SYSTEM VRAC BASIC

AUTOMATIC MULTIPORT VALVE

MODBUS MANUAL V1.0

1. INTRODUCTION TO MODBUS AND PRODUCT

Thank you very much for purchasing our Automatic Multiport Valve 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.

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1.1. PRINCIPLE OF OPERATION

The Automatic Multiport Valve (hereinafter AMPV) 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 AMPV with the more relevant operational and error events.

Whenever the AMPV 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 AMPV can run in local mode, as traditionally done, without using the MODBUS layer.

However, we expect that the implementation of MODBUS-RTU in the AMPV 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 AMPV can move to a specific port, 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 AMPV.

1.2. BASIC CHARACTERISTICS

The MODBUS communication system provides a Master/Slave implementation among devices sharing a physical connection. For the AMPV, 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 AMPV, a RS-485 half duplex wired connection has been implemented and the valve 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.
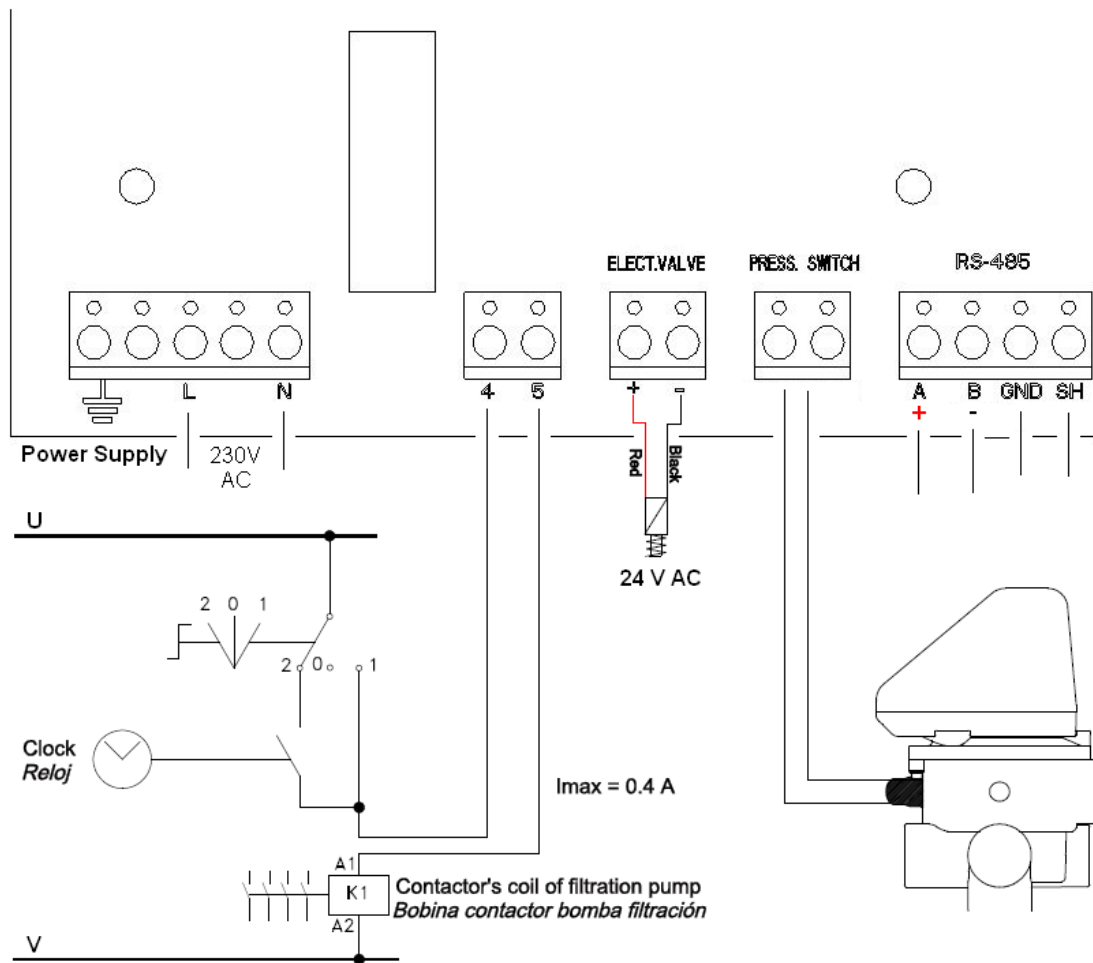
Image 1 Electrical connections

Note: some manufacturers assign for the RS-485 port the "A" connection as a "+", and "B" as a "-", while others reverses this nomenclature. The AMPV 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. 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 been implemented in the AMPV 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 2. Interconnection of devices.
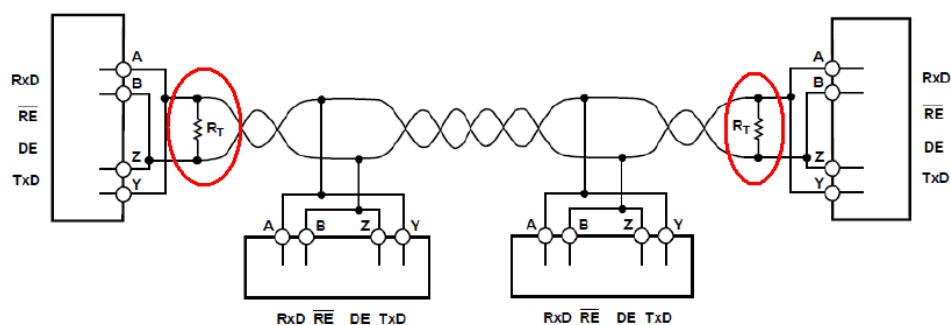
Image 2. Interconnection of devices

5. BOARD AND PANEL INDICATORS

The valve's module cover may have (depending on the model) panel with push buttons and LEDs to indicate its various functions.
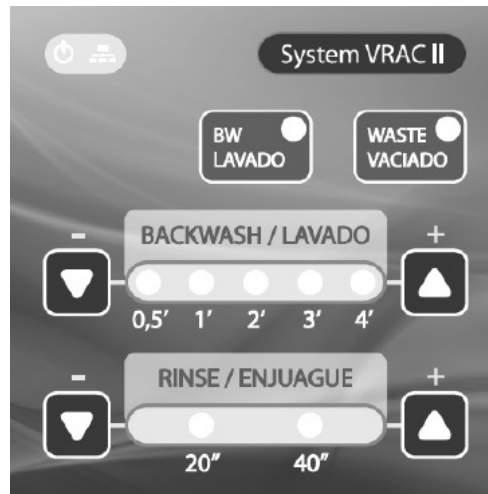
Image 3 Panel indicator

MODBUS Communication: this LED indicates when data is transmitted through MODBUS. Whenever a message is successfully received, the AMPV will send either the acknowledgement, the exception or frame reply and this led will blink. If the transmission is not successful this LED does not blink.

Backwash time: when the backwash time is configured through Modbus, LEDs will light from side to side. If the time configured through Modbus match with any value of the panel indicator will still light from side to side. For further information to know how to change the Backwash time through Modbus, see the chapter 8.2.2 Backwash time.

Rinse time: when the rinse time is configured through Modbus, LEDs will light from side to side. If the time configured through Modbus match with any value of the panel indicator will still light from side to side. For further information to know how to change the Rinse time through Modbus, see the chapter 8.2.3 Rinse time.

6. MODBUS FUNCTIONS

6.1. 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

0x01 READ COILS.

0x0F WRITE MULTIPLE COILS.

0x05 WRITE SINGLE COIL. *This function is not implemented in the AMPV. Since they can be work rounded with the functions "Write Multiple Coils", to the special case where the number of coils to be written is one.*

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.

0x03 READ HOLDING REGISTERS

0x04 READ INPUT REGISTERS

0x10 WRITE MULTIPLE REGISTERS

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 3.

7. DEVICE DESCRIPTION AND CONFIGURATION

7.1. GENERAL DESCRIPTION

Depending on your AMPV model, Circulation and Closed states may not exist. Therefore, they cannot be requested through the Request Word. The six ports AMPV has all the operation modes available while four ports AMPV does not has Recirculation and Close modes.

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 the 7.2 State Machine Diagram and all that is explained below is in the chapter 9 Basic Modbus-RTU Register Map.

7.2. STATE MACHINE DIAGRAM

7.2.1. STANDARD MODE

When the system starts, the only mode available is Filtration. It is the default mode. The Closed and Circulation states may not be available in your product if it is a four ports unit. If some error occurs during a change of mode, the AMPV will change to filtration mode, and the only way to change to another mode, will be powering off the AMPV.

The filtration mode is the only mode in which requests to change to another modes are possible. To change to any mode, it is necessary to make a request and be in Filtration mode. The operation modes Circulation, Waste and Close need a request to change to Filtration mode.
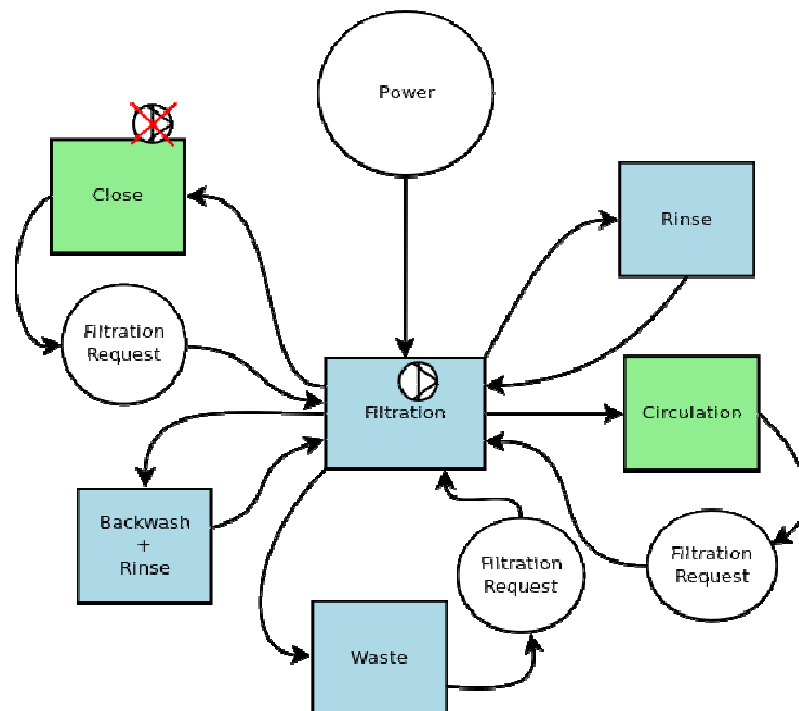
Diagram 1. Standard Mode State Machine Diagram

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7.2.2. ADVANCED MODE

The advanced mode allows from the master the manual activation/deactivation of the Pump Solenoid manually by a bit. It can be useful if the user does not need a clock for the activation of the Pump, typical case when the activation of the Pump Solenoid is activated through a PLC. The manual mode can be chosen in the Actuators of the Basic Modbus RTU Register map.
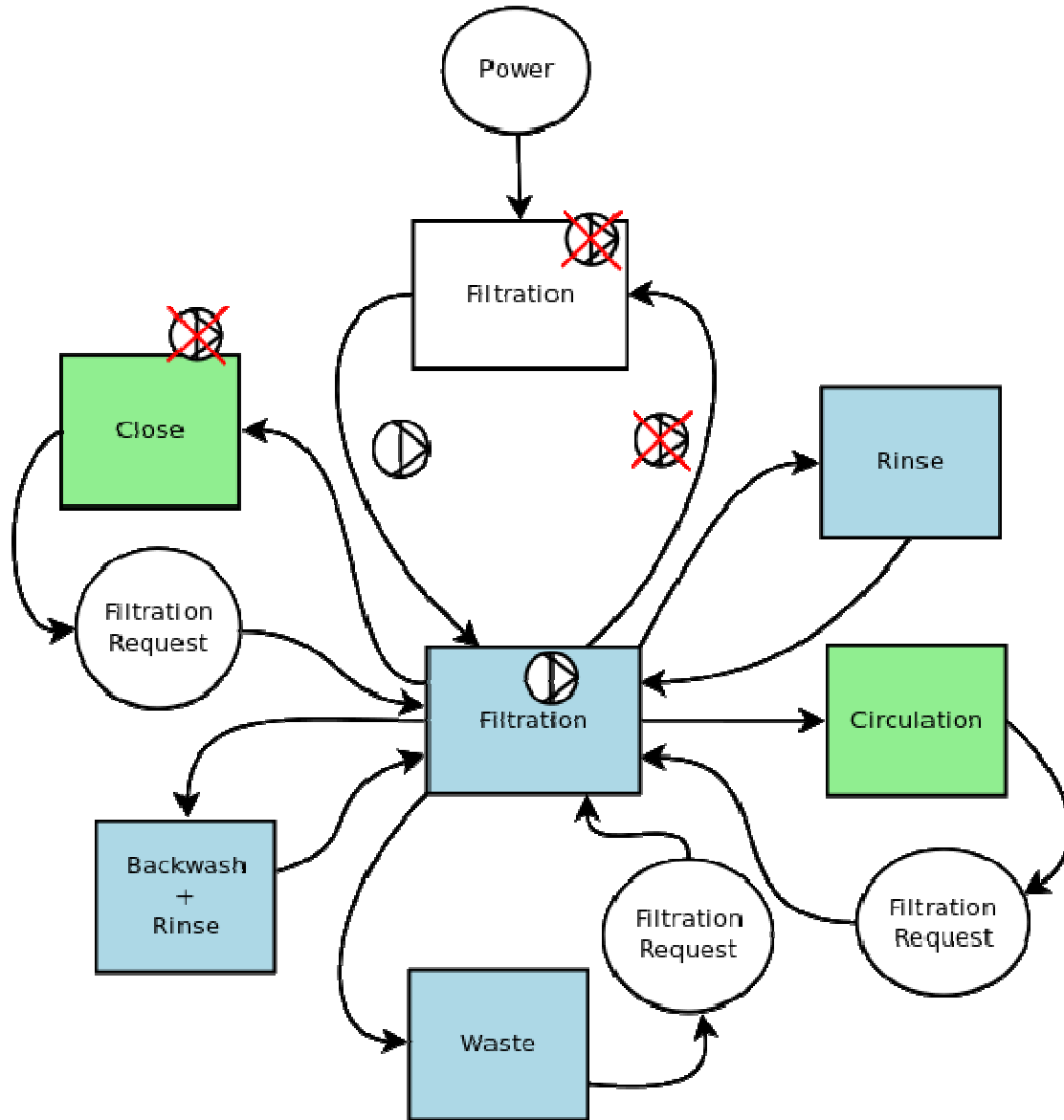
Diagram 2 Advanced Mode State Machine Diagram.

7.3. ADDRESS AND BAUD RATE SELECTION

7.3.1. ADDRESS SETTING

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

ID_Address: Address of the AMPV in the bus.

Factory setting: 0x0B.

Suggested range: 0x0B - 0x14.

The factory default for the AMPV is 0x0B. 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 slaves' addresses.

Example: changing the address ID from 0x0B (default) to 0x14.

Transmit Message: 0B 10 00 00 00 01 02 00 14 D8 FF

Where:

> 0B 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 14 is the new ID address.
> D8 FF is the CRC.

7.3.2. BAUD RATE SELECTION

The Baud Rate selection of the serial communications with the AMPV 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

7.4. BROADCASTING

Broadcasting is not supported by the AMPV.

7.5. WATCHDOG

The watchdog is a feature implemented in the AMPV aimed to check if the communications in the bus keep alive. This is meanly a safety feature intended to detect a fail in the communications and allows moving to a predefined state.

The watchdog is triggered when the device does not receive two messages in less than watchdog time specified.

According to these descriptions, either the time considered for triggering the watchdog as well as how to proceed then, needs to be defined.

To allow correct errors if a bad configuration of the watchdog has been done, the first 30 seconds of the Power ON of AMPV, the watchdog timer will be stopped. This allows the user to change the watchdog time if a short time has been configured, or allows deactivating the watchdog.

7.5.1. WATCHDOG TRIGGERING

The watchdog triggering time is defined in the Holding Register 0x10. This time is set in seconds. 0s means watchdog is disabled. This is the default value.

To enable the watchdog feature, set the watchdog time to a value different from 0. However, mind the implications of this value as long times may deal to useful setups.

Example: Set watchdog triggering time to 30s:

Transmit Message: 0B 10 00 10 00 01 02 00 1E 5A 68

Where:

      0B is the slave address.
      10 is the function used. Write Multiple Registers.
      00 10 is the address of the first 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 1E is the value to be sent. 30 in decimal.

5A 68 is the CRC.

Now, the watchdog time is set to 30s. Therefore, whenever two properly constructed messages are read in less than 30s, even not addressed to the AMPV, the watchdog is not triggered. Otherwise, it is triggered.

To know the Watchdog time is necessary read the holding registers.

The response of the Watchdog time in this case, will be: 0B 03 02 00 1E A0 4D

> 0B is the slave address.
> 03 is the function used. Read Holding Registers.
> 02 is the number of bytes of data to be read.
> 00 1E is the time configured. 30 in decimal.
> A0 4D is the CRC.

7.5.2. WATCHDOG SETUP AND DESTINATION STATE

The Watchdog Setup and Destination State register 0x11, must be setup in conjunction with the Watchdog triggering register. This setup considers two scenarios that need to be clearly understood.

The High Byte of the register defines how to proceed when the Watchdog is triggered. If it is set to 0, then the destination state is defined in the Low Byte of the register. If it is set to 1, then the communication bridge is reset.

Example: Set filtration state as destination state in case that watchdog is triggered:

Transmit Message: 0B 10 00 11 00 01 02 00 01 1A 71

Where:

> 0B is the slave address.
> 10 is the function used. Write multiple registers.
> 00 11 is the address of the first register to be written.
> 00 01 is the number of registers to be written (quantity of outputs). 1 in this case
> 02 is the number of bytes to be sent.
> 00 High Byte. Move to the state defined in Low Byte.
> 01 Low Byte. Filtration State.
> 1A 71 is the CRC.

Now, the filtration state has been defined if the watchdog is triggered (watchdog time different than 0).

NOTE: Mind that watchdog function is implemented for safety reasons. However, the reasons for activating it, or not, depends exclusively on the installer/integrator criteria. Always, mind of implications on what is being implemented. Use this feature under your responsibility.

8. OPERATION MODES

8.1. BASIC MODES

In this section it is assumed that a successful connection has been established with the AMPV and therefore, address, baud settings and watchdog behavior has been already set. The filtration pump contactor coil is also assumed to be wired to port 4-5 in the PCB. Other configurations are out of the scope of the Basic Mode.

8.1.1. CHECKING CURRENT STATE

The state in which the valve is currently set is available through *Status* Input Register 0x00. This register has a different meaning for the less significant byte and for the more significant byte.

The less significant bit is used to show if an error has occurred and is set to 1 whenever an error exist. Detailed information of the error/errors detected can be requested to the Alarms Input register at 0x01.Further to the raising of an error the AMPV automatically moves to the filtration port and report an unrecoverable error that needs to power off-power on to reset.

The more significant byte is used to show the current state (port) of the valve. An additional state, called "in-transit", is defined to show when the AMPV is moving from one port to other.

The codes for the different states implemented in the more significant byte (high byte) are shown in the following table:

        0x00 Closed
        0x01 Filtration
        0x02 Waste
        0x03 Circulation
        0x04 Backwash
        0x05 Rinse
        0x06 In transit

Depending on your AMPV model, Circulation and Closed states may not exist. Therefore, they cannot be requested through the Request Word.

Coding Examples (More significant byte first)

0x**0000**	0	Closed. No error.
0x**0100**	256	Filtration, No error.
0x**0180**	384	Filtration. No error. Pump Relay On. (Default).
0x**0181**	385	Filtration. Error. Pump Relay On.
0x**0101**	257	Filtration. Error. Reset needed.
0x**0600**	1536	In transit between states. No error.
0X**0601**	1537	In transit between states. Error. Moving to Filtration with errors.

Example: to know in which State is the AMPV, the transmit message must be:

0B 04 00 00 00 01 31 60

Where:

> 0B 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 input registers to be read, 1 in this case.
> 31 60 is the CRC.

The response is 0B 04 02 01 80 21 01 , that indicates in filtration mode, without alarm:

Where:

> 0B is the slave address.
> 04 is the function used. Read input registers.
> 02 is the number of bytes to be read.
> 01 is the high byte, it indicates that is in filtration mode.
> 80 is the low byte, it indicates that the Pump Relay are ON.
> 21 01 is the CRC

8.1.2. STATE CHANGE REQUEST

A state change request can be sent to the AMPV through the Control Request, Holding Register 0x21. However, these requests can also be sent using a bit address mode starting on coil, bit 0x210. Mind that you can choose either register address mode or bit address mode. However, for clarification purposes and to avoid misunderstandings, you should not mix both approaches as far as you do not have a clear idea on what you are doing.

The states available depend on the AMPV model purchased and therefore the Circulation and Closed states may not be available.

8.1.3. FILTRATION STATE REQUEST

Filtration state is the default for the AMPV. Whenever an error occurs, this is the final state taken as it is understood to be the safest state for the valve.

However, depending on the model of the AMPV installed, other stable states as circulation or closed states can be requested. In this sense, whenever the filtration system is aimed to be in functioning, a request of filtration stated shall be stated, as far as the AMPV is not already in this state.

The simplest way to request a change to filtration state is using the bit-address mode on the Requests Holding Register 0x21. This can be done addressing the state related Coil 0x210, and set it to 1 to request a change to Filtration.

Example:

Transmit Message: 0B 0F 02 10 00 01 01 01 AF 09

Where:

> 0B is the slave address.
> 0F is the function used. Write multiple coils.
> 02 10 is the address of the first coil to be written.
> 00 01 is the number of coils to be written. 1 in this case.
> 01 is the number of bytes of data to be sent.
> 01 is the value set.
> AF 09 is the CRC.

Now, the filtration state has been requested.

8.1.4. BACKWASHING + RINSE STATE REQUEST

The backwashing and rinse request can always be sent to all AMPV. This state is defined by a sequence that moves sequentially from filtration to backwash and rinse, to eventually come back to filtration.

During this sequence, the AMPV automatically stop and start the filtration pump.

The simplest way to request a change to Backwash + Rinse is using the bit-address mode on the Requests Holding Register 0x21. This can be done addressing the state related Coil 0x211 and set it to 1 to request a change to Backwash + Rinse.

Example:

Transmit Message : 0B 0F 02 11 00 01 01 01 92 C9

Where:

> 0B is the slave address.
> 0F is the function used. Write multiple coils.
> 02 11 is the address of the first coil to be written.
> 00 01 is the number of coils to be written. 1 in this case.
> 01 is the number of bytes of data sent.
> 01 is the value set.
> 92 C9 is the CRC.

Now, the backwashing + rinse state has been requested.

8.1.5. CLOSED STATE REQUEST

This state is requested able as far as this functionality is available in the AMPV model installed. The request for closed state can be sent only when the AMPV is in the filtration position. If the AMPV is at any other position, first move it to Filtration and then to close.

The simplest way to request a change to closed state is using the bit-address mode on the Requests Holding Register 0x21. This can be done addressing the state related Coil 0x214, and set it to 1 to request a change to Closed.

Example:

Transmit Message: 0B 0F 02 14 00 01 01 01 5E C9

Where:

> 0B is the slave address.
> 0F is the function used. Write multiple coils.
> 02 14 is the address of the first coil to be written.
> 00 01 is the number of coils to be written (quantity of outputs). 1 in this case.
> 01 is the number of bytes of data to be sent.
> 01 is the value set.
> 5E C9 is the CRC.

Now, the Closed position has been requested and the progress to final destination can be followed up pooling Input Register 0x00 (Status).

To change to different mode, it is necessary to change to Filtration first by making a Filtration request, as explained above, in chapter 8.1.3 Filtration state request.

8.1.6. CIRCULATION STATE REQUEST

This state is requested able as far as this functionality is available in the AMPV model installed. The request for circulation state can be sent only when the AMPV is in the filtration position. If the AMPV is at any other position, first move it to Filtration and then to circulation.

The simplest way to request a change to Circulation state is using the bit-address mode on the Requests Holding Register 0x21. This can be done addressing the state related coil 0x213, and set it to 1 to request a change to Circulation.

Example:

Transmit Message: 0B 0F 02 13 00 01 01 01 EB 09

Where:

> 0B is the slave address.
> 0F is the function used. Write multiple coils.
> 02 13 is the address of the first coil to be written.
> 00 01 is the number of coils to be written. 1 in this case
> 01 is the number of bytes of data to be sent.
> 01 is the value set.
> EB 09 is the CRC.

Now, the Circulation position has been requested and the progress to final destination can be followed up pooling Input Register 0x00 (Status).

To change to different mode, it is necessary to change to Filtration first by making a Filtration request, as explained above, in chapter 8.1.3 Filtration state request.

8.1.7. WASTE STATE REQUEST

Warning! A wrong or inaccurate use of this request can empty your pool. Use it only under your supervision and with a clear idea on what you are doing

Waste state is considered dangerous, it can produce an accidental empty of the pool if it is not used properly or is used for a longer time than supposed. This is the reason why a double confirmation it is requested to achieve this State. Additionally, mind that there is not a time defined for this position (as it is with the backwashing process). Therefore, the AMPV will remain in this position till you move it out.

Double confirmation process: This process is designed to ensure that you do not accidentally request the Waste State. To do so, a sequential request of activation for Coils 0x215 and 0x216 must be sent with a delay between them less than 10s. Since this request must be sent sequentially, do not set both coils at the same time since this is not understood as sequential but simultaneous.

Example:

AMPV Address is 11 (0x0B) and use 0x0F MODBUS function (Write Multiple Coils), for sequentially setting to 1 the coils 0x215 and 0x216.

First: Transmit Message: 0B 0F **02 15** 00 01 01 01 63 09

Second: Transmit Message: 0B 0F **02 16** 00 01 01 01 27 09

Now, the Waste position has been requested and the progress to final destination can be followed up pooling Input Register 0x00 (Status).

To change to different mode, it is necessary to change to Filtration first by making a Filtration request, as explained above, in chapter 8.1.3 Filtration state request.

Warning! Mind that this state does not have a defined permanency time. AMPV will remain in the Waste position till it receives a request to move to filtration. Therefore, an unsupervised operation or inaccurate operation may deal with emptying the pool.

For using this functionality, it is strongly suggested to work in combination with the Watchdog setup. Using the watchdog and setting it up to, i.e. 60s, will stop the Waste process and move to Filtration.

8.2. ADVANCED MODES

Advanced configuration and operation modes assume that you have a strong background in configuring AMPV as well as in automation. As far as you know what you are doing, consider to stop reading and ask for technical and training assistance.

8.2.1. NUMBER OF BACKWASHES ALLOWED IN 24H

The Holding Register 0x13 allows configuring the maximum number of backwashes allowed in 24h made by the pressure switch trigger. A manual backwash or a Modbust request will not be considered. It is understood as a protection to avoid accidentally empty of the pool due to miss operations or pressure switch fails. A bad regulation of the pressure switch will be considered as switch fail.

Example: the transmit message will be 0B 10 00 13 00 01 02 00 **03** 9A 52, where the 03 is the number of backwashes allowed in 24 hours.

Mind that this value does not affect to backwash requests through MODBUS or manual request, so, when using this requests, do it at your responsibility.

8.2.2. BACKWASH TIME

The Holding Register 0x24 allows configuring how much the backwash process will last (in seconds). This is the time that the AMPV will stay in the backwash port during a Backwashing + Rinse process. This value has a direct link with the AMPV console. This value has a direct link with the AMPV console in the models that have it.

Warning! The backwash time is expressed in seconds and cannot exceed, due to safety reasons, 640s. Mind that an excessively last of this time may empty the pool while not necessarily providing a better backwash of the filter media.

Use this parameter cautiously.

Example: Set backwash time to 30s:

Transmit Message: 0B 10 00 24 00 01 02 00 1E 5E 1C

Where:

      0B is the slave address.
      10 is the function used. Write Multiple Registers.
      00 24 is the address of the first 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 1E is the value sent. 30 seconds in decimal.
      5E 1C is the CRC.

8.2.3. RINSE TIME

The Holding Register 0x25 allows configuring how much the rinse process will last (in seconds). This is the time that the AMPV will stay in the rinse port during a Backwashing + Rinse process. This value has a direct link with the AMPV console in the models that have it.

The Rinse time is expressed in seconds and can not exceed, due to safety reasons, 640s. Mind that an excessively last of this time may empty the pool while not necessarily providing a better Rinse of the filter media.

Use this parameter cautiously.

Example: Set the Rinse time and rinse time to 45s and 10s respectively, using only one MODBUS command.

Transmit Message: 0B 10 00 24 00 02 04 00 2D 00 0A C1 92

Where:

> 0B is the slave address.
> 10 is the function used. Write Multiple Registers.
> 00 24 is the address of the first Holding Register to be written.
> 00 02 is the number of Holding Registers to be written. 2. Backwash time and Rinse time.
> 04 is the number of bytes of data to be sent.
> 00 2D is the value sent for backwashing, register 0x24, 45 seconds in decimal.
> 00 0A is the value sent for rinse, register 0x25, 10 seconds in decimal.
> C1 92 is the CRC.

8.2.4. PRESSURE DETECTION TIME FOR VALIDATION

The value of Holding Register 0x27 defines the time (in seconds) needed to acknowledge a trip from the pressure switch as valid. This implementation aims to avoid false tripping due to water hammer, transitory, and so on.

By default the pressure detection time to consider a true trip from the pressure switch is set to 7s. Shorter times are not recommended since it may trigger backwash processes due to transitory pressure changes that are not representative from a stationary process (i.e. filter saturation).

Example: Set pressure detection time for validation to 10s:

Transmit Message: 0B 10 00 27 00 01 02 00 0A 5E 20

Where:

> 0B is the slave address.
> 10 is the function used. Write Multiple Registers.
> 00 27 is the address of the first 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 0A is the value to be sent: 10 seconds in decimal.
> 5E 20 is the CRC.

8.2.5. REMOTE PUMP OPERATION

This remote pump operation functionality (Coil 0x21A) is a very powerful implementation that allows to remotely turning ON/OFF the filtration pump. However, the configuration of the AMPV as well as the physical electrical wiring shall be done accordingly. In the same way, the operation in this mode shall be done only provided you know exactly what you are doing. Please consider asking for assistance or specific training before using this function as it may be dangerous if the valve is operated independently from the filtration pump. This Pump solenoid (Coil 0x21A), must be setup in conjunction with the Manual mode, and only will be available if the Manual mode is activated (Coil 0x217 at 1). In order to know the state of the Pump Relay, check the .bit7 of Input Register 0x00 (Status) or the input 0x007.

8.2.6. CHECKING HISTORICAL COUNTERS

Counters of the number of process that have been done by the AMPV can be requested by reading the holding registers 0x30 to 0x36 with the following assignation:

0x30	Number of Pressure Switch Status ON
0x31	Number of push-button Backwashes
0x32	Number of Backwashes
0x33	Number of Rinses
0x34	Number of Wastes
0x35	Number of Recirculation's
0x36	Number of Closes

Counters for the instantaneous errors occurred in the AMPV are implemented. Whenever an instantaneous error occurs, the related counter register is incremented. However, as a difference to the instantaneous error word, the error counters are not reset when powering off and powering on again.

Error counters can be requested by reading the holding registers 0x37 to 0x41 with the following assignation:

0x37	Closed switch Error Counter
0x38	Filtration switch Error Counter
0x39	Waste switch Error Counter
0x3A	Recirculation switch Error Counter
0x3B	Backwash switch Error Counter
0x3C	Rinse switch Error Counter
0x3D	Distributor up switch Error Counter
0x3E	Distributor sec. Switch Error Counter
0x3F	Ratchet switch Error Counter
0x40	Reserved
0x41	More daily backwashes than allowed Counter
0x42	Motor Overload Counter.

In case of a persistent instantaneous error, consider requesting technical assistance. In this case, submitting with the request the content of the registers above may significantly simplify the resolution process.

8.2.7. CHANGE OF STATE FOLLOW-UP

If you aim to follow up the changes in state, i.e. during full backwashing process, you shall poll against the Status Input Register on address 0x00 where the sequence of states will be observed, as far as no errors appear.

Example: Follow up the state change after a backwashing + rinse request. Therefore, pooling against 0x00 Input register shall be done:

Transmit Message: 0B 04 00 00 00 01 31 60

Where:

> 0B 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 input registers to be read. 1 in this case.
> 31 60 is the CRC.

Pooling this instruction periodically should show as a sequence in response as follow:

> 0x0180   384   Filtration. No error. Pump Relay On. (Default).
> 0x0600   1536   In transit. Moving to backwash. No errors. Pump Relay OFF.
> 0X0480   1152   Backwash . No error. Pump Relay ON.
> 0x0600   1536   In transit. Moving to Rinse. No errors. Pump Relay OFF.
> 0x0580   1408   Rinse. No errors. Pump Relay ON.
> 0x0600   1536   In transit, moving to default mode, filtering. Pump Relay OFF.
> 0x0180   384   Filtration. No error. Pump Relay On. (Default).

8.2.8. CHECKING INSTANTANEOUS ERROR 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 errors occurred, these can be requested to the Input Register 0x01. The bit-interpretation of this error register (Input Register 0x01) is shown below:

> .bit 0   Closed switch Error
> .bit 1   Filtration switch Error
> .bit 2   Waste switch Error
> .bit 3   Recirculation switch Error
> .bit 4   Backwash switch Error
> .bit 5   Rinse switch Error
> .bit 6   Distributor up switch Error
> .bit 7   Distributor sec. Switch Error
> .bit 8   Ratchet switch Error
> .bit 9   Reserved
> .bit 10   More daily backwashes than allowed
> .bit 11   Maintenance recommendation
> .bit 12   Motor Overload
> .bit 13   NOT USED
> .bit 14   NOT USED
> .bit 15   MODBUS watchdog

In case of error, note it and reset the AMPV. After resetting the AMPV all the errors are set to 0. If the error persists, or another error is triggered, then consider requesting technical assistance.

8.2.9. CHECKING 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. However, the recommended way is addressing the register in bit mode by reading its sixteen coils, from 0x200 to 0x20F –as far as each bit has an independent meaning-.

The values in 1, indicates that the alarm has been activated.

If the alimentation fails, all the alarms will be at 0.

Coil 0x200	Closed switch Error
Coil 0x201	Filtration switch Error
Coil 0x202	Waste switch Error
Coil 0x203	Recirculation switch Error
Coil 0x204	Backwash switch Error
Coil 0x205	Rinse switch Error
Coil 0x206	Distributor up switch Error
Coil 0x207	Distributor sec. Switch Error
Coil 0x208	Ratchet switch Error
Coil 0x209	Reserved
Coil 0x20A	More daily backwashes than allowed
Coil 0x20B	Maintenance recommendation
Coil 0x20C	Motor Overload
Coil 0x20D	Not Used
Coil 0x20E	Not Used
Coil 0x20F	MODBUS watchdog

Example checking all alarms:

To check all alarms at once, the recommended way is reading 16 coils, from 0x200 to 0x20F. The transmitting message will be: 0B 01 02 00 00 10 3C D4

Where:

    0B is the slave address.
    01 is the function used. Read Coils.
    02 00 is the address of the first Coil to be read.
    00 10 is the number of Coils to be read. 16 in decimal in this case.
    3C D4 is the CRC.

    The data values responded are:
    0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; **1**
    It indicates that only the watchdog alarm has been activated (the last number is 1).

However, the alarms can be read as a Holding Register:

The Transmitting message will be: 0B 03 00 20 00 01 85 6A

Where:

0B is the slave address.
03 is the function used. Read Holding Registers.
00 20 is the address of the first Holding Register to be read.
00 01 is the number of Holding Registers to be read. 1 in this case.
85 6A is the CRC.

The Response of a **Read Holding Registers** 0x20 is: 0B 03 02 **80** 00 41 85

Only Watchdog alarm has activated :

Where:

0B is the slave address.
03 is the function used. Read Holding Registers.
02 is the number of bytes returned.
80 is the high byte, it indicates that only watchdog alarm has been activated.
00 is the low byte, it indicate that the first 8 alarms has not been activated.
41 85 or is the CRC.

Any Alarm has been activated:

Received message: 0B 03 02 **00** 00 20 45

Where:

0B is the slave address.
03 is the function used. Read Holding Registers.
02 is the number of bytes of data to be read.
00 is the high byte, it indicates that the second 8 alarms has not been activated.
00 is the low byte, it indicate that the first 8 alarms has not been activated.
20 45 or is the CRC.

8.2.10.TIME FOLLOW UP SINCE LAST WASTE/BACKWASH

The AMPV implements time counters to follow up:

- Hours since last backwash. Input Register 0x03
- Hours to next backwash (if time deferred backwashing is activated). Input Register 0x04
- Hours since last waste. Input Register 0x05

This registers can be read using the MODBUS function Read Input Registers.

NOTE: These input registers are defined as unsigned int. Therefore they will overflow at 65535. This value is expressed in hours.

Example 1:

Read hours since last backwash.

Transmit Message: 0B 04 00 03 00 01 C1 60

Where:

> 0B 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 input registers to be read. 1 in this case.
> C1 60 is the CRC.

Then the AMPV will return the hours past since last backwash.

Example 2:

Read simultaneously the three input registers.

Transmit Message: 0B 04 00 03 00 03 40 A1

Where:

> 0B 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 03 is the number of input registers to be read. 3 in this case.
> 40 A1 is the CRC.

Then the AMPV will return: hours past since last backwash, hours to next backwash (if defined) and hours since last waste.

NOTE: These input registers are defined as unsigned int. Therefore they will overflow at 65535. This value is expressed in hours.

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.

Furthermore to the register map itself, it is important to understand two main relationships among registers. More precisely, the relationship between Control Word (Holding Register 0x21) and State Word (Input Register 0x00), and the relationship between Error words (Holding Register 0x20) and Instantaneous alarms (Input Register 0x01).

There is a direct relationship between Holding Register 0x21 and Input Register 0x00. While Holding Register 0x21 stands for a requested action, the Input Register 0x00 states for the current action in progress. This relationship also applies to the bit-to-bit relation between registers.

Example:

To change from State Filtration to Rinse, it is necessary to use the Holding Register 0x21, requesting the Rinse actuator. The simplest way to make a Rinse request is setting to 1 the Coil 0x212. To know the state that is in progress, it is necessary to see the Status, on Input Register 0x00. In this case, it will indicate: from Filtration (Pump ON) (01 80) to "in transit" (Pump OFF) (06 00), from "in transit" to "Rinse" (Pump ON) (05 80), from Rinse to "in transit" (Pump OFF) (06 00), and from "in transit" to Filtration, (Pump ON) (01 80).

The Holding Register 0x21 always indicates the request state, until the current state, becomes the request state.

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.

Name	Holding Registers	Input Registers	Coils	Inputs	Description
ID_Address	0x00				This parameter is the address of the AMPV, by default is set to 0x0B. If the installation has more than one device connected in the network, is necessary to change the ID_Adress of the device before connecting another one.
COM_Setup	0x01				This parameter determinates the Baud rate selection. There are 6 possible configurations to choose: Factory setting: 0. 9600, 8E1 Supported values: 1. 19200, 8E1 2. 9600, 8N2 3. 19200, 8N2 4. 9600, 8N1 5. 19200, 8N1
ID_Manufacturer_hi	0x02				This parameter indicates the high byte that represents the Manufacturer code.
ID_Manufacturer_lo	0x03				This parameter indicates the low byte that represents the Manufacturer code.
ID_Product_code_hi	0x04				This parameter indicates the high byte that represents the Product code.
ID_Product_code_lo	0x05				This parameter indicates the low byte that represents the Product code.
Reserved	0x06				Reserved.
HW_Version	0x07				This parameter indicates the Hardware Version of the AMPV.
SW_Version	0x08				This parameter indicates the Software Version of the AMPV.
MODEL_Serie_hi	0x09				This parameter indicates the high byte of the Serial Number.
MODEL_Serie_lo	0x0A				This parameter indicates the low byte of the Serial Number.
MODEL_Production_hi	0x0B				This parameter indicates the high byte of the production batch.
MODEL_Production_low	0x0C				This parameter indicates the low byte of the production batch.

Name	Holding Registers	Input Registers	Coils	Inputs	Description
Watchdog_time	0x10				This parameter defines the time in seconds that can elapse between the last communication and the actuation of the watchdog. If it is set to 0, the Watchdog is disabled. Range: 0 – 65535.
Watchdog_config State when overflow WD Config of working mode	0x11 low byte high byte				This parameter defines how will actuate the watchdog if the communications fail. **The low byte** is the State that can be chosen in the Input Register 0x00. **The high byte** is the configuration of the working mode. 0 = state defined in the low byte. 1 = reset
Number of Backwashes allowed in 24h	0x13				This parameter defines the maximum number of pressure gage tripped backwashes within 24 hours. The purpose is to avoid inconsistent backwashing loops due to a pressure gage malfunction. Maximum pressure backwashes in 24h error are fired in the n+1 backwashing process, where n is the value of this parameter. Range : 3 to 10. Note: BW_Button and MODBUS BW_Requests are not considered in this parameter.

Name	Holding Register	Input Registers	Coils	Inputs	Description
Status		0x00			This parameter indicates in which operation mode is the AMPV and if there is any alarm.
Alarm		low byte .bit 0 .bit 1..6		0x000	**The Low byte** indicates if there is an alarm, and the state of the Pump. Not Used.
Pump Relay ON		.bit 7		0x007	See chapter 8.2.5
Valve State		high byte 0x00 Closed 0x01 Filtration 0x02 Waste 0x03 Circulation 0x04 Backwash 0x05 Rinse 0x06 In transit			**The high byte** indicates the actual working status of the AMPV, from State 0x00 Closed to 0x06 In transit.

Name	Holding Registers	Input Registers	Coils	Inputs	Description
Latched Alarms	0x20				This parameter indicates which alarm has been activated (at any time before alimentation fail), it is recommended to use the COIL address, however you can use Holding Register.
Closed switch Error	.bit 0		0x200		
Filtration switch Error	.bit 1		0x201		
Waste switch Error	.bit 2		0x202		
Recirculation switch Err	.bit 3		0x203		
Backwash switch Error	.bit 4		0x204		
Rinse switch Error	.bit 5		0x205		
Distributor up switch Err	.bit 6		0x206		
Distributor sec. Switch Err	.bit 7		0x207		
Ratchet switch Error	.bit 8		0x208		
Reserved	.bit 9		0x209		
More daily backwashes than allowed	.bit 10		0x20A		
Maintenance recommendation	.bit 11		0x20B		
Motor Overload	.bit 12		0x20C		This parameter indicates that the motor has been working above the nominal specifications, usually by a blockage.
	.bit13..14				Not Used.
Watchdog	.bit 15		0x20F		

Name	Holding Registers	Input Registers	Coils	Inputs	Description
Instantaneous Alarms		0x01			This parameter indicates the instantaneous state of the alarms; it can be read as an Input Register, or as a Discrete Input.
Closed switch Error		.bit 0		0x010	
Filtration switch Error		.bit 1		0x011	
Waste switch Error		.bit 2		0x012	
Recirculation switch Err		.bit 3		0x013	
Backwash switch Error		.bit 4		0x014	
Rinse switch Error		.bit 5		0x015	
Distributor up switch Err		.bit 6		0x016	
Distributor sec. Switch Err		.bit 7		0x017	
Ratchet switch Error		.bit 8		0x018	
Reserved		.bit 9		0x019	
More daily backwashes than allowed		.bit 10		0x01A	
Maintenance recommendation		.bit 11		0x01B	
Motor Overload		.bit 12		0x01C	This parameter indicates that the motor is working above the nominal specifications, usually by a blockage.
		.bit13..14			Not Used
Watchdog		.bit 15		0x01F	

Name	Holding Registers	Input Registers	Coils	Inputs	Description
Actuators	0x21				These parameters are the operation modes that can be requested.
Request FILTERING	.bit 0		0x210		
Request BACKWASH+RINSE	.bit 1		0x211		
Request RINSE	.bit 2		0x212		
Request RECIRCULATION	.bit 3		0x213		
Request CLOSE	.bit 4		0x214		
Request WASTE	.bit 5		0x215		
Confirm WASTE	.bit 6		0x216		
MANUAL	.bit 7		0x217		Manual mode: see chapter 8.2.5.
	.bit 8..9				Reserved.
Pump Solenoid	.bit 10		0x21A		Pump Solenoid: see chapter 8.2.5.
	.bit 11..15				Not Used.

Name	Holding Registers	Input Registers	Coils	Inputs	Description
Inputs		0x02			This parameter indicates the state of the inputs of the AMPV, are activated by 1. The states that input can indicate, are deployed below. It can be read as an Input Register or as a Discrete Input.
Closed switch		.bit 0		0x020	
Filtration switch		.bit 1		0x021	
Waste switch		.bit 2		0x022	
Recirculation switch		.bit 3		0x023	
Backwash switch		.bit 4		0x024	
Rinse switch		.bit 5		0x025	
Distributor up switch		.bit 6		0x026	
Distributor security switch		.bit 7		0x027	
Ratchet switch		.bit 8		0x028	
Pressure switch		.bit 9		0x029	
Pump solenoid input		.bit 10		0x02A	
		.bit 11..15			Not Used.

Name	Holding Registers	Input Registers	Coils	Inputs	Description
Backwash time	0x24				This parameter defines the time in seconds that the AMPV will be backwashing. If it is different from 0, the Led's of the backwash time will turn ON from side to side. If it is 0,the time set is chosen by the keyboard, then the LED of the corresponding Backwash time will be ON.
Rinse time	0x25				This parameter defines is the time in seconds that the AMPV will be rinsing. If it is different from 0, the Led's of the Rinsing time will turn On from side to side. If it is set to 0, the time set is chosen by the keyboard, and then the LED of the corresponding Rinse time will be ON.
Max number of days between washes	0x26				This parameter defines the maximum number of days between backwashes (in days). When the time since last backwash is greater than this value, the AMPV automatically requests a Backwash.
Pressure detection time for validation	0x27				This parameter defines the seconds of signal from the pressure gauge remaining stable at the trip value for acceptance.
Hours since last Backwash		0x03			This parameter indicates the time in hours since last backwash.
Hours to next Backwash		0x04			This parameter indicates the remaining hours for the next Backwash.
Hours since last Waste		0x05			This parameter indicates the time in hours since last Waste.
Enclosure temperature Estimation		0x06			This parameter indicates an estimation temperature (in ºC) of the AMPV enclosure.

Name	Holding Registers	Input Registers	Coils	Inputs	Description
Number of pressure switch status ON	0x30				This parameter indicates the number of pressure switch ON that has been accepted. According to Holding Register 0x27.
Number of push-button Backwashes	0x31				This parameter is the number of Backwashes carried out by pushing the button.
Number of Backwashes	0x32				This parameter indicates the number of total Backwashes: push button, pressure switch, Modbus request and timer requests, counts without differentiation.
Number of Rinses	0x33				This parameter indicates the number of total Rinses: (backwash push button), pressure switch, Modbus request and timer requests counts without differentiation.
Number of Wastes	0x34				This parameter indicates the number of total Wastes.
Number of Recirculations	0x35				This parameter indicates the number of total Recirculations.
Number of Closes	0x36				This parameter indicates the number of total Closes.

Name	Holding Registers	Input Registers	Coils	Inputs	Description
Closed switch Error Counter	0x37				This parameter indicates the number of errors of the Closed switch.
Filtration switch Error Counter	0x38				This parameter indicates the number of errors of the Filtration switch.
Waste switch Error Counter	0x39				This parameter indicates the number of errors of the Waste switch.
Recirculation switch Error Counter	0x3A				This parameter indicates the number of errors of the Recirculation switch.
Backwash switch Error Counter	0x3B				This parameter indicates the number of errors of the Backwash switch.
Rinse switch Error Counter	0x3C				This parameter indicates the number of errors of the Rinse switch.
Distributor up Switch Error Counter	0x3D				This parameter indicates the number of errors of the Distributor up switch.
Distributor sec. Switch Error Counter	0x3E				This parameter indicates the number of errors of the Distributor sec. switch.
Ratchet switch Error Counter	0x3F				This parameter indicates the number of errors of the Ratchet switch.
Reserved	0x40				Reserved.
More daily backwashes than allowed Counter	0x41				This parameter indicates the number of errors produced by more daily backwashes than allowed.
Motor overload Counter	0x42				This parameter indicates the number of errors produced by a motor overload.

10. PRODUCT REVISION

Manual v.1.0 : All the information of this manual, describes the behavior of the Hardware Version 4, and Software Version 5.