

## Contents

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## General

All Rheonics SME devices implement a MODBUS RTU compliant RTU slave. The default configuration of the MODBUS RTU slave is 38400 and odd parity. Connection is by RS485-2W (2 wire) where the interface is not electrical isolated.

## Wiring

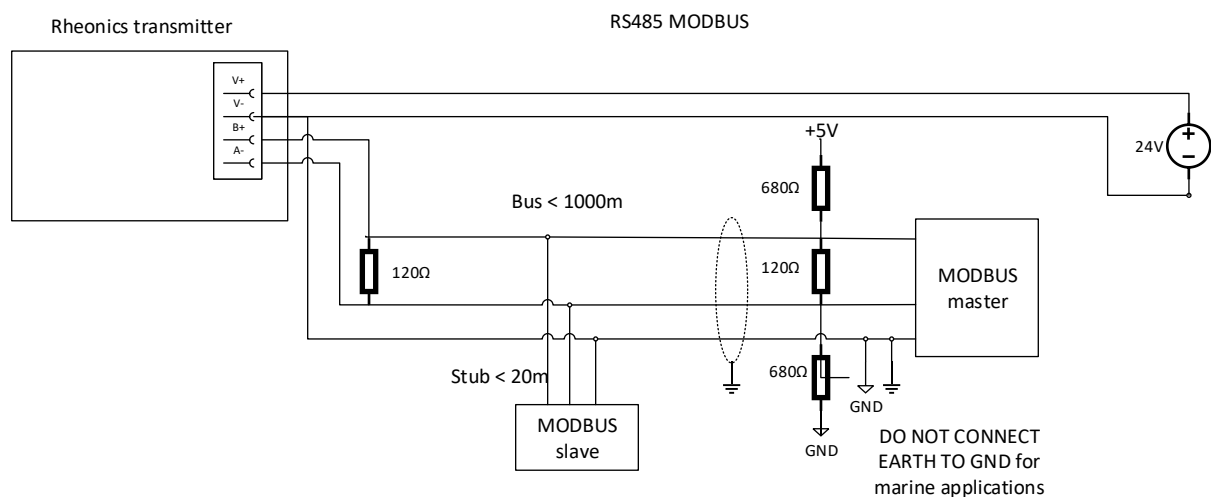
Wiring is RS485-2W. The device does not have internal biasing resistors and termination resistors and proper setup of the RS485 network has to be ensured.

**Termination:** Termination should be only at the end and beginning of the bus to avoid reflections. Requirements on termination differ not only on the baud-rate used but also on the slew-rate of device internal drivers. As a general rule, if there are devices on the RS485 bus that allow fast transmission speeds, and cable lengths exceed a few meters, then termination is required.

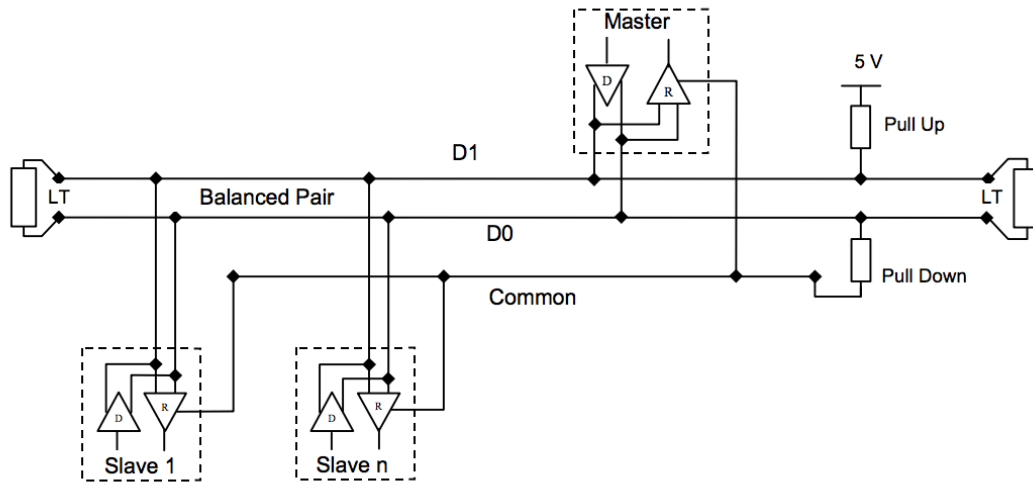
**Biasing:** Biasing of the RS485 BUS is required. If biasing is omitted, communication may work unreliably or not at all. See figure below for Pull-Up/Pull-Down resistors.

**Connections:** Connection stubs on the RS485 bus should be kept to the minimum.

**Common:** RS485 does allow common mode voltages of +12V / -7V. It is therefore recommended to use a common wire to ensure common mode voltage is within safe limits for all receivers. In case of problems it might be necessary to introduce RS485 isolators into the network. The common terminal for the SME device (referred to as Rheonics transmitter sometimes) is the 0V terminal (GND) for the power supply.



Next figure shows multiple Rheonics SME transmitters connected on the RS485 network as Slave 1 to n.



## Configuration

The SME device allows the configuration of the Modbus address using the RCP software. Please refer to the RCP software manual for instructions.

### Factory default settings of Modbus parameters:

address=1

baudrate=38400

parity=ODD

The system is capable of supporting:

- parity settings of odd, even and none
- baudrates of 9600, 19200 and 38400

## Protocol

The SME device uses the Modbus RTU function code x04 to read the analog inputs of the device. All other function codes of the Modbus RTU protocol are for internal use and will not be mentioned in this document.

Function Code (Dec)	Name	Description
04	Read Input Registers	Read Analog Inputs (AI)

The measured parameters are mapped into the Modbus RTU input registers; the variable associated with each parameter is listed in Table 1.

Parameter	Measurand	Description
Parameter 1	Viscosity median	Takes the median of the last 5 sensor measurements points
Parameter 2	Density median	
Parameter 3	Temperature median	
Parameter 4	Viscosity average	Calculates the average of the last 5 measurement points
Parameter 5	Density average	
Parameter 6	Viscosity raw 'process measurement'	Reads the direct measurement taken by the sensor.
Parameter 7	Density raw	
Parameter 8	Temperature raw	
Parameter 9	Viscosity Last Good	Keeps the last-good median measurement in memory when there is a measurement error
Parameter 10	Density Last Good	
Error	Error State	Error state of the sensor

Table 1 Measured parameters list

## Input Registers

For each parameter there is going to be four registers associated; the first two contain the value of the parameter in float data type, and the last two are the value scaled by 100 in Int16 format, and the status of the parameter in Uint16.

The table uses PDU addressing; addresses start at 40. Depending on the PLC used it might be required to add 1 to the addresses/registers in the table below

Address (Dec)	Register (Dec)	Length (Reg.)	Type	Description
<b>Parameter 1</b>				
40	300041	2	Float	Parameter 1 value as float
42	300043	1	Int16	Parameter 1 value scaled by 100 as signed integer

<b>43</b>	300044	1	Uint16	Parameter 1 status (See data-types section)
<b>Parameter 2</b>				
<b>48</b>	300049	2	Float	Parameter 2 value as float
<b>50</b>	300051	1	Int16	Parameter 2 value scaled by 100 as signed integer
<b>51</b>	300052	1	Uint16	Parameter 2 status (See datatypes)
<b>Parameter 3</b>				
<b>56</b>	300057	2	Float	Parameter 3 value as float
<b>58</b>	300059	1	Int16	Parameter 3 value scaled by 100 as signed integer
<b>59</b>	300060	1	Uint16	Parameter 3 status (See datatypes)
<b>Parameter 4</b>				
<b>64</b>	300065	2	Float	Parameter 4 value as float
<b>66</b>	300067	1	Int16	Parameter 4 value scaled by 100 as signed integer
<b>67</b>	300068	1	Uint16	Parameter 4 status (See datatypes)
<b>Parameter 5</b>				
<b>72</b>	300073	2	Float	Parameter 5 value as float
<b>74</b>	300075	1	Int16	Parameter 5 value scaled by 100 as signed integer
<b>75</b>	300076	1	Uint16	Parameter 5 status (See datatypes)
<b>Parameter 6</b>				
<b>80</b>	300081	2	Float	Parameter 6 value as float
<b>82</b>	300083	1	Int16	Parameter 6 value scaled by 100 as signed integer
<b>83</b>	300084	1	Uint16	Parameter 6 status (See datatypes)
<b>Parameter 7</b>				
<b>88</b>	300089	2	Float	Parameter 7 value as float

<b>90</b>	300091	1	Int16	Parameter 7 value scaled by 100 as signed integer
<b>91</b>	300092	1	Uint16	Parameter 7 status (See datatypes)
<b>Parameter 8</b>				
<b>96</b>	300097	2	Float	Parameter 8 value as float
<b>98</b>	300099	1	Int16	Parameter 8 value scaled by 100 as signed integer
<b>99</b>	300100	1	Uint16	Parameter 8 status (See datatypes)
<b>Parameter 9</b>				
<b>136</b>	300136	2	Float	Parameter 9 value as float
<b>138</b>	300138	1	Int16	Parameter 9 value scaled by 100 as signed integer
<b>139</b>	300139	1	Uint16	Parameter 9 status (See datatypes)
<b>Parameter 10</b>				
<b>144</b>	300144	2	Float	Parameter 10 value as float
<b>146</b>	300146	1	Int16	Parameter 10 value scaled by 100 as signed integer
<b>147</b>	300147	1	Uint16	Parameter 10 status (See datatypes)
<b>Error</b>				
<b>514</b>	300514	1	Uint16	Error value

Table 2 Modbus input registers

## Data-Types

**Float:** IEEE754 floating point. This data type spans two registers which should be read together. Depending on the endianness of the host it might be necessary to swap high/low byte and/or the respective registers.

**Int16:** Signed 16 bit integer (register)

**Uint16:** Unsigned 16 bit integer

**Parameter status:** The parameter status is a bitmask of individual status bits. As a general rule Bit 0 checking should be implemented where a set bit corresponds to an error/warning

condition. In case of a critical error the parameter value is also set to NAN (not a number – See IEE754)

**Bit 0:** General error – Check other bits for more detailed configuration

**Bit 1:** Internal configuration error – Restart. If error persists call Rheonics for support

**Bit 2:** Hardware error, e.g. broken temperature sensor. Call Rheonics for support and arrange RMA

**Bit 3:** Dependency error: a parameter is calculated from other parameters and one of the source parameter has an error. Check all other parameters for errors.

**Bit 4:** Device is starting up and no results are ready.

**Bit 5:** Internal error – Restart. If error persists call Rheonics for support.

**Bit 8:** Parameter result is not stable. Check measurement conditions (flow, vibration, etc.)

**Bit 15:** Parameter exceeds sensor upper limit. No results available.

**Bit 14:** Parameter below sensor lower limit. No results available.

**Bit 13:** Parameter value above upper warning range. Measurements might not be accurate and sensor performance might be reduced.

**Bit 12:** Parameter value below lower warning range. Measurements might not be accurate and sensor performance might be reduced.

## Error Status

The error register shows information about the sensor state and measurements. A 0 value means no error.

A combination of values from 1-13 means the sensor is either not attached to the SME or not locking to the right frequency to give an accurate measurement.

And error of 20 indicates that there is no power supply attached to the sensor (24 Volts).

## Modbus RTU Command and Response Examples

Reading the parameter 3, Temperature median, in float data type, from the SMET.

Device Address= 01 = 0x01 (byte).

Address 40057-40001=56 = 0x0038 (word) (Address in Hex of the first register)

Functional code= 04=0x0004 (word)-Read input registers

Number of registers = 02=0x0002 (word)

CRC = CRC16 (Word) (Little Endian)

### Command Structure:

Device Address	Functional Code	Address of the first register (Hi byte)	Address of the first register (Lo Byte)	Number of registers (Hi byte)	Number of registers (Lo byte)	CRC (Lo Byte)	CRC (Hi Byte)
01	04	00	38	00	02	F0	06

### Command Response

Device Address	Functional Code	Number of Bytes	Value of the first register (Hi Byte)	Value of the first register (Lo Byte)	Value of the second register (Hi Byte)	Value of the second register (Lo Byte)	CRC (Lo Byte)	CRC (Hi Byte)
01	04	04	41	B1	5C	29	47	41

Data = **0x41B15C29** = 22.17 (Float)

Temperature median = 22.17 °C (default unit)

### Reading the Parameter 1, Viscosity median, status.

Device Address= 01 = 0x01 (byte).

Address 40044-40001=43 = 0x002B (word) (Address in Hex of the first register)

Functional code= 04=0x0004 (word)-Read input registers

Number of registers = 01=0x0001 (word)

CRC = CRC16 (Word) (Little Endian)

### Command Structure:

Device Address	Functional Code	Address of the first register (Hi byte)	Address of the first register (Lo Byte)	Number of registers (Hi byte)	Number of registers (Lo byte)	CRC (Lo Byte)	CRC (Hi Byte)
01	04	00	2B	00	01	41	C2

### Command Response

Device Address	Functional Code	Number of Bytes	Value of the first register (Hi Byte)	Value of the first register (Lo Byte)	CRC (Lo Byte)	CRC (Hi Byte)
01	04	02	00	01	78	F0



Data = **0x0001** = 1 (Uint16) Referring to the parameter status, this value means a general error occurred.

### Reading the Parameter 8, Temperature raw, Int16 value.

Device Address= 01 = 0x01 (byte).

Address 40099-40001=98 = 0x0062 (word) (Address in Hex of the first register)

Functional code= 04=0x0004 (word)-Read input registers

Number of registers = 01=0x0001 (word)

CRC = CRC16 (Word) (Little Endian)

#### Command Structure:

Device Address	Functional Code	Address of the first register (Hi byte)	Address of the first register (Lo Byte)	Number of registers (Hi byte)	Number of registers (Lo byte)	CRC (Lo Byte)	CRC (Hi Byte)
01	04	00	62	00	01	90	14

#### Command Response

Device Address	Functional Code	Number of Bytes	Value of the first register (Hi Byte)	Value of the first register (Lo Byte)	CRC (Lo Byte)	CRC (Hi Byte)
01	04	02	08	9E	3F	58

Data = **0x089E** = 2206 (Int16)

Since the register value is the temperature scaled by 100. The actual raw temperature value is 22.06 °C.

This register is useful for devices in which single point conversion requires too much computation.

## Changelog

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Version	Description	Date	Name
1.0	Version Creation	27.03.2017	C. Walter
1.1	Update for wiring and map table	26.04.2017	C. Walter
2.0	Update for map, function code, and examples	24.10.2018	M. Hernandez
3.0	Update for last good and error registers	06.02.2020	M. Hernandez