REFERENCES	
54068-MB (B100M)	54078-MB (R100M)
54069-MB (B150M)	54079-MB (R150M)
54070-MB (B150T)	54080-MB (R150T)
54071-MB (B200M)	54081-MB (R200M)
54072-MB (B200T)	54082-MB (R200T)
54073-MB (B250M)	54083-MB (R250M)
54074-MB (B250T)	54084-MB (R250T)
54075-MB (B300T)	54089-MB (R300T)

ASTRALPOOL HEAT II HEAT PUMP

MODBUS AND AUTOMATION MANUAL V1.0

ASTRALPOOL

CODE: 05470114
EDITION: 3

1. INTRODUCTION TO MODBUS AND PRODUCT

Thank you very much for purchasing the AstralpoolHeat heat pump with MODBUS-RTU features. This manual is intended for professional installer, if you are not, please consult to your official distributor.

MODBUS is an open field bus successfully used through the world to connect field devices to a main controller. This is the reason why MODBUS has been our choice to offer to our customers and partners an automated solution easy to integrate not only with our brand products but also with a vast collection of third party components and controllers.

MODBUS, MODBUS-RTU and other related names are registered trademarks of MODBUS Organization. Further information and documentation can be found at http://www.MODBUS.org/

1.1. PRINCIPLE OF OPERATION

The AstralpoolHeat heat pump implements MODBUS-RTU as a control-communications feature that allows its operation and supervision tasks from a MODBUS automation environment. Preventive maintenance and fault analysis is also possible thanks to the implementation of internal registers in the AstralpoolHeat heat pump with the more relevant operational and error events.

Whenever the AstralpoolHeat heat pump is installed, you are not forced to connect it to a MODBUS system, as far as you do not aim to control or supervise it externally. The AstralpoolHeat heat pump can run in local mode, as traditionally done, without using the MODBUS layer.

However, we expect that the implementation of MODBUS-RTU in the AstralpoolHeat heat pump will open to our advanced customers and partners a wide range of new opportunities and implementation scenarios thanks to the simplicity and flexibility of the MODBUS-RTU layer.

Using a MODBUS-RTU message, the AstralpoolHeat heat pump can report errors, historical data and so on, giving to the user/installer a wide range of new features based in the automation of an already existing and proved AstralpoolHeat heat pump.

1.2. BASIC CHARACTERISTICS

The MODBUS communication system provides a Master/Slave implementation among devices sharing a physical connection. For the AstralpoolHeat heat pump, the physical connection is a RS485 half-duplex serial layer, which has been chosen among other options due to its wide implementation and roughness.

For the AstralpoolHeat heat pump, a RS-485 half duplex wired connection has been implemented and the AstralpoolHeat heat pump is designed to run in a single-master system. In this implementation, Master and Slave figures has a clear role that is crucial to clear understand for a proper system implementation.

Master Device: Device that controls the data exchange in the bus and, if necessary, implements co-ordination tasks among different slaves (i.e. PLC Programmable Logic Controller, SCADA, etc.).

Slave Device: Devices connected to the bus that attends to the requests from the master, either reporting information or executing tasks as per Master request.

2. ELECTRICAL CONNECTIONS

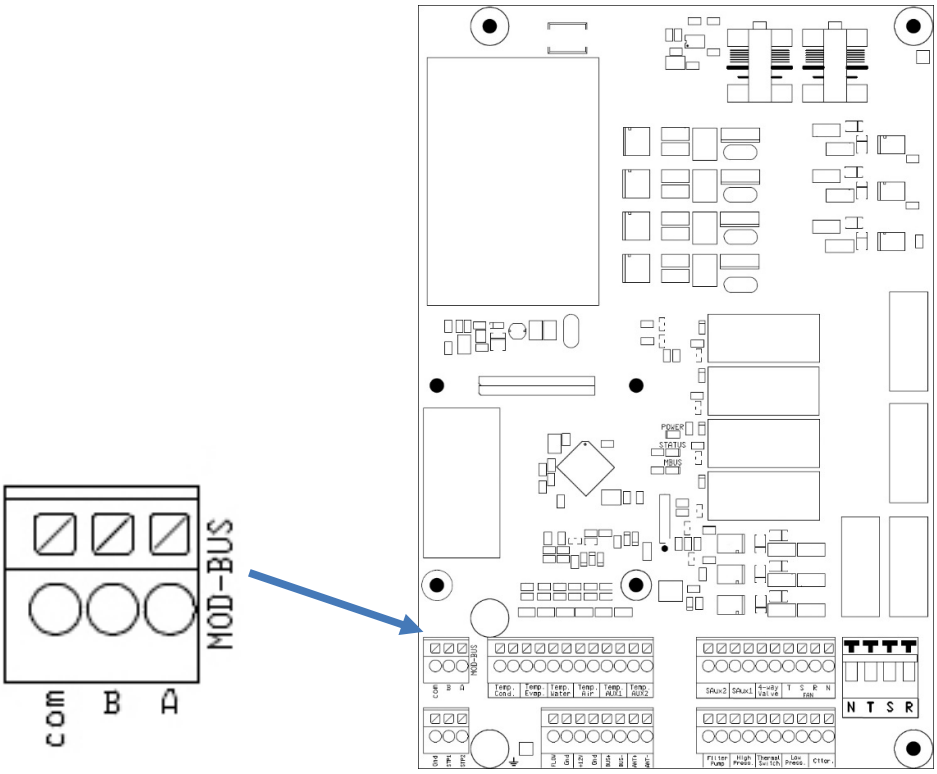

Image 1: electrical connection

Note: some manufacturers assign for the RS-485 port the "A" connection as a "+", and "B" as a "-", while others reverses this nomenclature. The AstralpoolHeat heat pump uses the "A" as "+", and the "B" as "-". Mind this aspect when connecting to the bus devices coming from different manufacturers.

Auxiliary output is an open collector circuit. It can be used to indicate the state of the valve to other systems like PLC, SCADA. The maximum voltage that can be applied between pins 1 and 2 is 30 VDC and 100 mA. An internal resistor of 100Ω limits the maximum current. It refers to Holding Register 0x70. When the valve is in the state selected in the Holding Register 0x70, the circuit below will be closed:

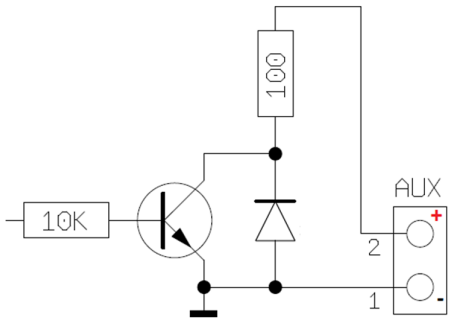

Image 2: auxiliary output

Warning! Reverse polarity could damage the device connected to the auxiliary port.

3. CABLE CHARACTERISTICS

The recommended wiring for a MODBUS-RTU Communication is based in a linear structure, active bus with termination at both ends. It is possible coupling and uncoupling of devices during operation without affecting other devices. The wire shall be twisted and shielded according to EN 50 170.

The values of transmission rate supported for the device, allow maximum cable length of 1,200 m without repeaters, or up to 10 km using repeaters, when installation is according to the standard.

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.

4. BUS ISOLATION AND TERMINATION RESISTORS

If the communication bus is accessible for the user, it shall be double insulated. As far as in general the accessibility of the bus to users will depend on each single installation, safety isolation has NOT been implemented in the AstralpoolHeat heat pump physical bus layer. Moreover, for safety purposes, it is recommended to ensure that other devices sharing this bus also implements this insulation.

Additionally, the use of bus insulated devices not only enhances the security level, furthermore increases the equipment reliability, larger immunity to electromagnetic interference, longer life, higher reliability, more stability over the range of temperatures.

Whenever single or multiple devices are connected sharing a bus physical connection, it is recommended to use terminating resistors at the ends of the bus, even more when use large cable length or high speed data rates. The terminating resistor is used to prevent an RF signal from being reflected back from the end, causing interference. The terminating resistor must be in both ends of the bus, connected in parallel (as shown in the image below). A typical value of this resistance is 120Ω, 0.5W. The value of the resistor must be the same in both ends. The terminating resistors are the resistors R_T of the Image 3: terminating resistors.

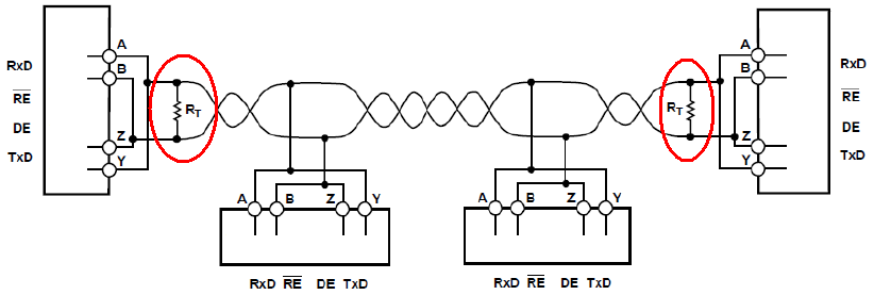

Image 3: terminating resistors

5. BOARD AND PANEL INDICATORS

The AstralpoolHeat heat pump module has a panel with push buttons and a display to indicate its various functions.

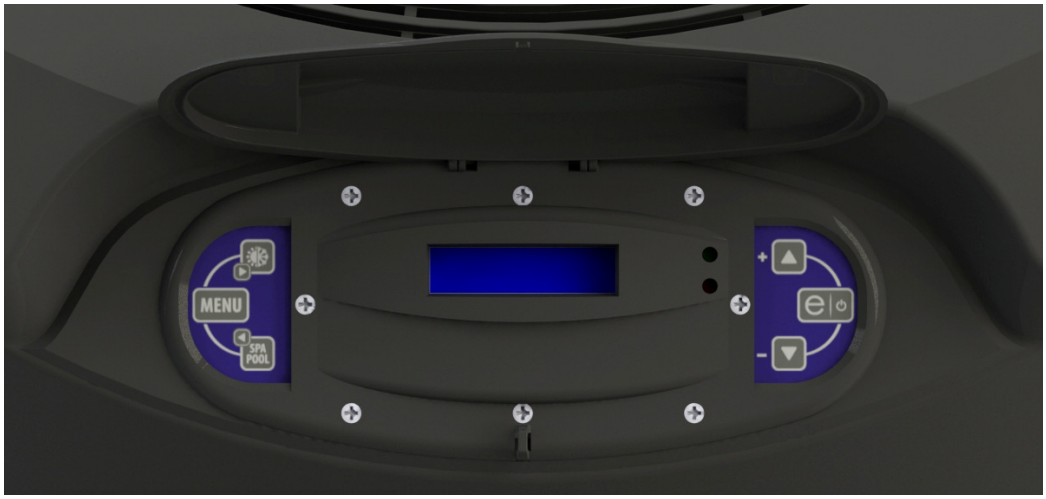

Image 4: keyboard panel

6. MODBUS FUNCTIONS

6.1. FUNCTIONS SUPPORTED

Please, be careful at the possible actuations, and make sure that the function used is the correct.

Functions are implemented according to the MODBUS-RTU standard described in http://www.MODBUS.org/docs/MODBUS_Application_Protocol_V1_1b.pdf. In general registers are unsigned 16 bit coded.

0x01 READ COILS

0x02 READ DISCRETE INPUTS

0x03 READ HOLDING REGISTERS

0x04 READ INPUT REGISTERS

0x05 WRITE SINGLE COIL

0x06 WRITE SINGLE REGISTER

0x0F WRITE MULTIPLE COILS

0x10 WRITE MULTIPLE REGISTERS

0x16 MASK WRITE REGISTER

6.2. EXCEPTION RESPONSES

Exception responses are implemented according to the MODBUS-RTU standard described in the chapter MODBUS exception responses:

http://www.MODBUS.org/docs/MODBUS_Application_Protocol_V1_1b.pdf

The exceptions implemented are from 1 to 4 I 6.

Exceptions of type 4 are used to indicate that you are trying to use or activate a heat pump function that cannot be used in the current configuration.

Exceptions of type 6 are used to indicate that the heat pump is in a transitory state and cannot answer with information that is representative of the state of the pump to a request for information. The master must repeat the operation after a few seconds.

7. DEVICE DESCRIPTION AND CONFIGURATION

7.1. GENERAL DESCRIPTION

In general, there is not check on the constancy of the values sent to specific registers. Therefore is the operator responsibility to check that consistency.

In this manual, the numbers in hexadecimal have been represented with the format **0xZZ**, where ZZ is the number.

The register map that governs heat pump is explained below is in the chapter 0 Basic MODBUS-rtu Register Map.

7.2 OPERATION DIAGRAM

When the system Powers ON, the AtralPoolHeat keyborad panel will turn ON. From this point the AstralPoolHeat will load the configuration parameters, such as setpoint temperatures, temperature units used and so on.

Finally the AtralPoolHeat.will remain in the stop state, waiting a request to heat the water, if the conditions in configuration parameters meet and the "on button is pushed", the appliance will activate the heat pump The **¡Error! No se encuentra el origen de la referencia.** shows this flow.

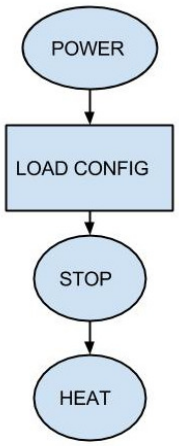

Image 5 Operation diagram

7.3 ADDRESS AND BAUD RATE SELECTION

7.3.1 ADDRESS SETTING

The address of the AP Heat in the bus is set through the 0x00 Holding Register.

ID_Address: Address of the AP Heat in the bus.

Factory setting: 0x06.

Suggested range: 0x06 - 0x0A.

The factory default for the AP Heat is 0x06. However you can change this value by writing this holding register and as far as you check to not introduce collisions or conflicts with other slave's addresses.

Example: changing the ID address from 0x06 (default) to 0x07.

Transmit Message: 06 10 00 00 00 01 02 00 07 C1 A2

Where:

06 is the slave address. (The actual ID address).
10 is the function used. Write Multiple Registers.
00 00 is the address of the first Holding Register to be written.
00 01 is the number of Holding Register to be written. 1 in this case.
02 is the number of bytes of data to be sent.
00 07 is the new ID address.
C1 A2 is the CRC.

7.3.2 BAUD RATE SELECTION

The Baud Rate selection of the serial communications with the AP Heat is set through the 0x01 Holding Register. By default, 9600 bps and 8E1 (8 data bits, Even Parity, 1 stop bit) is implemented. However, 19200 bps, 1 and 2 stop bits with no parity are also supported. It allows us a total of six different configurations.

The reason for supporting N2 frames is to keep the MODBUS standard requirement of sending eleven bits per byte (1 start + 8 data + 1 parity + 1 stop). Whenever an 8N2 configuration is chosen, then 2 stop bits are introduced to keep the eleven bits per byte required by the standard.

Although 8N1 frames are also supported, keep in mind that with this selection you are not fulfilling the MODBUS standard requirements as far as only ten bits per byte are used.

According to this, the baud rate and frame selection is completed defining the baud rate (in bauds), number of data bits, parity and number of stop bits.

COM_Setup: Communication setup

Factory setting:	**0**	**9600, 8E1**
Supported values:	0	9600, 8E1
	1	19200, 8E1
	2	9600, 8N2
	3	19200, 8N2
	4	9600, 8N1
	5	19200 8N1

7.4 BROADCASTING

Broadcasting is not supported by the AP Heat.

8 OPERATION MODES

8.2 BASIC OPTIONS

In this section it is assumed that a successful connection has been established with the AP Heat and therefore, address, baud settings and watchdog behavior has been already set.

The less significant bit corresponds to the bit 0, and the most significant bit corresponds to bit 15.

In section 9 a detailed description of all records defined in the heat pump can be found. This section provides examples of how you can use MODBUS to remotely control and monitor the operation of the heat pump.

8.2.1 TECHNICAL CONFIGURATION OPTIONS

To complete the basic configuration of the pump, we should choose the temperature set point. As we are going to work in POOL mode, edit the Holding Register 0x24, and enter a value in tenths of Celsius degrees (°C) multiple of five. If we want to set a 22.5 ° C value, write the value 225.

06 06 00 24 00 E1 08 3E

Where:

06 is the slave address.

06 is the function used. Preset Single Register.

00 24 is the holding register to be written. 36 in decimal.

00 E1 is the value equivalent to 22, 5°C. 225 in decimal

08 3E is el CRC.

8.2.2 REQUEST WORD

Once we have made the heat pump configuration, we can send an order to power on the heat pump using the Holding Register 0x21.

.bit 2..1 Sets the heat pump in one of these four operation modes:
0x00: Off
0x01: Heat

.bit 3 0: Filtration mode.
1: Comfort mode. Choose if heat pumps commands the filtration pump.

.bit 4 0: Normal
1: ECO or OEM. Choose if energy saving mode is activated.

.bits 9..8 Pool/Spa State. Equivalent to SPA/POOL keys in heat pump console.
0x00: POOL
0x01: SPA
0x10: POOL+SPA

.bit 15 1=°C, 0=°F.

Example: Turn the heat pump in heat mode, Comfort, no energy savings in POOL mode and in degrees Celsius. So we must set the bits 1, 3 and 15.

06 06 00 21 80 0A 39 B0

Where:

06 is the slave address.

06 is the function used. Preset Single Register.
00 21 is the holding register to be written. 33 in decimal.
80 0A the order to power up the unit.
39 B0 is the CRC.

8.2.3 CHECKING STATUS

Once sent the power on command to the heat pump, it is possible via MODBUS, to monitor the operating status of the heat pump. There are different levels of detail provided.

By reading the Input Register 0x00, we can examine the operation mode of the pump.

06 04 00 00 00 01 30 7D

Where:

06 is the slave address.
04 is the function used. Read Input Registers.
00 00 is the address of the first Input Register to be read.
00 01 is the number of records to be read.
30 7D is the CRC.

The heat pump response is:

06 04 02 80 0A ED 37

Where:

06 is the slave address.
04 is the function used. Read Input Registers.
02 is the quantity of bytes received.
80 0A is the state received:
- Bit 15 is 1: centigrade degrees.
- Bits 9...8 are 0: Pool mode.
- Bit 6 and 5 are 0: no defrost nor Standby.
- Bit 4 is 0: No energy saving mode activated.
- Bit 3 is 1: Comfort mode (heat pumps commands the filtration pump).
- Bits 2...1 are 01: Heating mode.
- Bit 0 is 0: There are no alarms.

ED 37 is the CRC.

By Input Register 0x03 we can access more detailed information about the internal state of operation of the heat pump. For example:

06 04 00 03 00 01 C0 7D

Where:

06 is the slave address.
04 is the function used. Read Input Registers.
00 03 is the address of the first Input Register to be read.
00 01 is the number of records to be read.
C0 7D is the CRC.

The heat pump response is:

06 04 02 08 08 0A F6

Where:

06 is the slave address.
04 is the function used. Read Input Registers.
02 is the quantity of bytes received.
08 08 is the state received:
- Bit 14 is 0: There is no external stop.
- Bit 13 is 0: Heat pump connected to POOL (POOL).
- Bit 11 is 1: According to set point and water temperature, there is need to heat.
- Bit 4…1 are 0100: Compressor on.
- Bit 0 is 0: There are no alarms.

0A F6 is the CRC.

8.2.4 TEMPERATURE PROBES READINGS

The values of the readings of the temperature probes installed in the heat pump can be read by the Input Registers 0x07 environment air temperature and 0x08, water temperature.

Specifically, to read water temperature, Input Register 0x08 is to be read.

06 04 00 08 00 01 B1 BF

Where:

06 is the slave address.
04 is the function used. Read Input Registers.
00 08 is the address of the first Input Register to be read.
00 01 is the number of records to be read.
B1 BF is the CRC.

Received response is:

06 04 02 00 C6 8C A2

Where:

06 is the slave address.
04 is the function used. Read Input Registers.
02 is the quantity of bytes received.
00 C6 is the temperature received in tenths of degrees. 198 in decimal equivalent to 19,8°C.
8C A2 is the CRC.

As temperature set point has been set to 22.5°C and the water temperature is 19,8°C, pump, as we have seen with Input Register 0x03 is with the compressor on and heating the water.

8.2.5 DIGITAL INPUTS

The status of the digital inputs of the heat pump can be monitored using the Input Register 0x02

06 04 00 02 00 01 91 BD

Where:

06 is the slave address.

04 is the function used. Read Input Registers.
00 02 is the quantity of bytes received.
00 01 is the number of records to be read.
91 BD is the CRC.

Received response is:

06 04 02 00 77 4C D6

Where:

06 is the slave address.
04 is the function used. Read Input Registers.
02 is the quantity of bytes received.
00 77 is the estate of digital inputs of the system:
- Bit 0 is 1: water flow detected.
- Bit 1 is 1: Fan ON.
- Bit 2 is 1: Compressor ON.
- Bit 3 is 0: 4 way valve off.
- Bit 4 is 1: External stop #1 is 1
- Bit 5 is 1: External stop #2 is 1
- Bit 6 is 1: Filtration pump is on.

8C A2 is the CRC.

The read states correspond to a heat pump that is warming since the water temperature is below the set point.

8.2.6 REAL TIME ALARMS

The state of the alarms of the heat pump can be consulted in real time and available in 0x01 Input register. This input register contains information about the status of alarms at that exact moment of time, activating the corresponding bits by:

.bit 0 Electrical supply alarm
.bit 1 Thermic switch alarm
.bit 2 too many attempts to reset thermal / mini pressure alarms
.bit 3 Fan alarm
.bit 4 4 way valve alarm
.bit 5 Can't perform defrost
.bit 6 Low pressure alarm
.bit 7 High pressure alarm
.bit 8 Ambient temperature probe alarm
.bit 9 No water flow alarm
.bit 10 Water temperature probe alarm
.bit 11 Evaporator coil temperature probe alarm
.bit 15 MODBUS Watchdog alarm

For example:

06 04 00 01 00 01 61 BD

Where:

06 is the slave address.
04 is the function used. Read Input Registers.
00 01 is the address of the first Input Register to be read.
00 01 is the number of records to be read.

61 BD is the CRC.

Received response is:

06 04 02 00 82 8C 91

Where:

06 is the slave address.
04 is the function used. Read Input Registers.
02 is the quantity of bytes received.
00 82 is the status of input digital signals:
- Bit 1 is 1: Thermic switch alarm.
- Bit 7 is 1: High pressure alarm.

8C 91 is the CRC

8.2.7 ALARMS MEMORY

It is possible to view a report on the alarms produced so far. The Holding Register 0x20 contains information about the status of alarms produced until that moment, activating the corresponding bit/s by:

.bit 0 Electrical supply alarm
.bit 1 Thermic switch alarm
.bit 2 too many attempts to reset thermal / mini pressure alarms
.bit 3 Fan alarm
.bit 4 4 way valve alarm
.bit 5 Can't perform defrost
.bit 6 Low pressure alarm
.bit 7 High pressure alarm
.bit 8 Ambient temperature probe alarm
.bit 9 No water flow alarm
.bit 10 Water temperature probe alarm
.bit 11 Evaporator coil temperature probe alarm
.bit 15 MODBUS Watchdog alarm

To check the status of the alarm memory, send the string:

06 03 00 20 00 01 84 77

Where:

06 is the slave address.
03 is the function used. Read Holding Registers.
00 20 is the address of the first Input Register to be read.
00 01 is the number of records to be read.
84 77 is the CRC.

Received response is:

06 03 02 00 CA 8D D3

Where:

06 is the slave address.
03 is the function used. Read Holding Registers.

02 is the quantity of bytes received.
00 CA is the state of the alarms memory:
- Bit 1 is 1: Thermic switch alarm
- Bit 3 is 1: Fan alarm
- Bit 6 is 1: Low pressure alarm
- Bit 7 is 1: High pressure alarm.

8D D3 is the CRC

The values of active bits will remain in that state even after disarming the alarm from the keyboard of the heat pump. To reset its value, do it by directly typing into Holding Register 0x20. It is also reset when the pump loses electrical supply.

Example:

06 06 00 20 00 00 89 B7

Where:

06 is the slave address.
06 is the function used Preset Single Register.
00 20 is the address of the Holding Register to be written.
00 00 is the value to be written
89 B7 is the CRC.

8.2.8 CHECKING COUNTERS

Using MODBUS it is also possible to check the status of operation counters of the heat pump. These counters keep information regarding the number of operation hours of the heat pump, number of times it has been powered off, number of times there has been a defrost, or the number of times the different alarms have risen. These counters, which are defined in a holding record type, can be set to 0.

Example query of the number of heat pump power offs:

06 04 00 06 00 01 D0 7C

Where:

06 is the slave address.
04 is the function used. Read Input Registers.
00 06 is the address of the first Input Register to be read.
00 01 is the number of records to be read.
D0 7C is the CRC.

Received response is:

06 04 02 00 06 8C F2

Where:

06 is the slave address.
03 is the function used. Read Input Registers.
02 is the quantity of bytes received.
00 06 is the number of times the heat pump has been powered off.
8C F2 is the CRC

Example query of the number of times a security series alarm has occurred:

06 03 00 33 00 01 75 B2

Where:

06	is the slave address.
03	is the function used. Read Holding Registers.
00 33	is the address of the Holding Register to be read.
00 01	is the number of records to be read.
75 B2	is the CRC.

Received response is:

06 03 02 00 05 CD 87

Where:

06	is the slave address.
03	is the function used. Read Holding Registers.
02	is the quantity of bytes received.
00 05	is the number of times a security series alarm has occurred
CD 87	is the CRC

8.2.9 ALARM HISTORY

Using MODBUS, we can also access a history of the last 12 alarms produced in the system. This information is stored in holding type records, with addresses between 0x40 and 0x45.

Its use is similar to the historical technical menu, as it also must choose which of the last twelve-saved alarms will consult the information.

Holding register address	Register contents
0x40	Index 1 to 12 indicating age of the alarm. 1 is newest, 12 is oldest. We can read and write this register.
0x41	16-bit word with the information of **active alarms**. Has the same meaning as seen in 8.1.7 section.
0x42	Elapsed 15 minutes units with the pump powered on since the event of the last alarm. 0 to 65535 (16383.75 hours)
0x43	Number of times the heat pump has been powered off since the event of the last alarm. 8 bits of information, therefore values 0-255.
0x44	16-bit word. The upper part contains the type of unit temperature: 0 means ° C, 128 means ° F. The lower part contains the water temperature in units of °.
0x45	16-bit word. The upper part contains the type of temperature unit: 0 means ° C, 128 means ° F. The lower part contains the air temperature in units of °. If the temperature is negative, the value of the lower part will be equal to or greater than 128. 128 will be subtracted to find the absolute value.

An alarm, in order to be stored in the historic, the system must be active (heat pump turned on and with water flow) and the alarm must be active for at least one minute.

For example, if we want to request data from the penultimate alarm occurred in the system:

06 06 00 40 00 02 08 68

Where:

06	is the slave address.
06	is the function used. Preset Single Register.
00 40	is the address of the Holding Register to be written.

00 02 is the value to be written
08 68 is the CRC.

Now, we have to read the holding registry 0x41, with information on the alarm:

06 03 00 41 00 01 D5 A9

Where:

06 is the slave address.
03 is the function used. Read Holding Register.
00 41 is the address of the first Holding Register to be read.
00 01 is the number of records to be read.
D5 A9 is the CRC.

Received response is:

06 03 02 00 82 8D E5

Where:

06 is the slave address.
03 is the function used. Read Holding Registers.
02 is the quantity of bytes received.
00 82 is the alarm's stored information. In this case, reports a high pressure and thermal switch alarm.
8D E5 is the CRC

Now, we read the holding registry 0x42 with information on the time since the alarm:

06 03 00 42 00 01 25 A9

Where:

06 is the slave address.
03 is the function used. Read Holding Register.
00 42 is the address of the first Holding Register to be read.
00 01 is the number of records to be read
25 A9 is the CRC.

Received response is:

06 03 02 00 02 8C 45

Where:

06 is the slave address.
03 is the function used. Read Holding Register.
02 is the quantity of bytes received.
00 02 is elapsed time with heat pump powered on and expressed in 15 minutes units since the alarm raised. In this case, 30 minutes
8C 45 is the CRC

Now, we have to read the holding registry 0x43 with contains information on the number of times the heat pump has been powered off since the alarm raised:

06 03 00 43 00 01 74 69

Where:

06 is the slave address.
03 is the function used. Read Holding Register.
00 43 is the address of the first Holding Register to be read.
00 01 is the number of records to be read
74 69 is the CRC.

Received response is:

06 03 02 00 05 CD 87

Where:

06 is the slave address.
03 is the function used. Read Holding Register.
02 is the quantity of bytes received.
00 05 is the number of times the electrical supply has been disconnected: 5 times since the rise of the alarm.
CD 87 is the CRC

Now, we can read the holding registry 0x44, with information on the water temperature at the time that the alarm occurred:

06 03 00 44 00 01 C5 A8

Where:

06 is the slave address.
03 is the function used. Read Holding Register.
00 44 is the address of the first Holding Register to be read.
00 01 is the number of records to be read
C5 A8 is the CRC.

Received response is:

06 03 02 00 13 4C 49

Where:

06 is the slave address.
03 is the function used. Read Holding Register.
02 is the quantity of bytes received.
00 13 is the water temperature at the time of the alarm rise. In decimal will be 19, so water temperature at the time of the alarm occurrence was 19 °C
4C 49 is the CRC

Now, we can read the holding registry 0x45, with information on the air temperature at the time that the alarm occurred:

06 03 00 45 00 01 94 68

Where:

06 is the slave address.
03 is the function used. Read Holding Register.
00 45 is the address of the first Holding Register to be read.
00 01 is the number of records to be read
94 68 is the CRC.

Received response is:

06 03 02 00 13 4C 49

Where:

06	is the slave address.
03	is the function used. Read Holding Register.
02	is the quantity of bytes received.
00 13	is the air temperature at the time of the alarm rise. In decimal will be 19, so air temperature at the time of the alarm occurrence was 19 °C.
4C 49	is the CRC

9 BASIC MODBUS-RTU REGISTER MAP

The table shown in this chapter is our exclusive and original register map with the name of the function and their address.

To reset the alarm errors, it is necessary to reset it from the Holding Register 0x20 and not from Input Register 0x01 due to, the Input Register 0x01 will reset when the current error alarm disappears. To reset all the alarms, it is necessary to set to 0 the Holding Register 0x20.

Note: a disconnection of the power supply will also reset the latched alarms.

In the register map, in some cases the data is split in two parts due to the size of the information. These parts are the high byte and the low byte. The high byte represents the more significant byte, and the low byte represents the less significant byte.

9.1 HOLDING TYPE REGISTERS (READ) FACTORY SETTINGS.

We can read and write to the registers 0x00 and 0x01.

Name	Address	Initial value	Information
ID_Adress	0x00	6	MODBUS slave address. The addresses assigned to the heat pump are 6 to 10. Returns a type 3 exception if you want to write a different value than 1..255.
COM_Setup	0x01	0	The configuration of the serial communication on the MODBUS. Allowed values: 0: 9600, 8, E, 1 1: 19200, 8, E, 1 2: 9600, 8, N, 2 3: 19200, 8, N, 2 4: 9600, 8, N, 1 5: 19200, 8, N, 1 An invalid value generates a type 3 exception.

9.2 CONFIG HOLDING TYPE REGISTERS (READ/WRITE)

We can read and write the Watchdog_time and the Watchdog_config. The interest of these two registers is to turn OFF the pump when the Watchdog triggers.

Name	Address	Initial value	Information
Watchdog_time	0x10	0	Time in seconds during which the slave can be without receiving MODBUS queries. If this time passes, an exception is thrown. If this value is 0, it is disabled. During the first 30 seconds after powering the pump, the timer does not apply. If the keyboard is disabled, attempts to write a 0 are answered with an exception of type 4. If set to 0, cannot disable the console. Values from 0 to 255 seconds.
Watchdog_config	0x11	0	Response to watchdog error: The low byte indicates what state should the heat pump be after watchdog error: 0: the heat pump stops > 0: heat pump continues in the same state With console disabled, a Watchdog error enables it. When resetting the alarm, the console is disabled again.

9.3. ALARMS & OPERATION HOLDING REGISTERS (READ/WRITE)

<table>
<tr><th>Name</th><th>Address</th><th>Initial value</th><th>Information</th></tr>
<tr><td>Alarm historic</td><td>0x20</td><td>0</td><td>Contains information on alarms that have been activated at some point. Must be reset by writing a 0 from the MODBUS or removing electrical supply. Each bit has a meaning associated with a type of alarm.

<table>
<tr><th>Bit</th><th>Alarm</th></tr>
<tr><td>0</td><td>Electrical supply alarm.</td></tr>
<tr><td>1</td><td>Thermal switch alarm.</td></tr>
<tr><td>2</td><td>If security serie (hight and low presure & termal switches) fails, retry up to three times daily.</td></tr>
<tr><td>3</td><td>Fan alarm.</td></tr>
<tr><td>4</td><td>4 way valve error.</td></tr>
<tr><td>5</td><td>Cannot perform defrost process.</td></tr>
<tr><td>6</td><td>Low pressure switch alarm.</td></tr>
<tr><td>7</td><td>High pressure switch alarm.</td></tr>
<tr><td>8</td><td>Ambient air temperature probe error.</td></tr>
<tr><td>9</td><td>Water flow error.</td></tr>
<tr><td>10</td><td>Water temperature probe error.</td></tr>
<tr><td>11</td><td>Evaporator temperature probe error.</td></tr>
<tr><td>12</td><td></td></tr>
<tr><td>13</td><td></td></tr>
<tr><td>14</td><td></td></tr>
<tr><td>15</td><td>Watchdog de MODBUS. Exceeded the limit time without receiving a MODBUS string.</td></tr>
</table>
</td></tr>
<tr><td>Request_Word</td><td>0x21</td><td>8</td><td>It is the register that allows us to turn on the pump in any possible operation mode. By default, the pump is off in Comfort mode.

bit 0 Not used.
bits 2..1 00 Heat pump off
01 Heat
bit 3 0: Filtration mode
1: Comfort mode. Returns a type 4 exception if comfort mode is not enabled.
bit 4 0: No energy saving mode activated
1: Energy saving mode activated according bits 11..10 of 0x12 register

The first two bits (8 & 9) of the high byte of the register allow us to choose whether we work on pool, SPA or both (Pool + SPA).
00: Pool
01: SPA
10: SPA+POOL

Bit 15 1: Units ° Celsius.
0: Units ° Fahrenheit</td></tr>
<tr><td>Set Point temperature (POOL)</td><td>0x24</td><td>250 o 77</td><td>Temperature set point for pool water. If in ° C, the units are tenths of a degree in multiples of 5. 120-400 tenths of ° C range. If in ° F, write value directly in ° Fahrenheit. Invalid values return a type 4 exception.</td></tr>
</table>

Set Point temperature (SPA)	0x25	250 o 77	Temperature set point for SPA water. If in ° C, the units are tenths of a degree in multiples of 5. 120-400 tenths of ° C range. If in ° F, write value directly in ° Fahrenheit. Invalid values return a type 4 exception.

9.4. COUNTERS & TEST HOLDING REGISTERS (READ ONLY)

We can read a list of counters that gather useful information, this info can help the installation to better understand a hypothetical problem.

Name	Address	Initial value	Information
Hour Quarters Since Last Defrost	0x30	0	Is set to 0 every time a defrost process is performed. From 0 to 65535 quarters of an hour (16383.75 hours).
Total Defrosts	0x31	0	Every time there is a defrost process, increases. When desired, it can be put to 0. Values from 0 to 65535.
Total Power Failure Alarms	0x32	0	Every time there is an electrical supply alarm, increases. When desired, it can be put to 0. Values from 0 to 65535.
Total Security Series Alarms	0x33	0	Every time there is an alarm in security series (thermal and high & low pressure switches), increases. When desired, it can be put to 0. Values from 0 to 65535.
Total Too Many Retries Alarms	0x34	0	Every time there is a too many retries alarm increases. When desired, it can be put to 0. Values from 0 to 65535.
Total Fan Alarms	0x35	0	Every time there is a fan alarm, increases. When desired, it can be put to 0. Values from 0 to 65535.
Total 4 Way Valve Alarms	0x36	0	Every time there is a 4 way valve alarm, increases. When desired, it can be put to 0. Values from 0 to 65535.
Total Can't Perform Defrost Alarms	0x37	0	Every time there is a cannot perform defrost process alarm, increases. When desired, it can be put to 0. Values from 0 to 65535.
Total Low Pressure Alarms	0x38	0	Every time there is a low pressure switch alarm, increases. When desired, it can be put to 0. Values from 0 to 65535.
Total High Pressure Alarms	0x39	0	Every time there is a high pressure switch alarm, increases. When desired, it can be put to 0. Values from 0 to 65535.
Total Ambient Air Temp Probe Alarms	0x3A	0	Every time there is an ambient air temperature probe alarm, increases. When desired, it can be put to 0. Values from 0 to 65535.
Total No Water Flow Alarms	0x3B	0	Every time there is a water flow alarm, increases. When desired, it can be put to 0. Values from 0 to 65535.
Total Water Temp Probe Alarms	0x3C	0	Every time there is a water temperature probe alarm, increases. When desired, it can be put to 0. Values from 0 to 65535.
Total Evaporator Probe Alarms	0x3D	0	Every time there is an evaporator temperature probe alarm, increases. When desired, it can be put to 0. Values from 0 to 65535.

9.5. ALARMS HISTORY HOLDING REGISTERS (READ/WRITE)

These records are writing prohibited except 0x40 register. Attempts to write to other registers are answered with a type 2 exception.

Name	Address	Initial	Information

		value	
Error Historic Index	0x40	1	Historic index of the last 12 saved alarms. Possible values of 1 to 12: 1 most recent alarm 12 oldest alarm. A value not allowed returns an exception of type 4.
Alarm Historic Word	0x41	0	Value it had the Input Register 0x01 at the time of saving the alarm. See description of that record.
Last Error Historic Delay	0x42	0	Elapsed time in hour quarters since the alarm occurred. 0 to 65535 (16383.75 hours).
ON/OFF Number Historic	0x43	0	Number of times that electrical supply has been disconnected since the alarm occurred. From 0-255.
Water Temperature Historic	0x44	0	Water Temperature in degrees (°C or °F) at the time of the alarm. Shown with the same units as the heat pump had at the time of the alarm. This information is in the high byte: 0: ° C, 128: ° F.
Air Temperature Historic	0x45	0	Air Temperature in degrees (°C or °F) at the time of the alarm. Shown with the same units as the pump had at the time of the alarm. This information is in the high byte: 0: ° C, 128: ° F. If the temperature is negative, the value of the low part will be equal to or greater than 128. Subtract 128 to find the absolute value.

9.6. INFORMATION ON THE HEAT PUMP INPUT TYPE REGISTERS (READ)

Name	Address	Initial value	Information
Operation Mode	0x00	0	Reports the operating mode of the heat pump. It is a reflection of the operating orders in the Holding Register 0x21. bit 0 0: No alarms. 1: There is an alarm present. bits 2..1 00 Heat pump off 01 Heat bit 3 0: Filtration mode 1: Comfort mode bit 4 0: No energy saving mode 1: Energy saving mode as on bits 11..10 of holding register 0x12 bit 5 0: No defrost undergoing 1: Defrost undergoing bit 6 is 1 when heat pump is in Standby (Water temp OK, checking water temperature, waiting or checking the flow of water). The first two bits (8 and 9) of the high byte of the record tell us if heat pump works on pool, SPA or both: (Pool + SPA). 00: Pool 01: SPA 10: SPA+POOL bit 15 1: Celsius units 0: Fahrenheit units If the heat pump is in a transition between two operating modes (from off to heat), returns a type 6 exception.
Alarms	0x01	0	Displays the alarms information in real time. Each bit has a meaning associated with a type of alarm.

<table>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>Bit</th><th>Alarm</th></tr>
<tr><td>0</td><td>Electrical supply alarm.</td></tr>
<tr><td>1</td><td>Thermal switch alarm.</td></tr>
<tr><td>2</td><td>If security series (high and low pressure & thermic switches) fails, retry up to three times daily.</td></tr>
<tr><td>3</td><td>Fan alarm.</td></tr>
<tr><td>4</td><td>4 way valve error.</td></tr>
<tr><td>5</td><td>Cannot perform defrost process.</td></tr>
<tr><td>6</td><td>Low pressure switch alarm.</td></tr>
<tr><td>7</td><td>High pressure switch alarm.</td></tr>
<tr><td>8</td><td>Ambient air temperature probe error.</td></tr>
<tr><td>9</td><td>Water flow error.</td></tr>
<tr><td>10</td><td>Water temperature probe error.</td></tr>
<tr><td>11</td><td>Evaporator temperature probe error.</td></tr>
<tr><td>12</td><td></td></tr>
<tr><td>13</td><td></td></tr>
<tr><td>14</td><td></td></tr>
<tr><td>15</td><td>Watchdog de MODBUS. Exceeded the limit time without receiving a MODBUS string.</td></tr>
</table>
</td></tr>
<tr><td>Digital Inputs Status</td><td>0x02</td><td>0</td><td>Indicates the status of the digital inputs:
Bit 0 0: No water flow.
1: Water flow detected.
Bit 1 0: fan off.
1: fan on.
Bit 2 0: compressor off
1: compressor on
Bit 3 0: 4 way valve off
1: 4 way valve on
Bit 4 0: Status of external stop #1 (POOL/SPA PCB)
Bit 5 0: Status of external stop #2 (POOL/SPA PCB)
Bit 6 0: Filtration pump off
1: Filtration pump on</td></tr>
<tr><td>Status</td><td>0x03</td><td>0</td><td>Used to display information regarding the heat pump status from the orders given via keyboard or holding register 0x21.

The information is organized by bits or groups of bits:

bit 0 0: No alarms.
1: There is an alarm present.
bits 1..4 Status (possible values 0 to 15)
0 Heat pump off
1 Alarm
2 Water temperature OK
4 Compressor heating
5 Checking water temperature
6 Air too cold. Heat pump cannot heat water.
7 Defrosting
8 Waiting for water flow
9 Verifying water flow
10 Heat pump off due to low efficiency (EOM)
11 Changing water valves SPA/POOL
12 Initial transitory state
bit 11 Set point demands heating
bit 13 Heat pump working on spa.
bit 14 External STOP</td></tr>
<tr><td>Unit With Electrical Supply</td><td>0x04</td><td>0</td><td>Units expressed in hours. From 0 to 65535 hours.</td></tr>
</table>

Total Hours Counter			
Hours Counter Since Last Operation	0x05	0	Elapsed time since heat pump came to meet the set point. Units in quarters of hour. 0 to 65535 (16383.75 hours)
Times Electrical Supply Has Been Removed Counter	0x06	0	It is incremented each time the heat pump loses electrical supply. 0 to 65535.
Ambient Air Probe Temperature	0x07		Shown in tenths of degree, °C or °F units. If the number is equal to or greater than 1000, means that it is a negative reading. For the absolute value, subtract 1000. (For example: 1042 is - 4.2 ° C and 1015 is - 15 ° F)
Water Probe Temperature	0x08		Shown in tenths of a degree both Celsius and Fahrenheit. (example: 196 is 19.6 °)

9.7. HEAT PUMP CONFIG; COIL TYPE REGISTERS (READ/WRITE)

These registers are oriented to a bit data type. Heat pump will only use these to activate some settings. They are equivalent to the corresponding bits of holding registers types.

Name	Address	Initial value	Information
Filtration Pump Control	0x120	1	Heat pump can control de filtration pump.
Console enabled	0x121	1	We can use the heat pump keyboard. Cannot disable (0) if the MODBUS watchdog is 0; such attempt will raise a type 4 exception.
Wireless Remote Enabled	0x122	1	Wireless remote controller can be used.
POOL/SPA Enabled	0x123	0	Heat pump can be used on pool or/and spa.
Reversible Defrost Enabled	0x124	0	Can only be activated if before we have configured that the heat pump has 4-way valve, if not, will raise a type 4 exception.
Defrost By Fan Enabled	0x125	1	Activates fan defrost if 0x124 is 0.
Comfort Enabled	0x128	1	The heat pump controls the filtration pump. First we have to activate the coil 0x120, if not, will raise a type 4 exception.
Comfort SPA Enabled	0x129	1	The heat pump controls the SPA filtration pump. First we have to activate the coil 0x120, if not, will raise a type 4 exception.
Energy Saving Low Bit	0x12A	0	The combination of these two bits allows us to choose the energy mode: 00 ECO 01 OEM *** 10 OEM **** 11 OEM *****
Energy Saving High Bit	0x12B	0	
External Control	0x12C	0	External system controls Pool/Spa change.
Electrical Supply Error	0x200	0	Allows writing a 0 to reset the Electrical Power Failure alarm memory. If we try to write a 1 it returns a type 2 exception.
Thermic Switch Open	0x201	0	Allows writing a 0 to reset the thermic switch Failure alarm memory. If we try to write a 1 it returns a type 2 exception.
Security Series (Thermic-High Low Pressure Switch) Repeated Alarm	0x202	0	Allows writing a 0 to reset the repeated failure (thermic-pressure switch) Failure alarm memory. If we try to write a 1 it returns a type 2 exception.

Fan Error	0x203	0	Allows writing a 0 to reset the fan failure alarm memory. If we try to write a 1 it returns a type 2 exception.
4 Way Valve Error	0x204	0	Allows writing a 0 to reset the 4 way valve Failure alarm memory. If we try to write a 1 it returns a type 2 exception.
Cannot Perform Defrost Process	0x205	0	Allows writing a 0 to reset the cannot perform defrost process Failure alarm memory. If we try to write a 1 it returns a type 2 exception.
Low Pressure Switch	0x206	0	Allows writing a 0 to reset the low pressure switch Failure alarm memory. If we try to write a 1 it returns a type 2 exception.
High Pressure Switch	0x207	0	Allows writing a 0 to reset the high pressure switch Failure alarm memory. If we try to write a 1 it returns a type 2 exception.
Ambient Air Temperature Probe Error	0x208	0	Allows writing a 0 to reset the ambient air probe reading Failure alarm memory. If we try to write a 1 it returns a type 2 exception.
No Water Flow	0x209	0	Allows writing a 0 to reset the water flow Failure alarm memory. If we try to write a 1 it returns a type 2 exception.
Water Temperature Probe Error	0x20A	0	Allows writing a 0 to reset the water temperature probe reading Failure alarm memory. If we try to write a 1 it returns a type 2 exception.
Evaporator Temperature Probe Error	0x20B	0	Allows writing a 0 to reset the evaporator temperature probe reading Failure alarm memory. If we try to write a 1 it returns a type 2 exception.
MODBUS Watchdog	0x20F	0	Allows writing a 0 to reset the watchdog Failure alarm memory. If we try to write a 1 it returns a type 2 exception.
Low Bit Heat Pump Operation Mode	0x211	0	The combination of these two bits allows us to choose the operation mode of the heat pump: 00 Heat pump off 01 Heat
High Bit Heat Pump Operation Mode	0x212	0	
Heat Pump Control Type	0x213		0: Filtration (independent filtration pump) 1: Comfort (the filtration pump is controlled)
Energy Saving Mode	0x214	0	0: There is no energy saving mode active. 1: Energy saving mode active, according bits 11..10 of register 0x12
Low Bit Pool/SPA Mode	0x218	0	The combination of these two bits allows us to choose the operation mode of Pool/SPA: 00: Pool 01: SPA 10: SPA+POOL
High Bit Pool/SPA Mode	0x219	0	
Temperature Units	0x21F	0	1: ° Celsius units. 0: ° Fahrenheit units.
Low Bit Filtration ON Con. To Slave	0x220		The combination of these two bits allows us to choose the mode of operation of Filtration ON Con To Slave (not yet operational):
High Bit Filtration ON Con. To Slave Pool/SPA	0x221		Low bit: When set to 1 indicates to the heat pump that the filtration pump is turned on after the heat pump asked for it; meaning that heat pump request has been evaluated. High bit: When set to 1 indicates to the heat pump that the filtration pump is stopped after the heat asked for it; meaning that heat pump request has been evaluated. It is not yet operational.

9.8. DISCRETE INPUT TYPE REGISTERS (READ) INFORMATION ON HEAT PUMP

Name	Address	Initial value	Information
Alarm	0x000	0	0: No alarms. 1: There is an active alarm.
Low Bit Heat Pump Operation Mode	0x001	0	The combination of these two bits informs us of about heat pump status: 00 Heat pump off 01 Heat
High Bit Heat Pump Operation Mode	0x002	0	
Heat Pump Control Type	0x003	0	0: Filtration (independent filtration pump) 1: Comfort (the filtration pump is controlled)
Energy Saving Mode	0x004	0	0: There is no energy saving mode active. 1: Energy saving mode active, according bits 11..10 of register 0x12
Performing Defrost Process	0x005	0	0: No defrost undergoing 1: Defrost undergoing
Standby	0x006	0	1 when heat pump is in Standby mode (Water temperature OK, checking water temperature, waiting or checking water flow).
Low Bit Pool/SPA Mode	0x008	0	The combination of these two bits allows us to choose the operation mode of Pool/SPA: 00: Pool 01: SPA 10: SPA+POOL
High Bit Pool/SPA Mode	0x009	0	
Temperature Units	0x00F	0	1: ° Celsius units. 0: ° Fahrenheit units.
Electrical Supply Error	0x010	0	Electrical power supply error.
Thermic Switch Open	0x011	0	Thermic switch error.
Safety Series (Thermic-High Low Pressure Switch) Repeated Alarm	0x012	0	Too much repeated failures in safety series (high and low pressure & thermal switches). Attempt reset up to three times daily.
Fan Error	0x013	0	Fan does not work correctly.
4 Way Valve Error	0x014	0	4 way valve does not work correctly.
Cannot Perform Defrost Process	0x015	0	Cannot perform defrost process.
Low Pressure Switch	0x016	0	Low pressure switch error.
High Pressure Switch	0x017	0	High pressure switch error.
Ambient Air Temperature Probe Error	0x018	0	Ambient temperature probe reading error.
No Water Flow	0x019	0	No water flow.
Water Temperature Probe Error	0x01A	0	Water temperature probe reading error.
Evaporator Temperature Probe Error	0x01B	0	Evaporator temperature probe reading error.
MODBUS	0x01F	0	MODBUS Watchdog. You have exceeded the limit time

Watchdog			without receiving MODBUS string.
Water Flow Error	0x020	0	0: No water flow. 1: Water flow detected.
Fan Error	0x021	0	0: Fan off. 1: Fan on.
Compressor Status	0x022	0	0: Compressor off. 1: Compressor on.
4 Way Valve Status	0x023	0	0: 4 way valve off. 1: 4 way valve on.
External Input #1 (POOL/SPA)	0x024	0	0: External stop #1 off. 1: External stop #1 on.
External Input #2 (POOL/SPA)	0x025	0	0: External stop #2 off. 1: External stop #2 on.
Filtration Pump	0x026	0	0: Filtration pump off 1: Filtration pump on
Alarm	0x030	0	0: No alarms. 1: An alarm is active.
Bit 0 of the Heat Pump Status	0x031	0	The combination of these 4 bits is used to display (with a value from 0 to 15) status information regarding heat pump status from the orders given with the keyboard, with Holding registers 0x21 or 0x211 & 0x212 coils: Bit 0 Heat pump off. Bit 1 Error. Bit 2 Water temperature OK. Bit 3 Bit 4 Compressor heating. Bit 5 verifying temperature. Bit 6 Too cold air, heat pump cannot heat water. Bit 7 Defrost process. Bit 8 Waiting for water flow. Bit 9 Verifying water flow. Bit 10 Heat pump off due to low efficiency (EOM). Bit 11 Moving water valves (SPA/POOL). Bit 12 Initial transitory state Bit 11 Set point demands heating. Bit 12 Bit 13 Heat pump working on SPA. Bit 14 External STOP
Bit 1 of the Heat Pump Status	0x032	0	
Bit 2 of the Heat Pump Status	0x033	0	
Bit 3 of the Heat Pump Status	0x034	0	
Set point requires Heating	0x03B	0	0: Required conditions for heating not met. Heat pump off 1: Required conditions for heating water are met.
SPA Connected	0x03D	0	0: Heat pump working on Pool. 1: Heat pump working on SPA.
External STOP	0x03E		0: There is no external stop. 1: External stop detected.

10. PRODUCT REVISION

Manual v.0.5 : All the information of this manual, describes the behavior of the Hardware Version 9130, and Software Version 3.14.

Changelog:

ASTRALPOOLHEAT ENG

ASTRALPOOLHEAT ESP

ASTRALPOOLHEAT FRA

ASTRALPOOLHEAT ITA