODBUS Data.

Category 5 cables may operate for RS485-MODBUS, to a maximum length of 600m.

For the balanced pairs used in an RS485-system, a **Characteristic Impedance** with a value higher than 100 Ohms may be preferred, especially for 19200 and higher baud rates.

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