	REFERENCES		
	ALASKA	SIBERIA	BERING
EF-4	32535	33301	66306
EF-6	32536	33302	66307
EF-8	32537	33303	66308
EF-10	32538	33304	66309
EF-15	32540	33306	66311
EF-17	32541	33307	66312

ALASKA – SIBERIA - BERING COMPACT CHILLER UNITS

MODBUS AND AUTOMATION MANUAL V1.0

ALASKA

SIBERIA

BERING

EDITION: 1

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1. INTRODUCTION TO MODBUS AND PRODUCT

Thank you very much for purchasing the EF compact chiller unit 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 EF compact chiller unit 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 EF compact chiller unit with the more relevant operational and error events.

Whenever the EF compact chiller unit 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 EF compact chiller unit can run in local mode, as traditionally done, without using the MODBUS layer.

However, we expect that the implementation of MODBUS-RTU in the EF compact chiller unit 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 EF compact chiller unit 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 EF compact chiller unit.

1.2. BASIC CHARACTERISTICS

The MODBUS communication system provides a Master/Slave implementation among devices sharing a physical connection. For the EF compact chiller unit, 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 EF compact chiller unit, a RS-485 half duplex wired connection has been implemented and the EF compact chiller unit 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

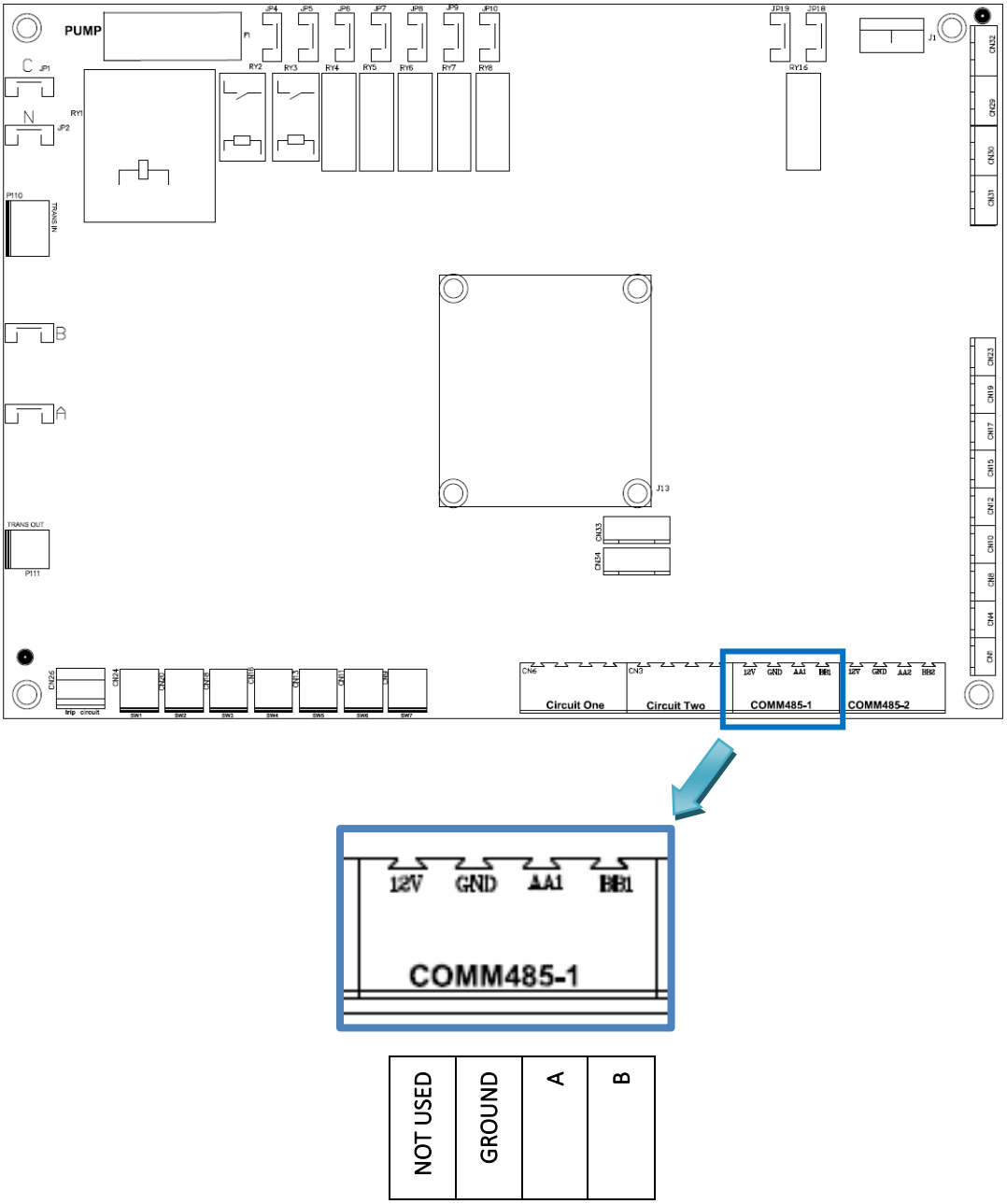


Image 1: electrical connection

Note: some manufacturers assign for the RS-485 port the “A” connection as a “+”, and “B” as a “-“, while others reverses this nomenclature. The EF compact chiller unit uses the “A” as “+”, and the “B” as “-”. Mind this aspect when connecting to the bus devices coming from different manufacturers.

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 EF compact chiller unit 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.

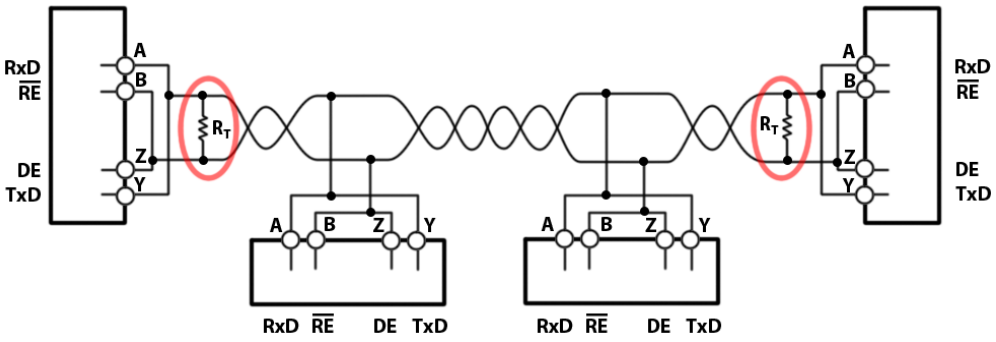
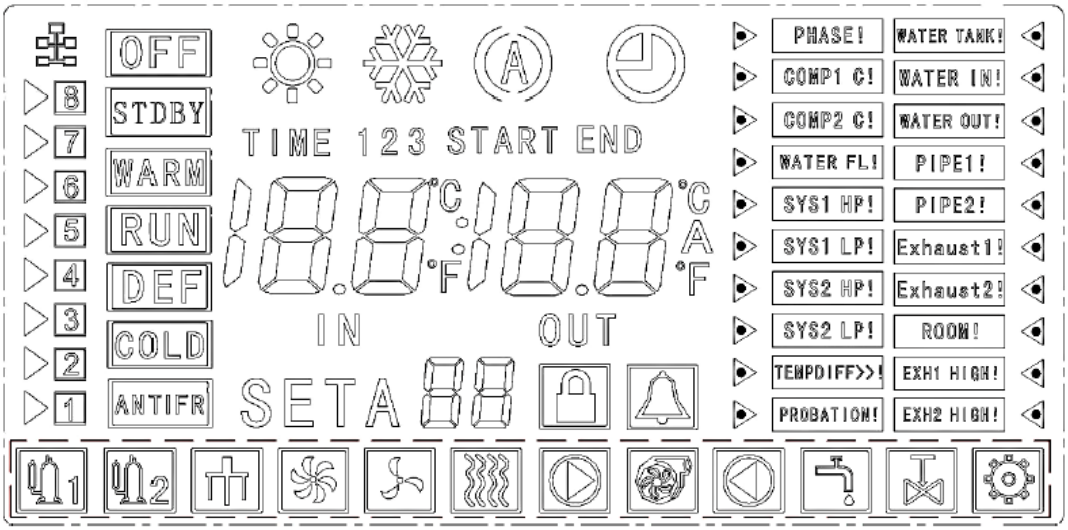


Image 2: terminating resistors

5. BOARD AND PANEL INDICATORS

The EF compact chiller unit module has a panel with push buttons and a display to indicate its various functions.



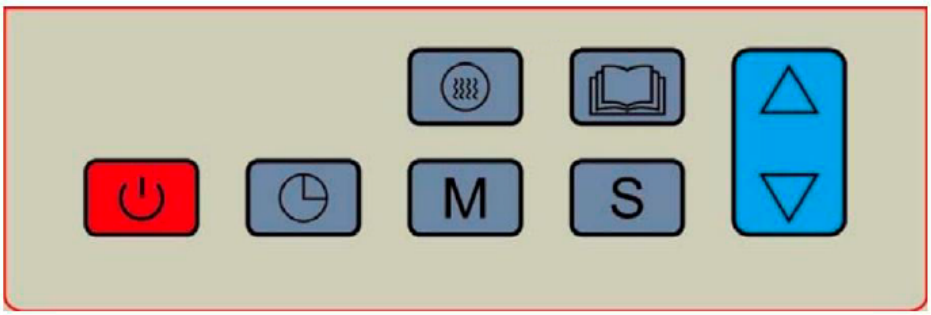


Image 3: keyboard panel

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 **(not implemented)**

0x06 WRITE SINGLE REGISTER **(not implemented)**

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 9: Basic MODBUS-rtu Register Map.

7.2 OPERATION DIAGRAM

When the system Powers ON, the keyborad panel will turn ON. From this point the EF chiller unit will load the configuration parameters, such as setpoint temperatures, temperature data and so on.

Finally, it will remain in the stop state, waiting a request to chill the water, if the conditions in configuration parameters are met and the “on button is pushed”, the appliance will activate the unit. The image 5 shows this flow.

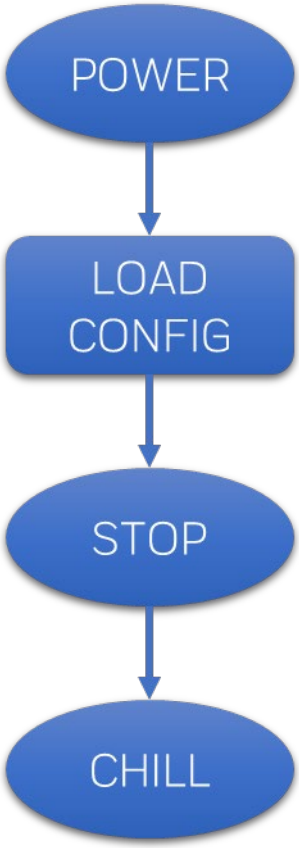


Image 4 Operation diagram

7.3 ADDRESS AND BAUD RATE SELECTION

7.3.1 ADDRESS SETTING

The address of the EF compact chiller unit in the bus is set through the 0x00 Holding Register.

ID_Address: Address of the EF chiller unit in the bus.

Factory setting: 0x09.

Suggested range: 0x06 - 0x0A.

The factory default for the EF chiller unit is 0x09. 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 0x09 (default) to 0x07.

Transmit Message: 09 10 00 00 00 01 02 00 07 80 52

Where:

09	is the slave address. (current 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.
80 52	is the CRC.

7.3.2 BAUD RATE SELECTION

The Baud Rate selection of the serial communications with the EF chiller unit 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 EF chiller unit.

8 OPERATION MODES

8.2 BASIC OPTIONS

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

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

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 set point temperature. Edit the Holding Register 0x24 and enter a value in tenths of Celsius degrees (°C) multiple of ten. If we want to set a 30° C value, write the value 300:

09 10 00 24 00 01 02 01 2C C7 39

Where:

09	is the slave address.
10	is the function used. Write multiple holding registers.
00 24	is the starting address.
00 01	is the quantity of registers to be written.
02	is the number of bytes of data to be sent.
01 2C	is the written value: 01 2C in hexadecimal corresponds to 300 in decimal.
C7 39	is the CRC.

8.2.2 REQUEST WORD

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

.bit 2..1	Sets the unit in one of these operation modes: 01: Heat. (if the machine is able). 10: Chill (if the machine is able). 11: Auto (if the machine is able).
.bit 3	0: Filtration mode. 1: Comfort mode. Choose if heat pumps commands the filtration pump.
.bit 8	Device start / stop: 1 / 0.

Example: Turn on the unit in chill mode, Comfort. So, we must set the bits 1, 2, 3 and 8 to 1:

09 10 00 21 00 01 02 01 0C C6 B4

Where:

09	is the slave address.
10	is the function used. Write multiple registers.
00 21	is the starting address (33 in decimal).
00 01	is the number of registers to be written.
02	is the number of bytes of data to be sent.
01 0C	the bits to transmit: 0000 0001 0000 1100
C6 B4	is the CRC.

If we only want to set the machine on and off, we can do it using coils: Coil 0x218 will do the task. Setting the machine ON:

09 0F 02 18 00 01 01 01 CF 11

Where:

09	is the slave address.
0F	is the function used. Write multiple coils.
02 18	is the starting address (536 in decimal).
00 01	is the number of registers to be written.
01	is the number of bytes of data to be sent.
01	is the written value.
CF 11	is the CRC.

Setting the machine OFF:

09 0F 02 18 00 01 01 00 0E D1

Where:

09	is the slave address.
0F	is the function used. Write multiple coils.
02 18	is the starting address (536 in decimal).
00 01	is the number of registers to be written.
01	is the number of bytes of data to be sent.
00	is the written value.
0E D1	is the CRC.

8.2.3 CHECKING STATUS

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

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

09 04 00 00 00 01 30 82

Where:

09	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 82	is the CRC.

The machine response is:

09 04 02 00 0C 58 F4

Where:

09	is the slave address.
04	is the function used. Read Input Registers.
02	is the quantity of bytes received.

00 0C is the state received: 0000 0000 0000 1100

- Bits 1 & 2 = 10 → Cooling mode.
- Bit 3 = 1 → Comfort mode.
- Bit 8 = 0 → Machine is off.

58 F4 is the CRC.

8.2.4 TEMPERATURE PROBES READINGS

The values of the readings of the temperature probes installed in the unit can be read. As an example, we can read ambient temperature and inlet & outlet water temperatures:

By reading the Input Register 0x07 to 0x09, we get those values:

08 04 00 07 00 03 01 53

Where:

08 is the slave address.
04 is the function used. Read Input Registers.
00 07 is the address of the first Input Register to be read.
00 03 is the number of records to be read.
01 53 is the CRC.

The unit's response is:

09 04 06 00 9F 00 97 00 95 E2 CC

Where:

09 is the slave address.
04 is the function used. Read Input Registers.
06 is the quantity of bytes received.
00 9F 00 97 00 95 are the values read:

- 00 9F is hexadecimal so 159 in decimal: corresponds to 15,9°C.
- 00 97 = 151 in decimal: corresponds to 15,1°C.
- 00 95 = 149 in decimal: corresponds to 14,9°C.

E2 CC is the CRC.

8.2.5 REAL TIME ALARMS

The state of the alarms of the unit can be consulted in real time and available in 0x01 and 0x0E Input registers. This input registers contain information about the status of alarms at that exact moment of time.

For instance, we can read Input register 0x01 to see if there is any alarm present:

09 04 00 01 00 01 61 42

Where:

09	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 42	is the CRC.

The unit's response is:

09 04 02 00 00 58 F1

Where:

09	is the slave address.
04	is the function used. Read Input Registers.
02	is the quantity of bytes received.
00 00	is the read value, that corresponds to 0000 0000 0000 0000 in binary: No alarms.
58 F1	is the CRC.

If we simulate an error, the received message from the heat pump would be:

09 04 02 00 80 59 51

Where:

09	is the slave address.
04	is the function used. Read Input Registers.
02	is the quantity of bytes received.
00 80	is the read value, that corresponds to 0000 0000 1000 0000 in binary: Indicates a high-pressure alarm on circuit 1: bit 7 = 1.
59 51	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.

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	8	MODBUS slave address. The addresses assigned to the heat pump are 8 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. HOLDING REGISTERS OPERATION (READ/WRITE)

Name	Address	Initial value	Information
Request_Word	0x21		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 Device mode: 00 Not used 01 Heat (if the machine is able) 10 Cool (if the machine is able) 11 Auto (if the machine is able) bit 3 0: Filtration mode 1: Comfort mode. bit 4 00 Not used bit 5 00 Not used bit 6 00 Not used bit 7 00 Not used bit 8 Device status control 0 OFF 1 ON bit 9 00 Not used bit 10 00 Not used bit 11 00 Not used bit 12 00 Not used bit 13 00 Not used bit 14 00 Not used bit 15 00 Not used

Set Point temperature	0x24	280	Temperature set point for water. If in ° C, the units are tenths of a degree in multiples of 10. Invalid values return a type 4 exception.

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

<table>
<tr><th>Name</th><th>Address</th><th>Initial value</th><th>Information</th></tr>
<tr><td>Status</td><td>0x00</td><td>0</td><td>Reports the operating mode of the heat pump. It is a reflection of the operating orders in the Holding Register 0x21.

bit 0 Alarm flag:
0 No alarm present
1 At least one alarm is present
bits 2..1 Device mode:
00 Not used
01 Heat (if the machine is able)
10 Cool (if the machine is able)
11 Auto (if the machine is able)
bit 3 0: Filtration mode
1: Comfort mode.
bit 4 00 Not used
bit 5 Defrost status.
0 Defrost is not active
1 Defrost is active
bit 6 00 Not used
bit 7 00 Not used
bit 8 Device status
0 OFF
1 ON
bit 9 00 Not used
bit 10 00 Not used
bit 11 Fan status
0 OFF
1 ON
bit 12 00 Not used
bit 13 00 Not used
bit 14 00 Not used
bit 15 00 Not used</td></tr>
<tr><td>Alarms</td><td>0x01</td><td>0</td><td>Displays the alarms information in real time. 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>Incorrect power supply</td></tr><tr><td>1</td><td>Outside temperature too low</td></tr><tr><td>2</td><td>Thermal protection of the fan</td></tr><tr><td>3</td><td>Compressor Shutdown protection</td></tr><tr><td>4</td><td>Circuit 2 low pressure error (only in machines with 2 compressors)</td></tr><tr><td>5</td><td>Circuit 2 high pressure error (only in machines with 2 compressors)</td></tr><tr><td>6</td><td>Circuit 1 low pressure error</td></tr><tr><td>7</td><td>Circuit 1 high pressure error</td></tr><tr><td>8</td><td>Ambient temp probe error</td></tr><tr><td>9</td><td>Flowswitch error</td></tr><tr><td>10</td><td>Water intake temperature probe error</td></tr><tr><td>11</td><td>Evaporator 1 probe error</td></tr></table></td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td>
<table>
<tr><td>12</td><td>Evaporator 2 probe error (only in machines with 2 compressors)</td></tr>
<tr><td>13</td><td>Compressor 1 discharge probe error</td></tr>
<tr><td>14</td><td>Compressor 2 discharge probe error (only in machines with 2 compressors)</td></tr>
<tr><td>15</td><td>Not used.</td></tr>
</table>
</td></tr>
<tr><td>Alarms</td><td>0x0E</td><td>0</td><td>Displays the alarms information in real time. 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>discharge 1 temperature error</td></tr>
<tr><td>1</td><td>discharge 2 temperature error (only in machines with 2 compressors)</td></tr>
<tr><td>2</td><td>Compressor 1 consumption too high</td></tr>
<tr><td>3</td><td>Compressor 2 consumption too high (only in machines with 2 compressors)</td></tr>
<tr><td>4</td><td>Preasure sensor 1 failure (Not implemented, always 0)</td></tr>
<tr><td>5</td><td>Preasure sensor 2 failure (Not implemented, always 0)</td></tr>
<tr><td>6</td><td>Preasure sensor 3 failure (Not implemented, always 0)</td></tr>
<tr><td>7</td><td>Preasure sensor 4 failure (Not implemented, always 0)</td></tr>
<tr><td>8</td><td>Outlet temp probe error</td></tr>
<tr><td>9</td><td>TBD</td></tr>
<tr><td>10</td><td>Water intake and outlet differencial temperature too high</td></tr>
<tr><td>11</td><td>Suction sensor 1 failure</td></tr>
<tr><td>12</td><td>Suction sensor 2 failure (only in machines with 2 compressors)</td></tr>
<tr><td>13</td><td>3 phase unbalance protection</td></tr>
<tr><td>14</td><td>Lack of phase protection</td></tr>
<tr><td>15</td><td>Running time limit failure</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:
<table>
<tr><th>Bit</th><th>Alarm</th></tr>
<tr><td>0</td><td>Flow Input: 0/1 = no flow/flow</td></tr>
<tr><td>1</td><td>Compressor 1 Output: 0/1 = OFF/ON</td></tr>
<tr><td>2</td><td>Compressor 2 Output: 0/1 = OFF/ON (only in machines with 2 compressors)</td></tr>
<tr><td>3</td><td>Not used</td></tr>
<tr><td>4</td><td>Filtration pump input: 0/1 = OFF/ON</td></tr>
<tr><td>5</td><td>Not used</td></tr>
<tr><td>6</td><td>Not used</td></tr>
<tr><td>7</td><td>Not used</td></tr>
<tr><td>8</td><td>Not used</td></tr>
<tr><td>9</td><td>Not used</td></tr>
<tr><td>10</td><td>Not used</td></tr>
<tr><td>11</td><td>Not used</td></tr>
<tr><td>12</td><td>Not used</td></tr>
<tr><td>13</td><td>Not used</td></tr>
<tr><td>14</td><td>Not used</td></tr>
<tr><td>15</td><td>Not used</td></tr>
</table>
</td></tr>
<tr><td>Ambient Temp</td><td>0x07</td><td></td><td>-200 to 600 decens of ºC (1 ºC = 10)</td></tr>
<tr><td>Water Inlet Temp</td><td>0x08</td><td></td><td>0 to 500 decens of ºC (1 ºC = 10)</td></tr>
<tr><td>Water Outlet Temp</td><td>0x09</td><td></td><td>0 to 500 decens of ºC (1 ºC = 10)</td></tr>
</table>

Evaporator circuit 1 temp	0x15		-200 to 700 decens of ºC (1 ºC = 10)
Evaporator circuit 2 temp	0x16		-200 to 700 decens of ºC (1 ºC = 10) (only in machines with 2 compressors)
Compressor 1 discharge temp	0x17		400 to 1350 decens of ºC (1 ºC = 10)
Compressor 2 discharge temp	0x18		400 to 1350 decens of ºC (1 ºC = 10) (only in machines with 2 compressors)
Current phase 1 compressor 1	0x19		0 to 50 A
Current phase 2 compressor 1	0x1A		0 to 50 A
Current phase 3 compressor 1	0x1B		0 to 50 A
Current phase 1 compressor 2	0x1C		0 to 50 A (only in machines with 2 compressors)
Current phase 2 compressor 2	0x1D		0 to 50 A (only in machines with 2 compressors)
Current phase 3 compressor 2	0x1E		0 to 50 A (only in machines with 2 compressors)
Suction 1 Temp	0x1F		-200 to 700 decens of ºC (1 ºC = 10)
Suction 2 Temp	0x20		-200 to 700 decens of ºC (1 ºC = 10) (only in machines with 2 compressors)
Low Pressure 1	0x21		0 to 500 cents of MPa (1 MPa = 100)
High Pressure 1	0x22		0 to 500 cents of MPa (1 MPa = 100)
Low Pressure 2	0x23		0 to 500 cents of MPa (1 MPa = 100) (only in machines with 2 compressors)
High Pressure 2	0x24		0 to 500 cents of MPa (1 MPa = 100) (only in machines with 2 compressors)

9.4. 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
Device mode control	0x211 0x212		00 Not used 01 Heat mode (if machine is able) 10 Cold mode (if machine is able) 11 AUTO (if machine is able)
Water pump working mode control	0x213		0 Filtration mode 1 Comfort mode
Device status control	0x218		0 Machine OFF 1 Machine ON

10. PRODUCT REVISION

Manual v.1.0 : All the information of this manual, describes the behavior of the Hardware Version 140, and Software Version 140.

Changelog:

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