
Modbus Protocol Guide

60363 MODBUS RTU KIT

ver. 1.3 rev.0



IMPORTANT: The instruction manual you are holding includes essential information on the safety measures to be implemented for installation and start-up. Therefore, the installer as well as the user must read the instructions before beginning installation and start-up. Keep this manual for future reference.



Disposal of waste electrical and electronic domestic systems in the European Union.

All the products marked with this symbol indicates that the product shall not be mixed or disposed with your household waste at their end of use. It is responsibility of the user to eliminate this kind of wastes depositing them in a recycling point adapted for the selective disposal of electrical and electronic wastes. The suitable recycling and treatment of these wastes contributes in essential way to the preservation of the Environment and the health of the users. For further information regarding the points of collection of this type of wastes, please contact to the dealer where you acquired the product or to your municipal authority.

For optimum performance of the C-MOD communication module, we recommend you to follow the instructions given below.

1. INTRODUCTION TO MODBUS ENABLED PRODUCTS

Thank you very much for purchasing our Astralpool system with MODBUS-RTU communication 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.

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1.1. PRINCIPLE OF OPERATION

Astralpool devices implements MODBUS-RTU as a control-communications feature that allows its operation and supervision tasks from a MODBUS automation environment.

We expect that the implementation of MODBUS-RTU 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.

Modbus Interface gives the user/installer a wide range of new features based in the automation of an already existing and proved devices.

1.2. BASIC CHARACTERISTICS

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

in which one or more transmitters (talkers) can communicate with one or more receivers (listeners) with only one transmitter being active at any one time. 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. Our system is a SLAVE device.

In a RS-485 network the 'master' will start the 'conversation' with a 'Query' addressed to a specific 'slave', the 'master' will then listen for the 'slave's' response. If the 'slave' does not respond within a pre-defined period (time-out set by control software in the 'master'), the 'master' will abandon the 'conversation'.

1.3. WIRING

The RS-485 differential line consists of three pins:

- **A** aka 'D-' aka TxD-/RxD- aka **inverting** pin
- **B** aka 'D+' aka TxD+/RxD+ aka **non-inverting** pin
- **SC** aka 'G' aka **reference** pin.

The B line is positive (compared to A) when the line is not idle (i.e., data is '1').

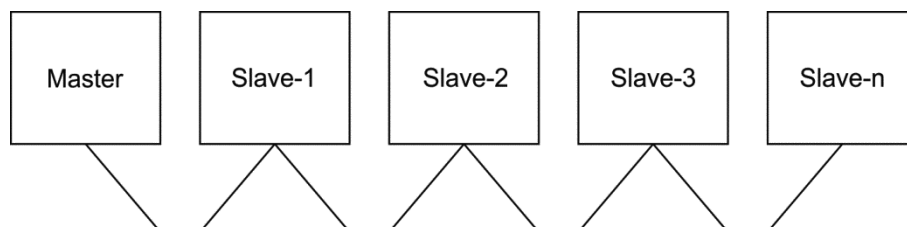
Note: In practice, some manufacturers assign for the RS-485 port the 'A' connection as a '+', and 'B' as a '-', while others reverses this nomenclature. **To avoid these confusions, some equipment manufacturers have created a third D+ and D- naming convention. ASTRALPOOL uses this convention.**

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 50170. The cable screen should be connected to the 'GND' terminal.

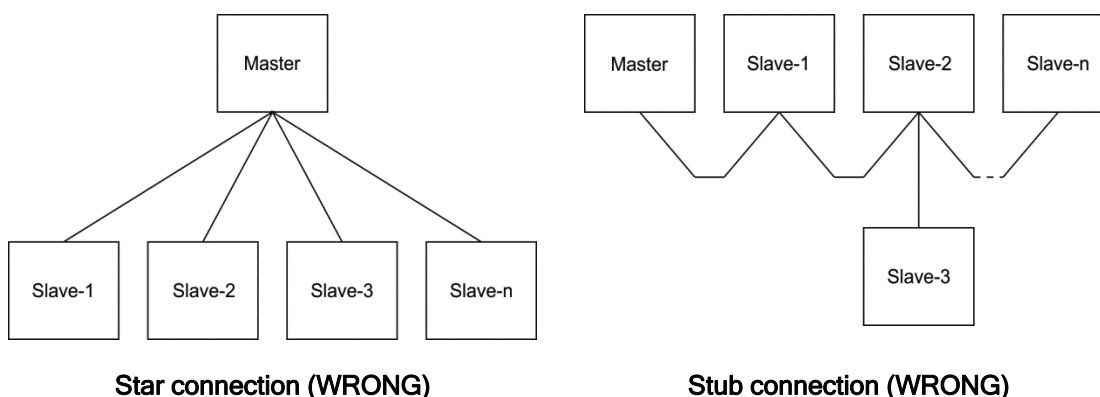
The values of transmission rate supported for the device, allow maximum cable length of 1,200 m. without repeaters, or up to 10 Km. using repeaters, when installation is according to the standard.

For the balanced pairs used in an RS485-system, characteristic Impedance with a value higher than 100 Ohms may be preferred, especially for 19200 and higher baud rates.

All 'D+' connections should be connected together using one conductor of the twisted pair cable, all 'D-' connections should be connected together using the other conductor in the pair. There must be no more than two wires connected to each terminal, this ensures that a 'Daisy-chained' configuration is used. A 'Star' or network with 'Stubs' is not recommended as reflections within the cable may result in data corruption.



Daisy-chained connection (CORRECT)

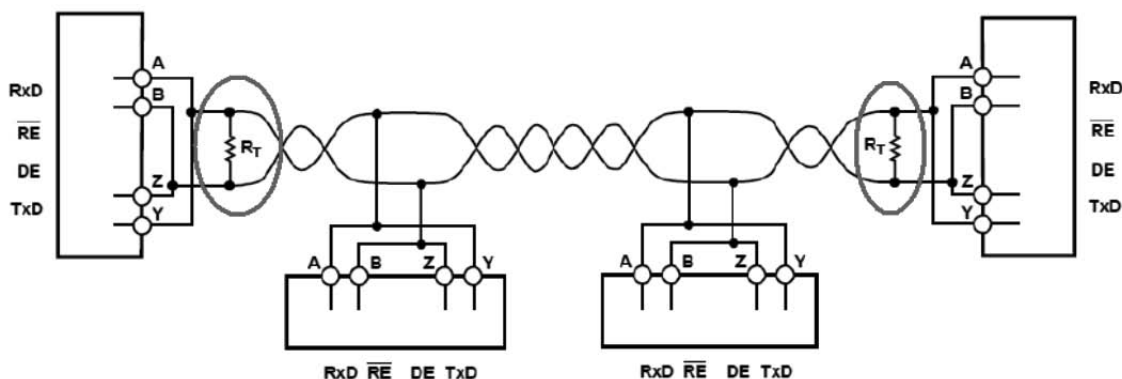


1.4. BUS ISOLATION AND TERMINATION RESISTORS

If the communication bus is accessible for the user, it shall be double isolated. As far as usually the accessibility of the bus to users will depend on each single installation, safety isolation has been implemented in the Astralpool device physical bus layer. Moreover, for safety purposes, it is recommended to ensure that other devices sharing this bus also implements this isolation.

Additionally, the use of bus isolated 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 below.



1.5. MODBUS PROTOCOL

1.5.1. Modbus message format

Communication on a MODBUS Network is initiated (started) by a 'Master' with a 'query' to a 'Slave'. The 'Slave' which is constantly monitoring the network for 'Queries' will recognize only the 'Queries' addressed to it and will respond either by performing an action (setting a value for example) and by returning a 'response'. Only the Master can initiate a query. The MODBUS protocol defines the format for the master's query and the slave's response. The query contains the device address, a function code defining the requested action, any data to be sent, and an error-checking field. The response contains fields confirming

the action taken, any data to be returned, and an error-checking field. If an error occurred in receipt of the message, or if the slave is unable to perform the requested action, the slave will construct an error message and send it as its response.

1.5.2. RTU Serial Transmission mode

Astralpool products support MODBUS RTU mode. In RTU mode (Remote Terminal Unit) mode, each 8-bit byte in a message contains two 4-bit hexadecimal characters. The main advantage of this mode is that its greater character density allows better data throughput than ASCII for the same baud rate, however each message must be transmitted in a continuous stream.

The format for each byte in RTU mode is:

Coding System: 8-bit binary, hexadecimal, two hexadecimal characters contained in each 8-bit field of the message

Bits per Byte: 1 start bit, 8 data bits, least significant bit sent first, 1 parity bit for even/odd parity; no parity bit for no parity, 1 stop bit if parity is used; 2 stop bits if no parity

Error Check Field: Cyclical Redundancy Check (CRC)

1.5.3. Modbus message timing

A MODBUS message has defined beginning and ending points. The receiving devices recognize the start of the message, read the 'Slave Address' to determine if they are being addressed and know when the message is completed so that they can use the Error Check bytes to confirm the integrity of the query.

Partial messages can be detected and discarded:

In RTU mode, messages start with a silent interval of at least 3.5 character times. The first field then transmitted is the device address. The allowable characters transmitted for all fields are hexadecimal 0-9, A-F. Devices monitor the network bus continuously, including during the 'silent' intervals. When the first field (the address field) is received, each device decodes it to find out if it is the addressed device. If the device determines that it is the one being addressed it decodes the whole message and acts accordingly, if it is not being addressed it continues monitoring for the next message.

Following the last transmitted character, a silent interval of at least 3.5 character times marks the end of the message. A new message can begin after this interval.

The entire message frame must be transmitted as a continuous stream. If a silent interval of more than 1.5 character times occurs before completion of the frame, the receiving device flushes the incomplete message and assumes that the next byte will be the address field of a new message. Similarly, if a new message begins earlier than 3.5 character times following a previous message, the receiving device will consider it a continuation of the previous message. This will result in an error, as the value in the final CRC field will not be valid for the combined messages.

1.5.4. Error Checking

Standard MODBUS serial networks use two error checking processes, the error check bytes mentioned above check message integrity whilst Parity checking (even or odd) can be applied to each character in the message. The master is configured by the user to wait for a predetermined timeout interval. The master will wait for this period of time before deciding that the slave is not going to respond and that the transaction should be aborted. Care must be taken when determining the timeout period from both the 'master' and the 'slaves' specifications. The slave may define the 'response time' as being the period from the receipt of the last bit of the query to the transmission of the first bit of the response. The master may define the 'response time' as period between transmitting the first bit of the query to the receipt of the last bit of the response. It can be seen that message transmission time, which is a function of the baud rate, must be included in the timeout calculation.

- **Parity Checking**

If parity checking is enabled - either Even or Odd Parity is specified - the quantity of '1's' will be counted in the data portion of each of the eight bits in the character. The parity bit will then be set to a 0 or 1 to result in an Even or Odd total of '1's'.

Note that parity checking can only detect an error if an odd number of bits are picked up or dropped in a character frame during transmission, if for example two 1's are corrupted to 0's the

parity check will not find the error. If No Parity checking is specified, no parity bit is transmitted and no parity check can be made. An additional stop bit is transmitted to fill out the character frame when 2 stop bits are selected. If No Parity checking is specified and one stop bit is selected the character is effectively shortened by one bit.

- **CRC Checking**

The error check bytes of the MODBUS messages contain a Cyclical Redundancy Check (CRC) value that is used to check the content of the entire message. The error check bytes must always be present to comply with the MODBUS protocol; there is no option to disable it. The error check bytes represent a 16-bit binary value, calculated by the transmitting device. The receiving device must recalculate the CRC during receipt of the message and compare the calculated value to the value received in the error check bytes. If the two values are not equal, the message should be discarded. The error check calculation is started by first pre-loading a 16-bit register to all 1's (i.e. Hex (FFFF)) each successive 8-bit byte of the message is applied to the current contents of the register.

Note: only the eight bits of data in each character are used for generating the CRC, start bits, stop bits and the parity bit, if one is used, are not included in the error check bytes.

During generation of the error check bytes, each 8-bit character is exclusive OR'ed with the register contents. The result is shifted in the direction of the least significant bit (LSB), with a zero filled into the most significant bit (MSB) position. The LSB prior to the shift is extracted and examined.

- If the LSB was a 1, the register is then exclusive OR'ed with a pre-set, fixed value.
- If the LSB was a 0, no exclusive OR takes place.

This process is repeated until eight shifts have been performed. After the last (eighth) shift, the next 8-bit byte is exclusive OR'ed with the register's current value, and the process repeated. The final contents of the register, after all the bytes of the message have been applied, is the error check value.

1.5.5. Functions supported

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

BIT ACCESS MODE

Functions in bit access mode are implemented according to the MODBUS-RTU standard described in http://www.Modbus.org/docs/Modbus_Application_Protocol_V1_1b.pdf

Supported bit-access functions are:

0x01 READ COILS

0x0F WRITE MULTIPLE COILS

0x02 READ DISCRETE INPUTS.

REGISTER ACCESS MODE

Functions in register access mode 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.

Supported register-access functions are:

0x03 READ HOLDING REGISTERS

0x04 READ INPUT REGISTERS

0x10 WRITE MULTIPLE REGISTERS

1.5.6. 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:

01 ILLEGAL FUNCTION

02 ILLEGAL DATA ADDRESS

03 ILLEGAL DATA VALUE

06 SLAVE DEVICE BUSY

2. DEVICE CONFIGURATION

2.1. ADDRESS AND BAUD RATE SELECTION

2.1.1. Address setting

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

ID_Address: Address of the device in the bus.

The device has default value. However you can change this value by sending writing this holding registers and as far as you check to do not introduce collisions or conflicts with other slave's addresses.

Example: changing the address ID from 0x30 (default) to 0x31.

Transmit Message: 01 10 00 00 00 01 02 00 02 27 91

Where:

- 01 is the slave address. (The actual ID address).
- 10 is the function used. Write Multiple Registers.
- 00 00 is the address of the Holding Register to be written.
- 00 01 is the number of Holding Registers to be written. '1' in this case.
- 02 is the number of bytes of data to be sent.
- 00 02 is the new ID address.
- 3E 15 is the CRC.

2.1.2. Baud rate selection

The Baud Rate selection of the serial communications with the Astralpool 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 and 2 stop bits are also supported (when NO parity is implemented).

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 a No parity configuration is chosen, then 2 stop bits are introduced to keep the eleven bits per byte required by the standard.

For compatibility reasons, N1 frames are also supported. However, mind that using 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

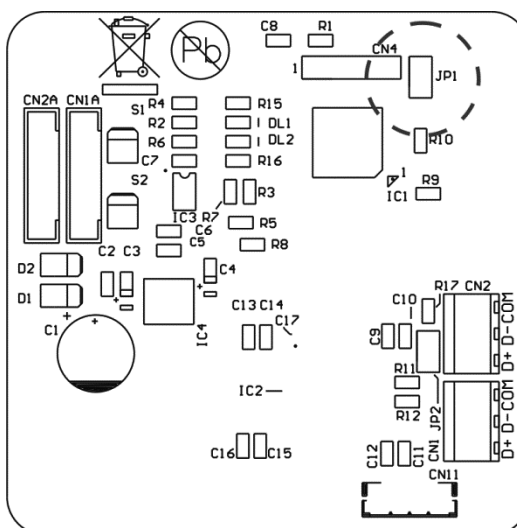
2.1.3. Reset to factory defaults

Address, baud and frame configuration are key settings in Modbus slaves. A bad (or unknown) configuration of these settings could cause that a Master can't communicate with the device anymore (master should try communication with every possible configuration).

In order to avoid this situation, our device has a "return-to-default" jumper (JP1). If C-MOD is turned on with this jumper closed (header pins connected), it will behave like its configuration was:

ID_Address = 1
COM_Setup = 0 (9600, 8E1)

Once that device has a known configuration, Modbus master will be able to set the proper Modbus configuration. This new proper configuration will be applied when you turn on the device with the jumper open (header pins non-connected)

2.2. BROADCASTING

Broadcasting is not supported by this device.

3. ALARMS

3.1. INSTANTANEOUS ALARMS REGISTER

Whenever errors exist, the less significant bit in the Status Input Register 0x00 is set to 1.

Furthermore, for having a more detailed information on the error occurred, these can be requested to the Input Register 0x01, or reading from Digital Input 0x010 to 0x01F.

3.2. LATCHED ALARMS REGISTER

It is possible to check which alarm has been activated since last alimentation disconnection or since last Alarm reset. To check it, Holding Register 0x20 must be read. The values in 1, indicates that the alarm has been activated. You can reset the bit. When that alarm activates again, that bit will set again.

It is important to understand the relationship between Error words (Holding Register 0x20) and Instantaneous alarms (Input Register 0x01).

There is also a direct relationship between Holding Register 0x20 and Input Register 0x01. While Holding Register 0x20 is the total alarms latched, the Input Register 0x01 is the current alarm. This relationship also applies to the bit-to-bit relation between registers.

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 from Coil 0x200 to 0x20F. Note: a disconnection of the power supply will reset all the latched alarms.

4. TROUBLESHOOTING

1. Check that all the 'D+' are connected together, check that all the 'D-' are connected together, check that all the 'Gnd's' are connected together.
2. Confirm that the Address of the instrument is the same as the 'master' is expecting.
3. If the 'network' operates with one instrument but not more than one check that each instrument has a unique address.
4. Check that the MODBUS mode (RTU or ASCII) and serial parameters (baud rate, number of data bits, number of stop bits and parity) are the same for all devices on the network.

5. BASIC MODBUS REGISTER MAP

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

REGISTER MAP

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
ID_Address	0x00		1			R/W	
COM_Setup	0x01		See Table 1			R/W	
ID_Manufacturer_hi	0x02		0			R	
ID_Manufacturer_lo	0x03		178			R	
ID_Product_code_hi	0x04		See Table 2			R	
ID_Product_code_lo	0x05		Electrolysis chlorine production (g/h)			R	
ID_Verify	0x06		See Note 1			R	
HW_Version	0x07		1			R	
SW_Version	0x08		1			R	

COM_Setup	
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

ID_Product_code_hi	
0	Electrolysis
1	Electrolysis with pH control
2	Electrolysis with pH and ORP control

Note 1
 ID_Verify = ID_Manufacturer_hi XOR ID_Manufacturer_lo XOR ID_Product_code_hi XOR ID_Product_code_lo XOR 0xF00A

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Status		0x00				R	
		.bit 0	Alarm		0x000	R	
		.bit 1	Electrolysis polarity		0x001	R	
		.bit 2	Electrolysis_ORP_Stop		0x002	R	
		.bit 3	Cover_input		0x003	R	
		.bit 4	pH_output		0x004	R	
		.bit 5	Electrolysis ON		0x005	R	
Bit description							
.bit 0	1: Alarm. Input Register 0x01 different from zero						
.bit 1	1: direct, 0: reverse						
.bit 2	1: Electrolysis halted by external ORP/PPM controller						
.bit 3	1: cover input ON						
.bit 4	1: dosing pH MINUS						
.bit 5	1: salt chlorinator producing chlorine						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Alarms (Instantaneous alarms)		0x01					
		.bit 0	flow_alarm		0x010	R	
		.bit 1	low_salt		0x011	R	
		.bit 2	high_salt		0x012	R	
		.bit 3	check_cell		0x013	R	
		.bit 4	Low pH		0x014	R	
		.bit 5	High pH		0x015	R	
		.bit 6	<i>Unused</i>		0x016		
		.bit 7	pump_stop_ph		0x017	R	
		.bit 8	low_mv		0x018	R	
		.bit 9	high_mv		0x019	R	
Bit description							
.bit 0	1: flow alarm. Null or Insufficient water flow through the electrolysis cell						
.bit 1							
.bit 2							
.bit 3							
.bit 4	1: low pH						
.bit 5	1: high pH						
.bit 6	1: pH product reservoir level is low						
.bit 7	1: pH minus overdose alarm						
.bit 8	1: low ORP						
.bit 9	1: high ORP						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Rsp_calibration		0x03	Controller response after calibration			R	
Word description	0: reset value, 1: succesful calibration, 2:E2 (calibration error. See Manual), 3: E3 (calibration error. See Manual)						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Chlorine_production		0x05				R	
Word description	Chlorine Production (g/h)						

REGISTER MAP

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Pct_production		0x06	Chlorine production value (electrolysis)			R	
Word description	0 - 100 (%)						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Setpoint_actual		0x07	Chlorine production setpoint (electrolysis)			R	
Word description	0: reset value, 1: succesful calibration, 2:E2, 3: E3						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Salt_test_result		0x08				R	
Word description	10: Reset value, 255: Test in progress, 0 - 6/ 0 (low salt) - 3 (normal) - 6 (high salt).						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Ph_measure		0x0A	Water pH reading			R	
Word description	0 - 999 (689 => pH=6,89)						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Ph_dosage_time		0x0B	Dosage pump time			R	
Word description	0 - 99 minutes						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Orp_measure		0x0F				R	
Word description	0 - 999 (mV)						

Nombre	Holding Register	Input Register	Description	Coil	Discrete input	Protección ⁽¹⁾	Comentarios
ppm_measure		0x10	Water CHLORINE (ppm) reading			R	
Descripción Word	0 - 999 (0.00 ... 9.99 ppm)						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
PPM_probe_current		0x11	CHLORINE sensor input current (mA)			R	"0" if not a PPM controller
Word description	0-255 (0.0 ... 25.5 mA)						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Control Word 1 (latched alarms)	0x20		Set this bit to '0' to reset the corresponding alarm. These alarms have been activated since the last system disconnection or alarm reset.				
	.bit 0		flow_alarm_rst	0x200		R/C	
	.bit 1		low_salt_rst	0x201		R/C	
	.bit 2		high_salt_rst	0x202		R/C	
	.bit 3		check_cell_rst	0x203		R/C	
	.bit 4		low_ph_rst	0x204		R/C	
	.bit 5		high_ph_rst	0x205		R/C	
	.bit 6		<i>Unused</i>	0x206			
	.bit 7		pump_stop_ph_rst	0x207		R/C	
	.bit 8		low_mv_rst	0x208		R/C	
	.bit 9		high_mv_rst	0x209		R/C	

Bit description

.bit 0	1: flow alarm. Null or Insufficient water flow through the electrolysis cell						
.bit 1							
.bit 2							
.bit 3							
.bit 4	1: low pH						
.bit 5	1: high pH						
.bit 6	1: pH product reservoir level is low						
.bit 7	1: pH minus overdose alarm						
.bit 8	1: low ORP						
.bit 9	1: high ORP						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Control Word 2	0x22						
	.bit 0		en_dis_device	0x220		R/W	
	.bit 1		local_remote	0x221		R/W	

Bit description

.bit 0	1: system ENABLED (ON), 0: system DISABLED (OFF). For a proper operation, if you want to disable de device, this coil (0x220) must be cleared periodically						
.bit 1	1: LOCAL mode (Modbus interface disabled) 0: REMOTE mode (Modbus interface enabled). Local mode finishes when the device is switched off						

REGISTER MAP

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Calibration_value	0x23					R/W	
Word description	Used in fast pH Calibration						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Elect_control_word	0x25						
	.bit 0		cover_ctrl_enable	0x250		R/W	
	.bit 1		cover_ctrl_config	0x251		R/W	
	.bit 2		orp_control_enable	0x252		R/W	
	.bit 3		internal_flow_detector_enable	0x253		R/W	
	.bit 4		flow_switch_enable	0x254		R/W	
	.bit 5		doing_salt_test	0x255		R/W	
	.bit 6		test_mode	0x256		R/W	
	.bit 7		cleaning_period_low	0x257		R/W	
	.bit 8		cleaning_period_high	0x258		R/W	
Bit description							
.bit 0	1: Cover input enabled. Bit 0x251 has the information about logic (NO or NC). 0: Cover input disabled						
.bit 1	1: Normally closed logic in cover input, 0: Normally open logic in cover input						
.bit 2	1: Automatical Electrolysis control by ORP mode enabled						
.bit 3	1: Internal Flow sensor enabled.						
.bit 4	1: External Flow sensor enabled						
.bit 5	1: Salt Test in progress						
.bit 6	1: Electrolysis changes its polarity every 2 minutes. 0: Electrolysis polarity change frequency is determined by coil 0x257. Test mode finishes when electrolysis switches off. After switching on, this coil (0x256) always is "0"						
.bit 7	See Table 3						
.bit 8	See Table 3						

0x257	0x258	Polarity reversal period
0	0	2 hours
0	1	3 hours
1	0	4 hours
1	1	Not defined

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Setpoint_normal	0x26					R/W	
Word description	Electrolysis setpoint with cover input disabled or open cover						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Setpoint_cover	0x27					R/W	
Word description	Electrolysis setpoint with cover input enabled or closed cover						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Ph_control_word	0x29						
	.bit 12		cal_ph_reset	0x29C		R/W	
	.bit 13		cal_ph7	0x29D		R/W	
	.bit 14		cal_ph4	0x29E		R/W	
	.bit 15		cal_fast	0x29F		R/W	
Bit description							
.bit 12	1: Set factory default pH calibration						
.bit 13	1: calibrate first point of a pH standard calibration (pH=7.0)						
.bit 14	1: calibrate second point of a pH standard calibration (pH=4.0)						
.bit 15	1: fast calibration. Holding register 0x23 (calibration_value) has the desired pH value (i.e. 740=7,40)						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Setpoint_ph	0x2A					R/W	
Word description	pH Setpoint: 700 ... 780 (PH 7,00 ... 7,80)						

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Dsg_time_limit_ph	0x2B					R/W	
Word description	PumpStop configuration. Dosing time necessary to PumpStop activation. Time in minutes						

REGISTER MAP

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
CI_control_word	0x36						
	.bit 12		cal_orp_reset	0x36C		R/W	
	.bit 13		<i>Unused</i>	0x36D		R/W	
	.bit 14		<i>Unused</i>	0x36E		R/W	
	.bit 15		cal_470mv	0x36F		R/W	
Bit description							
	.bit 12	1: Set factory default ORP calibration					
	.bit 15	1: ORP calibration (470mV)					

Name	Holding Register	Input Register	Description	Coil	Discrete input	Protection	Comments
Setpoint_orp	0x37					R/W	
Word description	ORP Setpoint: 600 ... 850 mV						

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Fabricado por:
I.D. Electroquímica, S.L.
Pol. Atalayas, Dracma R-19, E-3114 Alicante, Spain
Phone: +34 965101979 Fax: +34 965107293

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