



Summary

R060 is a Modbus RTU / RS485 and Modbus TCP to Belimo MP-Bus converter for control of up to 8 communicative Belimo actuators.

Application

- **control and diagnostics of up to 8 Belimo damper / valve actuators communicating over MP-Bus, from a PLC which uses Modbus RTU protocol over RS485 or Modbus TCP over Ethernet. The actuators are connected on a bus and it is not necessary to connect them to analogue outputs, which saves cabling and control system costs.**

Function

The R060 acts as a Modbus slave (server), which accepts commands issued by a Modbus master (client), which is a PLC or another supervisory system. The commands are translated into MP-Bus telegrams and sent to the MP-Bus. The responses from the actuators are then available in the Modbus registers.

The converter works in Simple mode or Complex mode, which can be set over the R060 web page. The modes have different functionalities. the Simple mode is compatible with the Belimo UK24MOD interface, while in the Complex mode also the configuration and diagnostic commands can be send on the MP-Bus, like reading of serial numbers, actuator types, etc. (see Modbus table). For normal control of actuators and valves, the Simple mode is more convenient and easier to use. **The converter always works in one of both modes only.**

The Modbus table is divided into three parts:

- System part at addresses 1 to 22, to setup the converter and perform internal diagnostics
- Complex mode registers at addresses 101 to 892
- Simple mode registers at addresses 1001 to 1160.

Converter functions and parameters are configured over the web interface (protocol HTTP). Setting the USR switch to ON and restart disables the web interface and FTP server for higher security. The power voltage presence is indicated by a green LED (PWR), processor activity signals the red LED (RUN). The Ethernet connector host two more LEDs: link and network activity. The Ethernet interface switches between 10 and 100 Mbit/s automatically.

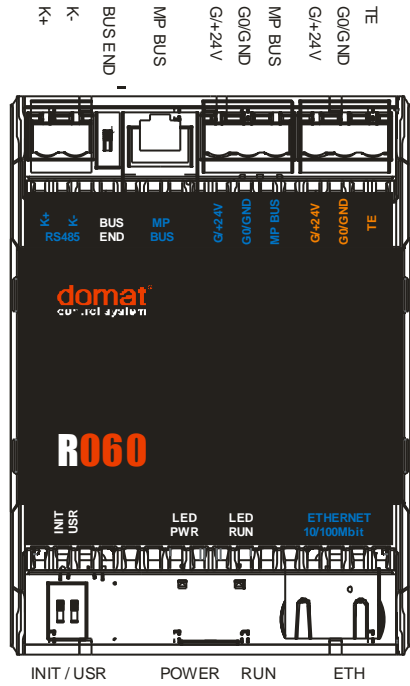
The R060 may work as both Modbus RTU and Modbus TCP server simultaneously. The commands from both interfaces are sent to the MP-Bus on a first come - first served basis. If a unicast message does not receive a response from the actuator on MP-Bus, it is repeated max. 2 x. For periodic readouts there are defined three priority levels, write commands having the highest priority.

The converter is mounted on a standard DIN rail. The width is 68 mm (4 DIN modules).

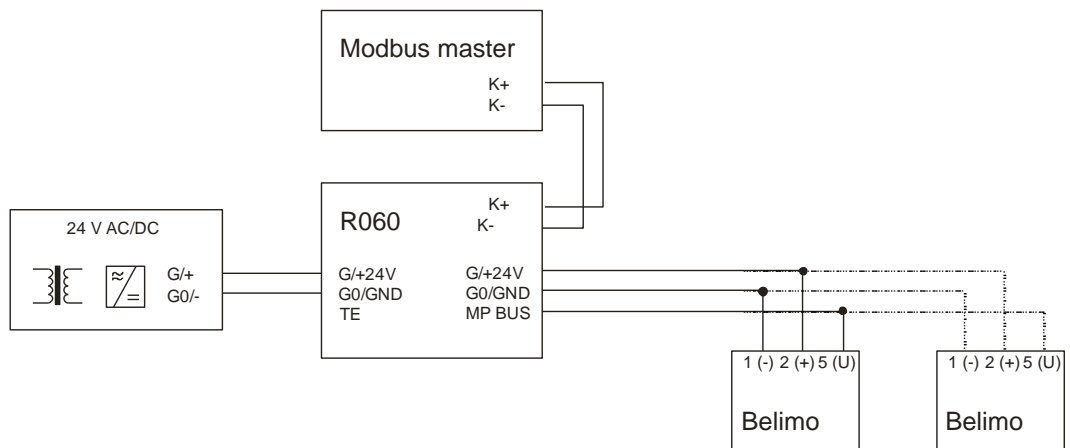
Technical data

Power	24 V AC/DC \pm 15 %
Consumption	3 VA internal consumption max. 85 VA if peripherals are also supplied from the R060 terminals
Ethernet	1 x Ethernet 10/100 Mbit/s (automatic switching) RJ45, 2 LED (link, data) integrated in the connector
RS485	two wire bus, 1200...115 200 bps, no / even / odd parity, 1 or 2 stop bits – all configurable by software, galvanical separation up to 1 kV protocol Modbus RTU
MP-Bus	1200 bps, max. 8 slave devices, max. length 800 m non-twisted cable 0.75 mm ² , supported MP-Bus power supply max. 80 W
MP-Bus service connector	RJ12, Belimo standard
LED	power: PWR – green, permanently on processor activity: RUN – red, 1 s cycles
HW	ARM Cortex M4 168 MHz, 4 MB FLASH, 256 KB SRAM
Cover	polycarbonate box (UL94V0 certified)
Dimensions	70.4 x 61.4 x 98.6 – See Dimensions below
Protection degree	IP20 (EN 60529)
Terminals	screw terminals M3, core cross-section max. 2.5 mm ² (recommended core cross-section 0.35...1.5 mm ²)
Operating conditions	5...40 °C; 5...85 % relative humidity; no aggressive environment, no condensing vapours (according to EN 60721-3-3 climatic class 3K3)
Storage	5...40 °C; 5...85 % relative humidity; no aggressive environment, no condensing vapours (according to EN 60721-3-1 climatic class 1K2)
Conformity with standards	EMC EN 61000-6-2 ed.3:2005, EN 55022 ed.3:2010 (industrial environment) electrical safety EN 60950-1 ed.2:2006 + A11:2009 + A12:2011 + A1:2010 + A2:2014 restriction of the Use of Certain Hazardous Substances EN 50581:2012

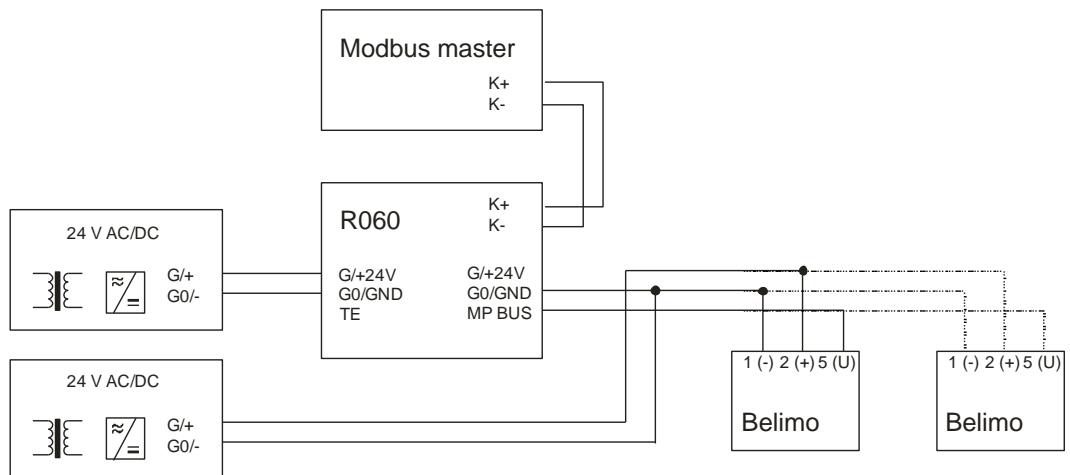
Connection



Connection when both control system and peripherals are powered from a single supply – only if the total consumption of the MP-Bus peripherals is less than 80 W:



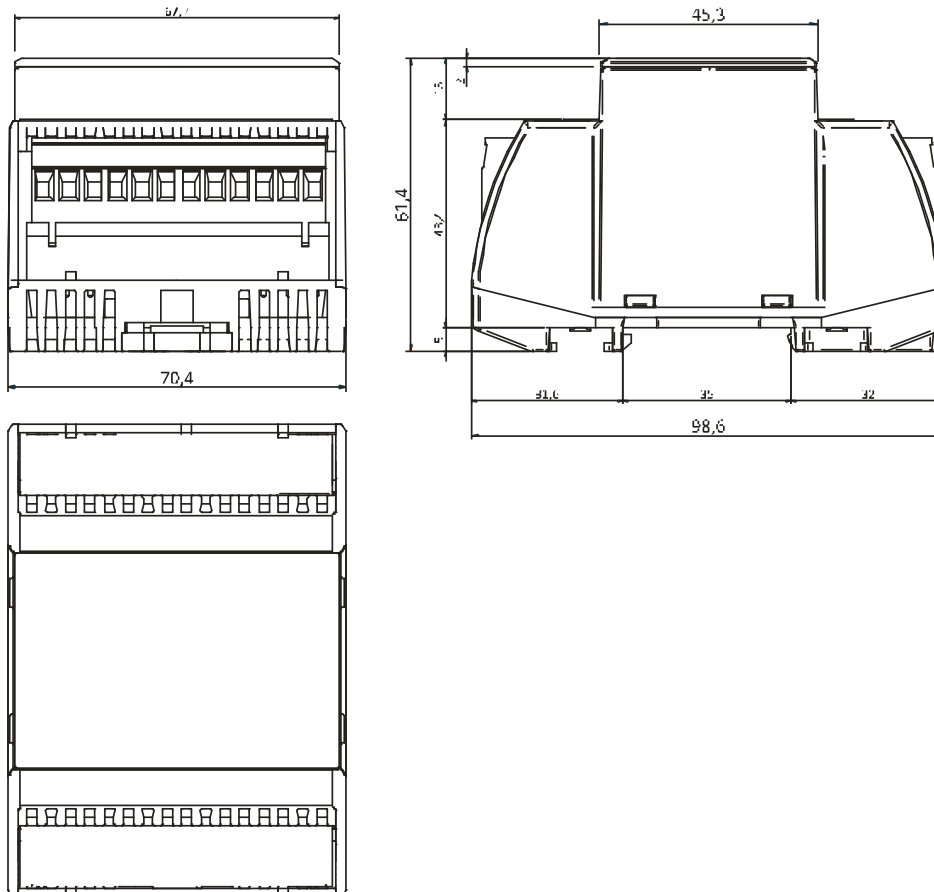
Connection when control system and peripherals are powered from different supplies – in general, or if the total consumption of the MP-Bus peripherals is higher than 80 W:



Terminals and connectors

G/+24 V (orange)	power
G0/GND (orange)	power – reference terminal
TE (orange)	technical earth – connection of metallic parts of the device
G/+24 V (blue)	power to peripherals (max. 80 W)
G0/GND (blue)	power to peripherals – reference terminal
MP-BUS (blue)	MP-Bus communication
K+	RS485, positive
MP-Bus (RJ12)	Belimo service connector
K-	RS485, negative
Ethernet	network interface (RJ45)
LED indication	
PWR	green LED – power (on: power OK; off: power not connected, power supply overloaded or failed, ...)
RUN	red LED – operation (1 s cycles: processor OK, on or off: processor failure)
Switches	
INIT	set to ON and restart: brings the converter into factory settings, IP address set to 192.168.1.99, network mask 255.255.255.0
USR	set to ON and restart: blocks access to web pages and FTP server

Dimensions



All dimensions are in *mm*.

Communication Default network settings are:
IP address 192.168.1.99
network mask 255.255.255.0
default gateway 192.168.1.1

Default port to access the web pages is TCP port 80.

Settings All parameters incl. network settings are available over the web interface on TCP port 80. Access is not protected by password, but it can be disabled by the USR switch.

Connection to the web interface:

1. Connect the Ethernet interface over a patch cable to your network. Apply power (24 V AC/DC, terminals G and G0, any polarity). Wait about 30 seconds before the converter boots up.
2. Set a fixed IP address on your PC in the 192.168.1.x network, e.g. 192.168.1.10.
3. In the web browser, enter the IP address of the R060 – default is 192.168.1.99.

MP-Bus actuator addressing

For addressing of the actuators and other MP-Bus related activities, it is not necessary to have an application program and functional Modbus master (a PLC) to send commands on the bus as in normal operation. All settings can be made over the R060 web pages and any web browser. The engineer who addresses the actuators should coordinate the MP-Bus addresses so that the application programmer can prepare the control application for the PLC. It is recommended to assign the MP-Bus addresses to the actuators already in the shop drawings.

A MP-Bus actuator is identified

- through a unique serial number (S/N) in a form of xxxxx-xxxxx-xxx-xxx, assigned in the production. The serial number can not be changed.
- through a settable MP-Bus address ranged 1...8.

A functional MP-Bus thus has maximum of 8 actuators with unique MP-Bus addresses. The serial number is printed at the actuator type label, and is used for detection and assignment of MP-Bus addresses. A MP-Bus address may also be blank (not set), such actuator may only be addressed using the serial number.

Every MP-Bus actuator has a **Status** LED (usually orange), which acts as a button (**Address**) at the same time. The **Address** button is used to detect the actuator on the bus and for assignment of addresses in the R060. (Note: The Belimo CQ24A-MPL actuator has the **Address** button at the green MPL LED, while the orange **Status** LED is at the **Adaption** button).

The addressing is to be done as follows:

- connect the actuators to 24 V power and to the MP-Bus
- open the web interface of R060, go to Addressing
- set all positions as Inactive using the Deactivate buttons to disable translation of Modbus commands to the MP-Bus which avoids collisions at addressing
- click the Bus Scan button
- after the bus has been scanned, the actuators with already set MP-Bus are visible in the table:
 - if there are no addresses set, continue with the next steps
 - if there are addresses and fit with the required addressing scheme, continue with the next steps
 - if there are addresses and readdressing is required, enter the new MP-Bus address to the Address to set field and click the Set MP-Address button. The new address must not collide with any of the existing addresses.

- if a MP-Bus address shall be deleted for an actuator, set it to address 0.

Then, set the addresses at the actuators with blank MP-Bus addresses:

- at the first actuator, enter the Serial number (printed on the type label), *or*
- click the *Get serial number* button at the first line (PP) and then push the **Address** button on the actuator (see notes below). The serial number fills in automatically into the *Serial number* field.

MP Address	Serial number	Status				Address to set	
PP	01544-10008-142-160	Inactive			Get Serial Number	PP	Set MP Address

- enter the required MP-Bus address into the *Address to set* field instead of the „PP“ letters. It is a free address in range 1...8. Then click the *Set MP Address* button.
- the actuator is addressed, and after the command is executed, the actuator S/N appears in the respective line with the MP-Bus address.

The *Get serial number* detection does not check if the found actuator has a MP address assigned already, the S/N appears in the *PP* row and is still assigned to the original MP address. Periodic querying stops after a reply from the actuator is received, or after manual cancellation on the R060 web page.

Finally, the Modbus communication must be enabled for every actuator by the *Activate* buttons, or for all actuators by the *Activate all* button.

Note. Some actuators do not have the **Address** button and its function is performed as follows:

- Fire dampers: turn the manual winder about 60 degrees
- NM24-MFT(2) and AM24-MFT(2): push the black Manual button
- LF24-MFT(2) and AF24-MFT(2): shortly (within 4 s) turn the rotation direction switch to the opposite direction and back
- Linear actuators NV...: push the S2 button (under the cover).

Web pages

The R060 web pages are used to configure the MP-Busu, setting of the communication parameters of the Ethernet and RS485 interfaces, and device diagnostics. The web is not password-protected. The access can be blocked by the USR switch.

MP-Bus values

Uptime: time since last restart or power-up.

Statistics

Number of received (RX) and sent (TX) telegrams for different protocols on the Ethernet. The *Reset frame stats* button resets all statistics.

Network config

DHCP on/off: activates and deactivates IP address assignment over DHCP. In technological networks, fixed IP addressing is more common (DHCP off).

MAC address: Ethernet interface physical address, bytes are not separated by colons. The MAC address can not be changed.

IP address: set IP address in format of XXX.XXX.XXX.XXX

Subnet mask: network subnet mask

Gateway IP address: default gateway address

Ethernet speed: automatically set physical baudrate of the network card

Set IP: button to set IP address, mask and gateway. The parameters must be edited in the fields above, and by clicking the *Set IP* button they are written into the device.

Default parameters (IP address 192.168.1.99, mask 255.255.255.0) are set by setting the INIT switch to ON and restart of the device.

Modbus config

Modbus address: Modbus address for the RS485 line. (At Modbus TCP the link address is always 1). The *Set modbus address* button writes the address into the device.

RS485 serial line config: RS485 serial line parameters. (The MP-Bus has a fixed baudrate of 1200 bit/s according to the Belimo standard.) The parameters are set by clicking the *Set serial* button.

Administration

Memory utilisation: For diagnostic purposes only. (Free OS heap = operation system free memory, Free app heap = free memory for communication clients/servers)

Info: Firmware version, time since last restart, last error code.

Reset error: Resets the last error code indicator.

Reset device: Restarts the device.

Module name: Device name, location etc. can be entered here as free text (max. 20 characters)

Upload new firmware: To upload a new firmware if necessary. Select the file and click the *Upload new firmware* button. The R060 restarts automatically after the firmware has been uploaded.

Addressing

MP-Address: MP-Bus actuator address ranged 1 to 8. The PP stands for Point to Point communication and is used to assign addresses to actuators with blank MP-Bus addresses. If an actuator already has a MP-Bus address and is detected again (or its S/N is entered manually) and another MP-Bus address is assigned to it, it is readdressed to the new MP-Bus address.

Serial number: displays the serial number of an actuator (the S/N is also printed at the actuator type label). In the PP position, the S/N can be entered manually and so the MP-Bus address of an actuator can be set even without detection.

Status: if set as *Inactive*, the device communicates on the MP-Bus for addressing purposes only. Other commands are not send, incl. the on-demand commands. Same function as bits of Modbus register 20 LSB (see the Modbus table).

Activate/Deactivate: button to enable or disable communication with a particular MP-Bus address, see Status.

Wink: for actuator identification. In normal operation, the orange LEDs **Address** on the actuator flash according to the communication. After the Wink button is clicked, the entire MP-Bus communication is stopped, the orange Address indicators at all actuators go off for about 5 s, and only at the actuator with the particular address the LED flashes three times.

GetSerialNumber: reads the S/N of the actuator with the given MP-Bus address. At the *PP (Point to Point)* position the *On-Event* command is sent periodically (5 s period), which should be responded by any device on which the *Address* button is pushed (at least 5 s, the button flashes shortly on receiving the command), or equivalent action is performed – see above, *MP-Bus actuator addressing*. The converter waits for the reply for unlimited time, the waiting can be cancelled by the *Cancel* button on the *Refresh* page.

Address to set: Enter the MP-Bus address to be set at the newly addressed or readdressed actuator. By entering 0 the actuator is set to the PP mode (not addressed, blank address).

Set MP Address: The new MP-Bus address is set at the particular position. The identifier for this function is the S/N rather than the MP-Bus address. At the *PP* address the S/N may be entered manually, with or without dashes. By entering 0 the actuator is set to the PP mode (not addressed, blank address).

Bus Scan – check of the attached actuators. The converter scans all addresses 1 to 8 (with max. 3 attempts) and waits for the responses. The process takes about 10 s. After an actuator is detected, its S/N is displayed close to its MP-Bus address in the *Serial number* column. Actuators which were not found have S/N of „xxxxx-xxxxx-xxx-xxx“. This command is also executed automatically after power up. Actuators with a blank MP-Bus addresses (PP state) will not be detected.

Auto Address – Automatic assignment of a free MP-Bus address to an actuator. The *On-Event* command is sent periodically, and by pushing the *Address* button on the actuator (see *Get Serial Number*) the actuator is assigned the lowest free MP-bus address. This mode is active for 5 minutes with a timeout indication, and can be cancelled by clicking the *Reset Addressing* button at the web page.

Activate All – All actuators with known serial number are set to *Active*.

Switch Mode – Switching between *Simple* and *Complex* modes. In both *Simple* and *Complex mode* the actuators must be *Active* to be sent commands from Modbus. In the *Simple mode*, the *Complex mode* commands are not active (incl. on-demand commands) and vice versa. Same function as the lowest bit of Modbus register 22 (see Modbus table).

Simple mode Detailed description of the Simple mode:

- For the Simple mode, registers 1001 and higher are reserved, see Modbus table
- Each MP address has a range of 20 registers reserved (of which 17 are used now) and another MP address follows immediately.
- **Register 1 – Setpoint. The most frequently used register.** It uses commands MP_Get_Relative for reading and MP_Set_Relative for writing. The value used for MP_Set_Relative is adapted to minimum and maximum – the nominal range is sent to Modbus.
- **Register 2 – Override control.** Sets the actuator into special mode. It uses commands MP_Get_Forced_Control for reading and MP_Set_Forced_Control for writing. If a command is not repeated within 120 s, the actuator goes back to normal function (this does not apply for Fast closed).
- **Register 3 – Command.** Start of adaptation / test. It uses command MP_Start_Adaptation. Value of 4 does not write to the actuator, it just resets the error attributes (register 6) signalled by the actuator.
- **Register 4 – Actual position.** Actual position of the actuator, it uses command MP_Get_Relative.
- **Register 5 – Relative flow.** Actual flow/pressure of a VAV/EPIV actuator. It uses command MP_Get_Vrelative.
- **Register 6 – Errors / Malfunctions.** The lower byte contains the status byte read by command MP_Get_Malfunction_Maintenance_State. The upper byte contains errors evaluated by the R060. Bits 8 and 9 are set if the response is not received, or there is a parity error (doubled for UK24MOD compatibility reasons). Bit 11 – the actuator responded with Value out of range error. Bit 12 – function not available for given actuator type – evaluated by both actuator and R060 (write only). Bit 13 is True if the fire damper does not close within 15 s.
- **Register 7 – Sensor type.** Specifies the type of sensor used to read value in register 8.
- **Register 8 – Actual sensor value.** Reading of sensor specified in register 7. Analogue sensors are read by command MP_AD_Convert, this does not work if Override control is active. Digital contact is read by command MP_Get_Forced_Control.
- **Registers 9, 10, 11 – Series number.** Parts 1, 2 and 4 of the actuator serial number, uses command MP_Get_SeriesNo.
- **Register 12 – Actuator type.** Decoded from the S/N by the R060.
- **Register 13 – Time monitoring.** Remaining time until end of Override control
- **Registers 14 and 15 – setting of Min/Vmin and Max/Vmax.** Minimum and maximum position / flow, depending on actuator type. Uses commands MP_Get_Min_Mid_Max to read and Set_Min_Mid_Max to write.
- **Register 16 – Absolute flow.** Absolute flow value calculated by the R060.
- **Register 17 – Nominal flow.** Nominal flow, uses command MP_Get_Vsettings. Can not be set over MP-Bus, must be set by the air handling unit manufacturer.

Safety note

The device is designed for monitoring and control of heating, ventilation, and air conditioning systems. It must not be used for protection of persons against health risks or death, as a safety element, or in applications where its failure could lead to physical or property damage or environmental damage. All risks related to device operation must be considered together with design, installation, and operation of the entire control system which the device is part of.

Modbus table

- Functions F01, F02, F03, F04, F05, F15, and F16 are supported.
- For EEPROM registers, the default values are typed **in bold**.
- Attempt to write into a read-only register is ignored (telegram is accepted, but data are discarded).
- Bit-oriented access (functions 01, 02, 05, 15) is only possible at addresses $16 \times \text{word} + \text{bit offset}$ (e.g. status bit „Test run active“ of the actuator at MP-address 3 has bit address $16 \times (3 \times 100 + 11) + 10 = 4986$).

Name	Register	Type	Description	Note
Module LSB	1 LSB	R	Device ID lower byte	fixed, 0x0092 hex
Module MSB	1 MSB	R	Device ID higher byte	
Firmware LSB	2 LSB	R	Firmware version, lower byte	
Firmware MSB	2 MSB	R	Firmware version, higher byte	
Status LSB	3 LSB	R,W RAM	Bit 0 ... enable writing to EEPROM	
Status MSB	3 MSB	R RAM	Bit 0 ... 1 = init mode Bit 1 ... 1 = EEPROM write enabled (the next EEPROM writing attempt writes data to EEPROM rather than in RAM only) Bit 2 ... 1 = USR switch on = http and ftp servers disabled Bit 3 ... 1 = Belimo service connector attached Bit 4 ... 1 = auto addressing active Bit 5 ... 1 = bus scan active Bit 6 ... 1 = HW malfunction of serial line	
Modbus address	4 LSB	R,W EEPROM	Slave Modbus address. Only for RTU. Default value is 1.	At Modbus TCP the slave address is always 1.
Modbus RTU baudrate	4 MSB	R,W EEPROM	10: 1200 11: 2400 12: 4800 13: 9600 14: 19200 15: 38400 16: 57600 17: 115200	Baudrate in bit/s, default value is 9600
Modbus RTU communication	5	R,W EEPROM	bit 0, bit 1 – parity bit 1: number of stop bits	0: none 1: even 2: odd 0: 1 1: 2
Reserved	6	R RAM		
Uptime 1	7	R RAM	Time since last restart, lower word	[s]
Uptime 2	8	R RAM	Time since last restart, higher word	
EEPROM writes	9, 10	R EEPROM	Number of Modbus writing commands into the EEPROM	

Global registers				
Active devices	20 LSB	R,W,EEPROM	Bit 0 ... MP addr. 1 Bit 1 ... MP addr. 2 Bit 2 ... MP addr. 3 Bit 3 ... MP addr. 4 Bit 4 ... MP addr. 5 Bit 5 ... MP addr. 6 Bit 6 ... MP addr. 7 Bit 7 ... MP addr. 8	Set by user according to the bus configuration Default value = 0
Retries	21	R,W,EEPROM	Number of communication attempts before timeout	Settable 0...3, default value = 2
Bit settings	22	R,W,EEPROM	Bit 0 ... 0: Simple mode, 1: Complex mode	Default value = 0
Simple mode				
<p>Simple mode is the most frequently used mode for actuator control. To set the actuator position, one writing operation into a single register (...01) is enough, actual value can be read for information in register ...04. See also detailed description above on page 9.</p> <ul style="list-style-type: none"> - functions correspond to those of the UK24MOD converter - each actuator maps a range of 20 Modbus registers (of which now 17 are used) and these ranges are following one after another without gaps, ie. the MP address 1 has reserved Modbus registers 1001 – 1020, MP2: 1021 – 1040, up to MP8: 1141 – 1160. In the table below, only relative addresses are written: for MP address 1 add 1000 to the values below, for MP address 2 add 1020 etc. - to communicate with a particular MP address, the communication must be enabled in a global register (20 LSB) - the values are read on a periodical basis, new values are written after receiving a Modbus writing telegram - supported actuators see reg. 12 				
Setpoint	01	R,W, RAM	Required actuator position	[0,01%] Fire / smoke dampers do not support writing
Override control	02	R,W, RAM	Simplified version of Get / Set Forced Control 0 – None 1 – Open 2 – Closed 3 – Min 4 – Mid 5 – Max 6 – Fast closed MPL actuators do not support this function. Fire / Smoke dampers only support values 1 and 6. The command must be repeated every 120 s	
Command	03	R,W, RAM	Service and testing function 0 – None 1 – Adaption 2 – Test run 3 – Synchronisation 4 – Reset malfunctions / errors MPL actuators only support values 1 and 4 After an acknowledge from the actuator is received, the register value is reset	
Actual position	04	R, RAM	Measured (real) actuator position	[0,01%]
Relative flow	05	R, RAM	VAV – STP mode % Pnom VAV and EPIV % Vnom	[0,01%] Only supported at VAV and EPIV actuators

Errors / Malfunctions	06	R, RAM	Malfunctions / Maintenance Bit 0: Excessive utilisation Bit 1: Control range increased Bit 2: Overload, setpoint position not reached Bit 3: Supercap malfunction Bit 4: Security relevant malfunction Bit 5: Damper test error Bit 6: Duct temperature too high Bit 7: Smoke detector Alarm NC Errors Bit 8: Device does not respond Bit 9: Copy of bit 8 for UK24MOD compatibility reasons Bit 10: Reserved Bit 11: Device does not accept this value Bit 12: Device does not accept this command Bit 13: Damper not closed within 15 s Bits 4, 5, 6, 7 and 13 are only supported by Fire / Smoke dampers MPL actuators do not support Malfunctions / Maintenance bits Bits 11, 12, 13 are reset by user by sending Command 4	
Sensor Type	07	R,W, RAM	0 – None 1 – Active sensor 2 – Passive sensor 1k 3 – Passive sensor 1-20k 4 – Switching contact	- [mV] [Ω] [Ω] 0 – open, 1 – closed
Actual Value	08	R, RAM	Measured value at the sensor	
Series Number 1	09	R, RAM	first part of the serial number - 01234	The whole S/N has a format of 01234-56789-876-543
Series Number 2	10	R, RAM	second part of the serial number - 56789	
Series Number 3	11	R, RAM	fourth part of the serial number - 543	
Actuator Type	12	R, RAM	0 – Not Connected / Unsupported 1 – Direct-coupled / Spring-return 2 – Linear Valve 3 – Rotary Valve 4 – Fire / Smoke Damper 5 – VAV Controller / EPIV 6 – MPL Actuator After 10 s with no communication the value is set to 0	
Time monitoring	13	R, RAM	Time until expiration of Override control (120 s)	[s]
Min/Vmin	14	R,W, RAM	Minimum position / flow	[0,01%]
Max/Vmax	15	R,W, RAM	Maximum position / flow	[0,01%]
Absolute flow	16	R, RAM	Nominal Flow * Relative flow Only VAV a EPIV, otherwise value is 65535	[m3/h] – VAV [Pa] – VAV – STP [l/min] – EPIV
Nominal flow	17	R, RAM	Only VAV a EPIV, otherwise value is 65535	[m3/h] – VAV [Pa] – VAV – STP [l/min] – EPIV

Changes in versions

08/2016 – First version of the data sheet.
11/2017 – Change modbus table, added safety note.
08/2021 – Stylistic adjustments, change of logo.