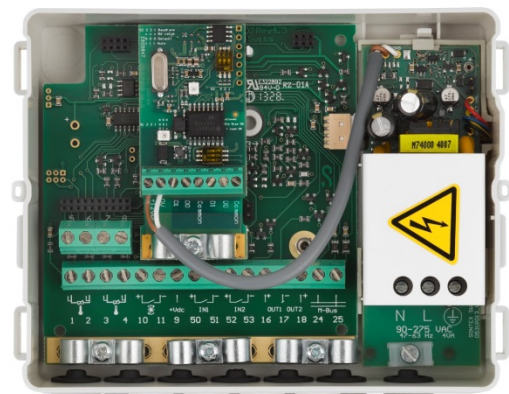
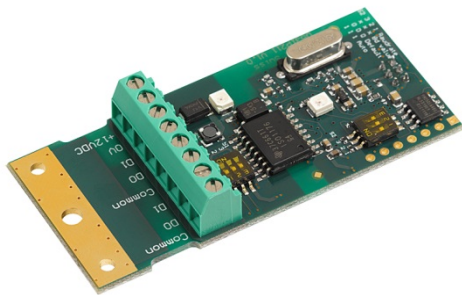


Module

Modbus EIA-485

For Supercal 531 and Superstatic 440/449

Instructions for Use



- Read this instructions carefully before using the module
- Please read the section "Safety Information" (page 8) to ensure proper use of the module
- After reading this manual, keep it in an easily accessible place for future reference

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V02	August 2018	SV	Modified DIP Switch S1 value in Example 2, Annex D
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1. Notes on this Document

This manual provides all the information needed to use the device correctly: From product identification, installation and commissioning to troubleshooting, maintenance and disposal.

1.1 Scope of Validity

This instrument documentation is valid for the module Modbus 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 Documents

The system operator must ensure that this instruction for use is accessible to the responsible persons at all times if required. If you lose the original document, you can download a current version of this device documentation from our website at any time.

1.4 Further Information

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

1.5 Symbols

Symbol	Description
	DANGER! Warning notice which, if ignored, will lead directly to death or serious injury.
	WARNING! Warning notice which, if ignored, may result in death or serious injury
	CAUTION! Warning notice which, if ignored, may result in minor or moderate injury
	NOTICE! Warning notice, non-observance of which can lead to property damage
	Advice Information that is important for a particular topic or objective but not relevant to security
	Disposal This symbol indicates that electrical and electronic equipment must be disposed of separately. Do not dispose of the calculator with household waste.

2. Safety Information

Safe and safe operation of the device is only ensured if the operating instructions have been read and the safety instructions have been observed.

Further information and data are available in the catalogues and data sheets of the product, via the local agency and on the Sontex homepage at www.sontex.ch.

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

2.1 Personnel Qualification

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

- Trained personnel: Has qualifications that correspond to this function and activity
- Authorized by the plant operator
- Knowledge of the relevant standards and directives as well as of 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 dealing with 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 according to the task requirements
- Follow the instructions in this instruction for use

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 the device:

- Wear necessary personal protective equipment according to national regulations.

2.3.2 Operational Safety

Risk of injury!

- Only operate the device in a technically faultless and reliable 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 unforeseeable dangers:
- If conversions are still necessary: Consult your local representative or Sontex SA.

Repair

- In order to continue to guarantee operational safety:
- Only if the repair is expressly permitted to be carried out on the device.
- Observe national regulations regarding the repair of an electrical device.
- Use only original Sontex spare parts and accessories.

Environmental demands

If a plastic transmitter housing is permanently exposed to certain vapour-air mixtures, the housing may be damaged.

- If you have any questions, please contact your Sontex sales office.
- For use in areas relevant to approval: Observe 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. General Remarks

3.1 Introduction



Additional information on Superstatic 440/449, Supercal 531, and Prog531/449 can be found in the instructions for use of those devices.

The documents can be found on our extranet at: <https://extranet.sontex.ch/index/>.

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 531 integrator as standalone product or in combination with the Superstatic 440 or Superstatic 449 energy meter.

The Modbus module communicates as a RTU or ASCII 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.

3.2 Delivery of the Module

Before installing the Modbus EIA-485 module check the items delivered.

Included in the delivery are:

- The Modbus EIA-485 module
- A fixing clamp for strain relief
- This installation instruction.

3.3 The Registers List

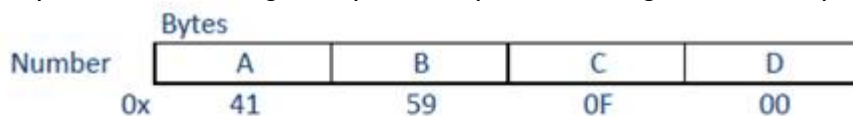
The registers list is available at the end of this document, see chapter **10 Annex A**.

These registers allow to access (or to read) to the values supported by the Supercal 531, Superstatic 440 and the Superstatic 449.

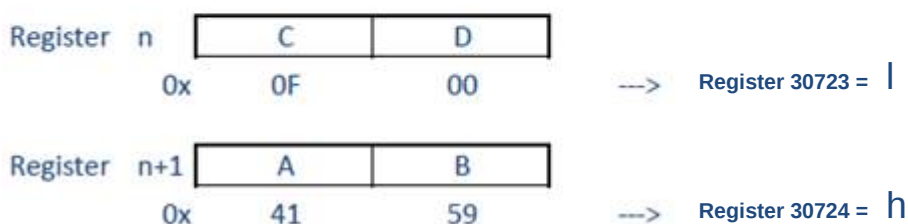
3.3.1 Word Swapping

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 values stored in the registers 30723-30724 are:



The converted value of the high temperature is 13,566162 [°C].

4. 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 *Prog531* and *Prog449* configuration software supplied by Sontex.

4.1.1 Default Settings

When the Modbus module is delivered, the default setting of the module is:

- RTU mode using 8 bit data, even parity, 1 stop bit, 19'200 bit/s.
- The default address programmed is 1.

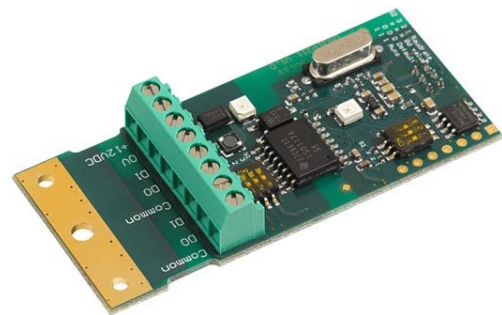
4.2 Modbus Connection

The optional Modbus module comprises:

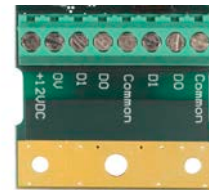
- +12 / 0 VDC input for the supply of the module
- 2x3 screw terminals (D1/D0/Common terminals for the RS-485 twisted pair connection).

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.



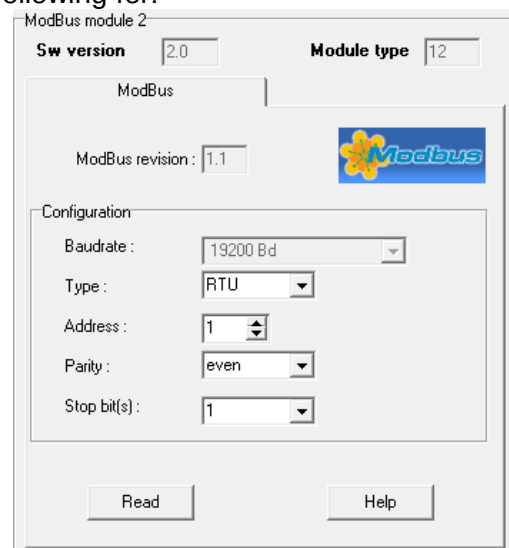
The name of the third terminal is called “**Common**” for the Modbus module and “**LGND**” for the BACnet module. The properties and functionalities are exactly the same, only the name is different.

4.3 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 DIP switch S2 (see chapter **4.8.1**). 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:
 - 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:
 - 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.



4.4 Installing the Modbus Module

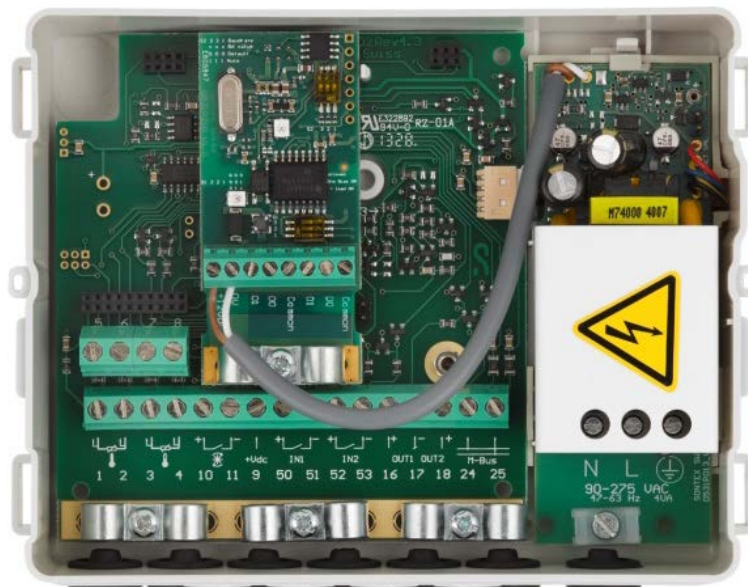
⚠ DANGER	Danger to life from electrical voltage! If the equipment has not previously been isolated from the mains supply, live components may be exposed when the cover is opened. If module replacement whilst the equipment is open and live is unavoidable, then this should only be undertaken by specialist 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 integrator or the Modbus module, you are advised to touch a grounded conductor (for example a water pipe or hot water pipe) to discharge electricity.

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

The following procedure must be respected:

- Disconnect the power supply of the integrator.
- Separate the cover (MET) from the housing (MIO).
- Place the Modbus module in one of the module slots of the integrator.
- Connect the mains power cable (external or internal) (12 VDC / 0 VDC) and the Modbus EIA-485 network (D0, D1 and Common, the latter if available) with the Modbus module.
- Close the integrator carefully.
- Reconnect the power supply cable.

The integrator Supercal 531 will automatically detect and recognize the new module. No other action is required. The Supercal 531 / Superstatic 440 / Superstatic 449 are now ready to communicate via the Modbus module.

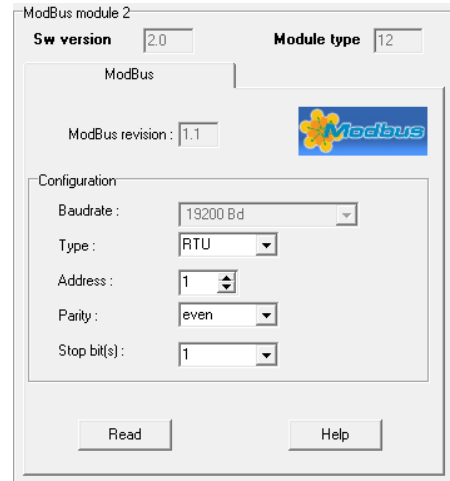


The default setting is: RTU mode using 8 bit data, even parity, 1 stop bit, 19'200 Bds, Address = 1

4.5 Detection of the Modbus Module with the Prog531 and Prog449 Software

The software Prog531 and Prog449 allows to detect the Modbus module and to see its configuration:

- The firmware release of the Modbus module.
- The Module type (12 corresponds to the Mobus).
- The SW version.
- Modbus revision.
- The Baudrate.
- The serial transmission mode (RTU or ASCII).
- The Modbus Address.
- The Parity.
- Stop bit number.



The software Prog531 and Prog449 allows to change the following parameters, though this approach is not recommended:

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

Other parameters can be set with the DIP switches S1 and S2:

- The communication speed.
- The bias resistors and the terminating resistor.

NOTICE

The Modbus module is compatible with Supercal / Superstatic integrators with firmware release FW 3.7 or higher (FW ≥ V3.7).

4.5.1 Changing the Communication Parameters by Prog531/449 Software

In case you have programmed new communication parameters with the optical probe via the Prog531/449 software, **it's obligatory to restart the Modbus module.**

As long as the module has not been restarted, the module always communicates (by Modbus protocol) with the previous or old settings.

The operations to restart the Modbus module consist to:

1. After programming the new communication parameters with the optical probe via the software *Prog531*, it's necessary to wait a refreshment period before doing the power down. The refreshment period can last up to **15 seconds**. During this period, the module keeps on communicating (by Modbus protocol) with the old settings.

As long as the power down was not realized, the communication parameters displayed by the Prog531/449 software will be the new communication parameters but the module is still communicates with the old setting.

2. After the refreshment period, power down the SC531. By either removing the main power cable or open/separate the upper part from the lower part of the integrator.

Before to reconnect the power cable or close the upper part with the lower part, it's necessary to wait a period of at least **10 seconds**.

During this period, the Modbus module will not communicate and not answer to the Modbus commands.

3. After the 10 seconds, reconnect the main power cable or close the integrator.

The new communication parameters will be activated only after a boot time. During the restart time, the Modbus module will not communicate. The boot time varies between **30 and 60 seconds**.

Only then the Modbus module will be detected on the Modbus network with the new setting.

4.6 Procedure to Use When Changing Parameters by Modbus Command

4.6.1 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

4.6.2 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.

A power down sequence must be avoided during **90-120 seconds** after sending the initial Modbus command with the new communication parameters.

Please note that **after the first 30 to 60 seconds** the Modbus module will already apply the new communication parameters while in the Prog531/449 the new parameters will not yet be visible. You will still see the old ones. Hence you absolutely need to wait for an additional 30 to 60 seconds until the new parameters will also be visible in the Prog531/449.

If a Power Down occurs during the **second period of 30-60 seconds**, at the next restart the Modbus module will communicate with the old communication parameters instead the new communication parameters (Write Back sequence).

As soon as the communication parameters are displayed correctly in the Prog531/449 software, the complete sequence of parametrization is over. There is no further risk of a write back at the next power down sequence.

4.7 Setting of the Line Terminating Resistor and the Bias Resistors with the DIP Switch S1

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 S1 is S1: [0 0 0], this indicates that there is a light polarisation induced by 2 47 k Ω resistors.

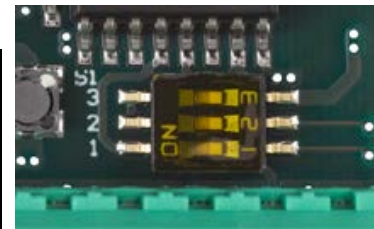
If the Modbus module is at the end of the bus line, it is necessary to terminate the line, by adding a terminating resistor 120 Ω . This can be done either by means of the DIP switch S1 on the module itself or by adding an external resistor between D0 and D1 to close the line.

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.

4.7.1 Settings with DIP Switch S1:

Pos. 1	Pos. 2	Pos. 3	
0	0	0	No Line Terminating resistor LT and no Bias resistor, only a light polarisation with 2x 47 k Ω (default)
0	0	1	Line Terminating resistor: LT = 120 Ω + 1nF
1	1	0	Bias resistors (2x510 Ω) without termination (120 Ω)
1	1	1	Bias resistors (2x510 Ω) with LT termination (120 Ω + 1 nF)

0 = OFF; 1 = ON



For correct handling of RS-485 lines please refer to **12 Annex C**.

	For DIP Switch S1, the position is defined as follows: Pos.1 Pos. 2 Pos. 3
---	--

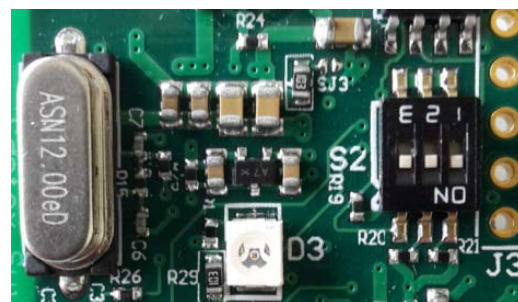
4.8 Setting the Communication Speed with the DIP Switch S2

The DIP switch S2 sets the communication speed. At delivery the default position is set to [1 1 1], meaning a communication speed of 19200 bit/s.

4.8.1 Settings with DIP Switch S2:

Pos. 3	Pos. 2	Pos. 1	
0	0	0	1200 bit/s
0	0	1	2400 bit/s
0	1	0	9600 bit/s
0	1	1	38400 bit/s
1	0	0	57600 bit/s
1	0	1	115200 bit/s
1	1	0	Modbus OFF
1	1	1	19200 bit/s (default)

0 = OFF; 1 = ON



	For DIP Switch S2, the position is defined as follows: Pos.3 Pos. 2 Pos. 1
---	--

4.9 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**.

The address **0** is used for broadcast.

At delivery by default the Modbus module address is 1 and the transmission mode is RTU.

5. Technical Data Modbus EIA-485 Module

General

Operating temperature	5° to 55°C
Storage temperature	-10° to 55°C (dry environment)

Dimensions

Dimensions	66 x 30 mm
Mounting	in one of the module slots of the Supercal 531/449 integrator

Power supply

please refer to the chapter **6 Power Supply for Modbus Modules**

Internal power supply:	Mains switching power supply of 531 / 449 integrator 0531A030, 230 VAC with 2 outputs 0690A013, 24 VAC with 2 outputs
External power supply:	12 VDC / 150 mA

Network transmission and technical details

Bus communication	RS-485 shielded twisted pair
RS-485 connection	Plug-screw terminal for D0, D1 and Common (2x3-pin) + 12 VDC / 0 VDC
Bus termination	Through DIP switch S1 or with an external resistor
Parity	Even, odd or none
Communication speed:	1200, 2400 9600, 19200, 38400, 57600 or 115200 bits/s

Firmware compatibility

Supercal 531 / Superstatic 449 firmware release FW 3.7 or higher (FW ≥ V3.7)

5.1 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.

5.2 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 standards 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 531 integrator 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 connection terminals are designed for the connection of wires with a cross-section of between 0.75 mm² and 1.5 mm².

6. 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 integrator 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 the communication modules Modbus there are two possibilities to provide the proper power supply.

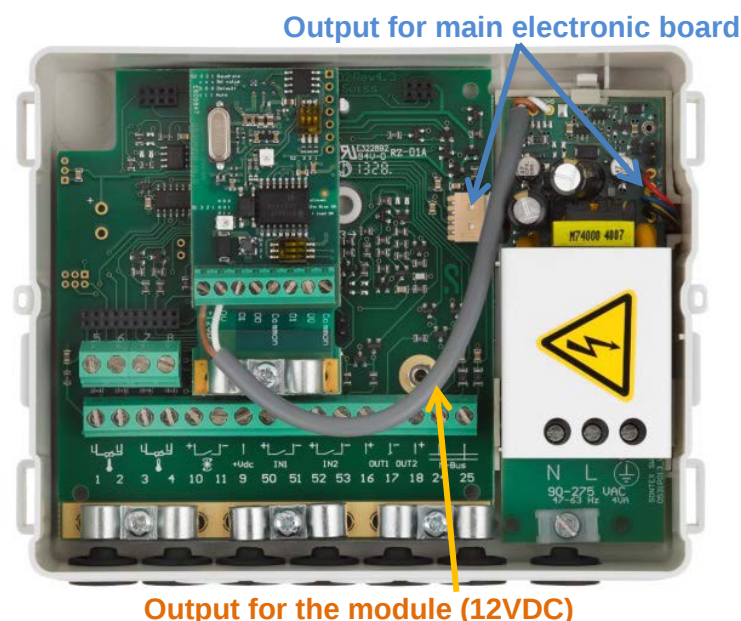
6.1 Mains Switching Power Supply with 2 Outputs

Two types of mains switching power supply with 2 outputs are available for the integrator Supercal 531/449:

- Power Supply Module for 230 VAC. Article Number: 0531A030
- Power Supply Module for 24 VAC. Article Number: 0690A013

6.1.1 Either 0531A030, 230 VAC or 0690A013, 24 VAC with 2 Outputs

- 1 output is for the main electronic board, flat plastic connector with 4 wires: red-yellow-blue-black. Voltage 3.6VDC
- 1 output is for the Modbus module, grey cable with 2 wires: brown-white. Voltage 12 VDC



6.2 24 VAC or 230VAC Power Supply with 1 Output

Two models of mains power supply are available for the integrator Supercal 531:

- Power Supply Module for 230 VAC. Article Number: 0531A027
- Power Supply Module for 24 VAC. Article Number: 0531A026

➔ Those two models of power supply are **completely electrically isolated**.

Those two models of power supply can be used for any communication module of the integrator Supercal 531/449.

If a Modbus module is used with one of these power supplies (0531A026 or 0531A027), it's necessary to use **an additional external power supply of 12VDC / 150 mA**, provided by the customer.

7. Power Supply Precautions



WARNING

Modbus devices powered from a common AC source could be damaged if a mix of half-wave and full-wave rectified devices exist.

According the type of power supply used by the Supercal 531 and the electronical specifications used by others slaves / gateway connected on the Modbus network, some guidelines must be respected:

- The mains power supply **0690A013, 24 VAC with 2 outputs** is built with a full-wave rectifier. Sharing AC power with half-wave rectified Modbus devices / gateway is not supported.
- The mains power supply **0531A030, 230 VAC with 2 outputs** is built with a full-wave rectifier and is completely electrically isolated. This power module can be used with either half-wave or full-wave rectified Modbus devices (slaves and gateway). Don't mix half and full-wave rectified devices in the same installation!
- With the *external +12VDC power supply*, it's necessary to use a completely isolated power supply.

Summarising:

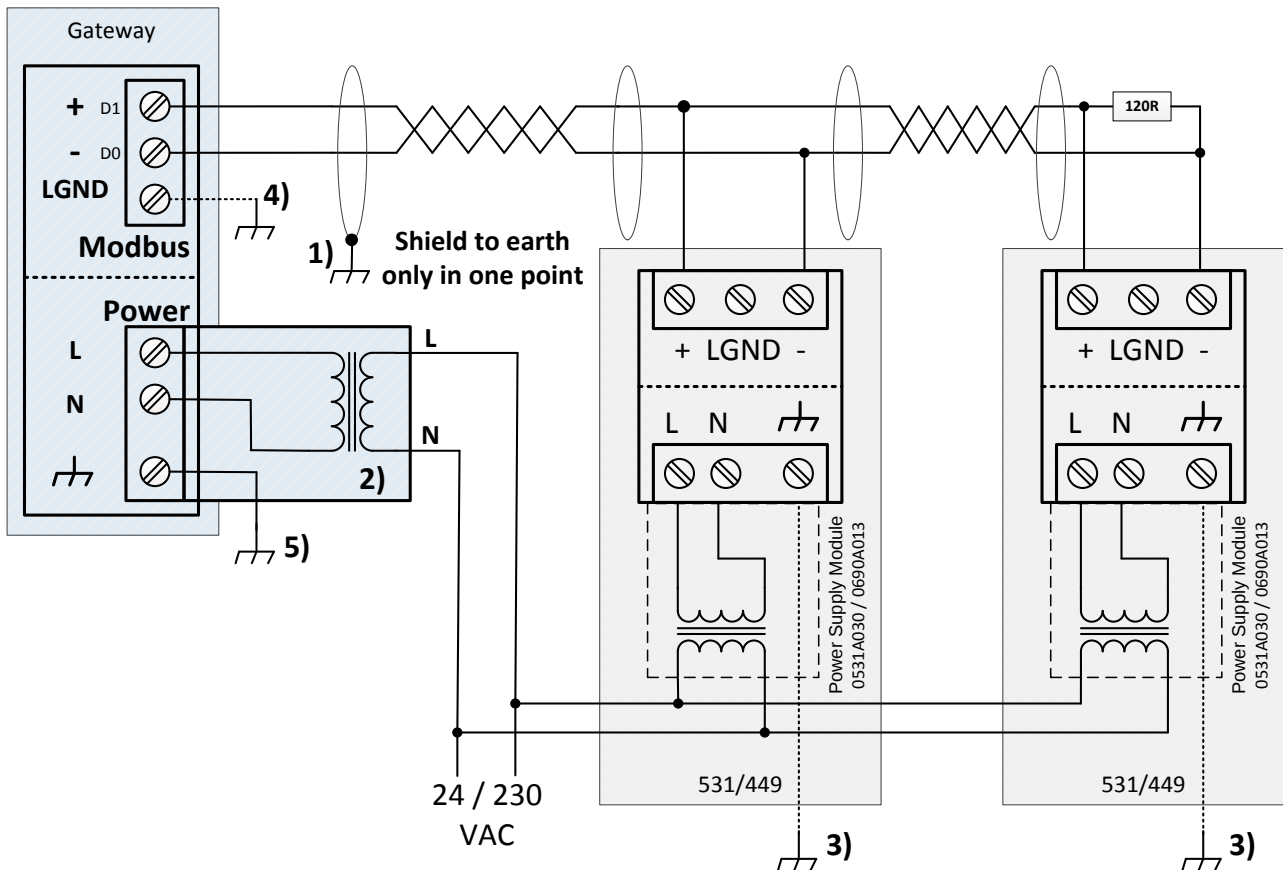
The mains power supply 230 VAC with 2 outputs, 0531A030, can be used with both kind of devices having either half-wave or full-wave rectified power supply.

The mains power supply 24 VAC with 2 outputs, 0690A013, can be used with devices having only a full-wave rectified power supply.

7.1 Two-Wires Bus Connections

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

7.1.1 Two-Wires Bus with a Gateway with a Galvanic Isolation



1) The screen (shield) of the complete cable must be connected to earth (⏏ or ≡) **in one point only**.

2) 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.**

3) There are two different rules depending on the type of power supply module used in the 531:

- Module 0531A030 (230 VAC): **connect** each power supply module to the earth (⏏ or ≡).
- Module 0690A013 (24 VAC): **do not connect** the earth (⏏ or ≡) of any power supply module to earth. **If not respected, there is a high risk of ground loop!**

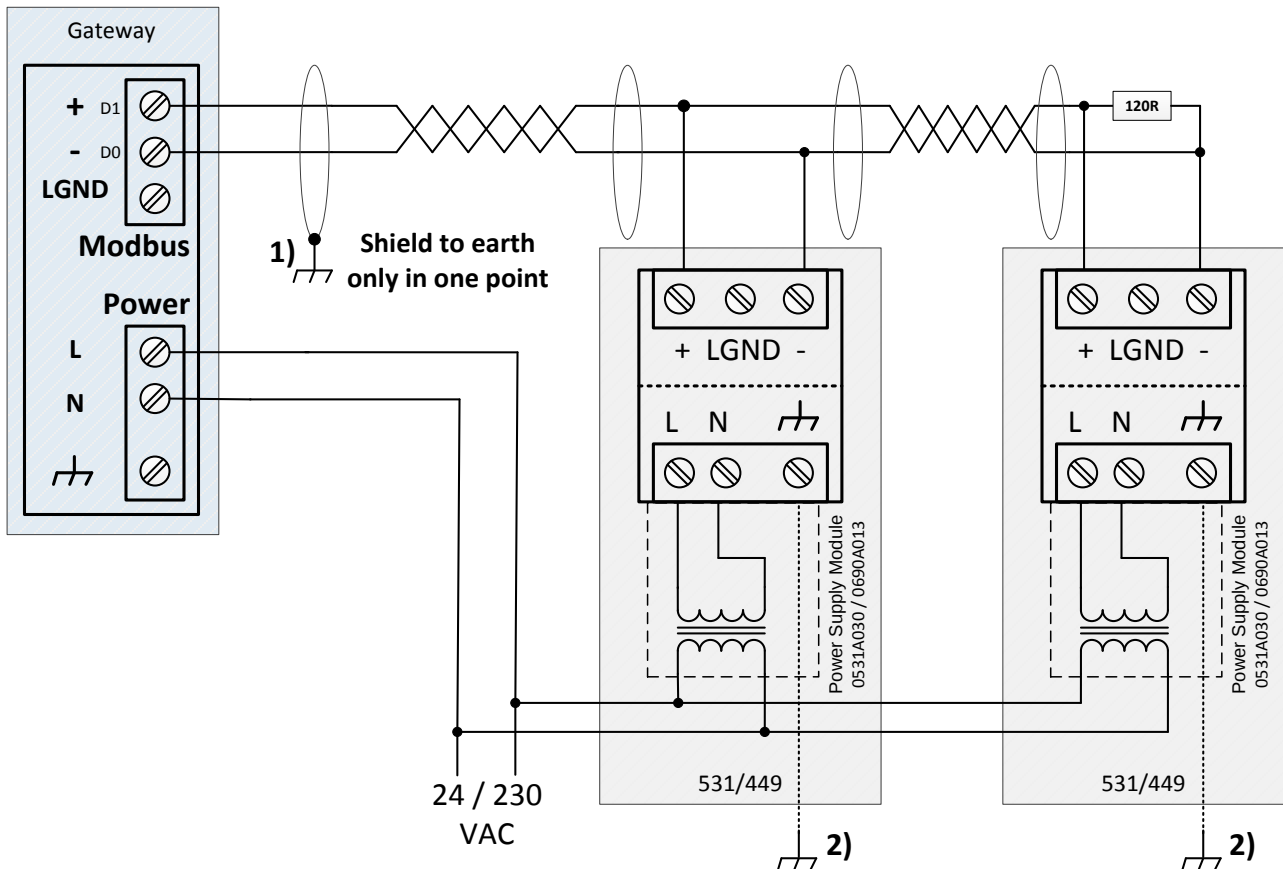
4) Check if the voltage between the LGND (Common) and the electrical earth (⏏ or ≡) is in the range of -7 and +12VDC, as per specified in the EIA-485 requirements. Then in any case connect the LGND (Common) terminal to the earth (⏏ or ≡).

Remarks:

In the case where others devices are connected on the BUS, these other devices must be built with a galvanic isolation to ensure proper working of the bus.

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

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



1) The screen (shield) of the complete cable must be connected to earth (⏏ or ⏚) **in one point only**.

2) There are two different rules depending on the power supply used:

- Module 0531A030 (230 VAC): connect each power supply module to the earth (⏏ or ⏚).
- Module 0690A013 (24 VAC): do not connect the earth (⏏ or ⏚) of any power supply module.

Remarks:

It is **NOT RECOMMENDED** to use a gateway built with a half-wave rectifier with the **Power Supply Module 0690A013 (24 VAC)**. The voltage value of the LGND will be higher than 0.9 VDC compared to the value of the earth (⏏ or ⏚). Electrical disturbances will be presents on the LGND (Common) signal.

It is not allowed to connect the LGND to earth (⏏ or ⏚).

If the gateway is built with a half-wave rectifier and does not have a galvanic isolation **the Power Supply Module 0531A030 (230 VAC) needs to be used.**

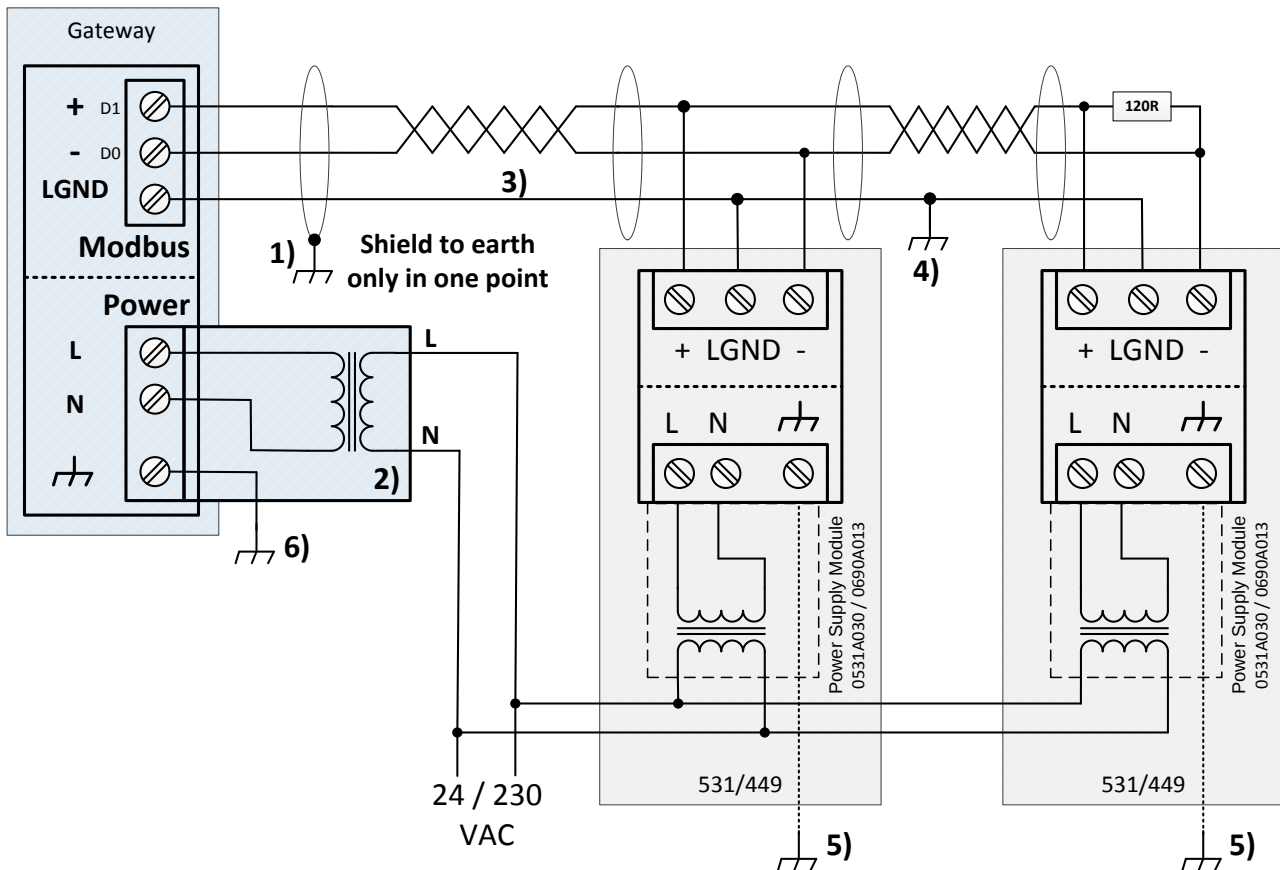
In the case where other devices are connected on the BUS, these other devices must be built with a galvanic isolation. The resistor 120 Ohm in drawing is built into the module and can be set via a dip switch.

The Power Supply Module 0690A013 (24 VAC) shall NOT be used with a gateway having a half-wave rectifier!
The Power Supply Module 0531A030 230 VAC can be used with either a half-wave or a full-wave rectified gateway. Don't mix half and full-wave rectified devices in the same installation!

7.2 Three-Wire Bus Connections

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

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

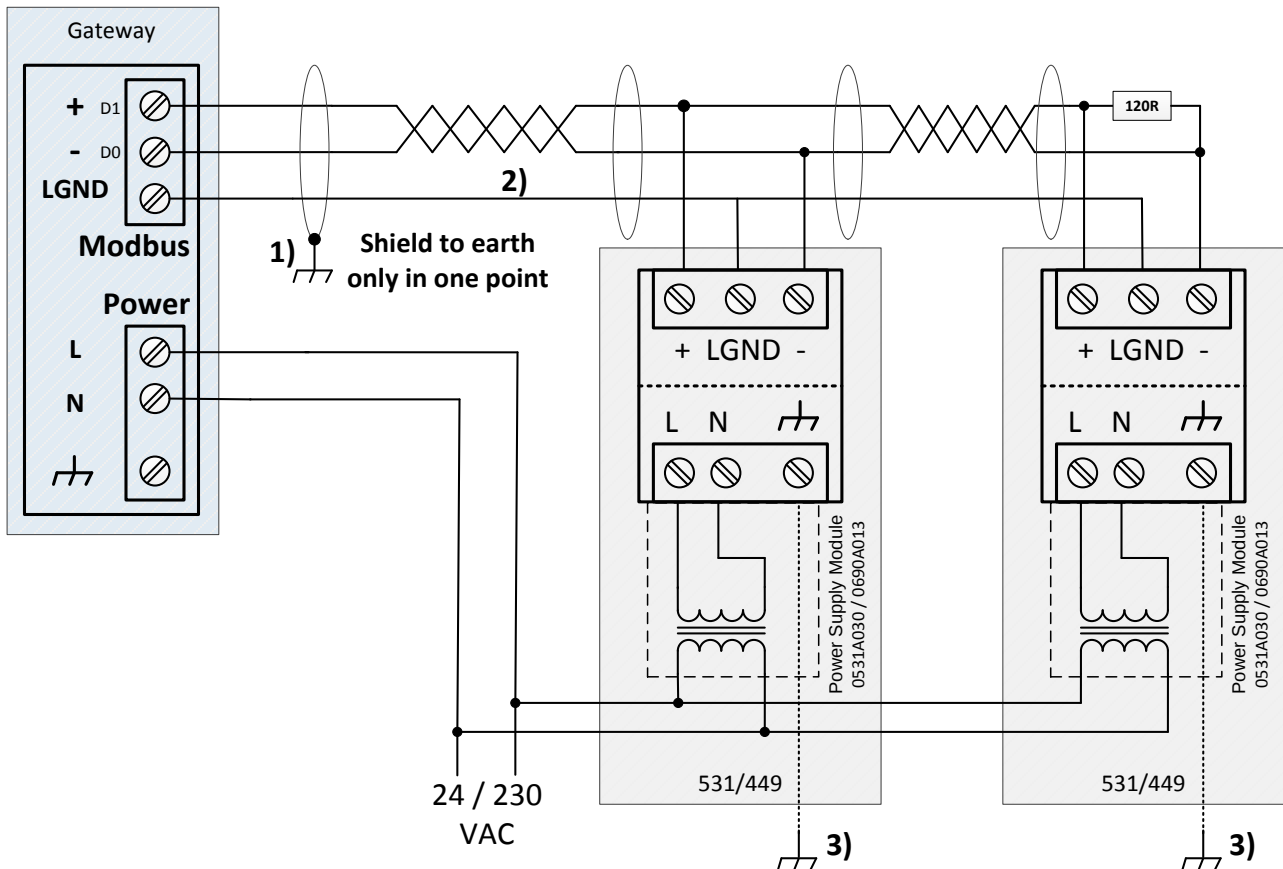


- 1)** The screen (shield) of the complete cable must be connected to earth (⏏ or ⏚) **in one point**.
- 2)** As the gateway is built with a full isolation, **the earth (⏏ or ⏚) of the gateway 6) can, but does not need to, be connected to the earth.**
- 3)** The line LGND is used to connect all modules mounted on the Bus with the gateway.
- 4)** **Only one point of this line must be connected to earth (⏏ or ⏚) when all devices (531/449, Gateway and other devices) connected on the Bus are galvanically isolated.**
- 5)** There are two different rules depending on the type of power supply module used:
 - Module 0531A030 (230 VAC), **connect** each power supply module to the earth (⏏ or ⏚).
 - Module 0690A013 (24 VAC), **do not connect** the earth (⏏ or ⏚) of any power supply module. **If not respected there is a high risk of ground loop!**

Remark:

In the case where other devices are connected on the BUS, these other devices must be built with a galvanic isolation. The resistor 120 Ohm in drawing is built into the module and can be set via a dip switch.

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



- 1)** The screen (shield) of the complete cable must be connected to earth (⏏ or ⏚) in one point.
- 2)** 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.
- 3)** There are two different rules depending on the power supply used:
 - Module 0531A030 (230 VAC): connect each power supply module to the earth (⏏ or ⏚).
 - Module 0690A013 (24 VAC): do not connect the earth (⏏ or ⏚) of any power supply module.

Remark:

It is **NOT RECOMMENDED** to use a gateway built with a half-wave rectifier with the **Power Supply Module 0690A013 (24 VAC)**. The voltage value of the LGND will be higher than 0.9 VDC compare to the value of the earth (⏏ or ⏚). Electrical disturbances will be presents on the LGNG signal.

If the gateway is built with a half-wave rectifier and has no electrical isolation, this wiring is **possible if the Power Supply Module 0531A030 is used**.

In the case where other devices are connected on the BUS, these other devices must be built with a galvanic isolation. The resistor 120 Ohm in drawing is built into the module and can be set via a dip switch.

In the case where the gateway or any other device is not electrically isolated, the line LGND, point 2), must not be connected to the earth!!

The Power Supply Module 0690A013 (24 VAC) shall NOT be used with a gateway having a half-wave rectifier!

The Power Supply Module 0531A030 230 VAC can be used with either a half-wave or a full-wave rectified gateway. Don't mix half and full-wave rectified devices in the same installation!

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 chapter **15 Annex F**, chapter **3.6 Cables** for all technical specifications.

8.3 Electrical Noise

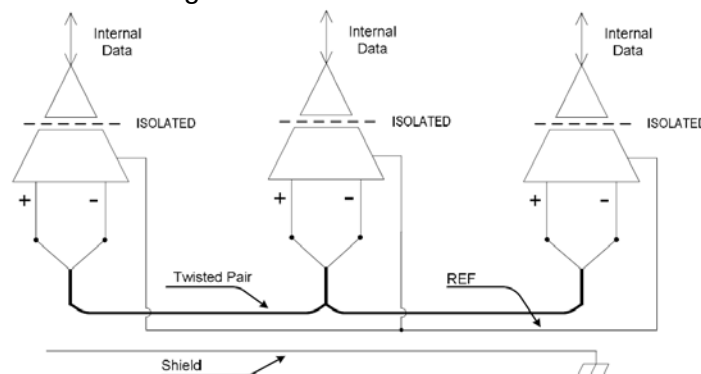
Electrical noise can affect both analogue signal and digital communication such as BACnet or Modbus. Therefore do not route high voltage lines next to the BACnet / Modbus network! Avoid noisy electrical sources such as:

- 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

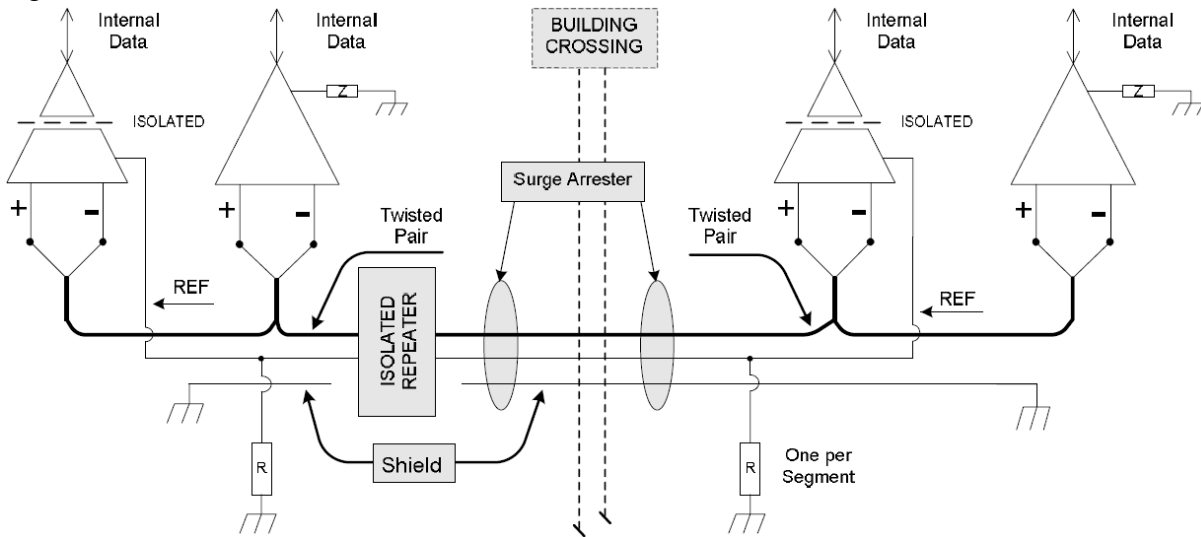
If the installation exclusively uses EIA-485 devices with third-wire reference connections, electrical noise rejection is best if a third conductor in the same cable is used to connect all of the reference connections together as shown in Figure below



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 conductor 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 isolated 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 isolation. 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 reference 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. Shutting Down

9.1 Exchange and return

In case of repair, factory calibration, incorrect delivery or order, the calculator must be returned. As an ISO-certified company and in accordance with legal requirements, Sontex is obliged to handle all returned products that come into contact with the medium in a certain way.

To ensure a safe, professional and fast return of your device, please inform yourself about the procedure and general conditions on the Sontex website and use our form for the return of goods. See also www.sontex.ch/downloads.

9.2 Disposal



In order to preserve and protect the environment, and to reduce the waste of natural resources and pollution, the European Commission has adopted a directive under which electrical and electronic equipment is taken back from the manufacturer for proper disposal or recycling.



If you dispose of the Module, it must be disposed of in accordance with the applicable local environmental regulations. Find out about recycling opportunities in your region.

10. Annex A

10.1 Mapping Registers for Supercal 531 and Superstatic 440 / 449

10.2 Product Description:

The integrator SUPERCAL 531/449 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 531/449 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.

10.3 Data Model Mapping

10.3.1 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	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	Reserved	16 Bit Integer	R/W	
40023 - 40024	Custom ID	32 bits integer (h-l)	R/W	OEM serial number
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	

(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.

10.3.2 Group (B) : Information

Input Register	M-Bus data Individual description Group (B) : Informations (read)	Data type	Read/Write
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	Error status: temp. sensor 1	1 Bit	R
10002	Error status: temp. sensor 2	1 Bit	R
10003	Error status: flow	1 Bit	R
10004	Error status: MET access	1 Bit	R
10005	Error status: MIO access	1 Bit	R
10006	Error status: eep. Blank inv.	1 Bit	R
10007	Error status: AD Converter	1 Bit	R
10008	Error status: Hardware	1 Bit	R
10009	Error status: Supply power	1 Bit	R
10010	Error status: Option 1	1 Bit	R
10011	Error status: Option 2	1 Bit	R
10012	Error status: A1	1 Bit	R
10013	Error status: A2	1 Bit	R
10014	Error status: Internal HW	1 Bit	R
10015	Error status: CRC Err	1 Bit	R
10016	Error status: Conf Err	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.

10.3.3 Group (C) : Actual Values

Input Register	M-Bus data Individual description Group (C) : Actual values (read)	Data type	Read/Write	Remarks
Energy data (IEEE754 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
30105 - 30106	Energy totalizer Tariff 1	IEEE754 Single (h-l)	R	Actual value
30107 - 30108	Energy totalizer Tariff 2	IEEE754 Single (h-l)	R	Actual value
30109 - 30110	Energy – stored ST1	IEEE754 Single (h-l)	R	
30111 - 30112	Energy Tariff 1 – stored ST1	IEEE754 Single (h-l)	R	
30113 - 30114	Energy Tariff 2 – stored ST1	IEEE754 Single (h-l)	R	
30115 - 30116	Energy – stored ST2	IEEE754 Single (h-l)	R	
30117 - 30118	Energy Tariff 1 – stored ST2	IEEE754 Single (h-l)	R	
30119 - 30120	Energy Tariff 2 – stored ST2	IEEE754 Single (h-l)	R	
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
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	
30213 - 30214	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	m3=80, USGallon=83
30302	Reserved			
30303 - 30304	Volume	IEEE754 Single (h-l)	R	Actual value
30305 - 30306	Volume Tariff 1	IEEE754 Single (h-l)	R	Actual value
30307 - 30308	Volume Tariff 2	IEEE754 Single (h-l)	R	Actual value
30309 - 30310	Volume – stored ST1	IEEE754 Single (h-l)	R	
30311 - 30312	Volume Tariff 1 – stored ST1	IEEE754 Single (h-l)	R	
30313 - 30314	Volume Tariff 2 – stored ST1	IEEE754 Single (h-l)	R	
30315 - 30316	Volume – stored ST2	IEEE754 Single (h-l)	R	
30317 - 30318	Volume Tariff 1 – stored ST2	IEEE754 Single (h-l)	R	
30319 - 30320	Volume Tariff 2 – stored ST2	IEEE754 Single (h-l)	R	
Volume data (long data points)				
30401	Volume Unit	16 Bit Integer	R	m3=80, USGallon=83
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	no unit=0, Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20, m3=80, USGallon=83
30502	Reserved			
30503 - 30504	Auxiliary-A1	IEEE754 Single (h-l)	R	Actual value
30505 - 30506	Auxiliary-A1 – stored ST1	IEEE754 Single (h-l)	R	
30507 - 30508	Auxiliary-A1 – stored ST2	IEEE754 Single (h-l)	R	
Auxiliary A1 data or complementary counter A1 totalizer (long data points)				
30601	Auxiliary-A1 Unit	16 Bit Integer	R	no unit=0, Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20, m3=80, USGallon=83
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	no unit=0, Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20, m3=80, USGallon=83
30512	Reserved			
30513 - 30514	Auxiliary-A2	IEEE754 Single (h-l)	R	Actual value
30515 - 30516	Auxiliary-A2 – stored ST1	IEEE754 Single (h-l)	R	
30517 - 30518	Auxiliary-A2 – stored ST2	IEEE754 Single (h-l)	R	
Auxiliary A2 data or complementary counter A2 totalizer (long data points)				
30611	Auxiliary-A2 Unit	16 Bit Integer	R	no unit=0, Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20, m3=80, USGallon=83
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, kW=48
30702	Reserved			
30703 - 30704	Power	IEEE754 Single (h-l)	R	Actual value
Power (long data points)				
30801	Power Unit	16 Bit Integer	R	W=47, kW=48
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	IEEE754 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
High temperature (IEEE745 single float values)				
30721	Temperature Unit	16 Bit Integer	R	°C=62
30722	Reserved			
30723 - 30724	High temperature	IEEE754 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	IEEE754 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	IEEE754 Single (h-l)	R	
Temperature difference (long data points)				
30831	Delta Temperature Unit	16 Bit Integer	R	K=63
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.

10.3.4 Group (D) : ST1 Values

Input Register	M-Bus data Individual description Group (D) : ST1 values (read)	Data type	Read/Write	Remarks
ST1 values (IEEE754 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	IEEE754 Single (h-l)	R	
30111 - 30112	Energy Tariff 1 – stored ST1	IEEE754 Single (h-l)	R	
30113 - 30114	Energy Tariff 2 – stored ST1	IEEE754 Single (h-l)	R	
30309 - 30310	Volume – stored ST1	IEEE754 Single (h-l)	R	
30311 - 30312	Volume Tariff 1 – stored ST1	IEEE754 Single (h-l)	R	
30313 - 30314	Volume Tariff 2 – stored ST1	IEEE754 Single (h-l)	R	
30505 - 30506	Auxiliary-A1 – stored ST1	IEEE754 Single (h-l)	R	
30515 - 30516	Auxiliary-A2 – stored ST1	IEEE754 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.

10.3.5 Group (E) : ST2 Values

Input Register	M-Bus data Individual description Group (E) : ST2 values (read)	Data type	Read/Write	Remarks
ST2 values (IEEE754 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	IEEE754 Single (h-l)	R	
30117 - 30118	Energy Tariff 1 – stored ST2	IEEE754 Single (h-l)	R	
30119 - 30120	Energy Tariff 2 – stored ST2	IEEE754 Single (h-l)	R	
30315 - 30316	Volume – stored ST2	IEEE754 Single (h-l)	R	
30317 - 30318	Volume Tariff 1 – stored ST2	IEEE754 Single (h-l)	R	
30319 - 30320	Volume Tariff 2 – stored ST2	IEEE754 Single (h-l)	R	
30507 - 30508	Auxiliary-A1 – stored ST2	IEEE754 Single (h-l)	R	
30517 - 30518	Auxiliary-A2 – stored ST2	IEEE754 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.

10.3.6 Group (F) : Monthly Values

Input Register	M-Bus data Individual description Group (F) : Monthly values (read)	Data type	Read/Write	Remarks
Day for monthly storage				
30012	Last Monthly Data: day	16 Bit Integer	R	
Energy Monthly value (IEEE754 single float values)				
31001	Energy Unit	16 Bit Integer	R	Wh=18, kWh=19, MWh=146, MJ=126(not a BACnet unit), GJ=226, BTU=20
31002	Reserved			
31003 - 31066	Energy Monthly Value - Stored [0..31]	IEEE754 Single	R	32 x 2 Input registers
31067 - 31130	Energy Monthly Value Tariff 1 – Stored [0..31]	IEEE754 Single	R	32 x 2 Input registers
31131 - 31194	Energy Monthly Value Tariff 2 – Stored [0..31]	IEEE754 Single	R	32 x 2 Input registers
Energy Monthly value (long data points)				
31201	Energy Unit	16 Bit Integer	R	Wh=18, kWh=19, MWh=146, MJ=126(not a BACnet unit), GJ=226, BTU=20
31202	Decimals	16 Bit Integer	R	Decimals: 0,1,2,3
31203 - 31266	Energy Monthly Value - Stored [0..31]	32 bits integer (h-l)	R	32 x 2 Input registers
31267 - 31330	Energy Monthly Value Tariff 1 – Stored [0..31]	32 bits integer (h-l)	R	32 x 2 Input registers
31331 - 31394	Energy Monthly Value Tariff 2 – Stored [0..31]	32 bits integer (h-l)	R	32 x 2 Input registers
Volume Monthly value (IEEE754 single float values)				
31401	Volume Unit	16 Bit Integer	R	m3=80, USGallon=83
31402	Reserved			
31403 - 31466	Volume Monthly Value - Stored [0..31]	IEEE754 Single (h-l)	R	32 x 2 Input registers
31467 - 31530	Volume Monthly Value Tariff 1 – Stored [0..31]	IEEE754 Single (h-l)	R	32 x 2 Input registers
31531 - 31594	Volume Monthly Value Tariff 2 – Stored [0..31]	IEEE754 Single (h-l)	R	32 x 2 Input registers
Volume Monthly value (long data points)				
31601	Volume Unit	16 Bit Integer	R	m3=80, USGallon=83
31602	Decimals	16 Bit Integer	R	Decimals: 0,1,2,3
31603 - 31666	Volume Monthly Value - Stored [0..31]	32 bits integer (h-l)	R	32 x 2 Input registers
31667 - 31730	Volume Monthly Value Tariff 1 – Stored [0..31]	32 bits integer (h-l)	R	32 x 2 Input registers
31731 - 31794	Volume Monthly Value Tariff 2 – Stored [0..31]	32 bits integer (h-l)	R	32 x 2 Input registers

(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 monthly value or complementary counter (IEEE745 single float values)				
32001	Auxiliary-A1 Unit	16 Bit Integer	R	no unit=0 , Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20, m3=80, USGallon=83
32002	Reserved			
32003 - 32066	Auxiliary-A1 Monthly Value - Stored [0..31]	IEEE754 Single (h-l)	R	32 x 2 Input registers
Auxiliary A1 monthly value or complementary counter (long data points)				
33001	Auxiliary-A1 Unit	16 Bit Integer	R	no unit=0 , Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20, m3=80, USGallon=83
33002	Decimals	16 Bit Integer	R	Decimals: 0,1,2,3
33003 - 33066	Auxiliary-A1 Monthly Value - Stored [0..31]	32 bits integer (h-l)	R	32 x 2 Input registers
Auxiliary A2 monthly value or complementary counter (IEEE745 single float values)				
32201	Auxiliary-A2 Unit	16 Bit Integer	R	no unit=0 , Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20, m3=80, USGallon=83
32202	Reserved			
32203 - 32266	Auxiliary-A2 Monthly Value - Stored [0..31]	IEEE754 Single (h-l)	R	32 x 2 Input registers
Auxiliary A2 monthly value or complementary counter (long data points)				
33201	Auxiliary-A2 Unit	16 Bit Integer	R	no unit=0 , Wh=18, kWh=19, MWh=146, MJ=126, GJ=226, BTU=20, m3=80, USGallon=83
33202	Decimals	16 Bit Integer	R	Decimals: 0,1,2,3
33203 - 33266	Auxiliary-A2 Monthly Value - Stored [0..31]	32 bits integer (h-l)	R	32 x 2 Input registers

(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.

11. Annex B

11.1 Example for Energy/Flow Coding with ModScan64 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/>

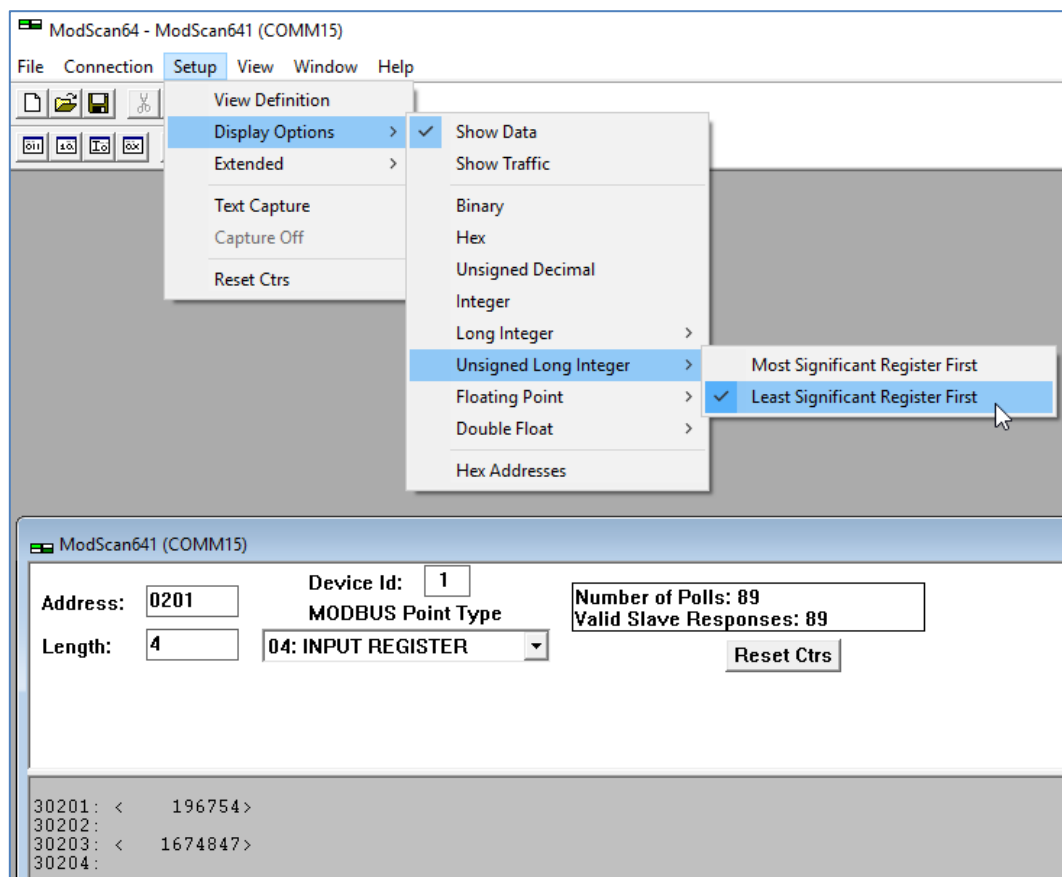
11.1.1 Long Data Points

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.

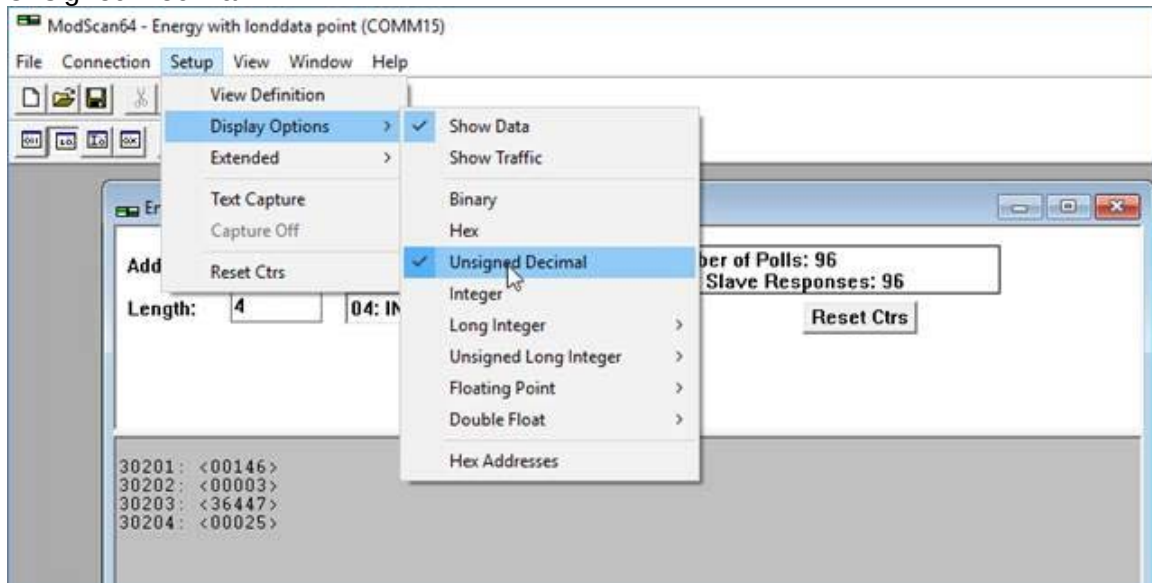
The Device ID is the address of the module.



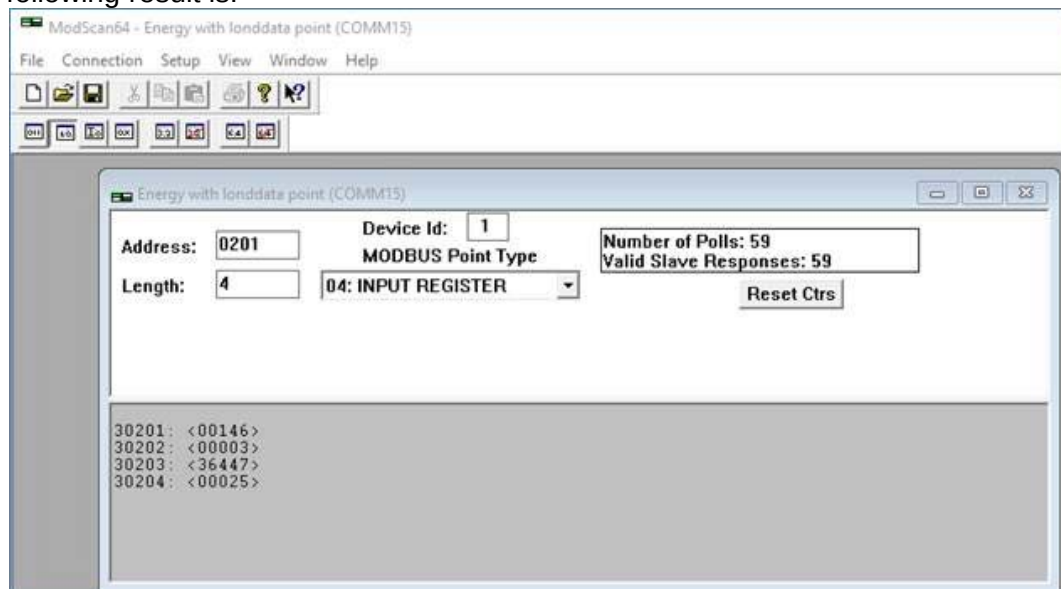
Only value displayed on address 30203 must be taken into consideration.

➔ 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 10.3.3:

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

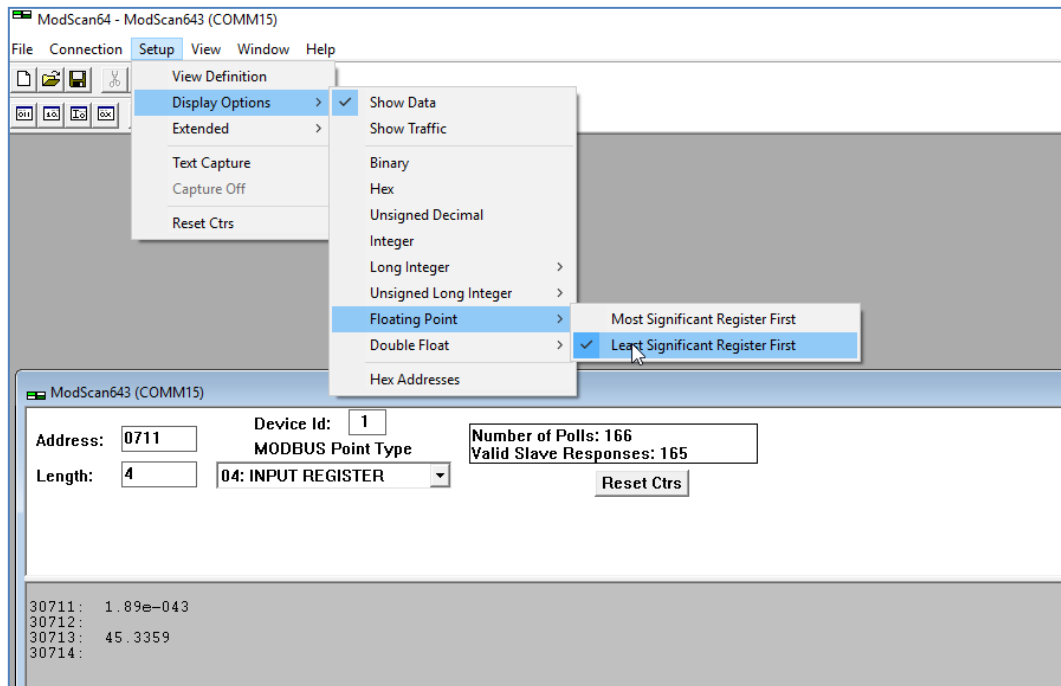
→ Thus, the real energy value is : 1674,847 MWh

11.1.2 IEEE754 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 IEEE754 Single (h-l).

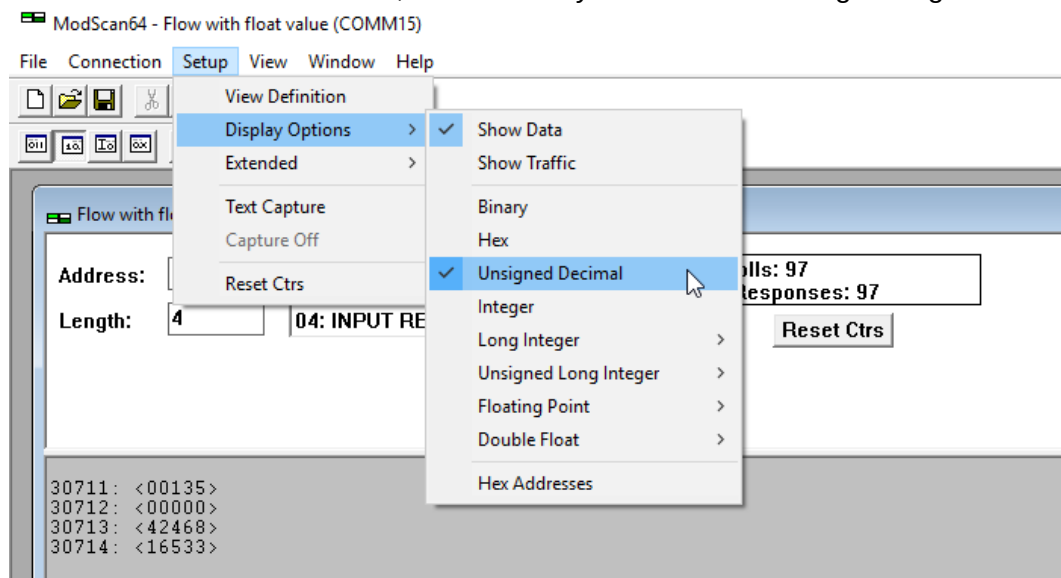
Example for the Flow:



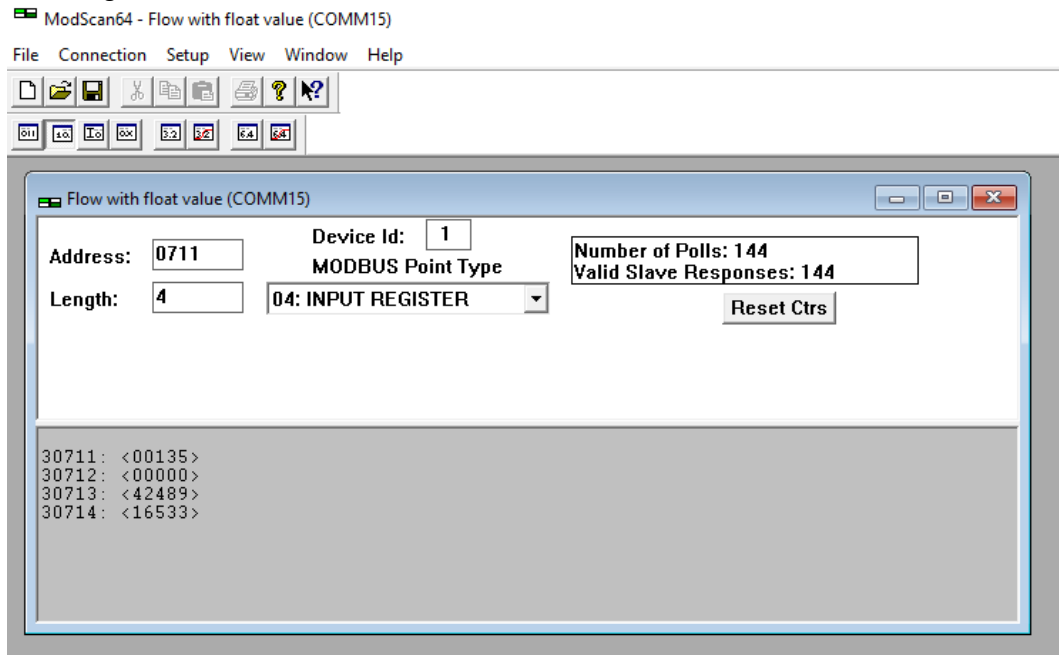
Only value displayed on address 30713 must be taken into consideration.

➔ 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 **10.3.3**:

Flow (IEEE745 single float values)				
30711	Flow Unit	16 Bit Integer	R	m ³ /h=135
30712	Reserved			
30713 - 30714	Flow	IEEE754 Single (h-l)	R	Actual value

■ $m^3/h = 135$

➔ Thus, the real flow is: 45,3359 m³/h

11.2 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>

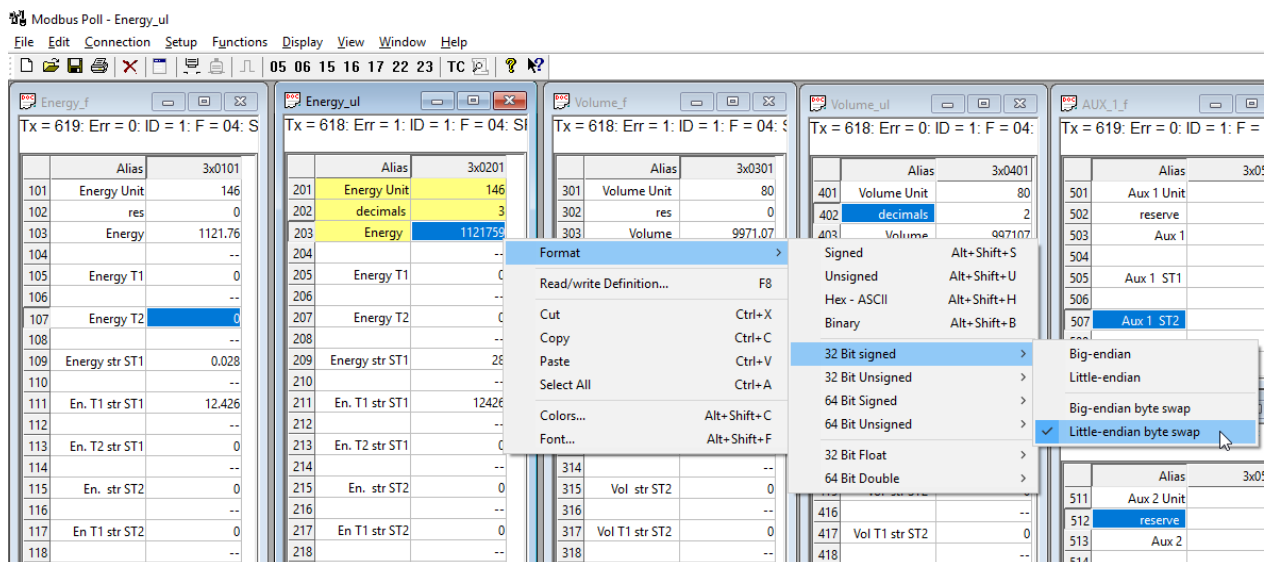
11.2.1 Long data points

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 **10.3.3**:

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

11.2.2 IEEE754 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 IEEE754 Single (h-l).

Example for the Energy:

The screenshot shows the Modbus Poll software interface with four data tables: Energy_f, Energy_ul, Volume_f, and Volume_ul. The 'Format' menu is open, showing options for Signed, Unsigned, Hex - ASCII, Binary, 32 Bit signed, 32 Bit Unsigned, 64 Bit Signed, 64 Bit Unsigned, 32 Bit Float, and 64 Bit Double. The '32 Bit Float' option is selected, and the 'Little-endian byte swap' option is checked.

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 **10.3.3**:

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

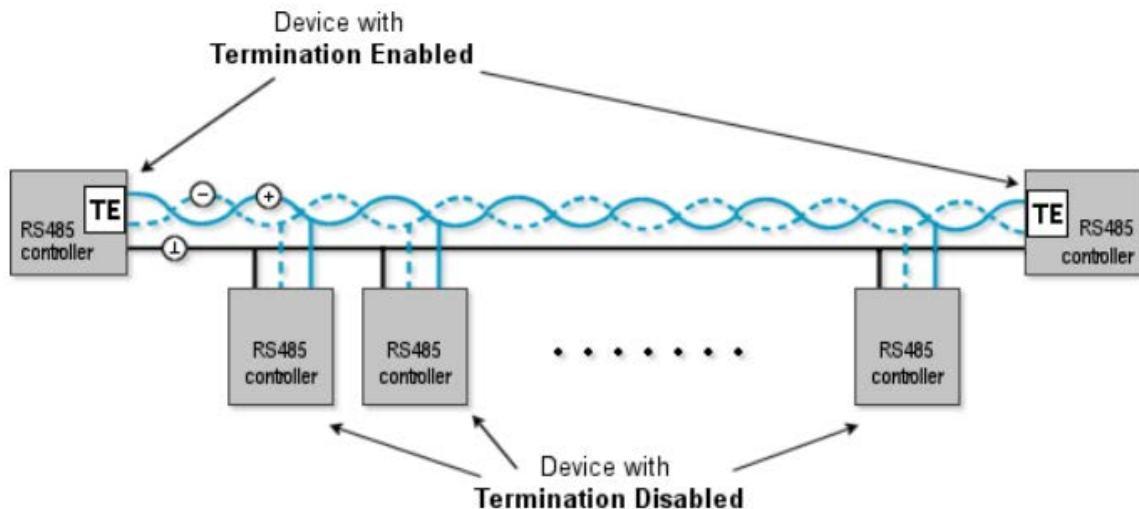
➔ Thus, the real energy is: 1121,77 MWh

12. Annex C

12.1 RS-485 lines

12.2 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 Ω resistor across the A- and B+ or D0 and D1 and lines. The BACnet and Modbus modules have the option for enabling termination via a DIP switch S1.

If the gateway/router has built in termination which is enabled by default (since the gateway / router is typically the beginning of the entire BACnet MS/TP or Modbus EIA-485 network), you only have to find and terminate that last device.

12.3 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; one device has 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 S1. See **Annex F**, chapter **3.4.6 Line Polarization** and **Annex G**, chapter **13.2.2** for explanations.

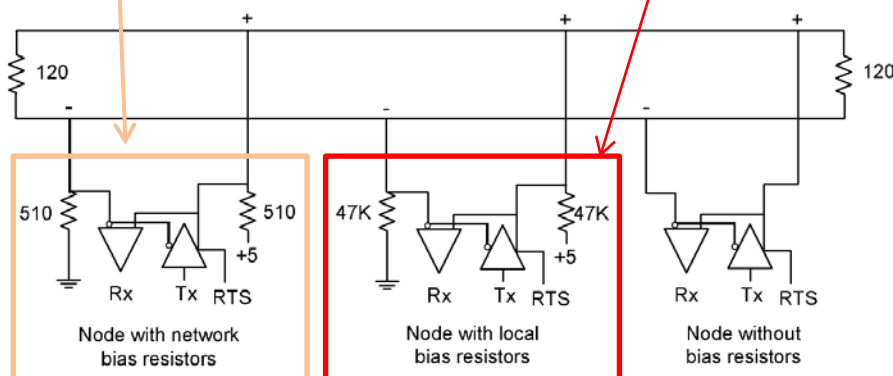
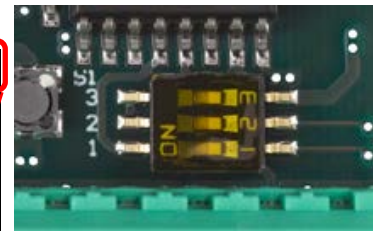
12.4 General Explanation with DIP Switch S1

By default, BACnet and Modbus modules are built with 2x47 kΩ polarization resistors (DIP Switch position: 0 – 0 – 0), there is no termination and no bias resistors activated by default.

A 510 Ω polarization of the pair must be implemented at one location for the whole bus.

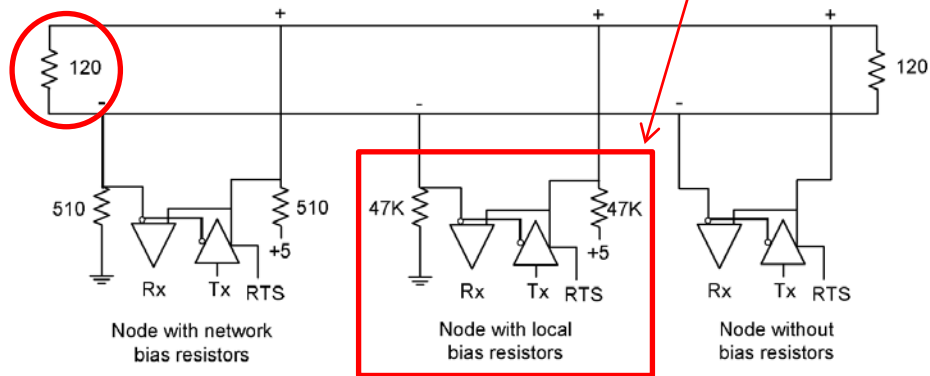
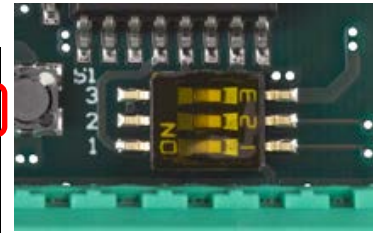
These following features are only enabled with the DIP switches S1:

Pos. 1	Pos. 2	Pos. 3	
0	0	0	No function, a light polarisation with 2x 47 kΩ (default)
0	0	1	Line Terminating resistor: LT = 120 Ω + 1nF
1	1	0	Bias resistors (2x510 Ω) without termination (120 Ω)
1	1	1	Bias resistors (2x510 Ω) with LT termination (120 Ω + 1 nF)

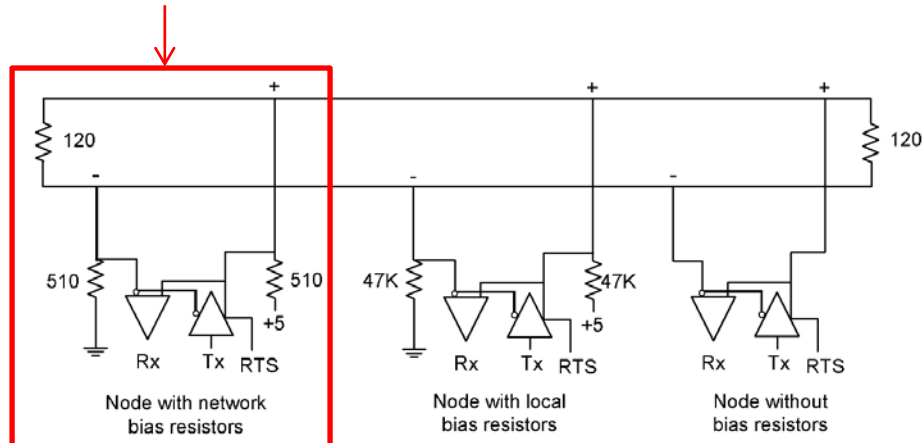
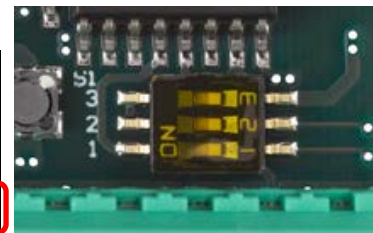


For DIP Switch S1, the position is defined as follows: Pos.1 Pos. 2 Pos. 3

Pos. 1	Pos. 2	Pos. 3	
0	0	0	No function, a light polarisation with 2x 47 kΩ (default)
0	0	1	Line Terminating resistor: LT = 120 Ω + 1nF
1	1	0	Bias resistors (2x510 Ω) without termination (120 Ω)
1	1	1	Bias resistors (2x510 Ω) with LT termination (120 Ω + 1 nF)



Pos. 1	Pos. 2	Pos. 3	
0	0	0	No function, a light polarisation with 2x 47 kΩ (default)
0	0	1	Line Terminating resistor: LT = 120 Ω + 1nF
1	1	0	Bias resistors (2x510 Ω) without termination (120 Ω)
1	1	1	Bias resistors (2x510 Ω) with LT termination (120 Ω + 1 nF)



For DIP Switch S1, the position is defined as follows: Pos.1 Pos. 2 Pos. 3

12.4.1 Summary

	ModBus	BACnet
Line termination	120 Ω + 1nF	120 Ω only
Bias resistors	2x 510 Ω	2x 510 Ω
Default	2x 47 kΩ, not termination	2x 47 kΩ, not termination

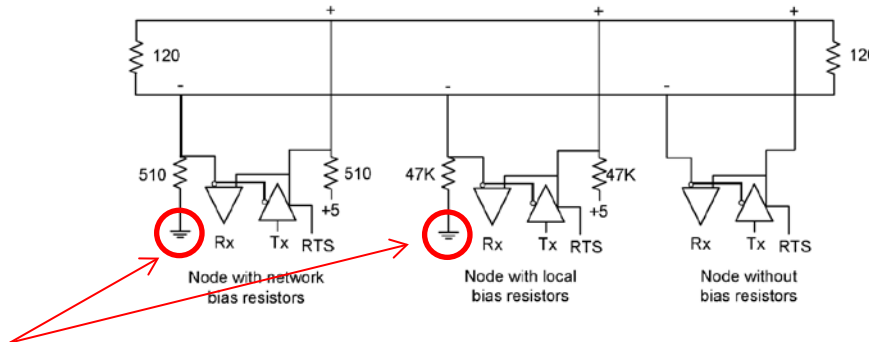
12.5 Cable and Length

A Modbus or BACnet over Serial Line Cable must be shielded.

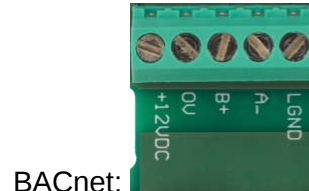
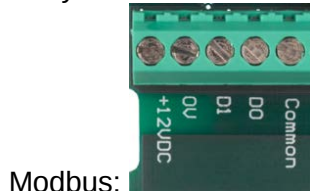
A figure of 32 devices is always authorized on any EIA-485 system without repeater.

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.



Remark:

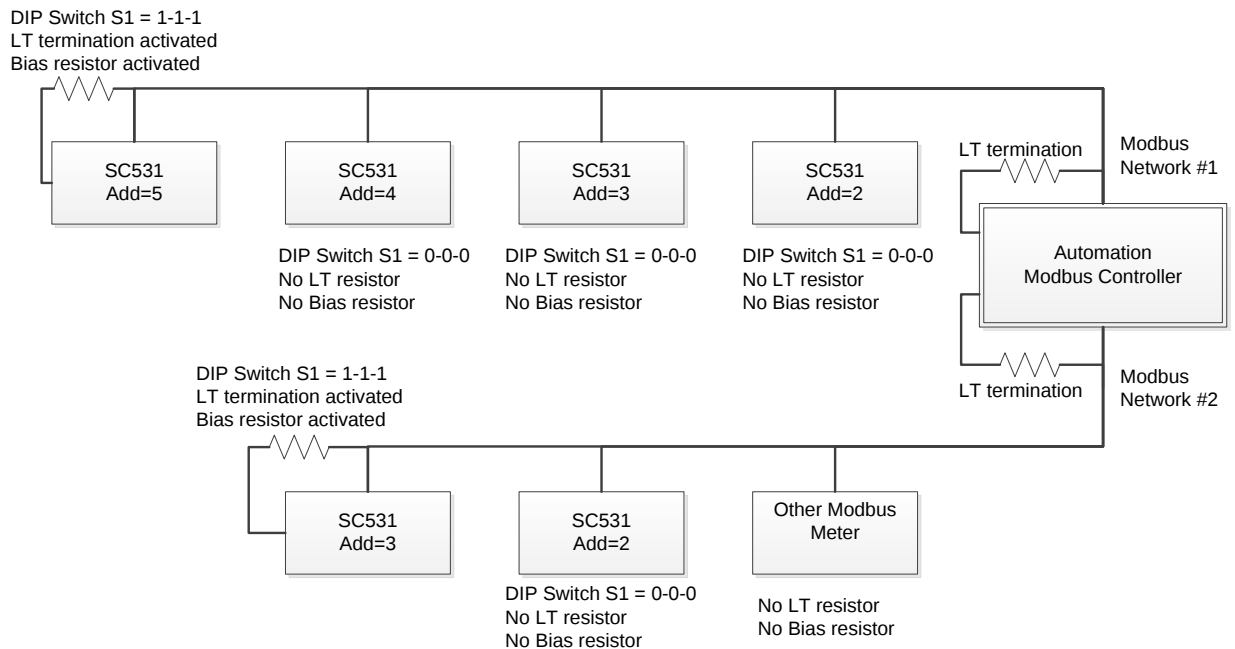
- If a full isolation is performed by all devices (531/449 and Gateway) connected on the Bus, **only one point of this line must be connected to earth** (⚡ or ⚡)!
- If a full isolation is not performed, in case where the gateway/router or another is not isolated, **this line must not be connected to earth!!**

Please refer to chapter **7.1.1 Two-Wires Bus with a Gateway with a Galvanic Isolation** for more explanations.

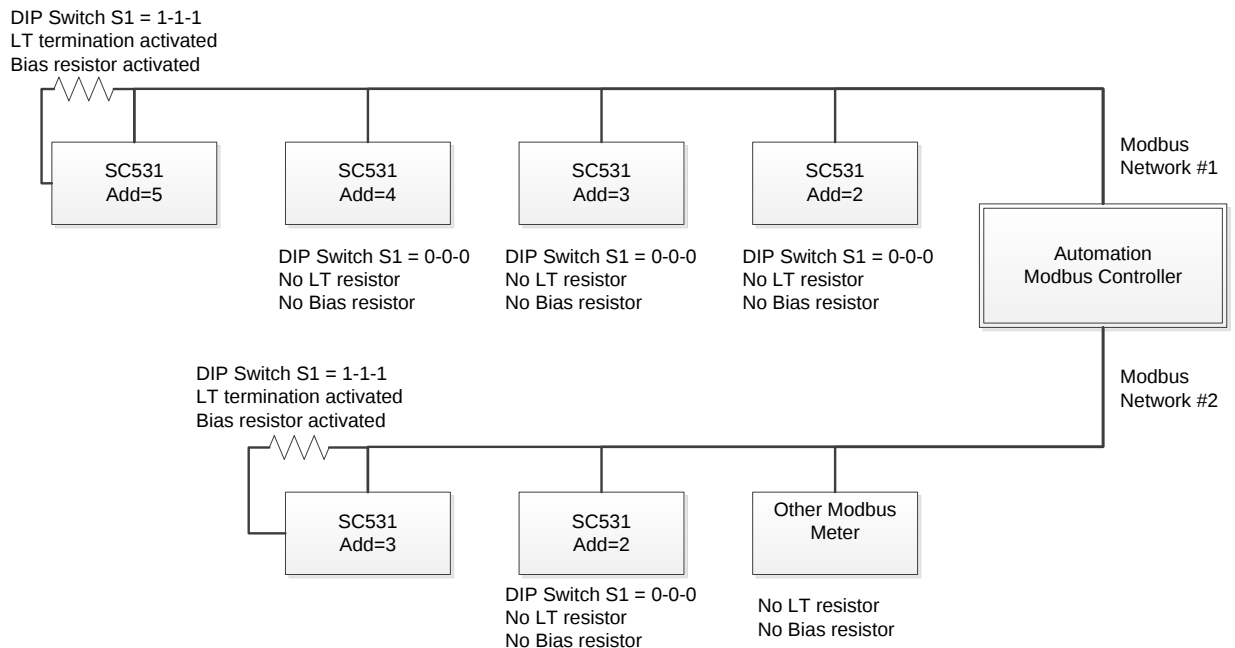
13. Annex D

13.1 Examples of Modbus EIA-485 Network with Line Terminating and Bias Resistors

13.1.1 Example 1



This setting is correct

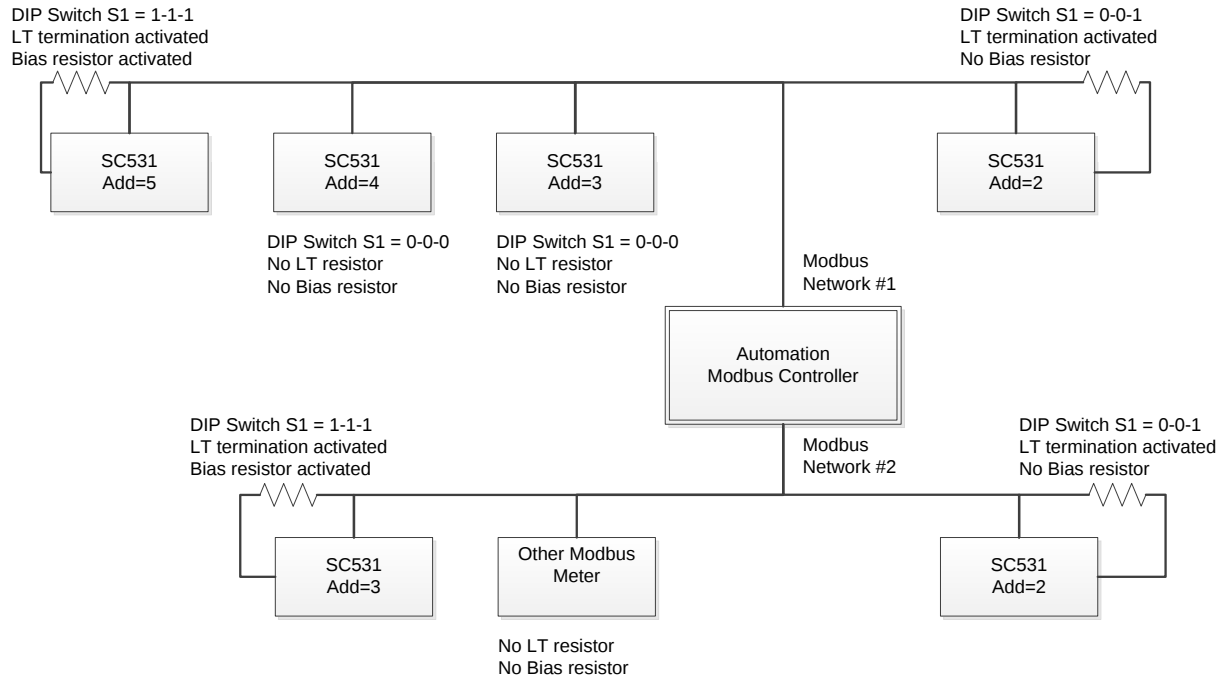


This setting is not correct, the Line termination is not connected on the Modbus Controller

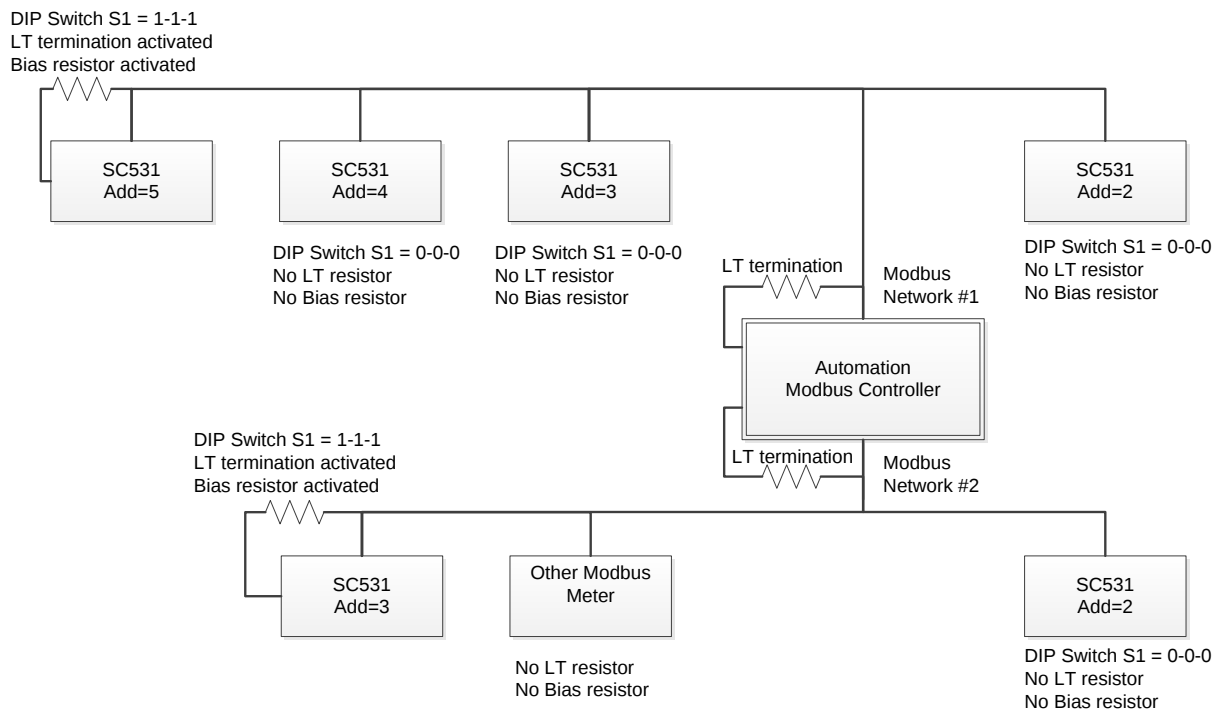


For DIP Switch S1, the position is defined as follows: Pos.1 Pos. 2 Pos. 3

13.1.2 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. The Bias Resistor is connected only on one point/end.

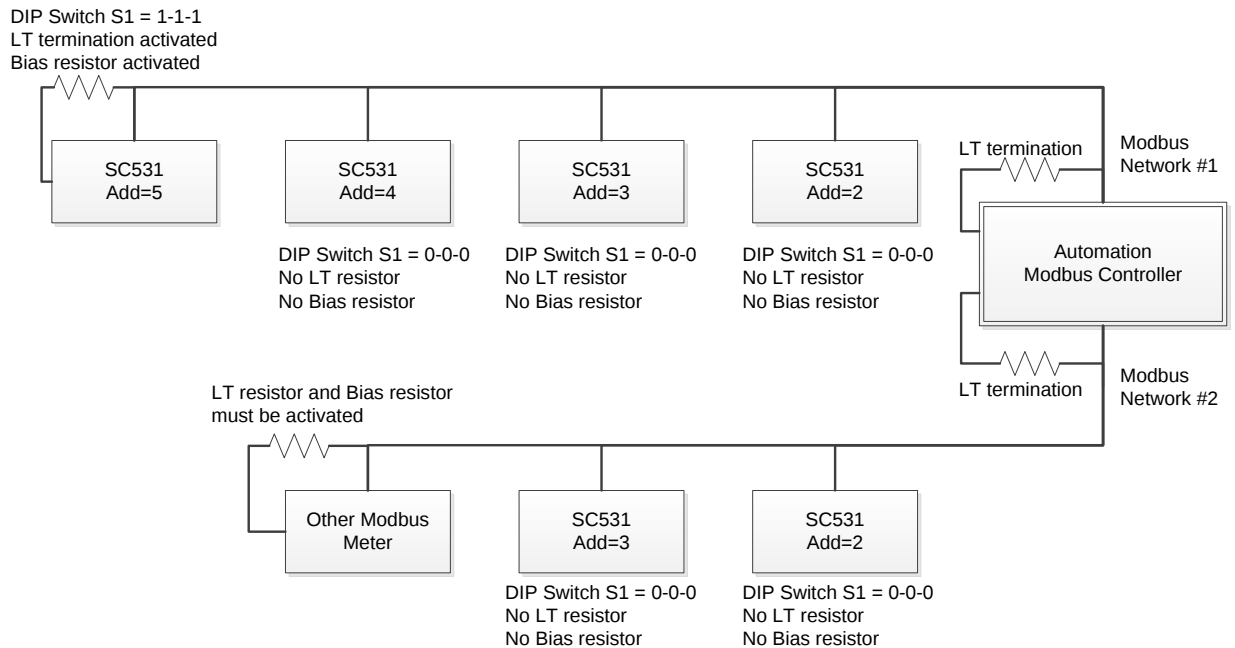


This setting is not correct; the LT termination should be mounted at the end of each side of the EIA-485 network and not directly on the Modbus Controller.

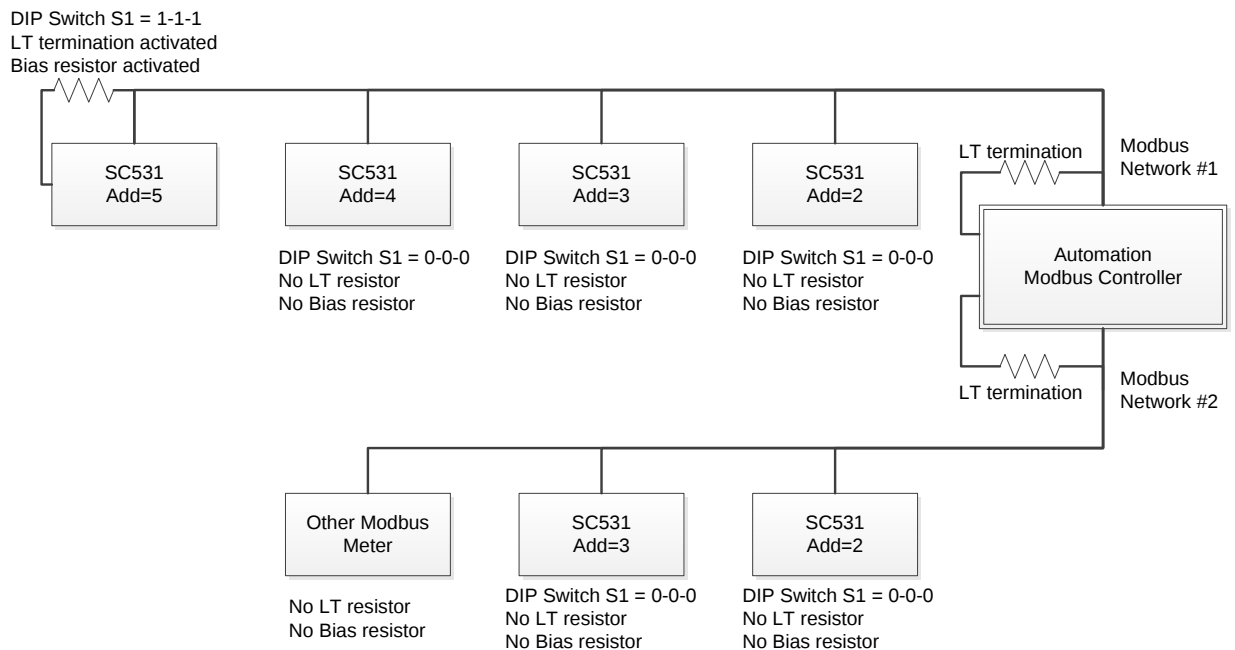


For DIP Switch S1, the position is defined as follows: Pos.1 Pos. 2 Pos. 3

13.1.3 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.



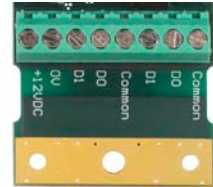
For DIP Switch S1, the position is defined as follows: Pos.1 Pos. 2 Pos. 3

14. Annex E

14.1 Voltage Control

14.1.1 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	$0 \pm 0,2$ VDC	



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

14.1.2 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.

15. Annex F

15.1 ModBus Specifications

The following explanations are available on the website [Modbus.org](http://www.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 Transmitter 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.

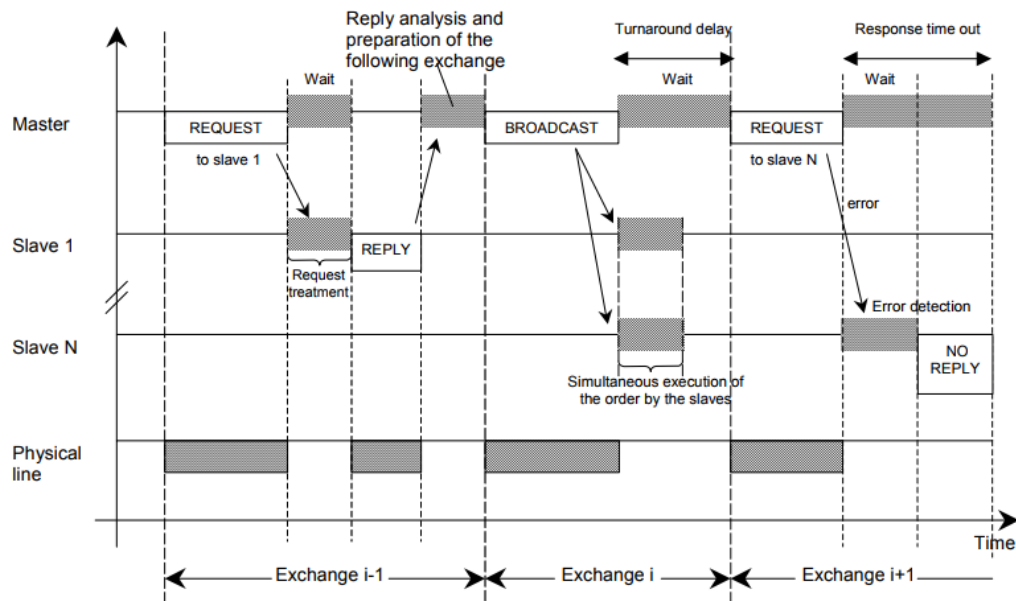


Figure 9: Master / Slave scenario time diagram

Remarks :

- the duration of the REQUEST, REPLY, BROADCAST 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.

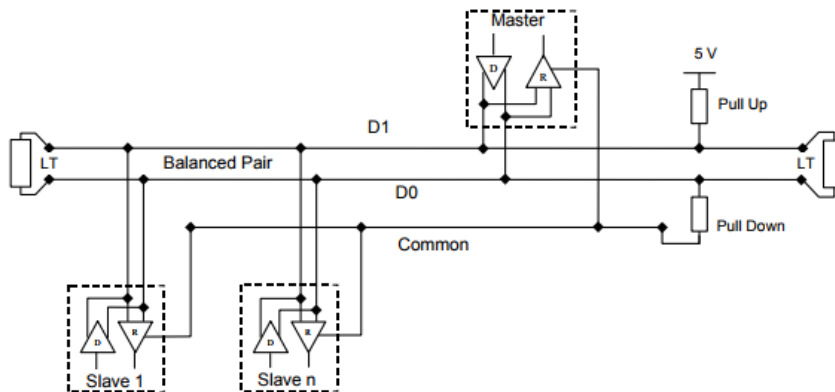


Figure 20: General 2-Wire Topology

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.

16. Annex G

16.1 BACnet Specifications

16.2 Data Link/Physical Layers: Master-Slave / Token Passing (MS/TP) LAN

This clause describes a Master-Slave/Token-Passing (MS/TP) data link protocol, which provides the same services to the network layer as ISO 8802-2 Logical Link Control. It uses services provided by the EIA-485 physical layer. Relevant clauses of EIA-485 are deemed to be included in this standard by reference. The following hardware is assumed:

- A UART (Universal Asynchronous Receiver/Transmitter) capable of transmitting and receiving eight data bits with one stop bit and no parity.
- An EIA-485 transceiver whose driver may be disabled.
- A timer with a resolution of five milliseconds or less.

16.3 Physical Layer

16.3.1 Medium

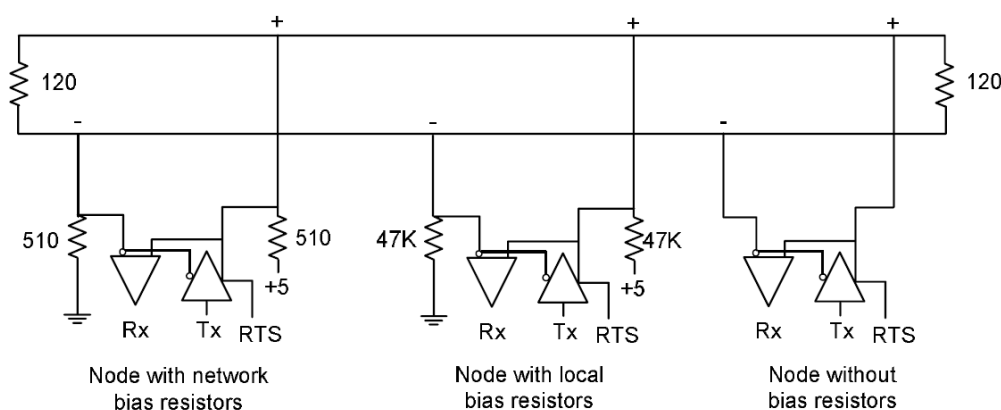
An MS/TP EIA-485 network shall use shielded, twisted-pair cable for data signaling with characteristic impedance between 100 and 130 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot). Distributed capacitance between conductors and shield shall be less than 200 pF per meter (60 pF per foot). Foil or braided shields are acceptable. The maximum recommended length of an MS/TP segment with AWG 18 (0.82 mm² conductor area) cable is specified in Clause 9.2.3. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.

16.3.2 Connections and Terminations

The maximum number of nodes per segment shall be 32 (as specified by the EIA-485 standard). Additional nodes may be accommodated by the use of repeaters, as described in Clause 9.9. Because MS/TP uses NRZ encoding, the polarity of the connection to the cable is important. The non-inverting input of the EIA-485 transceiver is designated in this specification as "plus" or "+" and the inverting input as "minus" or "-". It is recommended, but not required, that the black or red insulated wire of the twisted pair be designated as "plus" and the white, clear, or green insulated wire be designated as "minus." The method of connection between the interface and the cable is not part of this specification.

An MS/TP EIA-485 network shall have no T connections. A termination resistance of 120 ohms plus or minus 5% shall be connected at each of the two ends of the segment medium. No other termination resistors are allowed at intermediate nodes.

Each MS/TP segment shall be provided with network bias resistors, connected as shown in Figure below, such that an undriven communications line will be held in a guaranteed logical one state.



The bias provides a reliable way for stations to detect the presence or absence of signals on the line. An unbiased line will take an indeterminate state in the absence of any driving node. Under some conditions, noise or cross-talk might result in some nodes receiving spurious octets from the undriven idle line.

At least one set, and no more than two sets, of network bias resistors shall exist for each segment. Each set of network bias resistors shall consist of two resistors, each having a value of 510 ohms, plus or minus 5%, connected as shown in Figure 9-1. If two sets of network bias resistors are provided, they shall be placed at two distinct nodes, preferably at the ends of the segment, so that proper bias levels can be maintained even if one of the bias nodes loses power. Other nodes may be provided with local bias resistors as long as each local bias resistor value is 47K ohms or greater. The use of local bias resistors is optional.

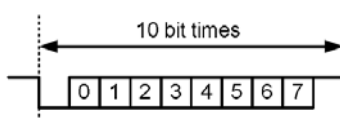
For any physical segment that runs between buildings there shall be at least 1500 V of electrical isolation between the EIA-485 signal conductors and the digital ground of any node on that physical segment.

The shield shall be grounded at one end only to prevent ground currents from being created.

16.3.3 Timing

Octets shall be transmitted using non-return to zero (NRZ) encoding with one start bit, eight data bits, no parity, and one stop bit.

The start bit shall have a value of zero, while the stop bit shall have a value of one. The data bits shall be transmitted with the least significant bit first. This is illustrated in Figure below :



Although asynchronous framing is used, there shall be no more than $T_{\text{frame_gap}}$ of idle line (logical ones or stop bits) between any two octets of a frame.

The standard baud rates are shown in the table below.

Baud Rate	Requirement	Recommended Maximum Distance
9600	Required	1200 meters (4000 feet)
19200	Optional	1200 meters (4000 feet)
38400	Required	1200 meters (4000 feet)
57600	Optional	1200 meters (4000 feet)
76800	Optional	1200 meters (4000 feet)
115200	Optional	1000 meters (3280 feet)

The required baud rates, plus or minus 1%, shall be supported. Any or all of the optional baud rates, plus or minus 1%, may be supported at the vendor's option.

Transmitter enable: A node shall enable its EIA-485 driver before it generates the leading edge of the first start bit of a frame.

The node shall drive the line to the logical one state during the time between the enable and the leading edge of the first start bit of a frame.

Transmitter disable: A node shall not disable its EIA-485 driver until the stop bit of the final octet of a frame has been generated.

The node shall disable its EIA-485 driver within $T_{\text{postdrive}}$ after the beginning of the stop bit of the final octet of a frame in order that it not interfere with any subsequent frame transmitted by another node. This specification allows, but does not encourage, the use of a "padding" octet after the final octet of a frame in order to facilitate the use of common UART transmit interrupts for driver disable control. If a "padding" octet is used, its value shall be X'FF'. The "padding" octet is not considered part of the frame, that is, it shall be included within $T_{\text{postdrive}}$.

Receive to Transmit turn-around: A node shall not enable its EIA-485 driver for at least $T_{\text{turnaround}}$ after the node receives the final stop bit of any octet.

17. Annex H

17.1 Troubleshooting Procedure

17.1.1 Procedure for Modbus Module

Please proceed as follows:

1. Ensure all 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.
2. Ensure all devices are running at the same baud rate. Confirm this someone may have changed it.
3. Ensure all devices are running at the same communication parameters. Confirm this someone may have changed it.
4. Ensure the communication parameters are the same on Master and on the devices Slaves.
5. Check wiring and power.
6. Bad ground connection between Master and Slaves.
7. Check for reversed polarity on RS485 lines. If uncertain, just try swapping them.
8. With RS485, check termination. Ensure only 2 devices in total are terminated for that Modbus segment.
9. With RS485, check if the bias resistors are used on the Modbus segment.
10. Chop network in half. Does it start to work? Keep chopping until network comes online. This will help narrow down the problem.
11. Have more than 32 Modbus devices on one segment? Not recommended. Break up that segment into separate ones.
12. 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.

Technical Support

For technical support, contact the local Sontex agent or Sontex SA directly.

Hotline Sontex:

support@sontex.ch

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