



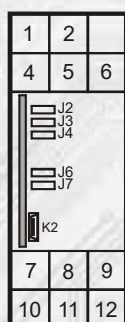
M-AO2 is a module with two analog outputs individually configurable in the full range of $0 \div 10 \text{ V}$ or $0 \div 20 \text{ mA}$.

The communication with superior system is led in the line RS485 by the protocol Modbus RTU and the device always operates in the "slave" mode. The device can be set to Safety mode, where after a communication failure exceeding a specified time, the outputs are automatically set to defined safe values entered by the user.

The module is housed in a compact box for DIN rail mounting. Operating conditions are suitable for a common chemically non-aggressive environment, where the modules do not require operation or maintenance.

The device is configured using the USBset configuration program using the USB interface or by overwriting individual registers using RS485 with the Modbus RTU protocol.

Layout of connecting terminals and connectors (fig. 1)



K2... connector USB mini B

J2...definition of still stand (conductor A)

J3...definition of still stand (conductor B)

J4...terminal resistor 120R

J6...device configuration

J7... reset

Term. 1.....power supply, positive pole (U_{cc})

Term. 2.....power supply, negative pole (GND)

Term. 4..... RS485 - A

Term. 5..... RS485 - B

Term. 6..... RS/GND (galv. separation from GND)

Term. 7..... output of voltage signal (OUT-U1)

Term. 8..... common pole (GND)

Term. 9..... output of current signal (OUT-I1)

Term. 10.....output of voltage signal (OUT-U2)

Term. 11.....common pole (GND)

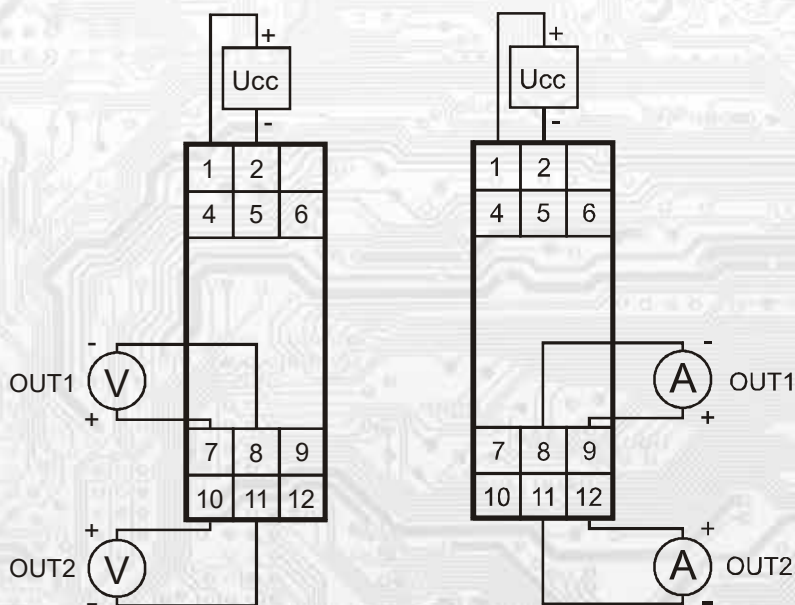
Term. 12.....output of current signal (OUT-I2)

Terminals 2, 8, 11 are galvanically connected.

Basic technical data

Power supply (U_{cc})	15 to 30 VDC
Current consumption without charged outputs	25mA
Max. consumption with loaded outputs	65mA (OUT_1 = 20mA, OUT_2 = 20mA)
Max. theoretical resolution (using DAC)	12-bits
Accuracy	$\pm 0,01\text{V}$, $\pm 0,02\text{mA}$
Load impedance of voltage outputs (R_z)	$> 50\text{k}\Omega$
Load impedance of current outputs (R_z)	$< (U_{cc} - 13) \times 50 \quad [\Omega]$
Max. setting range of voltage outputs	$0 \div 10\text{V}$
Max. setting range of current outputs	$0 \div 20\text{mA}$
Communication	RS485, protocol ModBus RTU, 8bits, 1 stop bit, no parity
Baud rate	$1200 \div 57600 \text{ Bd}$
Input impedance of RS485 receiver	min. $96 \text{ k}\Omega$, typ. $150 \text{ k}\Omega$
Max. number of sensors in the line	254
Galvanic separation RS485	yes, $< 50\text{V}$
-	-
FW upgrade program	USB_BOOT; freeware; www.regmet.cz
Range of recommended working temp. / RH	$-30 \div 50 \text{ }^\circ\text{C}$ / $< 95 \%$ no condensation
Range of recommended storage temp. / RH	$-30 \div 50 \text{ }^\circ\text{C}$ / $< 95 \%$ no condensation
Protection level	IP20
Terminal board	conductors max. $1,5 \text{ mm}^2$
Dimensions	$85 \times 22,5 \times 65 \text{ mm}$

Connecting diagram (fig.2)



Terminals 2, 8, 11 are galvanically connected.

SW output configuration:

It is performed by command 06 (0x06 Write Single Register) or command 16 (0x10 Preset Multiple Registers) with J6 shorted (accessible after removing the front panel). If this jumper is shorted, the converter communicates at 19200 Bd at address 255. Writing to flash memory is performed after writing the appropriate value to the Status register and the changes take effect after the device is reset (by shorting J7).

1.1 Properties of communication protocol:

Protocol Modbus RTU with adjustable Baud rate 1200 - 57600 Bd, 8 bits, no parity, 1 stop bit, line RS485, half-duplex operation.

Supported features:

- 03 (0x03): Read Holding Registers
- 04 (0x04): Read Input Registers
- 06 (0x06): Write Single Register
- 16 (0x10): Write Multiple Registers

The communication protocol description is available at www.regmet.cz, in the document named the Implementation of Modbus protocol in devices Regmet of second generation.

1.1 Configuration of module using the USBset program:

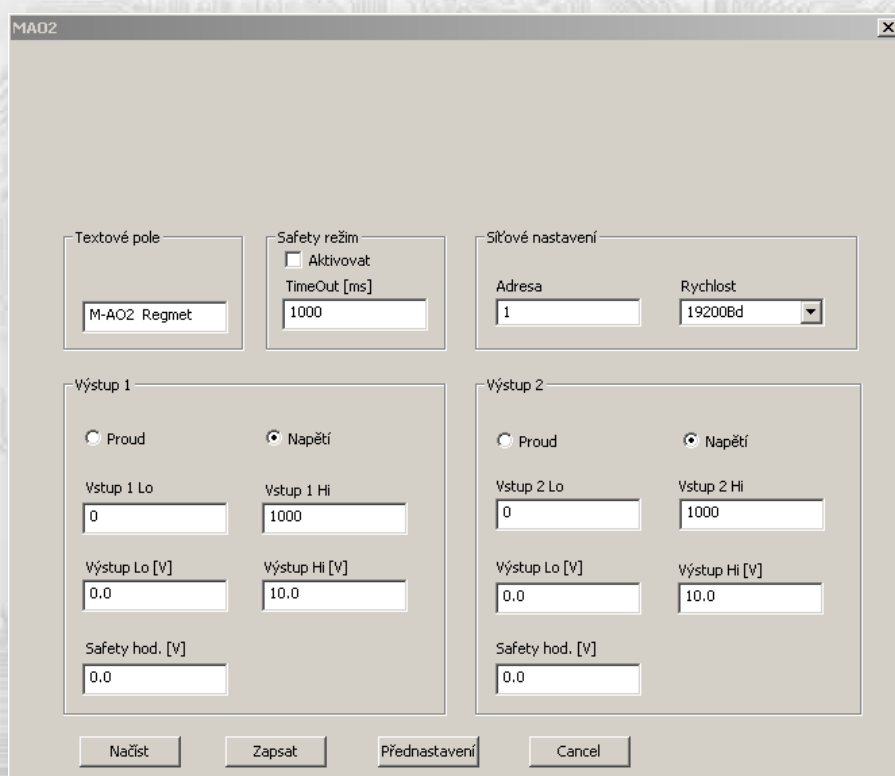
The configuration application USBset is freely available at producer's web pages.

The module is connected with PC using the cable of USB mini B type. With connected cable the USB communication has the priority over the line RS485.

After the launching of USBset program, the basic window is opened and the connected module is automatically connected with the hosting PC.



With clicking on the button "SET" the configuration window gets opened.



With clicking on the button "Read " (Načíst) the configuration values from the flash memory of moduler are read.

The text field can be used freely for customer identification of the device.

Safety mode: Safe mode is selected by checking "Activate", where in the event of a communication failure for a period longer than that set in the "TimeOut" window, the outputs are set to the values entered in the "Safety time" window.

TimeOut: Setting the time (in ms) after which, in the event of a communication failure, the outputs are set to the safe values entered in the "Safety time" window.

Address: select a network address in the range 1 ÷ 254 for sensor operation on a serial line.

Baud rate: Selection of baud rate in the range of 1200 ÷ 57600 Bd for operating the controller on a serial line.

Output 1:

The output signal type (**voltage/current**) is selected.

Input 1 Lo: The lower value of input signal range is entered in the max. range -32768 ÷ 32767.

Input 1 Hi: The upper value of input signal range is entered in the max. range -32768 ÷ 32767.

Both of these values serve as the input parameter value for setting the output value. For example, if we want to control the output in the range 0 ÷ 100% with a resolution of 0.1%, we enter Input 1 Lo = 0, Input 1 Hi = 1000.

For example, if we want to control the output in a certain temperature range (with values measured on a remote temperature sensor), we assign this temperature range to the input range of the device, for example, for the range -30 ÷ 60°C we enter Input 1 Lo = -300, Input 1 Hi = 600 (this will give us a resolution of 0.1°C, for a resolution of whole degrees we enter Input 1 Lo = -30, Input 1 Hi = 60).

Output Lo, Output Hi:

The specified input signal range is assigned an output signal range in the max. range of 0 ÷ 10V or 0 ÷ 20mA and the inverse is also possible.

Safety value: is used to enter a safe value to which the output is set after switching on or resetting the device before it starts working correctly or in the event of a communication failure for a period longer than that set in the "TimeOut" window, if Safety mode is activated.

After setting of required values and quantities the new configuration values are saved in the flash memory of the device by clicking on the button „Write“.

The writing into the flash memory is conditioned by insertion of jumper J6 (authorisation for configuration values recording) before the clicking on the button "Write".

By clicking on the button "Cancel" the configuration windows gets closed.

After USB cable disconnection the jumper J6 is pulled out and the device is ready for operation.

Factory default settings (if the customer does not specify the required values):

Safety mode: inactive

Adresa: 1

Baud rate: 19200 Bd

Output 1: voltage

Input range: 0 ÷ 1000

Output range: 0 ÷ 10V

Safety value: 0V

Output 2: voltage

Input range: 0 ÷ 1000

Output range: 0 ÷ 10V

Safety value: 0V

The module is therefore set to the values shown in the configuration window image. These values can be recalled by clicking the "Presets" button.

2.1 Description of registers of the device:

During the transfer the register addresses are indexed from zero, i.e. register 0x0001 is physically sent through the busbar as 0x0000... (zero based addressing).

The Holding registers will be mentioned in the description together with the function code field 4xxxx and the Input registers including 3xxxx. Thus the Holding register 40001 is physically sent through the busbar as register 0000 and the Input register 30001 as 0000.

Examples of communication are shown in Chapter 2.8.

1Modbus register = 2 Byte

The registers are divided in four basic memory zones:

Operational registers are situated in the zone of Holding registers at addresses 40001 to 40028. They are used for the common operational communication, registration in registers is unlimited and unprotected. The registration in FLASH will be made after recording 0xC001 (49153 dek) to 40029 – the Register Status. Provided the registration in FLASH is not done, the changes of operational registers made during the operation will not be saved for future starting.

Some operational registers enable parallel manual access from the device menu and these changes are automatically saved in FLASH.

User registers are situated in the zone of Holding registers at addresses from 40030 to 40036. They are used for preservation of user setting of the device (for example LCD contrast). The registers are accessible due to the remote zeroing of user setting (for example in hotels). The registration in registers is unlimited and unprotected. The change of setting and at the same time the registration in FLASH is done only after writing 0xC002 (49154 dek) to 40029 – the Register Status. All user registers enable the parallel manual access from the device menu and these changes are automatically saved in FLASH.

The configuration registers are situated in the zone of Holding registers at addresses 40041 to 40140. They are used for configuration of the device. The registration in registers is protected and allowed under the configuration mode, i.e. when the jumper shorts out the link J6. In this mode the device communicates at dedicated address 255 of the Baud rate 19200 Bd. The configuration registers can be rewritten only using the communication protocol and under the above stated conditions. The change of setting and at the same time the registration in FLASH is done only after writing 0xC003 (49155 dek) to 40029 – the Register Status.

The information registers are situated in the zone of Input registers at addresses 30001 to 30032. They serve for unchanged preservation of device identification data.

The Status Register serves for two-way communication between the device and the superior system. The device notifies the superior system of the internal status and the superior system sends requests for performance of commands.

STATUS Information messages from the device to the superior system:

- Normal Run, 0x0000 (0 dek) the device works in normal operational mode
- Menu Active, 0xB000 (45056 dek) the user has opened the manual menu
- Memory Read, 0xB001 (45057 dek) the device is reading from FLASH
- Memory Write 0xB002 (45058 dek) the device is registering to FLASH

STATUS Error messages from the device to the superior system:

- CRC Error 0xBE00 (48640 dek) Application program is damaged in the FLASH memory
- LCD Error 0xBE01 (48641 dek) Error of communication with LCD
- Sensor Error 0xBE02 (48642 dek) Error of communication with the sensor
- Memory Error 0xBE03 (48643 dek) Error of communication with FLASH

STATUS Commands for the device issued from the superior system:

- Clear STATUS 0x0000 (0 dek) writes 0 to the register
- Write Area 1 0xC001 (49153 dek) it rewrites the Operational registers to FLASH
- Write Area 2 0xC002 (49154 dek) it rewrites the User registers to FLASH
- Write Area 3 0xC003 (49155 dek) it rewrites the Configuration registers to FLASH

In brackets behind the registers described, abbreviations of possible features may appear:

- R Read for reading
- W Write for writing
- WP Write protect for protected writing
- M Parallel manual access from the device menu

2.2 Description of operational registers:

Saving to FLASH memory is performed only after writing 0xC001 (49153 dec) to 40029 - Register Status.

				Modbus register [dek]
Value OUT1	Value OUT2	-	-	1 - 4
-	-	-	-	5 - 8
Safety value OUT1	Safety value OUT2	-	-	9 - 12

40001 (R,W) - Value OUT1:

the value to which output OUT1 is currently set, i.e. writing to this register directly controls output OUT1. The number format is 16-bit signed integer. This value is never stored in the device's FLASH memory.

40002 (R,W) - Value OUT2:

the value to which output OUT2 is currently set, i.e. writing to this register directly controls output OUT1. The number format is 16-bit signed integer. This value is never stored in the device's FLASH memory.

40009 (R,W) – Safety value OUT1:

The value to which the OUT1 output is set after the device is turned on or after its reset, and at the same time the value to which this output is set in the event of a communication failure if Safety mode is activated (40040 = 4dek). It is entered in the form of a 16-bit unsigned integer multiplied by a constant 10. For example, with the selected voltage output: 0x0032 = 50dek = 5V.

40010 (R,W) – Safety value OUT2:

The value to which the OUT2 output is set after the device is turned on or after its reset, and at the same time the value to which this output is set in the event of a communication failure if Safety mode is activated (40040 = 4dek). It is entered in the form of a 16-bit unsigned integer multiplied by a constant 10. For example, with the current output selected: 0x0024 = 40dek = 4mA.

2.3 Description of Status register:

				Modbus register [dek]
Status register				29

40029 (R,W) – Status register:

provides the master system with information about the internal state of the device, e.g. current error states. It also serves as a receiving register for special commands, e.g. overwrite / backup working registers to FLASH memory. The number format is 16-bit unsigned integer. For a more detailed description, see Status register in chap. 2.1 Description of device registers.

2.4 Description of user registers:

Saving to FLASH memory is performed only after writing 0xC002 (49154 dec) to 40029 - Register Status.

				Modbus register [dek]
-	-	-	Bit_Field, SME.2	37 – 40

40040 (R,W) – Bit_Field, SME.2:

Selecting Safety mode

0x00 (0 dek) = Safety mode is inactive

0x04 (4 dek) = Safety mode is active

If Safety mode is active, then in the event of a communication failure for a period longer than that set in the register 40051 – Safety TimeOut TOP the outputs are set to the values from registers 40009 – Safety value OUT1 and 40010 – Safety value OUT2.

If Safety mode is inactive, then the outputs are set to the value from registers

40001 - OUT1 Value and 40002 - OUT2 Value, until the value in these registers changes or the device is reset.