MODBUS OPTION USER GUIDE

Chiller Control

Document number ECG-UG-19-004

IMPORTANT INFORMATION

PURPOSE

This document aims to provide an overview on the MODBUS option implemented on chiller controller.

Document Name	Document ID	Publication Date
MODBUS User Guide	ECG-UG-19-004	July 2019

REFERENCES

The following list includes all documents that may be the source of reference for material discussed in this publication.

- IOM Control
- IOM Machine
- Service Guide

CONVENTIONS

The following symbols are used to highlight important information in this document.

CAUTION

This symbol is used to indicate potentially hazardous situations and conditions.

IMPORTANT

This symbol is used to present information relevant to the topic.

INFORMATION

This symbol is used to provide some useful information.

REVISIONS HISTORY

REV	DATE (yyyy-mm-dd)	DESCRIPTION	DONE BY
Original	2019-07-02	• Original	ER
A	2020-03-12	• Remove mapping to make the document generic to all chillers	ER
B	2020-07-08	• Modbus configuration updated (real_typ, reg32bit descriptions added)	BF
C	2022-01-12	• Recommendation for the refresh time period for Modbus communication added	MG
D	2022-02-17	• Modbus RTU parity settings updated (section 4.1.2)	MG
E	2022-12-01	• Modbus RTU stop bit settings updated (section 4.1.2)	YN
F	2023-03-24	• Modbus RTU stop bit settings updated (section 4.1)	YN
G	2023-04-27	• Mapping interface description updated (section 7)	ER/MG
H	2023-07-13	• Mapping interface description updated (section 7) • IP address setting added (section 3)	MG

ABBREVIATIONS

Abbreviation	Description
CIDR	Classless Inter-Domain Routing
DI	Discrete Input
EXV	Expansion Valve
FC	Free Cooling
HR	Holding Register
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IR	Input Register
Net	Network
OAT	Outside Air Temperature
RTU	Remote Terminal Unit
SCT	Saturated Condensing Temperature
SST	Saturated Suction Temperature
TCP	Transmission Control Protocol
xxLS	..Low Speed
xxHS	..High Speed

CONTENTS

1   INTRODUCTION

1.1   Purpose

This guide describes the Modbus option for chillers. It is intended for Building Management System (BMS) engineers.

All information already provided in the product IOM are not available in this document.

1.2   Modbus

Modbus is *a data communication protocol for building automation and control networks.* It is based on a client-server model.

2 HOW TO TRANSFORM A NON-MODBUS CHILLER TO A MODBUS CHILLER

2.1 Prerequisites

Modbus (option 149B) may be an option which requires a Software Activation Key to be activated. This software-protected option can be factory-installed or installed on-site by a service technician. See section 2.3 to know if a software option key is required.

2.2 Software activation key

The Software Activation Key is an individual license key based on machine MAC address.

To obtain the Software Activation Key

1. Please contact your local Service representative.

2. Please beware that the controller **eth0/J15** MAC address will be requested in order to provide the correct Software Activation Key.

    o   A **sticker** is present on the back of the controller panel (top right location) with J15 MAC.
        The address is coded using 12 digits: XX-XX-XX-XX-XX-XX

    o   You may check the MAC address via the controller **user interface**.
        Go to the Configuration menu and select the *Add Options* menu (ADD_OPT).
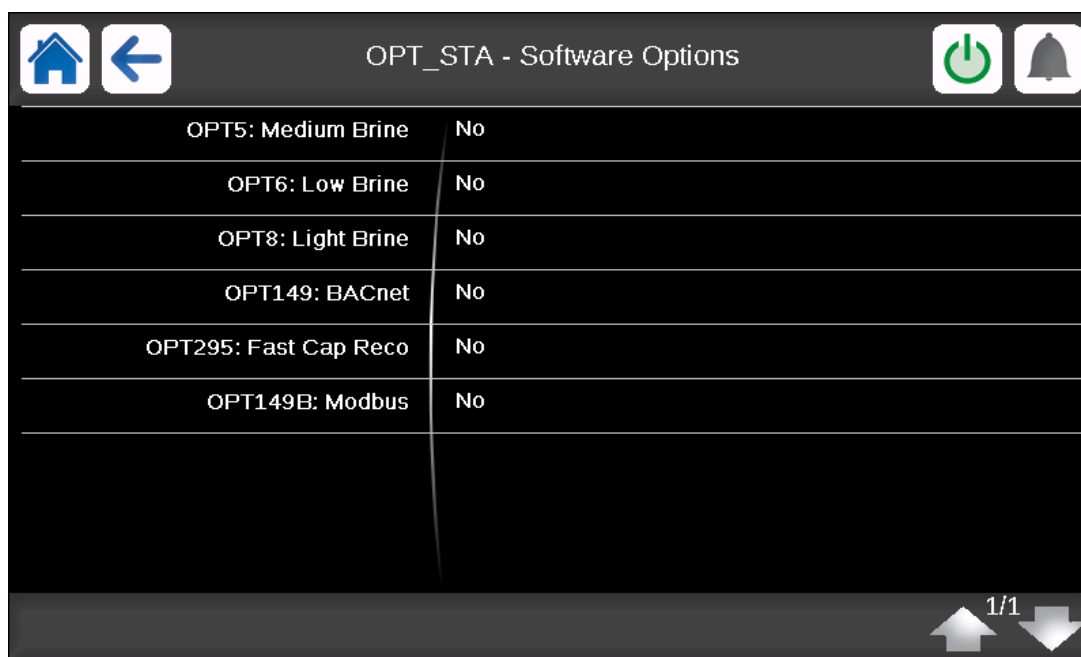   The MAC address will be displayed.
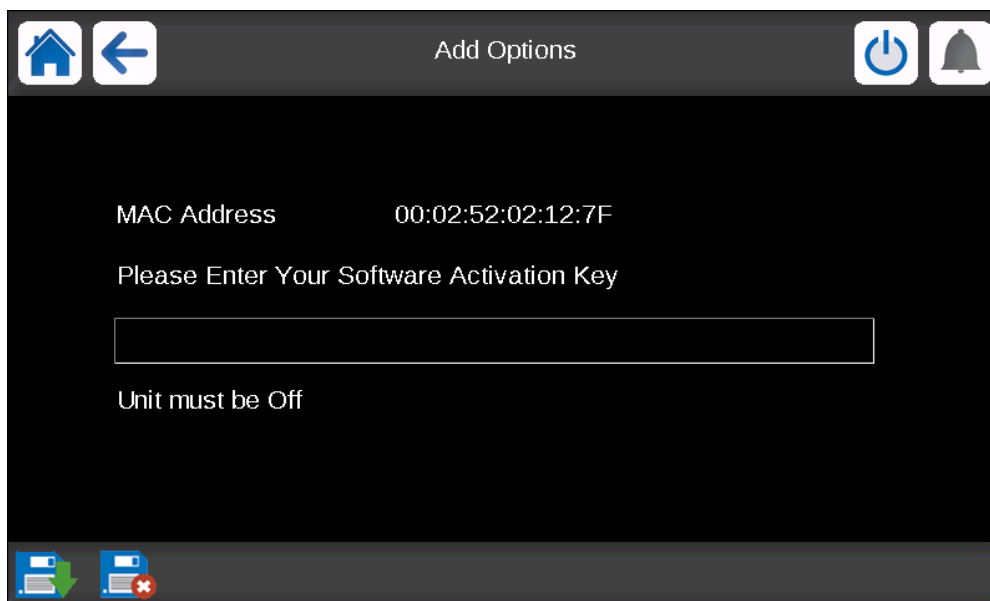
2.3 List of available software options

The list of currently available software options can be verified via the controller user interface.

To verify available software options

1. Go to the Main menu.

2. Select the *Software Options* menu (OPT_STA).
   o The menu can be accessed when logged in (at least user-access level required).

3. If the status of the specific option is set to "Yes", it means that the Software Activation Key for this option is already installed.

4. Verify the status of the "OPT149B: Modbus" parameter.

   o If the status of Modbus option is set to "No", please go to section 2.2 Software activation key

    The Software Options menu is read-only. Once the Software Activation Key is installed, the status of the option that was installed will change to "yes".
The number of options that are available may differ depending on the chiller type.

    In case the controller is replaced, the Software Activation Key must be installed again. Please contact your local Service representative for more information.
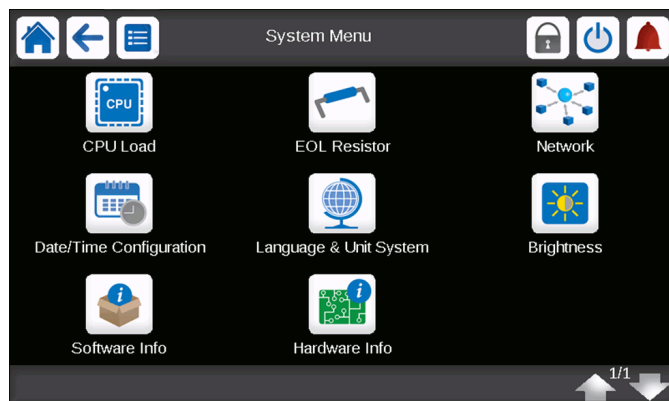
3 IP ADDRESS SETTING

3.1 IP address SmartVu controller

The IP address information can be accessed via the System menu available on the SmartVu user interface.

To go to IP address settings

1. Go to the home screen on the SmartVu user interface.

2. Press the **System** menu button in the upper-right corner of the screen.

3. Select the *Network* menu (NETWORK).

3.2 IP address modification

If necessary, you may change unit IP address on the SmartVu user interface or via the web browser (the web browser interface looks similar to the touch screen).

To modify unit IP address

1. Go to the *Network* menu (NETWORK).
   - The first page displays eth0 (J15) settings.
   - The second page displays eth1 (J16) settings.

2. Change the IP address and mask as necessary.

   IMPORTANT: The Gateway Mask may be displayed differently depending on the software version. As of 2023, the Gateway Mask is in the CIDR format.

   Network screen – version 1

   Network screen – version 2 **(Gateway Mask in CIDR notation)**

   Example: Gateway 169.254.1.3

Gateway mask	Gateway mask in CIDR notation
255.255.0.0	169.254.0.0/16
255.0.0.0	169.0.0.0/8
0.0.0.0	0.0.0.0/0

3. Press the Save button to confirm or the Cancel button to cancel changes.

4   MODBUS FOR CHILLER

The Modbus communication option can be set for Modbus RTU or for Modbus TCP/IP.

To modify Modbus parameters:
- The user must be logged in with a user access level.
- Modbus option must be activated.

4.1   Modbus RTU

Refresh time period for Modbus communication

When setting Modbus communication, it is highly recommended to set the refresh time period to **1 second** or **5 seconds**.

The Modbus communication refresh rate should NOT be too low. For example, if you set the Modbus communication with the refresh time period of 200 ms per point, this is likely to overload the controller and cause some errors.

Note: This refresh time period is defined in the customer Modbus RTU controller.

4.1.1   Modbus Settings

In order to enable/disable the Modbus RTU option:
- Go to the Main menu.
- Navigate to the Configuration menu, and then the Network menu.
- Select the MODBUSRS menu for Modbus over RS485
- Set the "RTU Server Enable" parameter to "Yes".

Available Modbus parameters**:**

Table Name: MODBUSRS		PIC Table Type: 13H	Instance: depends on equipment		//MAINMENU/CONFIG/Network
	Point Name	**Displayed text***	**Status**	**Default**	**Unit**
1	modrt_en	RTU Server Enable	No / Yes	No	-
2	ser_UID	Server UID	1 to 247	1	-
3	metric	Metric Unit	No / Yes	Yes	-
4	swap_b	Swap Bytes	0 to 1	0	-
5		0 = Big Endian			-
6		1 = Little Endian			-
7	baudrate	Baudrate	0 to 2	0	-
8		0 = 9600			-
9		1 = 19200			-
10		2 = 38400			-
11	parity	Parity	0 to 4	0	-
12		0 = No Parity			-
13		1 = Odd Parity			-
14		2 = Even Parity			-
15	stop_bit	Stop bit	0 to 1	1	-
16		0 = One Stop Bit			-
17		1 = two Stop Bits			-
18	real_typ**	Real type management	0 to 1	1	-
19		0 = Float X10			-
20		1 = IEEE 754			-

Table Name: MODBUSRS   **PIC Table Type: 13H**   **Instance: depends on equipment**   **//MAINMENU/CONFIG/Network**

	Point Name	Displayed text*	Status	Default	Unit
21	reg32bit**	Enable 32 bits registers	0 to 1	1	-
22		0 = IR/HR in 16 bit mode			-
23		1 = IR/HR in 32 bit mode			-

* Displayed text may differ depending on the language selected.

** Please note that some configurations are forbidden and they will not work. The following configurations are allowed:

real_typ	reg32bit	Config result
0	0	Float x10 : 16bits
0	1	Float x10 : 32bits
1	1	IEEE 754 : 32bits

In the Excel file containing the list of Modbus points, the "Display mode" column depends on the configuration given above.

- Float X10 correspond to the decimal value multiplied by 10 and displayed using an integer format.
- IEEE 754 correspond to the decimal value displayed using a float format.

    Please note that changing parameters in the Modbus table will require/cause a software reboot.

    Use a Modbus device discovery tool, e.g. ModbusDoctor, to verify communication with Modbus devices – Chiller must be discovered.

4.1.2 MODBUSRS

MODBUSRS	
RTU Server Enable	After a power up, "RTU Server Enable" parameter MUST BE enabled (default configuration is Disable) to start the Modbus RTU driver. This parameter is available in the Configuration menu, inside Modbus RTU Config menu. If the conditions are met, then the Modbus stack is built and chiller objects are created from the existing configuration file `variables_modbus.txt` An easy way to verify that the chiller became a Modbus device is to use a free and easy to use software like "ModbusDoctor".
Server UID	The Modbus server UID value can be modified from 1 to 247. The default value is equal to 1.
Metric Unit	Metric units and Imperial units are supported. By default, Modbus data will be in metric units. Default value = YES
Swap Bytes	The Swap Bytes value can be set to 0 for Big Endian or 1 for Little Endian. The default value is equal to 0 for Big Endian.
Baudrate	The Modbus Baudrate can be set to: • 0 for 9600 bauds, • 1 for 19200 bauds or • 2 for 38400 bauds. The default value is 0 for 9600 bauds.
Parity	The Modbus parity can be set to: • 0 for No parity • 1 for Odd parity • 2 for Even parity When no parity is selected, it is recommended to select two stop bits (see also "stop bit" description below). For example, no parity and one stop bit is NOT recommended. The default value is 0 for No parity.

Stop bit	One (set 0) or Two (set 1) stop bits can be selected.
	    0 = One Stop Bit
	    1 = Two Stop Bits

Real type management	Due to no native floating point representation for the Modbus communication protocol, IEEE754 representation has been integrated. As the opposite, float handled as integer is also available (i.e. float x 10) depending on setup. The Real Type Management can be set to: • 0 for Float X10 configuration or • 1 for IEEE 754 configuration. The default value is 1 for IEEE 754 configuration.
Enable 32 bits registers	Inputs Registers and Holding Registers can be set over 16 bits or over 32 bits. Set Enable 32 bits registers to: • 0 for 16 bits mode • 1 for 32 bits mode The default value is 1 for 32 bits mode.

The Chiller Controller MUST BE in "Network" mode to be controlled from Modbus.
Occupancy status from Modbus is ignored in "Local" mode.

4.2 Modbus TCP/IP

4.2.1 Modbus Settings

In order to enable/disable the Modbus TCP/IP option:
- Go to the Main menu.
- Navigate to the Configuration menu.
- Select MODBUSIP menu.
- For Modbus over TCP/IP, set the "TCP/IP Server Enable" parameter to "Yes".

Available Modbus TCP/IP parameters:

Table Name: MODBUSIP   PIC Table Type: 13H   Instance: depends on equipment   //MAINMENU/CONFIG/Network

	Point Name	Displayed text*	Status	Default	Unit
1	modip_en	TCP/IP Server Enable	No / Yes	No	-
2	ser_UID	Server UID	1 to 247	1	-
3	port_nbr	Port Number	0 to 65535	Yes	-
4	metric	Metric Unit	No / Yes	0	-
5	swap_b	Swap Bytes	0 to 1		-
6		0 = Big Endian			-
7		1 = Little Endian		1	-
8	real_typ**	Real type management	0 to 1		-
9		0 = Float X10			-
10		1 = IEEE 754			-
11	reg32bit**	Enable 32 bits registers	0 to 1	1	-
12		0 = IR/HR in 16 bit mode			-
13		1 = IR/HR in 32 bit mode			-
14	conifnam	IP port interface name	0 to 1	0	-
			0=J5/J15		-
			1=J16		-
15	timeout	Com. timeout (s)	60 to 600	120	sec
16	idle	Keepalive idle delay(s)	0 to 30	10	sec
17	intrvl	Keepalive interval(s)	0 to 2	1	sec
18	probes	Keepalive probes nb	0 to 10	10	-

* Displayed text may differ depending on the language selected.
** Please note that some configurations are forbidden and they will not work. The following configurations are allowed:

real_typ	reg32bit	Config result
0	0	Float x10 : 16bits
0	1	Float x10 : 32bits
1	1	IEEE 754 : 32bits

In the Excel file containing the list of Modbus points, the "Display mode" column depends on the configuration given above.
- Float X10 correspond to the decimal value multiplied by 10 and displayed using an integer format
- IEEE 754 correspond to the decimal value displayed using a float format

> **Please note that changing parameters in the Modbus table will require/cause a software reboot.**

> **Use a Modbus device discovery tool, e.g. ModbusDoctor, to verify communication with Modbus devices – Chiller must be discovered.**

> **Updating controller configuration, including Network IP address, mask address, gateway address parameters MUST be followed by a user power cycle – in order to make these changes effective in Modbus stack.**

4.2.2 **MODBUSIP**

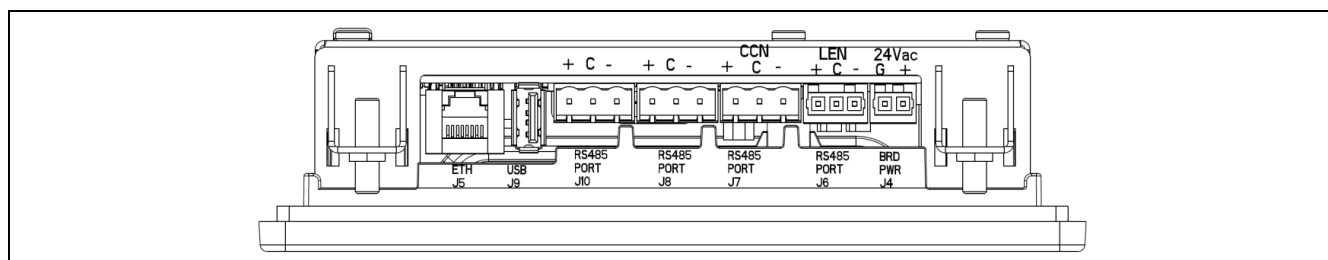| MODBUSIP	
TCP/IP Server Enable	After a power up, "TCP/IP Server Enable" parameter MUST BE enabled (default configuration is Disable) to start the Modbus IP driver. This parameter is available in the Configuration menu, inside Modbus IP Config menu. If the conditions are met, then the Modbus stack is built and chiller objects are created from the existing configuration file `variables_modbus.txt` An easy way to verify that the chiller became a Modbus device is to use a free and easy to use software like "ModbusDoctor".
Server UID	The Modbus server UID value can be modified from 1 to 247. The default value is equal to 1.
Port Number	The Transfer Control Protocol port number for Modbus can be modified from 0 to 65535. The default value is equal to 502.
Metric Unit	Metric units and Imperial units are supported. By default, Modbus data will be in metric units. Default value = YES
Swap Bytes	The Swap Bytes value can be set to 0 for Big Endian or 1 for Little Endian. The default value is equal to 0 for Big Endian.
Real type management	Due to no native floating point representation for the Modbus communication protocol, IEEE754 representation has been integrated. As the opposite, float handled as integer is also available (i.e. float x 10) depending on setup. The Real Type Management can be set to: • 0 for Float X10 configuration or • 1 for IEEE 754 configuration. The default value is 1 for IEEE 754 configuration.
Enable 32 bits registers	Inputs Registers and Holding Registers can be set over 16 bits or over 32 bits. Set Enable 32 bits registers to: • 0 for 16 bits mode • 1 for 32 bits mode The default value is 1 for 32 bits mode.
IP port interface name	IP port can be selected: For 7-inch display, two interfaces are available, default value is 1 (J16). For J15, it shall be set to 0. For 4.3-inch display, only one interface is available, default value is 0 (J5).
Com. timeout (s)	This is the number of seconds to wait to disconnect the TCP Connection when there is no response from the client. It can be configured between 60 and 600 seconds. If the user didn't select the time within in the range, default value of 120 seconds will be enabled to disconnect the TCP connection in case of no communication from the client.
Keepalive idle delay(s)	The number of seconds to keep idle the Modbus connection before to start sending keep alive packets can be configured using the idle value set between 0 and 30 seconds. If the user wants to disable this feature, the points should be set to zero.
Keepalive interval(s)	This value defined the intermediate seconds between each keep alive packet. It can be configured between 0 and 2 seconds. If the user wants to disable this feature, the points should be set to zero.
Keepalive probes nb	This is the number of counts to check before disconnecting the connection if there are no acknowledged packets from the client. Value can bet set between 0 and 10. If the user wants to disable this feature, the points should be set to zero.

The Chiller Controller MUST BE in "Network" mode to be controlled from Modbus.
Occupancy status from Modbus is ignored in "Local" mode.
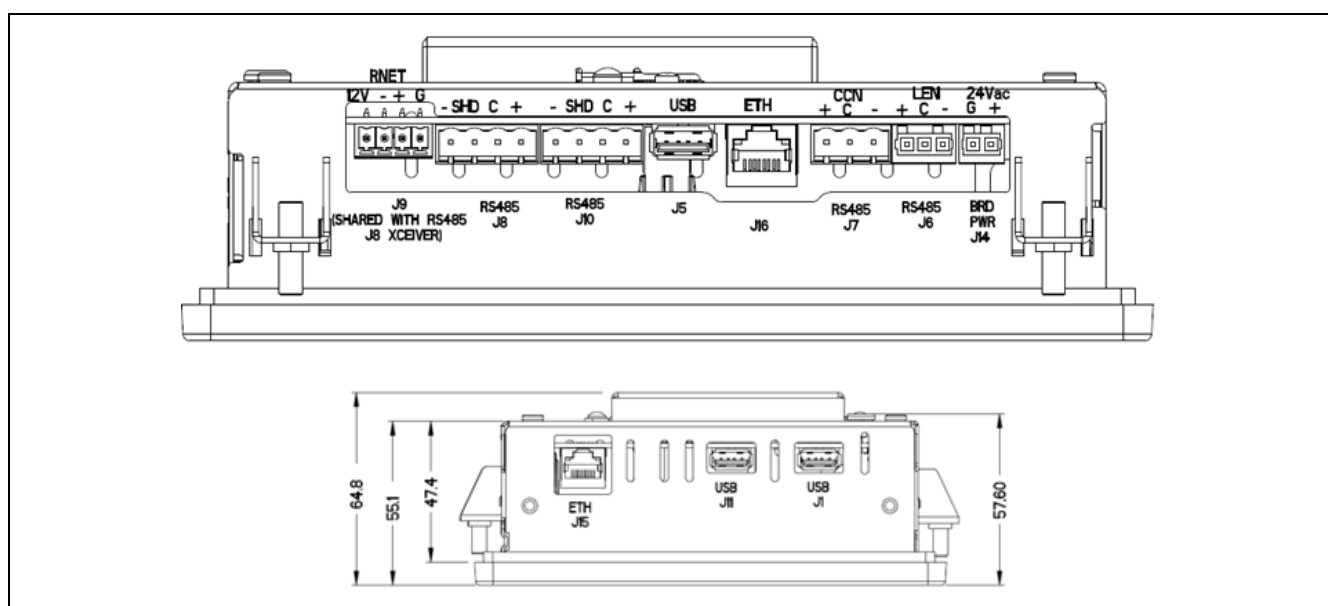**Modbus RS and Modbus TCP/IP cannot run at the same time.**

5   CONNECTION CHANNELS

Diagrams below show sockets available for communication purposes with external devices.

Sockets available for communication on a 4.3-inch interface

Sockets available for communication on a 7-inch interface

5.1   RS485 socket details (Modbus RTU)

Port J10 is intended for Modbus RTU with RS485 (i.e. no control flow).

Transmission mode:

Used for Local area network communication type by external devices.

- With twisted shielded pair.

- Distance up to 1000 m without amplifier.

- Normally configurable at 9600, 19200 or 38400 baud in half duplex.

- Parity bit may be active or deactivated. If parity is disabled, additional stop bits are automatically set for frame timing considerations. Otherwise, parity may be odd or even according to the settings chosen.

    Exclusively RTU mode operates with configurable combination (No ASCII mode permission)
    1 start, 8 data, even parity, 1 stop bit
    1 start, 8 data, odd parity, 1 stop bit
    1 start, 8 data, no parity, 2 stop bits
    1 start, 8 data, no parity, 1 stop bit (NOT recommended)

- RTU protocol is compatible with both Little/ Big Endian for data field (i.e. either most significant byte is sent first or least significant byte is sent first).

- Unit identifier must be declared from 1 to 247 as slave product number setup (i.e. station number)

- Cyclic Redundancy Check is made by the RTU protocol layer as defined in Appendix A of "Modbus over serial line" specification available at modbus.org

- Due to floating no native floating point representation for the Modbus communication protocol, IEEE754 representation has been integrated. As the opposite, float handled as integer is also available (i.e. float X 10) depending on setup.

5.2 RJ45 socket details (Modbus TCP)

RJ45 Ethernet port J5 (4.3" display) or RJ45 Ethernet port J15/J16 (7" display) is/are intended for Modbus IP.
- For a 7-inch display, the default port value is 1 (J16).
- For a 4.3-inch display, the port value is 0 (J5)

Used for wide area network communication type by external devices (building management system tool or maintenance tool and so on…).

- Cross pair wired cable shall be used for nominal configuration.

- Distance up to 100m without amplifier.

- Speed communication at 10 Mega baud not configurable.

- IPv4 address configurable for class address with DHCP NOT active for

  Class A (0.xxx.xxx.xxx to 127.xxx.xxx.xxx)

  Class B (128.0.xxx.xxx to 191. 255.xxx.xxx)

  Class C (192.0.0.xxx to 223.255.255.xxx)

  (IP address declared on the control unit needed to set up connection with external device)

- All requests are sent via Transfer Control Protocol on registered port 502 by default but other port numbers may be set as calibrate value.

- TCP/IP Modbus protocol is compatible with both Little/Big Endian for data field (i.e. either most significant byte is sent first or least significant byte is sent first).

- Unit identifier must be declared from 1 to 247 as slave product number setup (i.e. station number).

6 MODBUS FUNCTIONS

The following standard functions are supported:

Code	Modbus function	Address register range	Application
01 with quantity 1	READ COIL STATUS	0 to 9999 (decimal)	None
01 with quantity N	READ MULTIPLE COIL STATUS (from 1 to 2000max. contiguous)		None
15 with quantity 1	WRITE COIL		None
15 with quantity N	WRITE MULTIPLE COILS (from 1 to 2000max. contiguous)		None
02 with quantity 1	READ DISCRETE INPUT	0 to 9999 (decimal)	Alarms
02 with quantity N	READ MULTIPLE DISCRETE INPUTS (from 1 to 2000max. contiguous)		
04 with quantity 2	READ INPUT REGISTER	0 to 9999 (decimal)	Useful user parameters
04 with quantity NX2	READ MULTIPLE INPUT REGISTERS (from 1 to 123 max. contiguous)		Useful user parameters
03 with quantity 2	READ HOLDING REGISTER	0 to 9999 (decimal)	Configuration or service dataset
03 with quantity NX2	READ MULTIPLE HOLDING REGISTERS (from 1 to 123 max. contiguous)		Configuration or service dataset
16 with quantity 2	WRITE HOLDING REGISTER		Configuration or service dataset
16 with quantity NX2	WRITE MULTIPLE HOLDING REGISTERS (from 1 to 123 max. contiguous)		Configuration or service dataset

7 MAPPING INTERFACE

The point list description is available on demand in an Excel format type.

GENUNIT_STATUS gives information about the current status of the unit.

For Modbus protocol this information is converted in a numerical value in UNIT_STATUS register:

UNIT_STATUS	GENUNIT_STATUS
0	Off
1	Running
2	Stopping
3	Delay
4	Tripout
5	Ready
6	Override
7	Defrost
8	Run Test
9	Test
10	Local
11	Network
12	Remote
13	FreeCool

UNIT_ALM is the equivalent of ALARMRST_ALM (0:Normal, 1:Partial, 2:Shutdown).

UNIT_HEATCOOL is the equivalent of GENUNIT_HEATCOOL (0:Cooling, 1:Heating, 2:Standby, 3:Both).