R005 DL (Sauter EY2400) / RS232 converter

Summary

R005 is a data converter of the DL bus (two-wire communication bus Sauter for the controllers of the series EY2400) to RS232. Interface RS232 is connected by three screw terminals.

Application

- **Integration of controllers of the EY2400 series into PLC or visualisation through a RS232 interface**

Function

The DL bus with up to 20 Sauter controllers can be connected to a process station with a corresponding driver (e.g. Domat IPCB.1, IPCT.1 or IPLC510) or the master system (e.g. RcWare Vision-x) through a RS232 communication line. The configuration of the converter is fully automatic – no manual configuration is necessary.

The device is installed on a DIN rail. To connect the Sauter bus, there are 2 pairs of screw terminals for comfortable mounting.

Technical data

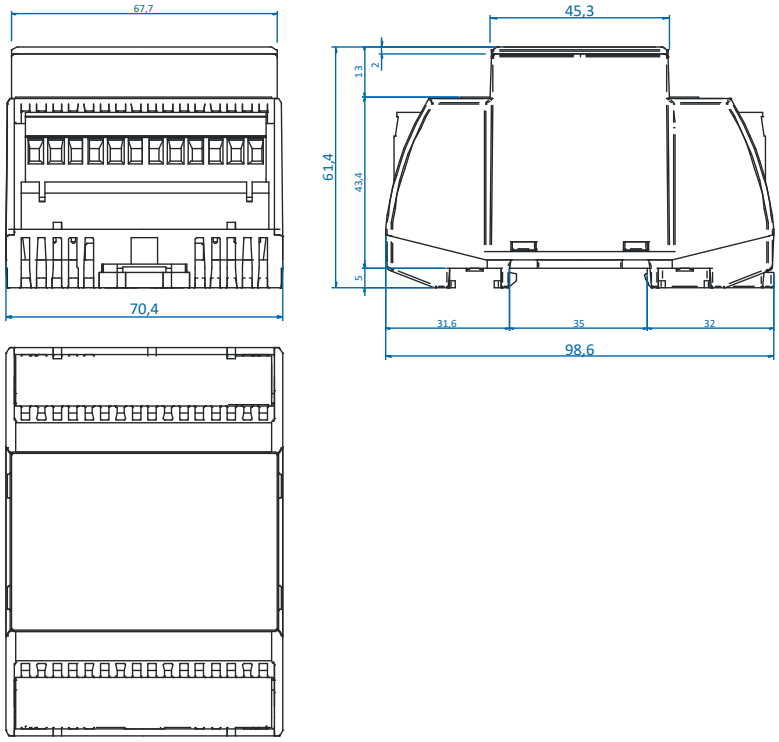
Power supply	230 V AC, 50 Hz
Consumption	max. 4 VA
Ambient temperature	-20…70 °C
Relative humidity	5...95 % non-condensing
DL	according to standard Sauter, max. 20 controllers
Maximum DL bus length	1200 m

Max. number of controllers on DL bus	20
Maximum RS232 bus length	15 m, according to standard RS232C
LED	2 × green Tx, 2 × yellow Rx
Dimensions	see below

Terminals, LEDs

L	power supply 230 V AC line
N	power supply 230 V AC neutral
+L/A	DL bus, positive cable
-D/B	DL bus, negative cable
TxD	RS232, transmit
GND	RS232, ground
RxD	RS232, receive

Dimensions



All dimensions are in *mm.*

WEEE notice

The device contains a non-rechargeable battery which backups the real-time clock and part of the memory. After the device is not operable, please return it to the manufacturer or dispose of it in compliance with local regulations.

Changes in versions	11/2016 – The first datasheet version. 08/2021 – Stylistic adjustments, change of logo.

R012 RS232 – RS485 data converter

Summary **R012 is a RS232 to RS485 multi-speed half-duplex physical level converter with galvanic separation at both ends and power part. The device is equipped with a microcontroller which controls the data flow switching. This converter is a successor of the previous types M010, M011 and M012.**

Applications

- **domat I/O modules link to PC**
- **any RS232 to RS485 conversion where galvanic separation is required**

Functions

The RS485 bus supports half-duplex communication. For automatic flow control, a microcontroller is used which is controlled by the CTS or DSR signals (DSR as default). The communication speed of both channels must be equal and is to be set by DIP switches under the front panel of the converter. There are LEDs at the front panel to indicate power presence and RS485 data flow.

For the RS485 connection is used 2-pole connector. The line is protected against overvoltage. In case the converter is used as the last in line, a terminating resistor may be employed by connecting DIP switch accessible behind the K connector.

For the RS232 connection, a CANON 9M (pins) connector is used. For PC connection, use nullmodem (cross) cable with CANON 9F (holes) at both ends. System **domat** only uses RxD, TxD, and GND signals for communication.

Technical data

Supply voltage	10…35 V DC, 14…24 V AC, any polarity
Consumption	1.5 W
Communication	
RS485	K+, K- communication asynchronous, 1200...115200 bit / s bits 8 or 9, 1 stop bit max. bus length to 1,200 meters galvanically isolated, isolation voltage 1 kV
Default settings	bus end OFF, 8, 9600 (suitable for I / O modules domat)
RS232	CANNON 9 male system **domat** only uses RxD, TxD, and GND signals. 1200...115200 bit/s bits 8 or 9, 1 stop bit galvanically isolated, isolation voltage 1 kV
Data flow control	auto, CTS, or DSR
Dimensions	see below
Operating environment	
Ambient conditions	-5…40 °C; 5…95 % relative humidity; non-condensing gases and chemically non-aggressive conditions (according EN 60721-3-3 climatic class 3K3)
Storage conditions	-5…45 ° C; 5…95% relative humidity; non-condensing gases and chemically non-aggressive conditions (according EN 60721-3-1 climatic class 1K3)
Standards Compliance	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 Hazardous Substances EN 50581: 2012

Terminals and settings

Terminals and connectors

G	power
G0	power
TE	optional connection for shielding
RS232	serial link RS232; CANNON 9 male (1- DCD, 2 - RXD, 3 - TXD, 4 - DTR, 5 - GND, 6 - DSR, 7 – RTS, 8 - CTS)
RS485	serial link RS485; terminals K+, K-

LED indication

TxD	red LED – RS485 transmitting data (flashing: transmitting data; OFF: no data traffic)
RxD	green LED – RS485 receiving data (flashing: transmitting data; OFF: no data traffic)
PWR	green LED – power (ON: power OK; OFF: no power applied, weak or damaged power supply, …)

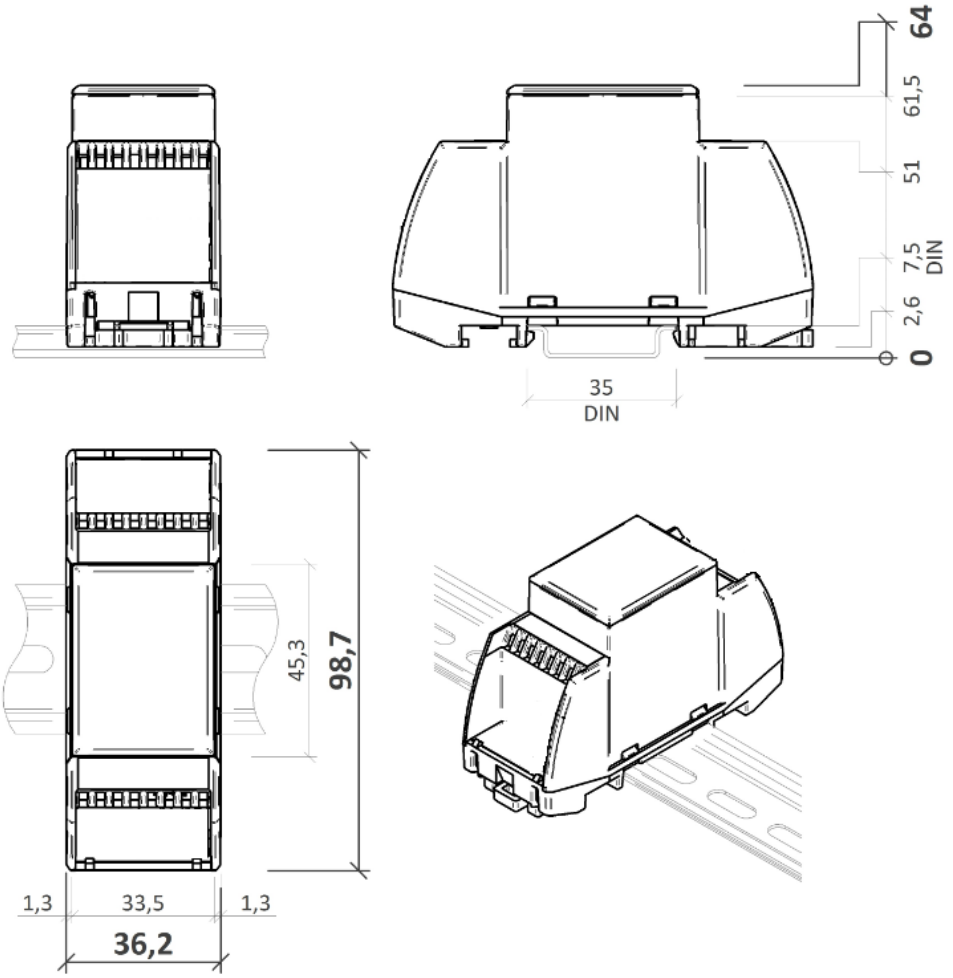
DIP switches

BUS END	(DIP1 under the RS485 terminal) ON = bus end; the first and last devices on bus should have bus end ON
SW 1, 2, 3	After removing the cover, you can adjust the speed of the serial line by the DIP switches. After setting required communication parameters switch device power OFF/ON.

	SW1	**SW2**	**SW3**
1 200 bps	OFF	OFF	OFF
2 400 bps	ON	OFF	OFF
4 800 bps	OFF	ON	OFF
9 600 bps (default)	**ON**	**ON**	**OFF**
19 200 bps	OFF	OFF	ON
38 400 bps	ON	OFF	ON
57 600 bps	OFF	ON	ON
115 200 bps	ON	ON	ON

SW 4	Number of bits OFF 8 bits / ON 9 bits. If parity (Even/Odd) is used, it is necessary to switch ON DIP SW 4 (9 bits)!

Dimensions



Dimensions are in *mm*.

Changes in versions	12/2016 – First datasheet version. 05/2018 – Change technical data. 08/2021 – Stylistic adjustments, change of logo.

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R025

Ethernet – RS232 data converter and Modbus RTU/TCP router

Summary

R025 is a 10/100 Mbit Ethernet to RS232 converter, also called "terminal server". It is configurable as Modbus RTU/TCP router. This converter is a successor of the previous type M025.

Application

- **remote Modbus RTU/RS232 device to SCADA Modbus TCP connection via an Ethernet network**
- **bridge function – virtual channel RS232 in an Ethernet network (between two R025)**
- **modem emulation - converters are connected using AT commands in an Ethernet network**

Function

The R025 module contains all the features of the R020 module. It is able to connect a RS232 device to a PC over an Ethernet network. The Digi RealPort Software creates a virtual COM port on the host PC. This virtual port enables any software to communicate with a remote RS232 device. The COM port redirector runs under Microsoft Windows, UNIX and Linux. Maximum communication speed is 230400 bps.

The main difference between R020 and R025 is the **industrial automation** profile selection option for R025. This is the Modbus RTU/TCP router functionality. On the TCP side the module acts as slave (server) and sends the requests as master (client) to the serial line with Modbus RTU.

The module parameters and functions are configured over SNMP or secured web communication (HTTP / HTTPS protocols). Power presence is indicated by a green LED close to the serial connector. The Ethernet connector provides two LEDs: Link and Network activity. The network switches automatically between 10 and 100 Mbit/s.

A CANON 9M device connects through a nullmodem ("crossed") serial cable with CANON 9F connector at both sides ("terminal-terminal" connection). A CANON 9F

device connects through a modem (“straight”) serial cable with CANON 9M and CANON 9F connectors. All RS232 signals except for RING (1- DCD, 2 - RXD, 3 - TXD, 4 - DTR, 5 - GND, 6 - DSR, 7 - RTS and 8 - CTS) are transmitted. Usually only RXD, TXD and GND are used.

The module is 36.2 mm wide and mounts on a standard DIN rail.

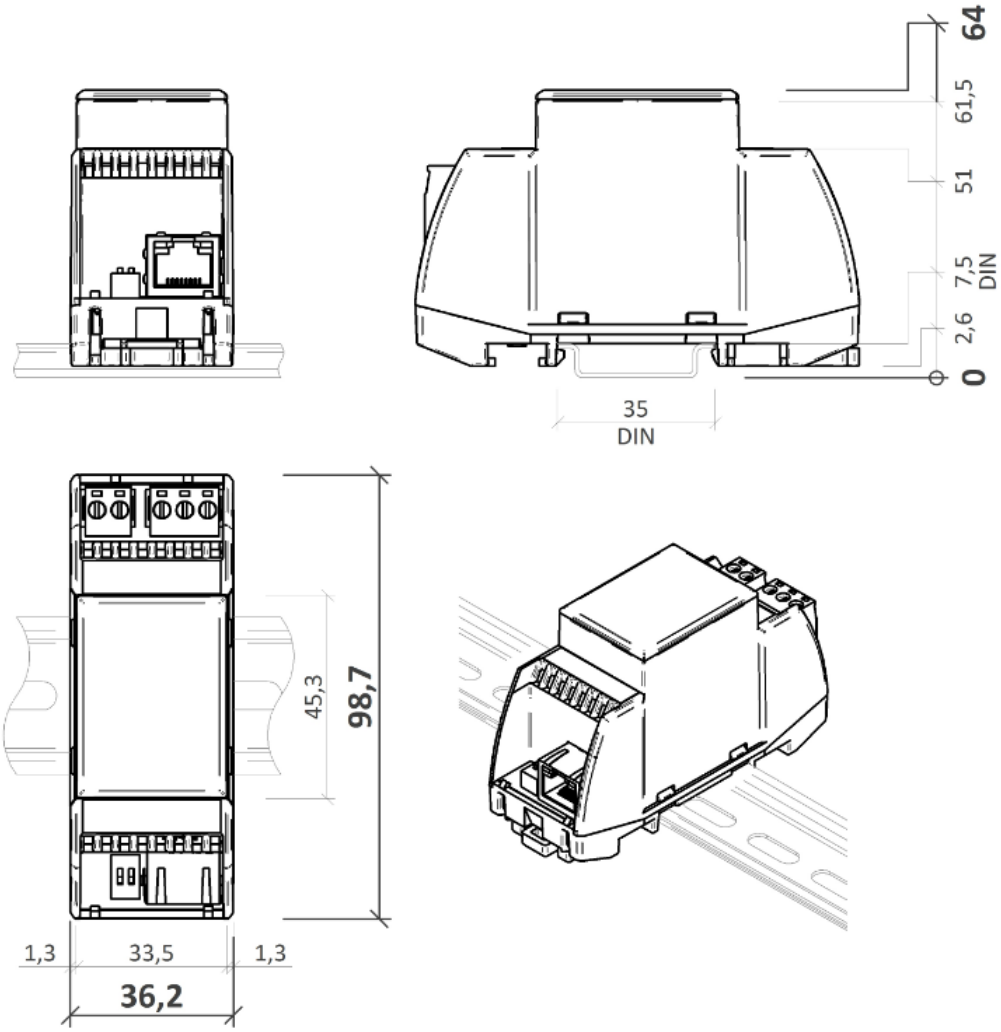
Technical data

Power	24 V AC/DC ± 10 %; max. 1.5 W
Ethernet	1 × Ethernet 10/100BaseT (automatic speed change) RJ45, 2 × LED (link, data) integrated in the connector
RS232	CANNON 9 male; (1- DCD, 2 - RXD, 3 - TXD, 4 - DTR, 5 – GND, 6 - DSR, 7 - RTS a 8 - CTS) high speed 1200...230 400 bit/s
1× LED	PWR
HW	NS7520 (RISC processor, 32-bit NET+ARM), 55 MHz, 2 MB Flash, 8 MB RAM
SW	digi RealPort (creates a virtual COM port on the host PC) configuration via web interface
Housing	polycarbonate box (certification UL94V0)
Dimensions	see below
Protection degree	IP20 (EN 60529)
Terminals	screw terminals M3, maximum wire cross-section 2.5 mm^2 (recommended wire cross-section is 0.35…1.5 mm^2)
Ambient conditions	5…40 °C; 5…85 % relative humidity; non-condensing gases and chemically non-aggressive conditions (according EN 60721-3-3 climatic class 3K3)
Storage conditions	5…40 °C; 5…85 % relative humidity; non-condensing gases and chemically non-aggressive conditions (according EN 60721-3-1 climatic class 1K2)
Standards conformity	EMC EN 61000-6-2 ed.3:2005, EN 55022 ed.3:2010 EN 60950-1 ed.2:2006 + A11:2009 + A12:2011 + A1:2010 + A2:2014 EN 50581:2012

Schema

Terminals and connectors:	
G	power
G0	power
Ethernet	network interface
COM	port COM - serial link RS232; CANNON 9 male (1- DCD, 2 - RXD, 3 - TXD, 4 - DTR, 5 - GND, 6 - DSR, 7 – RTS, 8 - CTS)
LED indication:	
PWR	green LED – power (ON: power OK; OFF: no power applied, weak or damaged power supply, …)
Jumper:	
INIT	For INIT function activation, disconnect power terminal and plug in a jumper on the pins between power terminal and the outside part of the box. If jumper is plugged in at power-up, converter will be set to factory defaults.

Dimensions



All dimensions are in *mm*.

Communication

Default network settings are:

IP address	192.168.1.37
subnet mask	255.255.255.0
default gateway	0.0.0.0

User: root
Password: dbps

For devices with PN4919 or higher:

User: root
Password: "code", the default password ("code") is written on the label on the side of the device.

Notice: Do not forget to note the new network and user settings after change!

Settings

All parameters inclusive network configuration are available at a web interface on TCP port 80. English help for each settings opinion is displayed after click on the „? Help“ button in the upper right corner.

Find the detailed description of all settings in the Digi Connect user guide. Actual version is available at http://www.digi.com/products/embedded-systems/system-on-modules/digiconnectme#resources in chapter Literature -> Integration Kits.

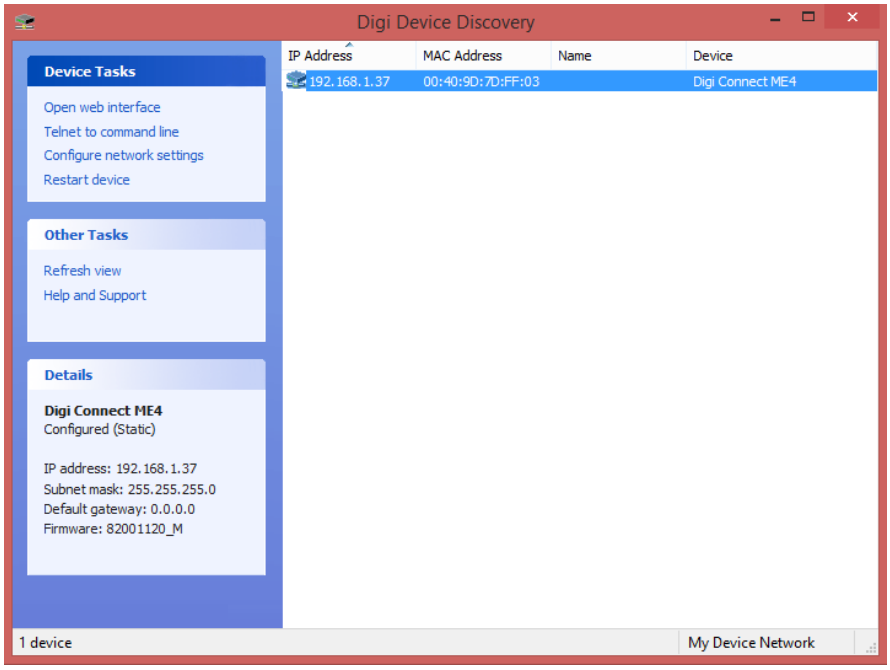
Connection to web interface and IP settings:

1. Use a RJ45 cable to connect converter to the web network. Connect converter to power supply (24 V DC/AC, terminals G and G0, any polarity). Please wait approximately 30 seconds for the converter to boot.

2. Fill converter IP address in web browser. Connect to the web interface.

3. If you don´t know the IP address of the converter, choose your operating system and download program Device Discovery Utility at http://www.digi.com/products/embedded-systems/system-on-modules/digiconnectme#resources , chapter Utilites.

4. Start the Device Discovery Utility. In case of successful detection, you can see the converter IP address in the program window. If there are some problem with detection switch off the PC firewall please. The network card must be able to receive the broadcast answers.



5. In the Device Tasks dialogue set the new IP address (Configure network settings) or go directly to the web pages of the M020 (Open web interface).

6. If you can not log in, set the converter to factory defaults (see below).

Modbus router settings:

1. Connect to the converter through web interface.

2. In section “Configuration” select “Serial Ports” and click on “Port 1”. Set serial port to profile “Industrial Automation” and “Apply” the changes.

3. The Modbus router listens at the default Modbus TCP port 502.

4. Do not change the advanced settings in the web interface unless you know what you are doing. False settings may result in communication trouble, timeouts etc.

Virtual COM port on PC - installation:

1. Download the actual drivers on:
   http://www.digi.com/support/productdetail?pid=2466&type=drivers
   in the Operating System Specific Drivers menu, choose your operating system and download the drivers.

2. Install the downloaded Digi RealPort software.

3. If the converter is in the same network, the program detects the device after installation. Otherwise, the IP settings must be configured properly.

4. Connect to the converter through web interface.

5. Under the title “Configuration” select “Serial Ports” and “Port1”. Set the profile “RealPort” and confirm the configuration by button “Apply”.

6. Do not change the advanced settings in the web interface unless you know what you are doing. False settings may result in communication trouble, timeouts etc.

Factory settings:

If the connection through web interface is not possible, bring the converter into Factory Default Settings:

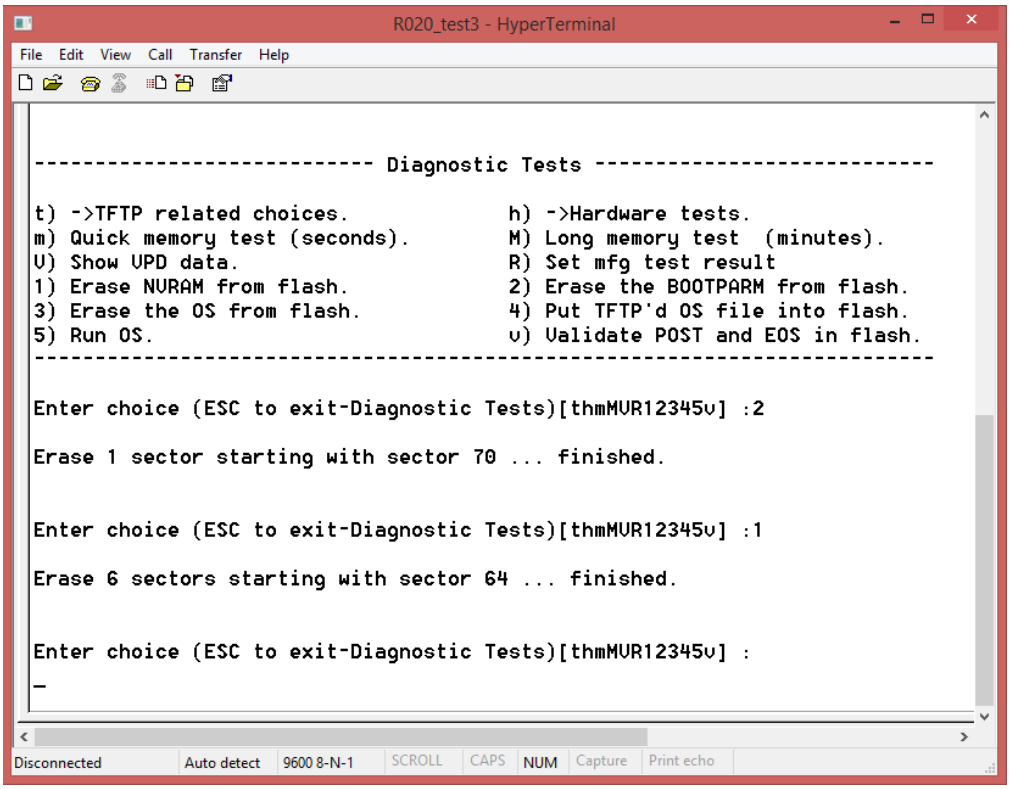
1. Disconnect power terminal and plug in a jumper on the pins between power terminal and the outside part of the box.

2. Connect converter and PC by a serial (nullmodem) cable. If the PC does not have a RS232 port, use a USB/RS232 converter.

3. Start a serial terminal software on the PC (e.g. Hyperterminal, TeraTerm) and select the COM port which connects to the converter. Communication parameters are 9600, 8 bits, N (none) parity, 1 stop bit. Data flow control None.

4. If the connection is established, switch on the converter power supply.

5. In window there is the R025 menu. Press 2 (Erase the BOOTPARM from flash) and wait for the “finished” message. Then press 1 (Erase the NVRAM from flash) and wait for the “finished” message. See screenshot below.



6. Terminate the connection, switch off power and disconnect the INIT jumper.

7. Connect the power supply. Approximately after one minute it is possible to detect the converter again. All the settings are default. The IP setting has DHCP set to ON. The converter will now ask for a new IP address from a DHCP server. If there is no DHCP server in the network, the device has address of 169.254.xxx.xxx. (Switch off the Windows firewall and detect device by the Device Discovery Utility.)

Changes in versions	04/2016 – First version of the datasheet. 12/2020 – Added note about default password change. 08/2021 – Stylistic adjustments, change of logo.

R035

Ethernet – RS485 data converter and Modbus RTU/TCP router

Summary

R035 is a 10/100 Mbit Ethernet to RS485 converter, also called "terminal server". It is configurable as Modbus RTU/TCP router. This converter is a successor of the previous types M031, M035, M036 and R031.

Application

- **remote Modbus RTU/RS485 device to SCADA Modbus TCP connection via an Ethernet network**
- **connection of domat I/O modules for data transmission and signal readout**
- **the usage depends on the communication protocol at the RS485; in some situations, the Ethernet delays may not meet the timing requirements of the serial protocol driver**

Function

The R035 module is able to connect a RS485 device to a PC over an Ethernet network. The Digi RealPort Software creates a virtual COM port on the host PC. This virtual port enables any software to communicate with a remote RS485 device. The COM port redirector runs under Microsoft Windows, UNIX and Linux. Maximum communication speed is 115200 bps.

R035 has the **industrial automation** profile selection option. This is the Modbus RTU/TCP router functionality. On the TCP side the module acts as slave (server) and sends the requests as master (client) to the serial line with Modbus RTU.

The module parameters and functions are configured over SNMP or secured web communication (HTTP / HTTPS protocols). Power presence is indicated by a green LED close to the serial connector. The Ethernet connector provides two LEDs: Link and Network activity. The network switches automatically between 10 and 100 Mbit/s.

To connect the RS485 bus there are 2 screw terminals. The RS485 data flow is indicated by LEDs: TxD (green) and RxD (red). The RS485 bus may be terminated by a pair of DIP switches (close to the RS485 terminals). Communication speed and number of data bits are set by DIP switches (the right of the RS485 terminals). The RS485 bus is galvanically isolated (insulation voltage 1000 V).

The module is 36.2 mm wide and mounts on a standard DIN rail.

Technical data

Power	24 V AC/DC ± 10 %; max 2 W
Ethernet	1 × Ethernet 10/100BaseT (automatic speed change) RJ45, 2 × LED (link, data) integrated in the connector
RS485	K+, K- galvanically insulated, insulating voltage 1 kV communication speed 300...115 200 bit/s is set by combination of SW DIP1-3; bits are set by SW DIP4 maximal bus length 1200 m maximum number of modules depends on requested response time – up to 255 addresses
3× LED	TxD, RxD, PWR
HW	NS7520 (RISC processor, 32-bit NET+ARM), 55 MHz, 4 MB Flash, 8 MB RAM
SW	Digi RealPort (creates a virtual COM port on the host PC) configuration via web interface
Housing	Polycarbonate box (certification UL94V0)
Dimensions	See below
Protection degree	IP20 (EN 60529)
Terminals	Screw terminals M3, maximum wire cross-section 2.5 mm^2 (recommended wire cross-section is 0.35…1.5 mm^2)
Ambient conditions	5…40 °C; 5…85 % relative humidity; non-condensing gases and chemically non-aggressive conditions (according EN 60721-3-3 climatic class 3K3)
Storage conditions	5…40 °C; 5…85 % relative humidity; non-condensing gases and chemically non-aggressive conditions (according EN 60721-3-1 climatic class 1K2)
Standards conformity	EMC EN 61000-6-2 ed.3:2005, EN 55022 ed.3:2010 EN 60950-1 ed.2:2006 + A11:2009 + A12:2011 + A1:2010 + A2:2014 EN 50581:2012

Schema

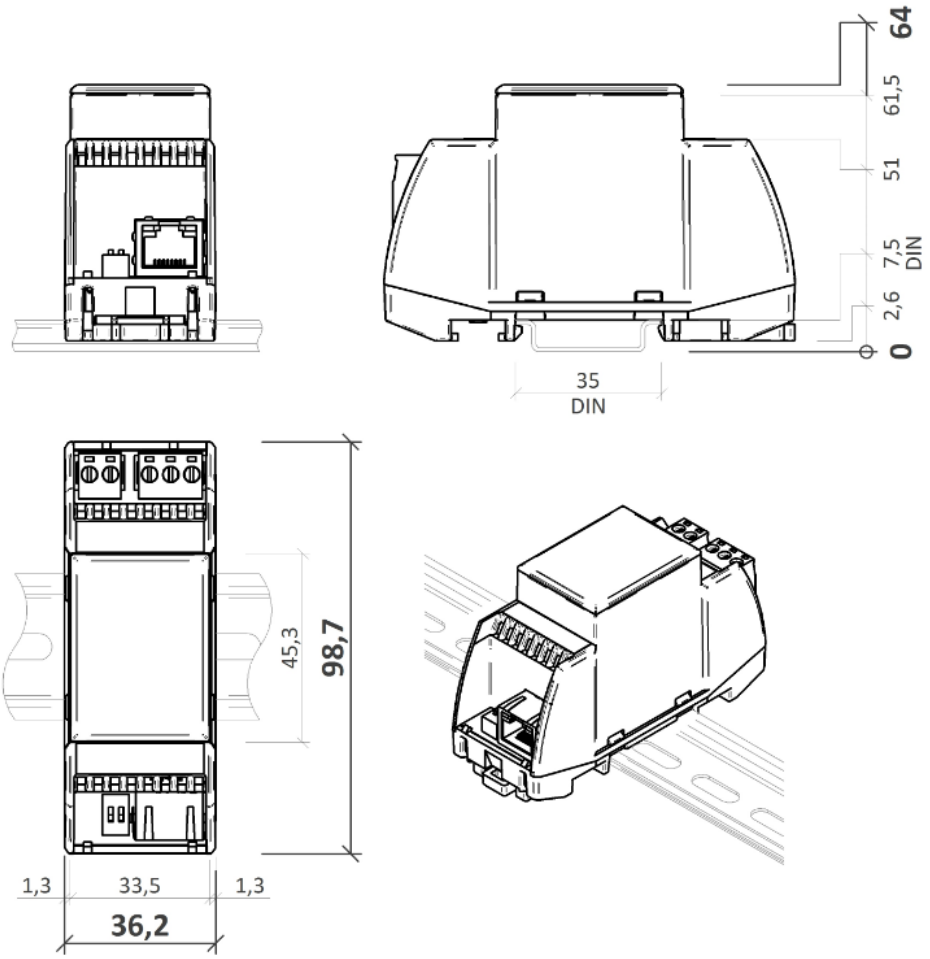
Terminals and connectors

G	power
G0	power
Ethernet	network interface
RS485	port COM - serial link RS485; terminals K+, K-
LED indication	
TxD	green LED – RS485 transmitting data (flashing: transmitting data; OFF: no data traffic)
RxD	red LED – RS485 receiving data (flashing: transmitting data; OFF: no data traffic)
PWR	green LED – power (ON: power OK; OFF: no power applied, weak or damaged power supply, …)
Jumper:	
INIT	For INIT function activation, disconnect power terminal and plug in a jumper on the pins between power terminal and the outside part of the box. If jumper is plugged in at power-up, converter will be set to factory defaults.
DIP switches	
BUS END	(DIP1 and 2 the left of terminal RS485) both ON = bus end; the first and last devices on bus should have bus end ON
SW 1, 2, 3	communication speed RS485

	SW1	**SW2**	**SW3**
1 200 bps	OFF	OFF	OFF
2 400 bps	ON	OFF	OFF
4 800 bps	OFF	ON	OFF
9 600 bps (default)	**ON**	**ON**	**OFF**
19 200 bps	OFF	OFF	ON
38 400 bps	ON	OFF	ON
57 600 bps	OFF	ON	ON
115 200 bps	ON	ON	ON

SW 4 Number of bits OFF 8 bits / ON 9 bits. If parity (Even/Odd) is used, it is necessary to switch ON DIP SW 4 (9 bits)!

Dimensions



All dimensions are in *mm*.

Communication

Default network settings are:

IP address	192.168.1.37
subnet mask	255.255.255.0
default gateway	0.0.0.0

User: root
Password: dbps

For devices with PN4920 or higher:

User: root
Password: "code", the default password ("code") is written on the label on the side of the device.

Notice: Do not forget to note the new network and user settings after change!

Settings

All parameters inclusive network configuration are available at a web interface on TCP port 80. English help for each settings opinion is displayed after click on the „? Help“ button in the upper right corner.

Find the detailed description of all settings in the Digi Connect user guide. Actual version is available at http://www.digi.com/products/embedded-systems/system-on-modules/digiconnectme#resources in chapter Literature -> Integration Kits.

Communication speed and number of data bits are set by DIP switches. See Schema -> DIP switches.

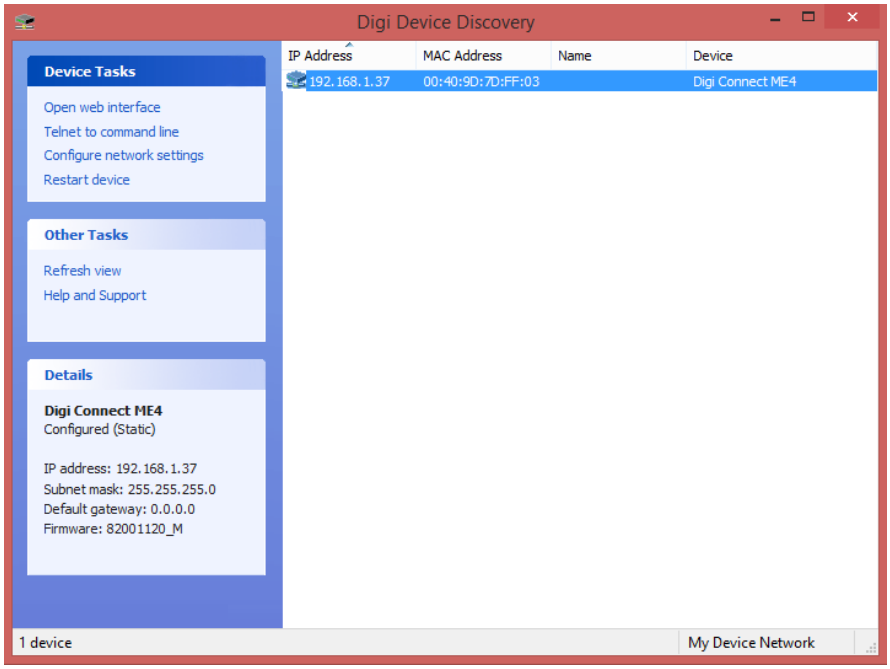
Connection to web interface and IP settings:

1. Use a RJ45 cable to connect converter to the web network. Connect converter to power supply (24 V DC/AC, terminals G and G0, any polarity). Please wait approximately 30 seconds for the converter to boot.

2. Fill converter IP address in web browser. Connect to the web interface.

3. If you don´t know the IP address of the converter, choose your operating system and download program Device Discovery Utility at http://www.digi.com/products/embedded-systems/system-on-modules/digiconnectme#resources , chapter Utilites.

4. Start the Device Discovery Utility. In case of successful detection, you can see the converter IP address in the program window. If there are some problem with detection switch off the PC firewall please. The network card must be able to receive the broadcast answers.



5. In the Device Tasks dialogue set the new IP address (Configure network settings) or go directly to the web pages of the M020 (Open web interface).

6. If you can not log in, set the converter to factory defaults (see below).

Modbus router settings:

1. Connect to the converter through web interface.

2. In section “Configuration” select “Serial Ports” and click on “Port 1”. Set serial port to profile “Industrial Automation” and “Apply” the changes.

3. The Modbus router listens at the default Modbus TCP port 502.

4. Do not change the advanced settings in the web interface unless you know what you are doing. False settings may result in communication trouble, timeouts etc.

Virtual COM port on PC - installation:

1. Download the actual drivers on:
   http://www.digi.com/support/productdetail?pid=2466&type=drivers
   in the Operating System Specific Drivers menu, choose your operating system and download the drivers.

2. Install the downloaded Digi RealPort software.

3. If the converter is in the same network, the program detects the device after installation. Otherwise, the IP settings must be configured properly.

4. Connect to the converter through web interface.

5. Under the title “Configuration” select “Serial Ports” and “Port1”. Set the profile “RealPort” and confirm the configuration by button “Apply”.

6. Do not change the advanced settings in the web interface unless you know what you are doing. False settings may result in communication trouble, timeouts etc.

Factory settings:

If the connection through web interface is not possible, bring the converter into Factory Default Settings:

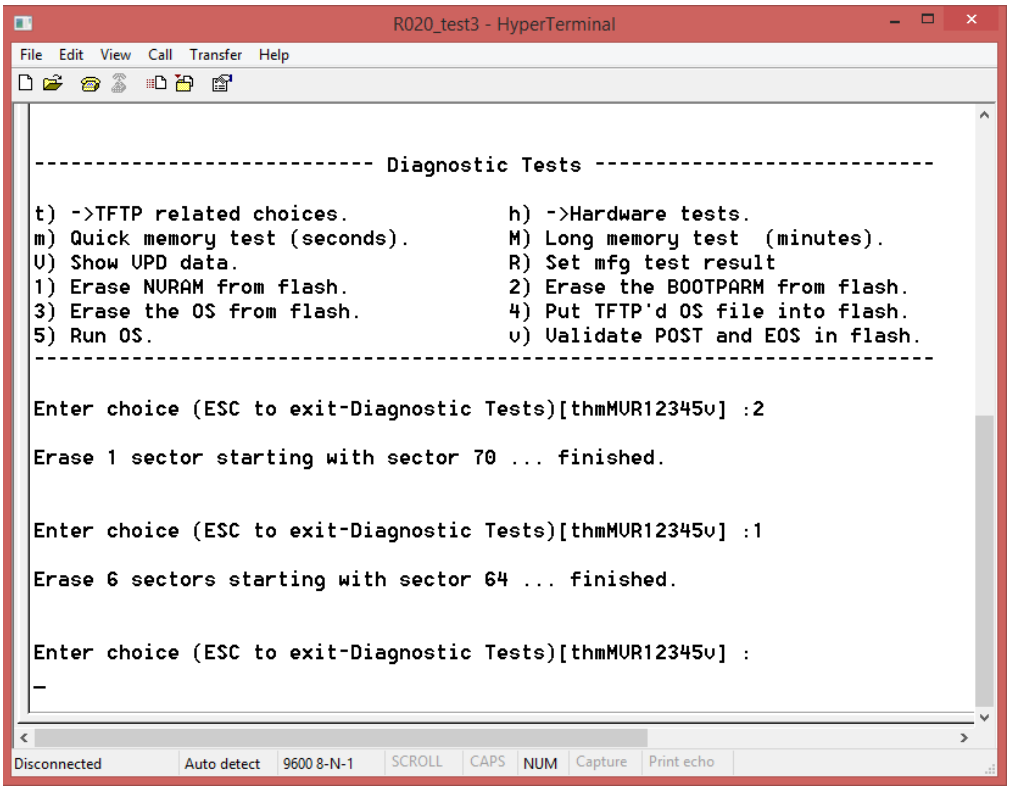
1. Disconnect power terminal and plug in a jumper on the pins between power terminal and the outside part of the box.

2. Connect converter and PC by a serial (nullmodem) cable. If the PC does not have a RS485 port, use a USB/RS485 converter.

3. Start a serial terminal software on the PC (e.g. Hyperterminal, TeraTerm) and select the COM port which connects to the converter. Communication parameters are 9600, 8 bits, N (none) parity, 1 stop bit. Data flow control None.

4. If the connection is established, switch on the converter power supply.

5. In window there is the R035 menu. Press 2 (Erase the BOOTPARM from flash) and wait for the “finished” message. Then press 1 (Erase the NVRAM from flash) and wait for the “finished” message. See screenshot below.



6. Terminate the connection, switch off power and disconnect the INIT jumper.

7. Connect the power supply. Approximately after one minute it is possible to detect the converter again. All the settings are default. The IP setting has DHCP set to ON. The converter will now ask for a new IP address from a DHCP server. If there is no DHCP server in the network, the device has address of 169.254.xxx.xxx. (Switch off the Windows firewall and detect device by the Device Discovery Utility.)

Changes in versions	04/2016 – First version of the datasheet. 09/2020 – Front image changed, replaced modules info changed. 12/2020 – Added note about default password change. 08/2021 – Stylistic adjustments, change of logo.

R060 Modbus TCP/RTU – MP-Bus converter

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.

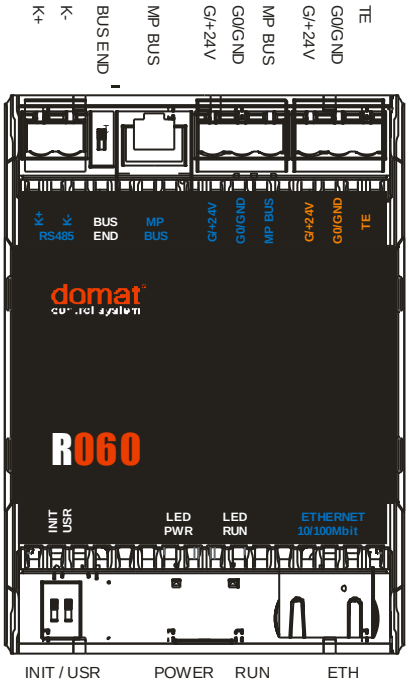
The R060 may work as both Modbus RTU and Modbus TCP server simultaneously. The commands from both interfaces are sent to the MP-Bus on a first come - first served basis. If a unicast message does not receive a response from the actuator on MP-Bus, it is repeated max. 2 ×. For periodic readouts there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

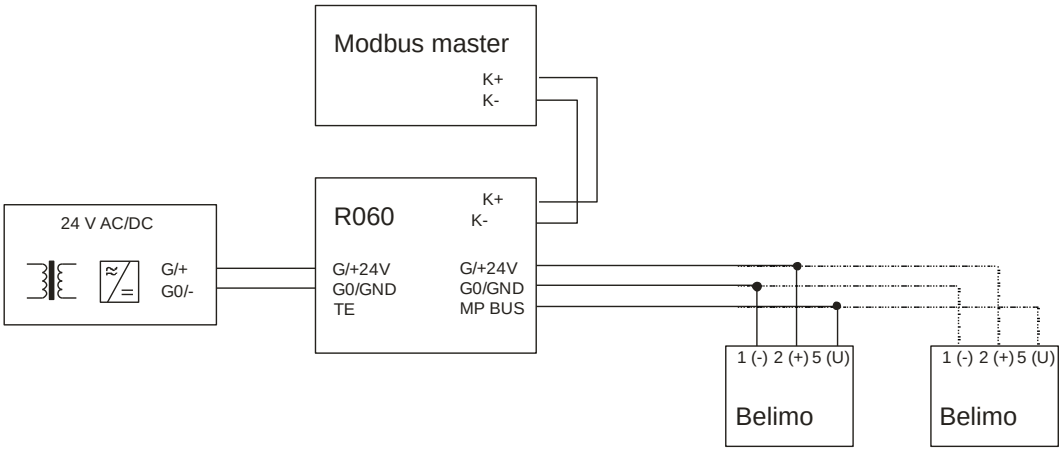
Technical data

Power	24 V AC/DC ± 15 %
Consumption	3 VA internal consumption max. 85 VA if peripherials are also supplied from the R060 terminals
Ethernet	1 × 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 × 61.4 × 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

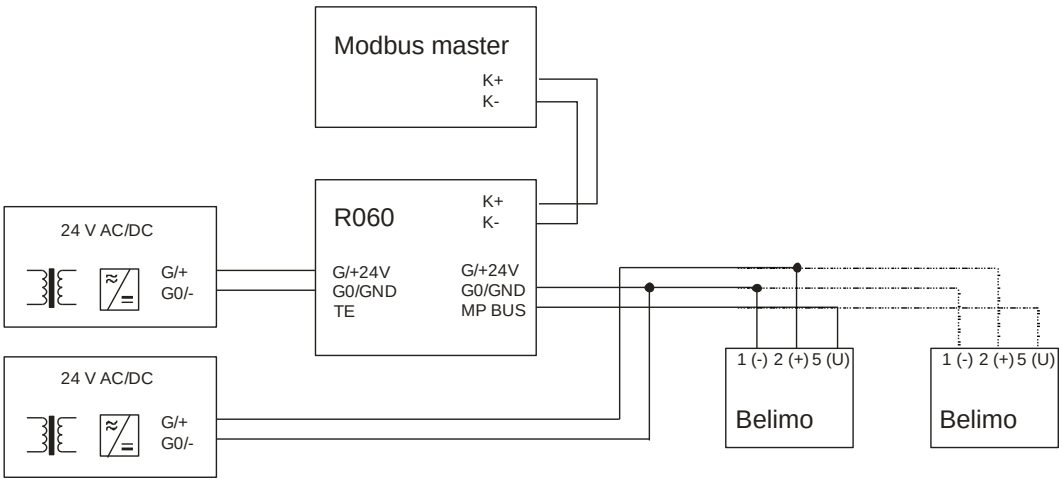
Connection



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



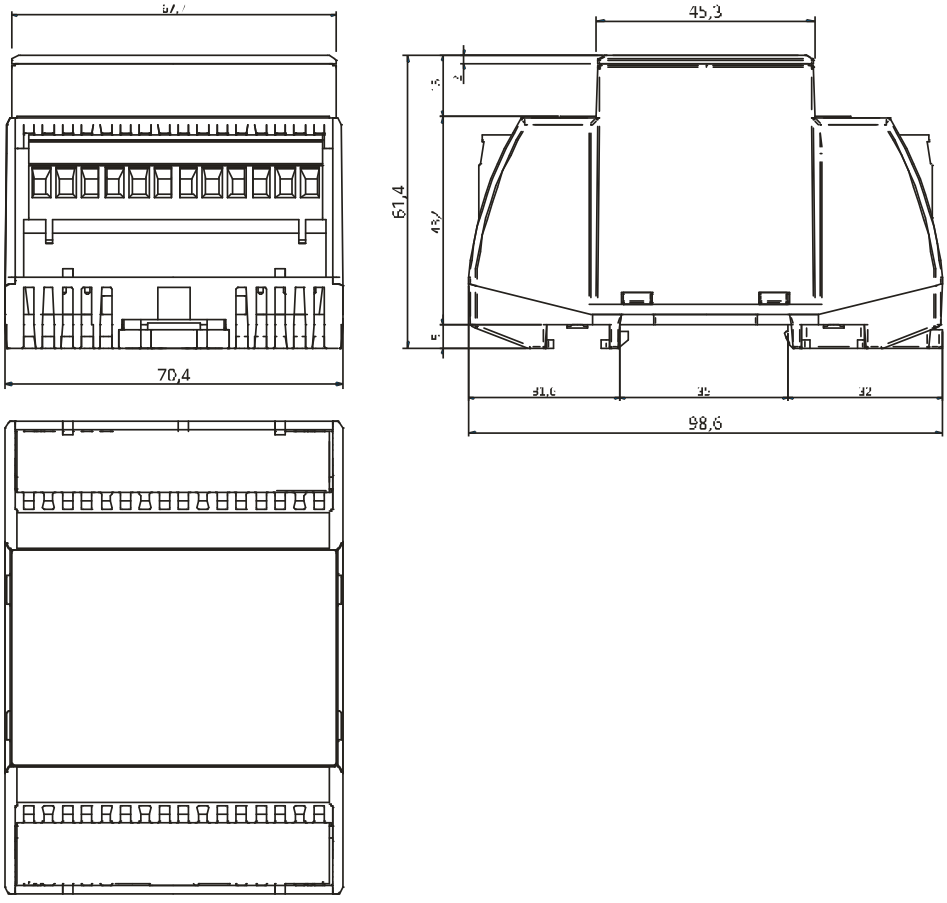
Connection when control system and peripherials are powered from different supplies – in general, or if the total consumption of the MP-Bus peripherials is higher than 80 W:



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 peripherials (max. 80 W)
G0/GND (blue)	power to peripherials – 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.

- 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 adressed, 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 adressed, 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 × word + bit offset (e.g. status bit „Test run active“ of the actuator at MP-address 3 has bit address 16 × (3 × 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

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.

- 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 suport 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.

R080 Data converter USB–RS485

Summary

R080 is a service USB to RS485 converter. It is used to link RS485-based devices or networks of those devices to a PC. Keep in mind R080 is service tool and it is not for permanent communication with a RS485 network.
R080 is replacement for converter M080.

Application

- **Addressing and setup of Domat I/O modules, room units and room controllers**

Function

After the drivers are installed and the converter is connected to the USB port of the computer, a virtual COM port is created. This port can be used by any PC software to communicate with a RS485 bus in the same way as if the bus devices were connected directly to a native serial port. Converter R080 connects to the PC by USB A-B cable (1.5 m) which is included in scope of delivery.

A very important feature is galvanical separation of the USB port from the RS485 bus. It brings high tolerance to EMC issues even in a harsh industrial environment.

Three LEDs indicate proper communication with the driver, and transmission and reception of data.

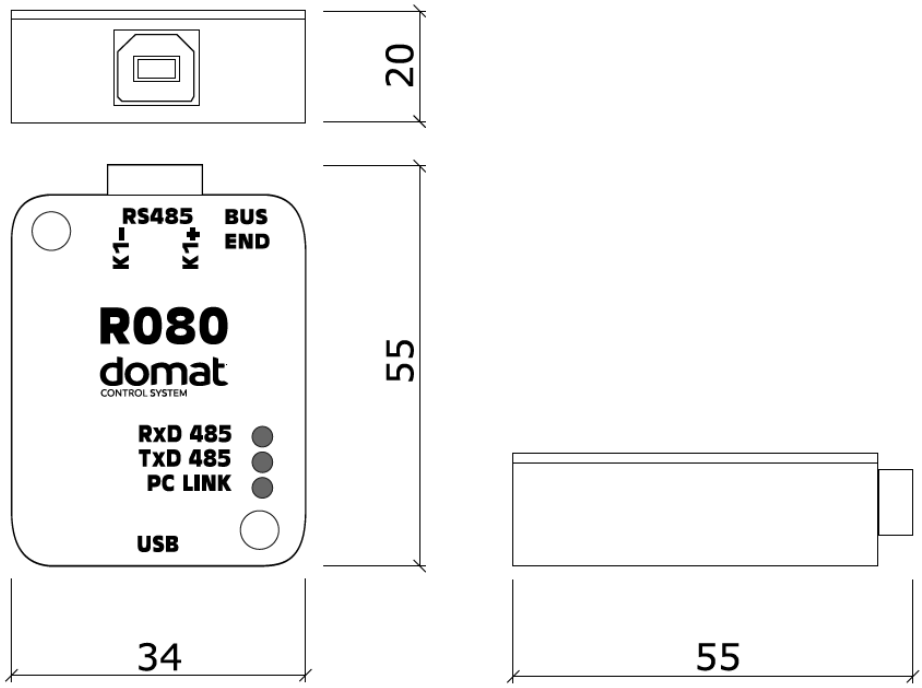
To configure and commission devices connected through controller use **ModComTool**, which is free to download at http://domat-int.com/en/downloads/software.

Technical data

Power	Powered via USB
Galvanic insulation	1 kV
Communication	RS485, Modbus RTU, 300 až 2304200 bit/s
SW	ModComTool (4.2.4.6 and above)
Terminals	Screw terminals M3, recommended wire 0.35…1.5 mm^2
Protection degree	IP20 (EN 60529)

Housing	UL94-V0
Dimensions	55 × 34 × 20 mm
Ambient conditions	external conditions: EN 60721-3-3. climatic class 3K3 (5…40 °C; 5...85 % relative humidity, non-condensing gases and chemically non-agressive conditions). storage: EN 60721-3-1 climatic class 1K2 (5…40 °C; 5…85 % relative humidity, non-condensing gases and chemically non-agressive conditions).
Standards of conformity	EMC EN 61000-6-2 ed.3:2005 + Cor.:2005-09, EN 61000-6-4 ed.2:2007 + A1:2011 (industrial enviroment) electrical safety EN 60950-1 ed.2:2006 + A11:2009 + A12:2011 + A1:2010 + A2:2013 + Corr.1:2011-10 hazardous substances reduction EN 50581:2012

Dimensions



Dimension are in *mm.*

Terminals

Terminals and connectors	
K1+	serial line RS485 +, BMS communication
K1-	serial line RS485 -, BMS communication
USB	Connection to PC, USB type B female

LED indication	
PC LINK	green LED – communication with PC drivers is ok
RxD 485	green LED – RS485 receiving data
TxD 485	red LED – RS485 transmitting data

DIP switches

BUS END RS485 bus termination

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.

Changes in versions	04/2020 – First datasheet version. 08/2021 – Stylistic adjustments, change of logo.

R085

R086

Converter P-Bus / Modbus RS485

Summary

R085 and R086 are microprocessor-controlled converters of Landis & Gyr P-Bus for I/O modules Landis & Gyr PTM..., PTK... to Modbus RTU over RS485. The converters provide galvanical separation of both interfaces and the power part, and they are able to supply 32 or 64 BE (P-Bus load units) respectively.

Application

- **integration of Landis & Gyr I/O modules into a SoftPLC or 3rd party environment – reconstruction and refurbishment of old plants using Landis & Gyr PRU.., PRV.., and RWP80 controllers.**

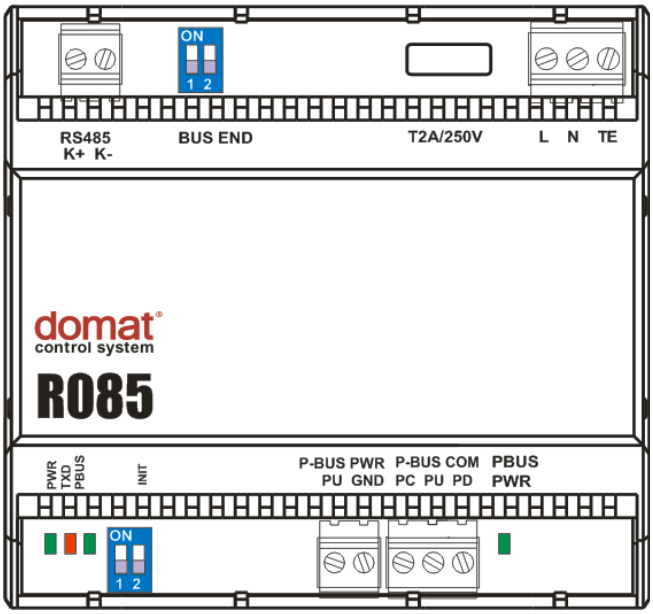
Function

The converter links the I/O modules of total load of up to 64 BE to Merbon process stations, Domat MiniPLC, Domat IPLC500, IPLC510, IPCB.1, IPCT.1, to a SoftPLC or Merbon runtime or to any other client capable of Modbus RTU communication.

After powering on, the converter continuously scans the P-Bus and searches for the connected I/O modules which updates the internal I/O list. Using special commands (over ModComTool or according to the Modbus table) it is possible to save the actual configuration of the P-Bus (addresses and types of the I/O modules) into the memory of the converter, which speeds up the P-Bus communication in the time between the device starts and the complete P-Bus scan. This is recommended especially at higher Modbus baudrates. The complete P-Bus scan takes about 5 s.

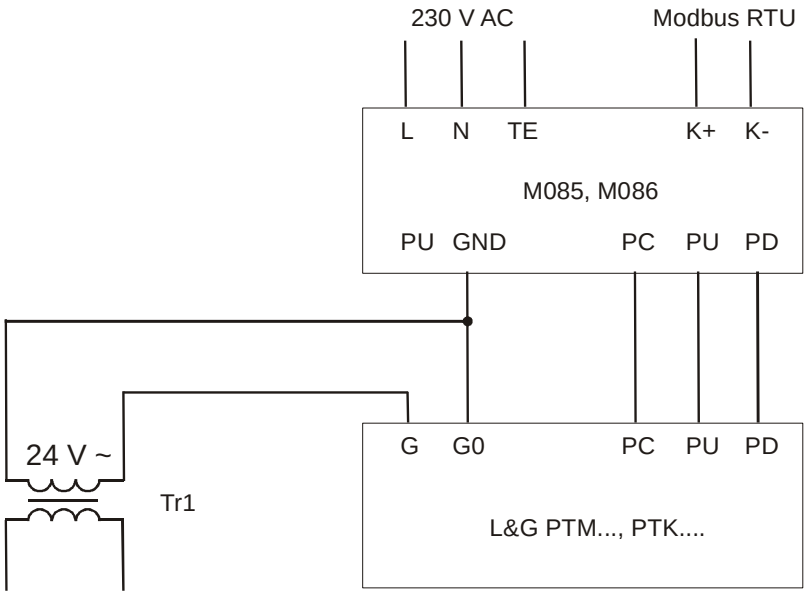
Power supply	universal 90...260 V AC, 120...370 V DC
Consumption	according to P-Bus load units, max. 30 VA
Fuse	replaceable fuse T2A / 250 V
Ambient temperature	0…50 °C
Ambient humidity	5…95 % non-condensing
Output P-Bus PWR	24 V DC
Max. current	**R085**: 0.6 A, **R086**: 1.0 A
Short-circuit protection	Automatic fuse against overload, short-circuit, overvoltage with automatic reset
RS485 communication	
Maximum bus length	1200 m
Max. number of devices on the bus	256
Baud rate	1200...115200 bps
Protocol	Modbus RTU slave
Modbus addressing	with free software: ModComTool or SoftPLC IDE
P-Bus communication	Permanently short-circuit resistant
Load	**R085**: 32 BE, **R086**: 64 BE
Galvanical separation	power supply part, RS485, and P-Bus are optically separated from each other up to 1000 V DC
Dimensions	see below

Terminals, LED



T2A/250 V	fuse
L	power, 230 V phase
N	power, reference
TE	technical earth (optional)
BUS END	both switches at ON: RS485 termination
RS485 K+	communication, positive
RS485 K-	communication, negative
PWR	on: power OK
TXD PBUS	RS485 data transmit, red on: communication error flashes 1:1: communication OK flashes 1:8: communication off
INIT	if ON at power-up, RS485 default communication parameters (adr. 1, 9600 bps, N, 8, 1) are set

Connection



Tr1... original transformer for powering of the I/O modules

The power supply 24 V of the R085, R086 (P-BUS PWR, terminals PU a GND) may be used e.g. as a power source for a process station (IPLC, mark) etc., but only up to the load limit of 0.6 A (R085) or 1 A (R086).

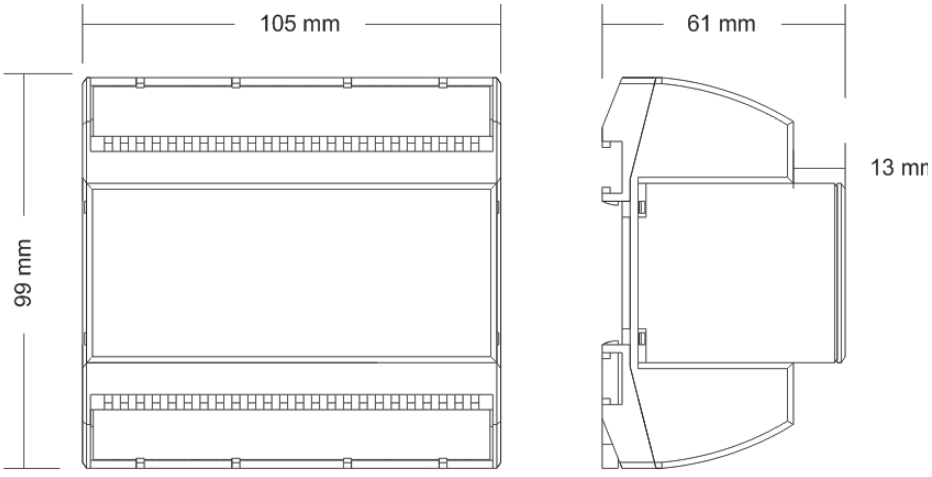
Installation

The converter is snapped on a DIN rail. Remember to leave space enough around the device to allow heat dissipation.

Maintenance

If the PWR LED is off, please check / replace the fuse. Use only fuse of the same type and rating!

Dimensions



Related products

IPLC220	Merbon process station
IPLC320	Merbon process station
IPLC301	MiniPLC process station
IPLC510	MiniPLC process station
M012	converter RS232-RS485
M080	converter USB-RS485
M035	Modbus RTU / TCP router
RC-Vision	SCADA software

Changes in versions

10/2016	New data sheet.
03/2017	Modbus table correction, reg. 3,4. PU output = DC voltage.
08/2021	Stylistic adjustments, Modbus table correction, reg. 5, change of logo.

Attachment 1: The Modbus table

The following Modbus functions are supported:

F01 Read Coil Status – reading bits

F03 Read Holding Registers – reading words

F15 Force Multiple Coils – writing bits

F16 Force Multiple Registers – writing words.

Maximum number of registers to be read in a single Modbus request is 52.

Register name	**Register number**	**Type**	**Description**	**Note**
module ID	1 LSB 1 MSB	R	module identification at RS485	2-byte number, here 0x0091
firmware	2 LSB 2 MSB	R	firmware version	0x0100 = V1.00
status LSB	3 LSB	R, W RAM	module status lower byte **bit 0** – EEPROM write enabled **bit 1** – P-Bus comm. stop **bit 2** – P-Bus config reset **bit 3** – Pbus config save **bit 4** – EEPROM init (not used) **bit 5** – P-Bus module search stop **EEPROM init** : init switch on, start module, init switch off, set bit 4 to 1 (indicated by bit 2 in status MSB)	**EEPROM init** Proceed as follows: - set the INIT switch to ON - power the module on - set the INIT switch to OFF - set bit 4 to 1 (indicated by bit 2 in status MSB)
status MSB	3 MSB	R RAM	**bit 0** – init mode active (INIT switch is ON) **bit 1** – EEPROM write enabled **bit 2** – EEPROM inited (not used) **bit 4** – P-Bus comm error	

Modbus address	4 LSB	R, W EEPROM	1...250	default address: 1
baud rate (communication speed)	4 MSB	R, W EEPROM	10_{dec} … 1200 bps 11_{dec} … 2400 bps 12_{dec} … 4800 bps 13_{dec} … 9600 bps (default value) 14_{dec} … 19200 bps 15_{dec} … 38400 bps 16_{dec} … 57600 bps 17_{dec} … 115200 bps	New baudrate setting is active only after restart. The register is written immediately.
serial RS485 port settings	5 LSB	R, W EEPROM	parameters of the RS485 communication (default = no parity, one stop bit: 0x00)	bit 0-1 ... parity (00 –no parity, 01 – even, 10 – odd) bit 2 ... stop bits (0 – one, 1 - two) New settings are active only after restart. The register is written immediately.
reserved	5 MSB			
number of found modules	6 LSB 6 MSB	R	number of I/O modules found on the P-Bus	for diagnostics only
number of definitions of known modules	7 LSB 7 MSB	R	number of I/O module types in the internal library (may differ with firmware versions)	for diagnostics only
uptime	8 LSB 8 MSB	R	uptime in ticks	for diagnostics only
module data	1001 LSB 1001 MSB	R, W RAM	Data of the P-Bus module with address 0, register 0	To be interpreted according to the I/O module type, see tables below
module data	1002 LSB 1002 MSB	R, W RAM	Data of the P-Bus module with address 0, register 1	
module data	1003 LSB 1003 MSB	R, W RAM	Data of the P-Bus module with address 0, register 2	

module data	1004 LSB 1004 MSB	R, W RAM	Data of the P-Bus module with address 0, register 3	
module data	1005 LSB 1005 MSB	R, W RAM	Data of the P-Bus module with address 1, register 0	
...				
module data	1008 LSB 1008 MSB	R, W RAM	Data of the P-Bus module with address 1, register 3	
...			(other modules and their registers)	
module data	1512 LSB 1512 MSB	R, W RAM	Data of the P-Bus module with address 127, register 3	
module info	2001 LSB 2001 MSB	R RAM	P-Bus module address 0, P-Bus address	LSB = module address MSB = internal position in the table (not important)
module info	2002 LSB 2002 MSB	R RAM	P-Bus module address 0, module status	bit 0: comm error bit 15: read from Flash
module info	2003 LSB 2003 MSB	R RAM	P-Bus module address 0, module type (code see below)	
module info	2004 LSB 2004 MSB	R RAM	P-Bus module address 0, detected module type (code see below)	FFFF: module not detected
module info	2005 LSB 2005 MSB	R RAM	P-Bus module address 1, P-Bus address	
...			(other modules and their states)	
module info	2512 LSB 2512 MSB	R RAM	P-Bus module address 127, detected module type (code see below)	

For commissioning, SoftPLC IDE or Merbon IDE and a converter RS232 or USB to RS485 are used. Define a serial channel in the SoftPLC / Merbon IDE, and insert the Landis & Gyr P-Bus I/O modules into the channel according to the module types and address pegs. The R085 or R086 is to be addressed in the menu or over Mod-ComTool (it may be connected on the RS485 bus together with more Mod-bus/RS485 modules if the data throughput is OK) and after the communication from the SoftPLC is started, the module starts to communicate with the P-Bus I/O modules. It is not necessary to use the Modbus table.

When communicating with other / 3rd Party clients, use Modbus registers 1001 and higher for communication with the converter. In the registers of 2001 and higher, there are diagnostic data: types and states of the P-Bus modules which were auto-detected by the converter. The address and other communication parameters can be set over the ModComTool software.

The PTK... compact modules are composed of the following PTM... modules:

PTK1.23V02 addressed 0:

2	2R1K
3	2R1K
4	2R1K
5	2R1K
6	2U10
7	2U10
8	11Q250

PTK1.30V01 addressed 0:

1	4Y10S
2	2R1K
3	2R1K
4	2U10
5	12D20
6	8Q250

Attachment 2: Variable maps for P-Bus I/O modules

The address of the first register (Register 0) with the module data is 1000 + 4 * P-Bus address (peg), see Modbus table. The module is represented by maximum 4 registers.

Example: Input 2 (Register 1, see below) of the module PTM1.2R1K (2x passive AI) with the address peg No. 3 is to be read in the register with address of

1000 + 4 * 3 + 1 = 1013.

PTM1.2C **2 × pulse counter**

Module code 0x0000

Register 0 (read)

Bit	Description
0	Pulse input 2 bit 0
1	Pulse input 2 bit 1
2	Pulse input 2 bit 2
3	Pulse input 2 bit 3
4	Pulse input 2 bit 4
5	Pulse input 2 bit 5
6	Pulse input 2 bit 6
7	No function
8	Pulse input 1 bit 0
9	Pulse input 1 bit 1
10	Pulse input 1 bit 2
11	Pulse input 1 bit 3
12	Pulse input 1 bit 4
13	Pulse input 1 bit 5
14	Pulse input 1 bit 6
15	No function

PTM1.2D20 **2 × potential-free digital input**

Module code 0x0101

Register 0 (read)

Bit	Description
0	Input 1 (0 – off, 1 – on)
1	Input 2 (0 – off, 1 – on)
2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	Input 1 (0 – off, 1 – on)
9	Input 2 (0 – off, 1 – on)
10	No function
11	No function
12	No function
13	No function
14	No function
15	No function

PTM1.2R1K **2 × analog passive input for Ni1000 L&G sensors**

Module code 0x0202

Register 0 (read, Input 1), Register 1 (read, Input 2)

Bit	Description
0	No function
1	No function
2	No function
3	A/D converter, bit 0
4	A/D converter, bit 1
5	A/D converter, bit 2
6	A/D converter, bit 3
7	A/D converter, bit 4
8	A/D converter, bit 5
9	A/D converter, bit 6
10	A/D converter, bit 7
11	A/D converter, bit 8
12	A/D converter, bit 9
13	A/D converter, bit 10
14	A/D converter, bit 11
15	Broken or short-circuit

The converter has 12 bit resolution (0...4095). The curve is linearised in the module. The temperature is calculated from the read value X :

$t = 0.05 * X – 52.4$

so e.g. for the read value of 1448 the temperature is $t = 0.05 * 1448 – 52.4 = 20$ °C.

Bit 15 in true indicates a broken or short-circuited sensor. The measured value range is 50...150 °C (read value 48...4048). Broken sensor: the read value is 4095, short circuited sensor: 0.

PTM1.2Y10 **2 × analog output 0...10 V**

Module code 0x0303

Register 0 (write, Output 1), Register 1 (write, Output 2)

Bit	Description
0	Back-up value, bit 0
1	Back-up value, bit 1
2	Back-up value, bit 2
3	Back-up value, bit 3
4	Back-up value, bit 4
5	No function
6	No function
7	D/A converter, bit 0
8	D/A converter, bit 1
9	D/A converter, bit 2
10	D/A converter, bit 3
11	D/A converter, bit 4
12	D/A converter, bit 5
13	D/A converter, bit 6
14	D/A converter, bit 7
15	No function

The converter has 8 bit resolution (0...240 dec), which corresponds to the output of 0...10 V (0...100 %).

The back-up value has 5 bit resolution, 0...31 dec, which corresponds to the output of 0...10 V (0...100 %). If the P-Bus is not communicating, i.e. the I/O module does not receive a valid telegram at least each 4 s, the output is set to the backup value.

PTM1.2U10 **2 × analog input 0...10 V**

Module code 0x0606

Register 0 (read, Input 1), Register 1 (read, Input 2)

Bit	Description
0	No function
1	No function
2	A/D converter, bit 0
3	A/D converter, bit 1
4	A/D converter, bit 2
5	A/D converter, bit 3
6	A/D converter, bit 4

7	A/D converter, bit 5
8	A/D converter, bit 6
9	A/D converter, bit 7
10	A/D converter, bit 8
11	A/D converter, bit 9
12	A/D converter, bit 10
13	A/D converter, bit 11
14	A/D converter, bit 12
15	No function

The converter has 13 bit resolution (0...8191). The measured value Y is calculated from the read value X:

Y = 0.03125 * (X / 2) – 14.0

so e.g. for a humidity sensor and the read value of 7296
the rH = 0.03125 * (7296 / 2) – 14.0 = 100 %rH.

The measured value range is 0...10 V (read value 896...7296). A value < 64 means underflow, a value > 8126 is overflow.

PTM1.2Y10S-M **2 × analog output 0...10 V with manual override**

Module code 0x0707

Register 0 (write, Output 1), Register 1 (write, Output 2)

Bit	Description
0	Back-up value, bit 0
1	Back-up value, bit 1
2	Back-up value, bit 2
3	Back-up value, bit 3
4	Back-up value, bit 4
5	No function
6	No function
7	D/A converter, bit 0
8	D/A converter, bit 1
9	D/A converter, bit 2
10	D/A converter, bit 3
11	D/A converter, bit 4

12	D/A converter, bit 5
13	D/A converter, bit 6
14	D/A converter, bit 7
15	No function

Register 3 (read)

Bit	Description
0	Output 1 in manual mode (1 = active)
1	Output 2 in manual mode (1 = active)
2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	Manual override status Output 1 (1 = on, 0 = off)
9	Manual override status Output 2 (1 = on, 0 = off)
10	No function
11	No function
12	No function
13	No function
14	No function
15	No function

The converter has 8 bit resolution (0...240 dec), which corresponds to the output of 0...10 V (0...100 %).

The back-up value has 5 bit resolution, 0...31 dec, which corresponds to the output of 0...10 V (0...100 %). If the P-Bus is not communicating, i.e. the I/O module does not receive a valid telegram at least each 4 s, the output is set to the backup value.

PTM1.2QD **Relay output 250 V AC with operation feedback**

Module code 0x0909

Register 0 (write)

Bit	Description
0	No function
1	No function

2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	No function
13	No function
14	No function
15	Relay command (0 = off, 1 = on)

Register 1 (read)

Bit	Description
0	No function
1	No function
2	No function
3	No function
4	Operation (feedback)
5	No function
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	No function
13	No function
14	No function
15	Relay status from Register 0 (Write), bit 15

PTM1.2P100 **2 × analog passive input for sensors Pt100, Ni100 or potentiometer 0...250 Ohm**

Module code 0x0A0A

Register 0 (read, Input 1), Register 1 (read, Input 2)

Bit	Description
0	No function
1	No function
2	A/D converter, bit 0
3	A/D converter, bit 1
4	A/D converter, bit 2
5	A/D converter, bit 3
6	A/D converter, bit 4
7	A/D converter, bit 5
8	A/D converter, bit 6
9	A/D converter, bit 7
10	A/D converter, bit 8
11	A/D converter, bit 9
12	A/D converter, bit 10
13	A/D converter, bit 11
14	A/D converter, bit 12
15	Broken or short-circuit

The converter has 13 bit resolution (0...8191). The A/D converter output is linear. This means that for the Pt100 sensors the value must be linarized: either by an approximation of part of the curve which is considered linear, or in the PLC. With SoftPLC it is recommended to perform the interpolation in the variable properties.

The measured value Y is calculated from the read value X:

$Y = S * (X/2) + O$

so e.g. for a Pt100 ranged 10...40 °C, where it is considered linear, and read value of 3580, the temperature is t = 0.1718213 * (3580/2) -287.5085 = 20 °C.

The measuring range is 0...250 Ohm (read value of 346...7846). The read value when overflow is > 7920, when underflow it is < 100. If bit 15 is set, the sensor is broken or short-circuited. Broken sensor returns the read value of 8191, short-circuited sensor sensor returns the read value of 346.

PTM1.2Y420 **2 × analogue output 4...20 mA**

Module code 0x0B0B

Register 0 (write, Output 1), Register 1 (write, Output 2)

Bit	Description
0	No function
1	No function
2	No function
3	No function
4	No function
5	No function
6	No function
7	D/A converter, bit 0
8	D/A converter, bit 1
9	D/A converter, bit 2
10	D/A converter, bit 3
11	D/A converter, bit 4
12	D/A converter, bit 5
13	D/A converter, bit 6
14	D/A converter, bit 7
15	No function

The converter has 8 bit resolution (0...240 dec), which corresponds to the output of 4...20 mA (0...100 %).

PTM1.2I25 **2 × analog input 0...25 mA**

Module code 0x0E0E

Register 0 (read, Input 1), Register 1 (read, Input 2)

Bit	Description
0	No function
1	No function
2	A/D converter, bit 0
3	A/D converter, bit 1
4	A/D converter, bit 2
5	A/D converter, bit 3
6	A/D converter, bit 4
7	A/D converter, bit 5
8	A/D converter, bit 6
9	A/D converter, bit 7

10	A/D converter, bit 8
11	A/D converter, bit 9
12	A/D converter, bit 10
13	A/D converter, bit 11
14	A/D converter, bit 12
15	No function

Using shunts, following ranges may be selected:

1 .. 5mA (200Ω); 0 .. 10mA (100Ω); 0(4) .. 20mA (50Ω) a 0 .. 25mA (40Ω). With no shunt the measuring range is voltage, 0...1 V DC.

The converter has 13 bit resolution (0...8191). The measured value Y is calculated from the read value X:

$Y = S * (X/2) + O$

where X = read value, S = slope, O = offset, Y = measured value.

Example: for a 0...20 mA sensor measuring 0...100 % rH, a 50 Ohm shunt and read value of 7296, the rH is

$rH = 0.03125 * (7296 / 2) – 14.0 = 100$ %rH.

The measured range is 0...25 mA (read value 896...7296). A value < 64 means underflow, a value > 8126 means overflow.

PTM1.4D20 **4 × potential free digital input**

Module code 0x0111

Register 0 (read)

Bit	Description
0	Input 1 (0 – off, 1 – on)
1	Input 2 (0 – off, 1 – on)
2	Input 3 (0 – off, 1 – on)
3	Input 4 (0 – off, 1 – on)
4	No function
5	No function
6	No function
7	No function
8	Input 1 (0 – off, 1 – on)
9	Input 2 (0 – off, 1 – on)
10	Input 3 (0 – off, 1 – on)
11	Input 4 (0 – off, 1 – on)
12	No function
13	No function
14	No function
15	No function

PTM1.4Y10S **4 × analogue output 0...10 V**

Module code 0x1313

Register 0 (write, Output 1), Register 1 (write, Output 2), Register 2 (write, Output 3), Register 3 (write, Output 4)

Bit	Description
0	Back-up value, bit 0
1	Back-up value, bit 1
2	Back-up value, bit 2
3	Back-up value, bit 3
4	Back-up value, bit 4
5	No function
6	No function
7	D/A converter, bit 0
8	D/A converter, bit 1

9	D/A converter, bit 2
10	D/A converter, bit 3
11	D/A converter, bit 4
12	D/A converter, bit 5
13	D/A converter, bit 6
14	D/A converter, bit 7
15	No function

The converter has 8 bit resolution (0...240 dec), which corresponds to the output of 0...10 V (0...100 %).

The back-up value has 5 bit resolution, 0...31 dec, which corresponds to the output of 0…10 V (0...100 %). If the P-Bus is not communicating, i.e. the I/O module does not receive a valid telegram at least each 4 s, the output is set to the backup value.

Module code 0x1616

Register 0 (read, Input 1), Register 1 (read, Input 2)

Bit	Description
0	No function
1	No function
2	A/D converter, bit 0
3	A/D converter, bit 1
4	A/D converter, bit 2
5	A/D converter, bit 3
6	A/D converter, bit 4
7	A/D converter, bit 5
8	A/D converter, bit 6
9	A/D converter, bit 7
10	A/D converter, bit 8
11	A/D converter, bit 9
12	A/D converter, bit 10
13	A/D converter, bit 11
14	A/D converter, bit 12
15	Broken or short-circuit

The converter has 13 bit resolution (0...8191). The A/D converter output is linear. This means that for the Pt1000 sensors the value must be linarized: either by an approximation of part of the curve which is considered linear, or in the PLC. With SoftPLC it is recommended to perform the interpolation in the variable properties.

The measured value Y is calculated from the read value X:

$Y = S * (X/2) + O$

so e.g. for a Pt1000 ranged 10...40 °C, where it is considered linear, and read value of 3580, the temperature is t = 0.1718213 * (3580/2) -287.5085 = 20 °C.

The measuring range is 0...2500 Ohm (read value of 346...7846). The read value when overflow is > 7920, when underflow it is < 100. If bit 15 is set, the sensor is broken or short-circuited. Broken sensor returns the read value of 8191, short-circuited sensor sensor returns the read value of 346.

Module code 0x1919

Register 0 (write)

Bit	Description
0	No function
1	No function
2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	No function
13	No function
14	Relay command Stage 2 (0 = Off, 1 = On)
15	Relay command Stage 1 (0 = Off, 1 = On)

Register 1 (read)

Bit	Description
0	No function
1	No function
2	No function
3	No function
4	Operation (feedback) 1
5	Operation (feedback) 2
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	No function
13	No function

14	Relay status Stage 2 from Register 0 (Write, bit 14)
15	Relay status Stage 1 from Register 0 (Write, bit 15)

PTM1.2I420 **2 × analogue input 4...20 mA**

Module code 0x1A1A

Register 0 (read, Input 1), Register 1 (read, Input 2)

Bit	Description
0	No function
1	No function
2	A/D converter, bit 0
3	A/D converter, bit 1
4	A/D converter, bit 2
5	A/D converter, bit 3
6	A/D converter, bit 4
7	A/D converter, bit 5
8	A/D converter, bit 6
9	A/D converter, bit 7
10	A/D converter, bit 8
11	A/D converter, bit 9
12	A/D converter, bit 10
13	A/D converter, bit 11
14	A/D converter, bit 12
15	No function

The converter has 13 bit resolution (0...8191). The measured value Y is calculated from the read value X:

$Y = S * (X/2) + O$

where X = read value, S = slope, O = offset, Y = measured value.

Example: for a 0...20 mA sensor measuring 0...100 % rH, a 50 Ohm shunt and read value of 7296, the rH is

rH = 0.03125 * (7296 / 2) – 14.0 = 100 %rH.

The measured range is 4...20 mA (read value 896...7296). A value < 64 means underflow, a value > 8126 means overflow.

PTM1.2Q250 **2 × relay output 24...250 V st**

Module code 0x1D1D

Register 0 (write)

Bit	Description
0	Relay command 1 (0 = Off, 1 = On)
1	Relay command 2 (0 = Off, 1 = On)
2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	No function
13	No function
14	No function
15	No function

PTM1.4R1K **4 × analog passive input for sensors Ni1000 L&G**

Module code 0x1E1E

Register 0 (read, Input 1), Register 1 (read, Input 2), Register 2 (read, Input 3), Register 3 (read, Input 4)

Bit	Description
0	No function
1	No function
2	A/D converter, bit 0
3	A/D converter, bit 1
4	A/D converter, bit 2

5	A/D converter, bit 3
6	A/D converter, bit 4
7	A/D converter, bit 5
8	A/D converter, bit 6
9	A/D converter, bit 7
10	A/D converter, bit 8
11	A/D converter, bit 9
12	A/D converter, bit 10
13	A/D converter, bit 11
14	A/D converter, bit 12
15	Broken or short-circuit

The converter has 13 bit resolution (0...8191). The curve is linearised in the module. The temperature is calculated from the read value X :

$t = 0.05 * X/2 – 52.4$

so e.g. for the read value of 2896 the temperature is $t = 0.05 * 2896 / 2 – 52.4 = 20$ °C.

Bit 15 in true indicates a broken or short-circuited sensor. The measured value range is –50...150 °C (read value 96...8096). Broken sensor: the read value is 8091, short circuited sensor: 0.

PTM1.2Q250-M **2 × relay output 24...250 V AC with manual override**

Module code 0x2020

Register 0 (write)

Bit	Description
0	No function
1	No function
2	No function
3	No function
4	No function
5	No function
6	No function

7	No function
8	No function
9	No function
10	No function
11	No function
12	No function
13	No function
14	Relay command 2 (0 = Off, 1 = On)
15	Relay command 1 (0 = Off, 1 = On)

Register 1 (read)

Bit	Description
0	Manual override of Output 1 active (1 = active)
1	Manual override of Output 2 active (1 = active)
2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	Status of manual override Output 1 (inverted, 0=on, 1=off)
9	Status of manual override Output 2 (inverted, 0=on, 1=off)
10	No function
11	No function
12	No function
13	No function
14	Status of Relay 2 from Register 0 (Write), bit 14
15	Status of Relay 1 from Register 0 (Write), bit 15

PTM1.2D42 2 × low voltage digital input 24 V AC or 10...42 V DC

Module code 0x2121

Register 0 (read)

Bit	Description
0	Input 1 (0 – no voltage, 1 – voltage applied)
1	Input 2 (0 – no voltage, 1 – voltage applied)
2	No function
3	No function

4	No function
5	No function
6	No function
7	No function
8	Input 1 (0 – no voltage, 1 – voltage applied)
9	Input 2 (0 – no voltage, 1 – voltage applied)
10	No function
11	No function
12	No function
13	No function
14	No function
15	No function

PTM1.3Q-M3 **Three-stage relay output with manual override**

Module code 0x2828

Register 0 (write)

Bit	Description
0	No function
1	No function
2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	No function
13	Relay command 3 (0 = Off, 1 = On)
14	Relay command 2 (0 = Off, 1 = On)
15	Relay command 1 (0 = Off, 1 = On)

Register 1 (read)

Bit	Description
0	Manual override of the output active (1 = active)

1	No function
2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	Status of manual override Output 1 (inverted, 0=on, 1=off)
9	Status of manual override Output 2 (inverted, 0=on, 1=off)
10	Status of manual override Output 3 (inverted, 0=on, 1=off)
11	No function
12	No function
13	Status of Relay 3 from Register 0 (Write), bit 13
14	Status of Relay 2 from Register 0 (Write), bit 14
15	Status of Relay 1 from Register 0 (Write), bit 15

PTM1.2D20S 2 × digital potential-free digital input with memory function

Module code 0x2929

Register 0 (read)

Bit	Description
0	Input 1 (0 – pulse not detected, 1 – pulse detected)
1	Input 2 (0 – pulse not detected, 1 – pulse detected)
2	Stav ukládání – Input 1 (0 = reset, 1 = aktivní) – kopie reg. pro write 0 bit 2
3	Stav ukládání – Input 2 (0 = reset, 1 = aktivní) – kopie reg. pro write 0 bit 3
4	No function
5	No function
6	No function
7	No function
8	Input 1 (0 – pulse not detected, 1 – pulse detected)
9	Input 2 (0 – pulse not detected, 1 – pulse detected)
10	Status storage function input 1 (Actual value write register 0 bit 2)
11	Status storage function input 2 (Actual value write register 0 bit 3)
12	No function
13	No function
14	No function
15	No function

Register 1 (write)

Bit	Description
0	No function
1	No function
2	Storage function – Input 1 (0 = reset, 1 = active)
3	Storage function – Input 2 (0 = reset, 1 = active)
4	No function
5	No function
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	No function
13	No function
14	No function
15	No function

The storage function is activated by setting the write register 1 bit 2 for input 1 or write register 1 bit 3 for input 2. After detection of a puls on the input read register 0 bit 0 (input 1) or read register 0 bit 1 (input 2) is set. The input can now be processed by the automation controller.

The read register 0 bit 0 or bit 1 remains set until the automation controller has reset the input by setting write register 1 bit 2 or 3 back to 0.

The contact input can either be used for the detection of make or break contact pulses. However, detection of a puls is always indicated by a 1 in the corresponding read register 0 (bit 0 or 1).

PTM1.2Q250-B **2 × bi-stable output with changeover contact 24...250 V AC**

Module code 0x2D2D

Register 0 (write)

Bit	Description
0	Relay 1 On command (1 = activation)
1	Relay 1 Off command (1 = activation)
2	Relay 2 On command (1 = activation)
3	Relay 2 Off command (1 = activation)
4	No function
5	No function
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	No function
13	No function
14	No function
15	No function

Relay 1 states

Command	Bit 0	Bit 1
No function	0	0
On	1	0
Off	0	1
No function	1	1

Relay 2 states

Command	Bit 2	Bit 3
No function	0	0
On	1	0
Off	0	1
No function	1	1

PTM1.4Q250-P **4 × relay output 24...250 V AC with manual override**

Module code 0x3030

Register 0 (write)

Bit	Description
0	No function
1	No function
2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	Relay 4 command (0 = Off, 1 = On) – make contacts Q23 and Q24
13	Relay 3 command (0 = Off, 1 = On) – break contacts Q21 and Q22
14	Relay 2 command (0 = Off, 1 = On) – make contacts Q13 and Q14
15	Relay 1 command (0 = Off, 1 = On) – break contacts Q11 and Q12

Register 1 (read)

Bit	Description
0	Manual override channel 1 (relay 1 and 2) active (1 = active)
1	Manual override channel 2 (relay 3 relay 4) active (1 = active)
2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	Relay 4, value from Register 0, bit 12
13	Relay 3, value from Register 0, bit 13
14	Relay 2, value from Register 0, bit 14
15	Relay 1, value from Register 0, bit 15

PTM1.2D250 **2 × digital input for 24...250 V AC or 24...100 V DC**

Module code 0x3131

Register 0 (read)

Bit	Description
0	Input 1 (0 – voltage-free, 1 – voltage applied, LED on)
1	Input 2 (0 – voltage-free, 1 – voltage applied, LED on)
2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	Input 1 (0 – voltage-free, 1 – voltage applied, LED on)
9	Input 2 (0 – voltage-free, 1 – voltage applied, LED on)
10	No function
11	No function
12	No function
13	No function
14	No function
15	No function

PTM1.2Y250T-M **3-point output 24...250 V AC with internal stroke model and manual override**

Module code 0x3838

Register 0 (write)

Bit	Description
0	No function
1	No function
2	No function
3	No function
4	Preset positioning time range bit 0
5	Preset positioning time range bit 1
6	Preset positioning time range bit 2

7	Preset positioning time range bit 3
8	Output value bit 0
9	Output value bit 1
10	Output value bit 2
11	Output value bit 3
12	Output value bit 4
13	Output value bit 5
14	Output value bit 6
15	Output value bit 7

Register 1 (read)

Bit	Description
0	Manual override active (1 = active)
1	No function
2	No function
3	1 = Positioning in progress
4	Preset positioning time range bit 0, actual value write register 0 bit 4
5	Preset positioning time range bit 1, actual value write register 0 bit 5
6	Preset positioning time range bit 2, actual value write register 0 bit 6
7	Preset positioning time range bit 3, actual value write register 0 bit 7
8	Output value status bit 0
9	Output value status bit 1
10	Output value status bit 2
11	Output value status bit 3
12	Output value status bit 4
13	Output value status bit 5
14	Output value status bit 6
15	Output value status bit 7

The output value has 8 bit resolution (0...255). The range 1...240 corresponds to the actuator value 0...100 %. The conversion of valve position (X) to the write value (Y) is calculated as follows:

$Y = (2.39 * X) + 1$

Calibration to Close = Write value 0

Calibration to Open = Write value 255

If the calibration is activated (by writing 0 or 255), the output is commanded for a longer time than the preset time range to make sure that the output had reached its end position and was synchronised with the internal controller. It is recommended to check the positioning time at the installation.

Preset positioning ranges

Preset value	Time range (s)	Preset value	Time range (s)
0	--	8	96 ... 138
1	8.5 ... 13	9	138 ... 192
2	13 ... 18	10	192 ... 270
3	18 ... 25	11	270 ... 378
4	25 ... 35	12	378 ... 540
5	35 ... 48	13	540 ... 660
6	48 ... 66	14	--
7	66 ... 96	15	--

PTM1.4D20R — 4 × digital input inverted, potential-free

Module code 0x4141

Register 0 (read)

Bit	Description
0	Input 1 (0 – off, LED active; 1 – on)
1	Input 2 (0 – off, LED active; 1 – on)
2	Input 3 (0 – off, LED active; 1 – on)
3	Input 4 (0 – off, LED active; 1 – on)
4	No function
5	No function
6	No function
7	No function
8	Input 1 (0 – off, LED active; 1 – on)
9	Input 2 (0 – off, LED active; 1 – on)
10	Input 3 (0 – off, LED active; 1 – on)
11	Input 4 (0 – off, LED active; 1 – on)
12	No function
13	No function
14	No function
15	No function

PTM1.2QD-M **Relay output 250 V AC with feedback and manual override**

Module code 0x6060

Register 0 (write)

Bit	Description
0	No function
1	No function
2	No function
3	No function
4	No function
5	No function
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	No function
13	No function
14	No function
15	Relay command (0 = Off, 1 = On)

Register 1 (read)

Bit	Description
0	Manual override active (1 = active)
1	No function
2	No function
3	No function
4	Operation (feedback)
5	No function
6	No function
7	No function
8	Manual output override status (inverted, 0 = on, 1 = off)
9	No function
10	No function
11	No function

12	No function
13	No function
14	No function
15	Relay status from Register 0 (Write), bit 15

PTM1.8D20E **8 × potential-free digital input**

Module code 0x8080

Register 0 (read)

Bit	Description
0	Input 1 (0 – off; 1 – on, LED active)
1	Input 2 (0 – off; 1 – on, LED active)
2	Input 3 (0 – off; 1 – on, LED active)
3	Input 4 (0 – off; 1 – on, LED active)
4	Input 5 (0 – off; 1 – on, LED active)
5	Input 6 (0 – off; 1 – on, LED active)
6	Input 7 (0 – off; 1 – on, LED active)
7	Input 8 (0 – off; 1 – on, LED active)
8	Input 1 (0 – off; 1 – on, LED active)
9	Input 2 (0 – off; 1 – on, LED active)
10	Input 3 (0 – off; 1 – on, LED active)
11	Input 4 (0 – off; 1 – on, LED active)
12	Input 5 (0 – off; 1 – on, LED active)
13	Input 6 (0 – off; 1 – on, LED active)
14	Input 7 (0 – off; 1 – on, LED active)
15	Input 8 (0 – off; 1 – on, LED active)

PTM1.4QD-M2 **2-stage 250 V AC relay output with feedback and manual intervention**

Module code 0xA0A0

Register 0 (write)

Bit	Description
0	No function
1	No function
2	No function

3	No function
4	No function
5	No function
6	No function
7	No function
8	No function
9	No function
10	No function
11	No function
12	No function
13	No function
14	Relay command 2 (0 = Off, 1 = On)
15	Relay command 1 (0 = Off, 1 = On)

Register 1 (read)

Bit	Description
0	Manual override active (1 = active)
1	No function
2	No function
3	No function
4	Operation (feedback) Stage 1
5	Operation (feedback) Stage 2
6	No function
7	No function
8	Manual output override Stage 1 status (inverted, 0 = on, 1 = off)
9	Manual output override Stage 2 status (inverted, 0 = on, 1 = off)
10	No function
11	No function
12	No function
13	No function
14	Relay 2 status from Register 0 (Write), bit 14
15	Relay 1 status from Register 0 (Write), bit 15

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R091 Modbus TCP / DALI converter

Summary **R091 is a serial converter which acts as a Modbus TCP server (accepts Modbus TCP commands) and web server and controls a DALI (Digital Addressable Light Interface) bus with up to 64 DALI devices. R091 is a multi master of the DALI bus and provides the power supply for the bus. It also incorporates a web interface for manual entering of DALI commands including bus configuration and diagnostics commands. The R091 fully covers the functionality of previous types M090 and R090 and now supports standard DALI v2.**

Applications

- **integration of DALI light controllers to a Modbus TCP compatible SCADA or PLC**
- **configuration and control of DALI bus over a comfortable web interface, even on a remote basis**
- **DALI bus control over CGI commands**

Function

R091 acts as a DALI bus multimaster controller (according to EN 60929 ed. 4:2011 Annex E, static priority 4, setting time 16 ms, retry timeout 300 ms), and provides the power supply for the bus, see below. The Modbus and web commands are translated into DALI protocol telegrams and sent to the DALI devices. The responses from the light controllers are translated back to Modbus registers and available at the corresponding addresses, see tables below.
Another way is to use CGI commands where all web functions may be also communicated to the device as CGI requests.

Compatibility

The R091 converter was designed and tested so as to comply with the standard EN 60929. Compatibility with this norm is guaranteed e.g. by DALI Compliant certification. It is recommended to use only DALI Compliant certified ballasts and other devices. There are also components on the market marked as DALI Compatible. DALI Compatible means that the product uses DALI technology, but may not support all functions according to the standard, and it may not have been tested using methods described in

the standard. A DALI Compatible device will most probably be working correctly together with other products by the same manufacturer, but it may not work as expected with other manufacturers' products. We can not guarantee complete functionality with DALI Compatible devices.

Design notes

The DALI bus supports up to 64 light ballast addresses, up to 16 scenes, and up to 16 groups. Wire length and diameter must always be respected! For the complete overview of the DALI bus specification, see the EN 60929. The DALI bus uses 22.5 V operation voltage.

The bus devices are connected over a 2-pole connector, regardless of polarity. The Ethernet is connected over RJ45 connector with PoE (Power over Ethernet).

When specifying the DALI bus load, the amount and types of the DALI components must be selected so as not to exceed the guaranteed DALI bus current of the power supply. Using the **single master** topology, up to 64 control devices may be installed. A **multimaster** bus load shall not exceed the maximum total current for all devices (incl. input devices and application controllers) of 250 mA.

At the place of installation, heat dissipation must be guaranteed. Please do not exceed the maximum permitted working temperature of 45 °C, otherwise the proper function is not guaranteed and the converter could be damaged.

Technical data

Power supply	24V AC/DC ±20 %, 6W (G, G0, TE)
	or PoE (Power over Ethernet, 802.3af class 2 (36-57 V)
Consumption	1 VA (no DALI load) ... max. 6 VA (full load, 64 DALI slaves)
Communication	
Ethernet	1x Ethernet 10/100BaseT; galvanically insulated to 1 kV
	RJ45, 2 LED (link, data) integrated in the connector
DALI	standard EN 60929 ed. 4:2011 Annex E, 1200 bps
	The R091 is according to this standard a bus power supply and application controller - multimaster (collision avoidance/ detection, priority 4 setting time 16 ms, retry timeout 300 ms).
	Power supply with digital stabilizer and guaranteed accuracy 1 % over the whole range.
	Galvanic separation DALI bus is separated up to 1000 V
	Short circuit protection of DALI power supply electronic with automatic reset, short-circuit current I_k= 250 mA
	Overload sustainability of the DALI power supply - sustainable to unlimited bus short-circuit.
	Guaranteed current according to EN 62386-101: 250 mA
	Fully compliant with EN 62386-101 ed2:2015 incl. non-standard user profiles (8/16/24/25 bits)
4x LED	RUN, PWR, TxD, RxD
Housing	Polycarbonate box (certification UL94V0); 4U

Dimensions	See below
Terminals	Screw terminals M3, maximum wire cross-section 2,5 mm^2
Protection degree	IP20 (EN 60529)
Operating environment	
Ambient conditions	-5…45 °C; 5…95 % relative humidity; non-condensing gases and chemically non-aggressive conditions (according EN 60721-3-3 climatic class 3K3)
Storage conditions	-5…45 °C; 5…95 % relative humidity; non-condensing gases and chemically non-aggressive conditions (according EN 60721-3-1 climatic class 1K3)
Standards conformity	EMC EN 61000-6-2 ed.3:2005, EN 55022 ed.3:2010 electrical safety EN 60950-1 ed.2:2006 + A11:2009 + A12:2011 + A1:2010 + A2:2014 + Opr.1:2012 + Z1:2016 RoHS EN 50581:2012

Power supply

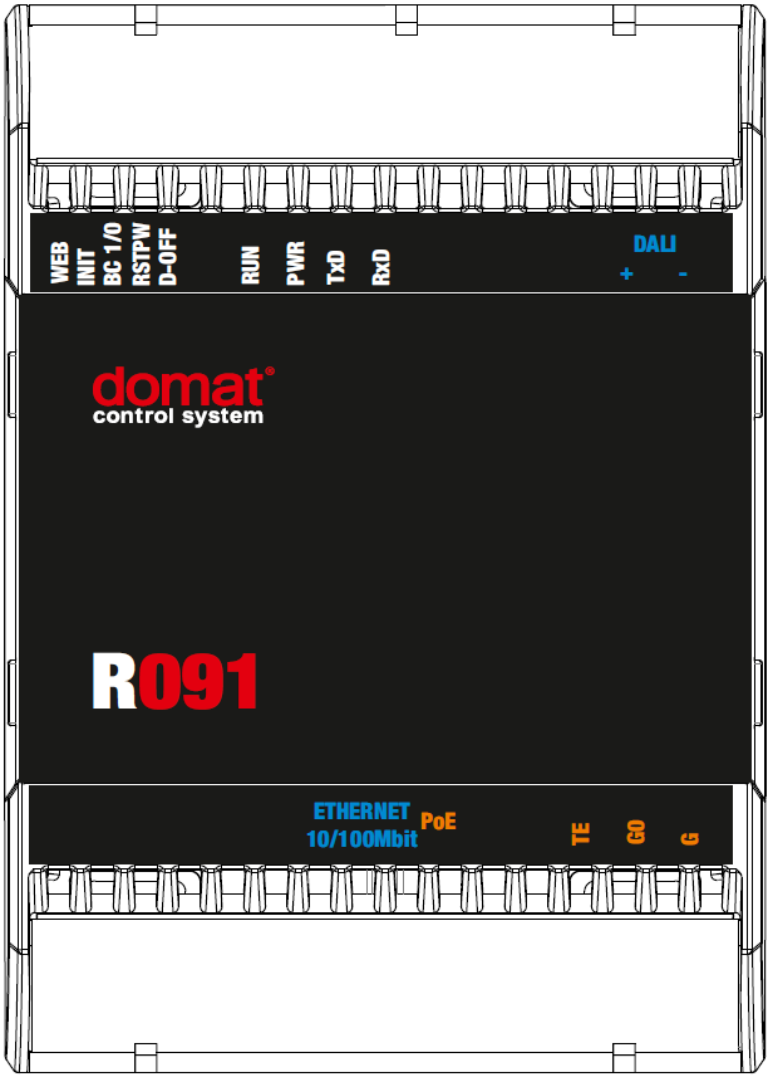
Alternative power supply (G/G0 terminals vs. PoE):

1. If the G/G0 power is applied first, the R091 is powered from this G/G0 external source. At power failure the power is switched over to PoE with a short dropout (device reset).

2. If the PoE power is applied first, the R091 is powered from the PoE. The switchover to G/G0 follows only if the G/G0 voltage is 27 V DC (19 V AC) and above.

3. If both G/G0 and PoE are applied at the same time, the R091 is powered from G/GO terminals. The device will not be damaged.

Schema



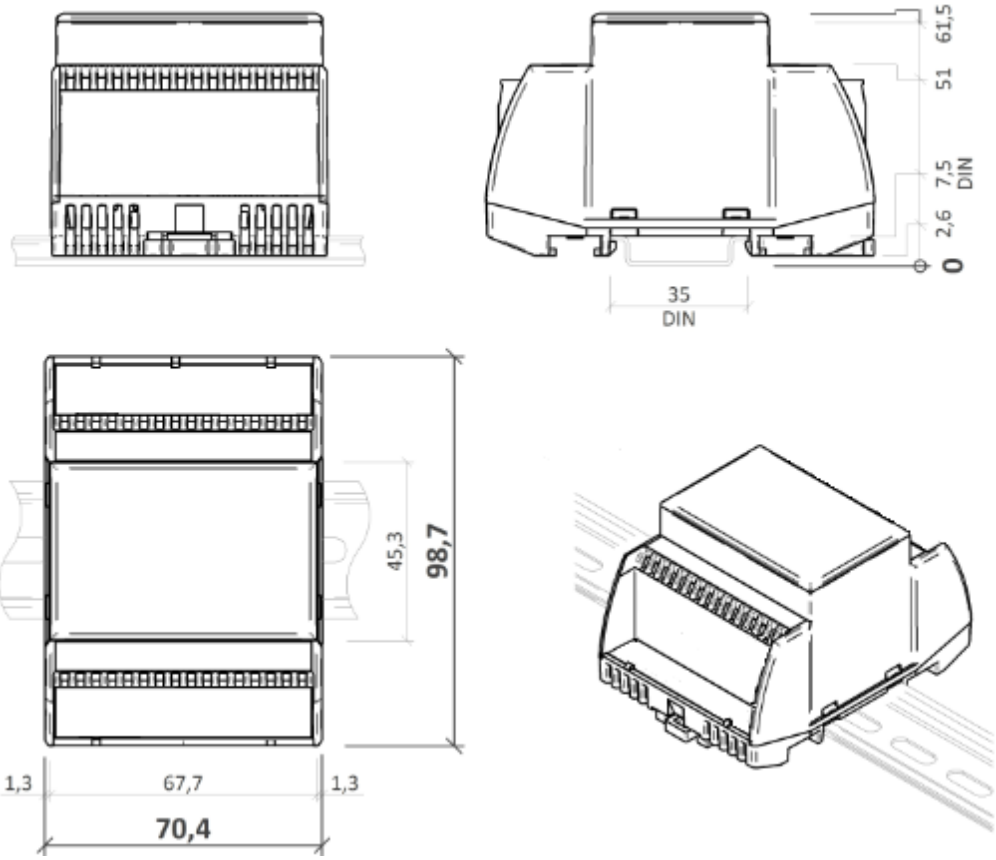
Terminals and connectors	
DALI	DALI bus, positive and negative
Ethernet, PoE	Network interface, PoE
G	power
G0	power, reference terminal
TE	optional connection for shielding

LED indication	
RUN	yellow LED – system cycle (OK: LED flashes periodically 1 s ON, 1 s OFF; ERROR: LED flashes in other pattern, LED is permanently ON or OFF)
PWR	green LED – power (ON: power OK; OFF: no power applied, weak or damaged power supply, …)
RxD	green LED – receiving data at DALI interface (flashing: receiving data; OFF: no data traffic)
TxD	red LED – transmitting data at DALI interface (flashing: transmitting data; OFF: no data traffic)
LINK/DATA	Ethernet activity

DIP switches

WEB	If ON at power-up, web, CGI, and FTP access is denied; set the switch to OFF and power cycle to enable web again.
INIT	If ON at power-up, configuration parameters are brought to defaults (see below); values are not saved to EEPROM
BC 1/0	When switched from OFF to ON, a central SET TO MAX command (broadcast) is sent, when switched from ON to OFF, a central OFF command is sent. For emergency manual control and testing.
RSTPW	Not used here.
D-OFF	When ON, the DALI bus power supply is disabled. Used if another DALI power supply is installed on the bus. The setting corresponds to the position of the DIP switch at power-up.

Dimensions



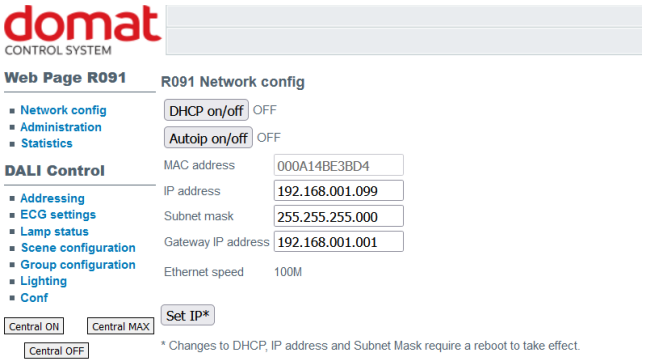
Dimensions are in *mm*.

Settings

The network properties are set over the R091's web interface. The default network settings are:

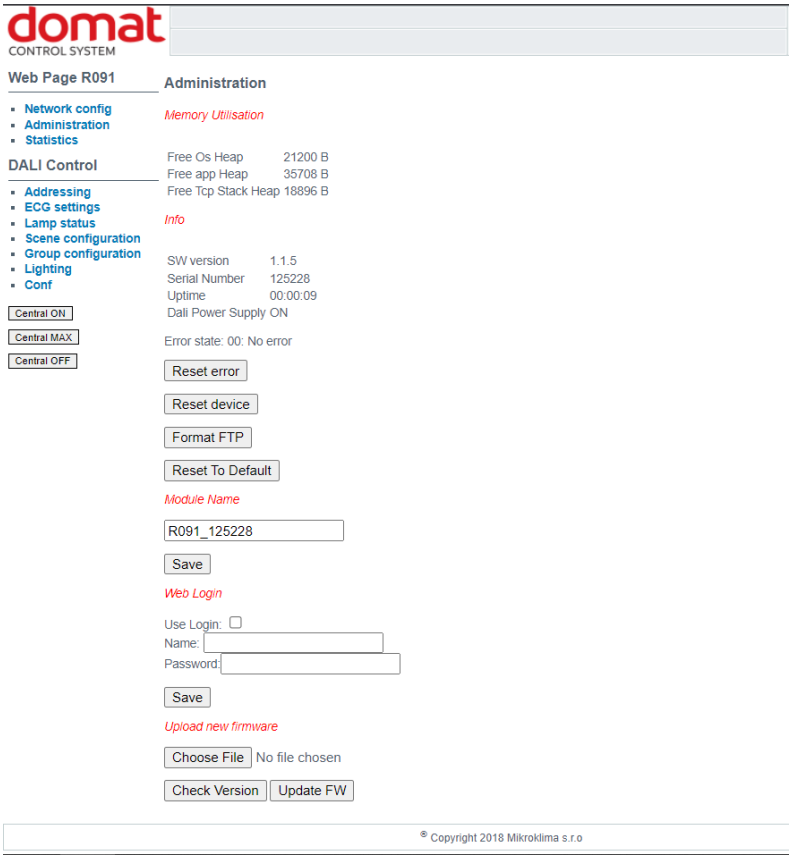
IP address	192.168.1.99
Network mask	255.255.255.0
Default gateway	192.168.1.1

All settings are stored in EEPROM.



Bringing the device to default settings:

1. Power off the R091.
2. Set the DIP switch 2 (INIT) to ON.
3. Apply power.
4. Locate the device at its default IP address and configure it as necessary.
5. Remove power.
6. Set the INIT switch to OFF.
7. Apply power again.
8. The R091 has the new settings.

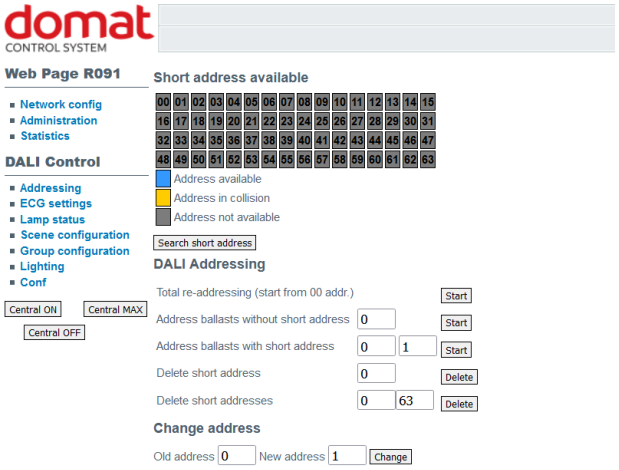


Administration

Web Login: Access to converter web interface (from fw v. 1.1.5 onward) can be limited with *username* and *password*.
Upload new firmware: New firmware can be chosen by clicking on button Choose file and then uploaded by *Update FW* button.

Web interface

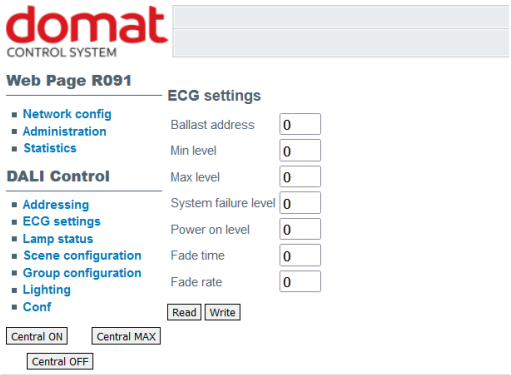
Over the web interface it is possible to set the R091 up (*Network config*), upload new firmware if necessary (*Administration*), and diagnose the interface (*Statistics*). The DALI Control menu is used to test if the DALI part is operating properly, to address the ballasts (*Addressing*), set the individual ballast parameters (*ECG settings*), see the states of the lamps at a glance (*Lamp status*), configure scenes and groups, issue group commands (*Ligthing*), and enable registers for simple control (*Conf*).



Addressing

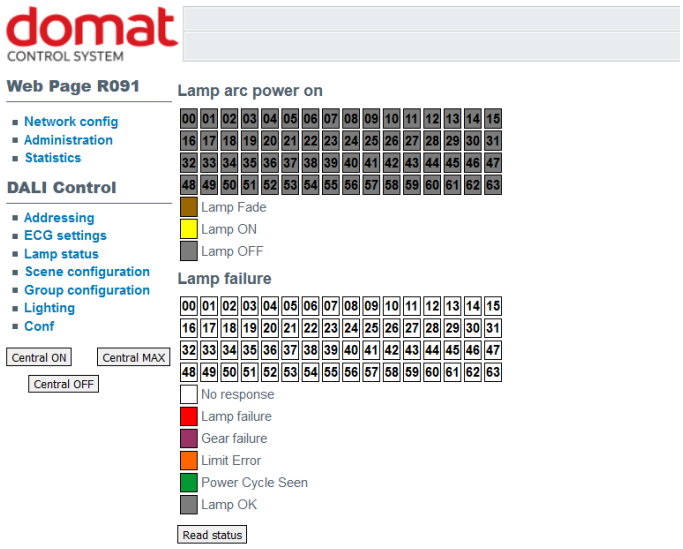
Total readdressing: Regardless of existing addressing, all ballasts will be readdressed starting from zero
Address ballast without short address: Enter the address (e.g. 1) to start with for addressing of ballasts without short address
Address ballast with short address: Enter the old address to start with, and the new starting address which replaces the old range
Delete short address: Enter the short address to delete (this ballast will have no short address after the operation is finished)
Delete short addresses: Enter the range of short addresses to delete (these ballasts will have no short address after the operation is finished)
Change address: Enter the address to change and new address

Please note that the numbering of the ballasts is:
0...63 at the web interface
0...63 in the Modbus telegrams.



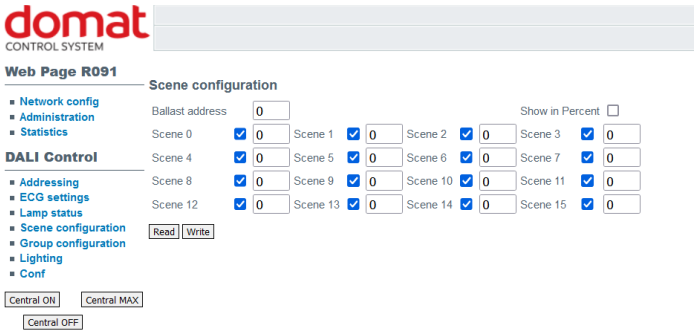
ECG Settings menu

In this menu, the parameters of a particular ballast can be read and set.
Ballast address: Set the ballast address to be configured.
Min level: Value (0...255) to set the ballast when receiving the Min level command
Max level: Value (0...255) to set the ballast when receiving the Max level command
System failure level: Value to set the ballast at DALI bus failure (e.g. short-circuit)
Power on level: Value to set the ballast between power on and receiving the first DALI command
Fade time: Time for change of value, see DALI standard
Fade rate: Frequency of changes (in steps/s), see DALI standard



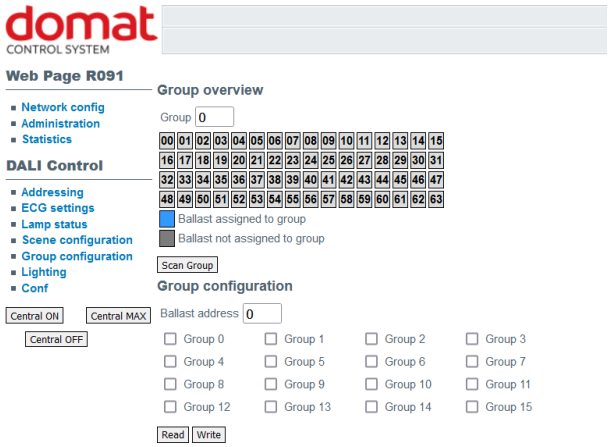
Lamp status – menu for ballast diagnostics

Lamp fade: Ballast is dimming
Lamp ON: Light is on (more than 0 %)
Lamp OFF: Light is off
Lamp failure table: DALI error according to DALI specification
Read status: Starts reading of status of all ballasts.



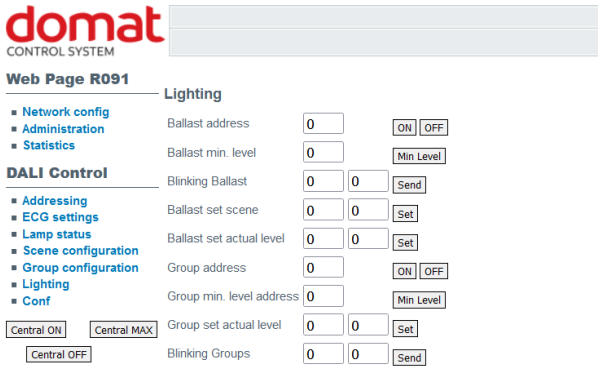
Scene configuration – menu for reading and configuration of scenes

Ballast address: Enter the ballast address to be configured
Read: Reads current setting of scenes in the ballast
(at scenes) tick box: a scene is defined, **number**: intensity for this scene
Show in Percent: Intensity is entered and displayed in % of a logarithmic scale, which fits better the human eye sensitivity, rather than as 0...255
Write: Saving of all scene settings to a ballast.



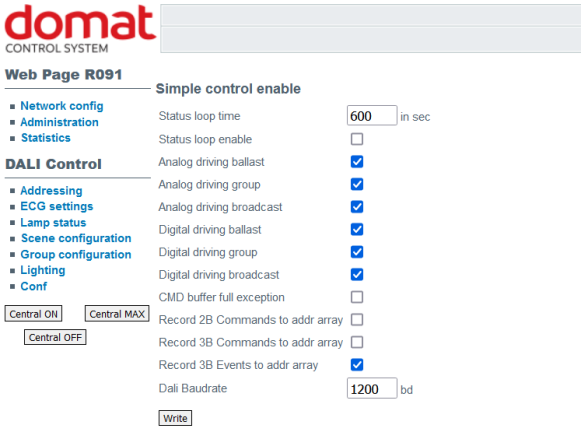
Group configuration

Group: Enter the group number which shall be displayed in the assignment below
Scan group: Displays ballasts which are assigned to the entered group
Ballast address: Enter the ballast address for which groups will be configured
Read: Reads assignment to groups for this address
Group x: tick = ballast is assigned to this group
Write: Writes the group assignment into the ballast



Lighting – Menu to control ballasts

Ballast address: Address to switch on (**ON**) or off (**OFF**)
Ballast min. level: Address to set to minimum level (**Min. Level**)
Blinking Ballast: Address and number of flashes. Activate by clicking **Send**
Ballast set scene: Address and scene number to be activated
Ballast set actual level: Address and light level to be set
Group address: Address of group to switch on (**ON**) or off (**OFF**)
Group min. level: Address of group to set to minimum level (**Min. Level**)
Group set actual level: Address of group and light level to be set
Blinking Groups: Address of group and number of flashes. Activate by clicking **Send**.



Conf – Menu to enable simple control functions

Status loop time: Period time to request ballast status. These requests bring substantial load to the bus, so it is recommended to keep the loop time as long as possible
Status loop enable: Enable ballast status requests.
Analog driving... / Digital driving...: Enable direct control of ballasts, groups and scenes over Modbus registers 95 to 182. Because of DALI bus load and possible collision of commands please only enable those commands which will be used.
CMD buffer full exception: When the buffer is full (and DALI commands are discarded), the R091 responds to a Modbus telegram with Modbus error 06 (Slave device busy). The client learns over Modbus that commands have been discarded. Should the Modbus error messages cause communication problems at the client side, do not check this option, and the telegrams will be confirmed correctly even when discarded. The number of discarded commands is listed in the *Statistics* menu.
Record 2B commands to addr array: All commands from application controllers to ballasts will be recorded in registers 601 and on.
Record 3B commands to addr array: All commands for configuration of input devices (switches, sensors, ...), will be recorded in registers 601 and on.
Record 3B events to addr array: All events sent by input devices will be recorded in registers 601 and on (typically pushing of a switch or light intensity change).
(In registers 801 and on, all telegrams are always recorded.)
Dali baudrate: Possibility to correct the baudrate for non-standard ballast types. Do not change if not necessary!

The web interface is useful for system commissioning: the DALI bus may be configured independently from the PLC program. As soon as the groups are configured and it is possible to control the DALI ballasts over the web interface, it is time to commission the PLC part.

When updating the firmware, update of the internal web pages may be necessary. The files are part of the firmware release package. For upload, use a FTP client with username/password: root / root99.

In the SoftPLC IDE, there is a special device for R091 so that the integration is easy – it is not necessary to map the Modbus registers via a generic Modbus driver, there are dedicated variables to control central commands, groups, scenes, as well as individual ballasts.

In the Merbon IDE, there are Modbus devices for direct commands through writing to Modbus registers.

Installation

Please ensure that when installed onto a DIN rail there is at least a 15 mm gap for air circulation at both vertical device sides, which is necessary for proper cooling of the device.

Modbus TCP communication

The supported Modbus functions are:

03 Read Holding Registers – read words
16 Force Multiple Registers – write words

The memory is divided into sections, and only registers which functionally stick together, like 95 to 158, 160 to 175, etc. are able to be written in a single command. In other words, the F16 command can not cross borders, like writing to registers 157 to 162 in one command.

The address space is accessible wordwise (16 bit words). See table below**.**

Tab. 1: Modbus table

Name	Address	Type	Description	Note
modul LSB	1 LSB	R	module ID lower byte	0x0191 hex
modul MSB	1 MSB	R	module ID upper byte	
firmware LSB	2 LSB	R	firmware version lower byte	
firmware MSB	2 MSB	R	firmware version upper byte	
	3 LSB	R	reserved	
status MSB	3 MSB	R	module status upper byte **bit 0** – 0: normal mode - 1: init mode **bit 1** – 1: at the next writing to any EEPROM registers, **all EEPROM data** will be written to EEPROM 0: data will only be written to RAM (changes will be lost after device restart) **bit 2 –** 1: web access blocked (WEB switch is ON) **bit 3** – 1**:** DALI FIFO full **bit 4** – 1: DALI bus shortcircuit detected, bus power is off **bit 5** – 1: DALI power supply disabled **bit 6** - 0 **bit 7** - 1	
Send twice mask	4 LSB	R, W RAM	**bit 0** = block 0 **bit 1** = block 1 **bit 2** = block 2 **bit 3** = block 3 **bit 4** = block 4 **bit 5** = block 5 **bit 6** = block 6 **bit 7** = block 7	**bit_x** = 1 -> send DALI command from **block x** twice within 100ms; works for all commands except for commands 32-128, 258 and 259, which are sent twice automatically set/reset of bit is done only by user
reserved	4 MSB	R RAM		
command mask	5 LSB	R,W RAM	**bit 0** = block 0 **bit 1** = block 1 **bit 2** = block 2 **bit 3** = block 3 **bit 4** = block 4 **bit 5** = block 5 **bit 6** = block 6 **bit 7** = block 7	By setting the bit, executing of the corresponding block is enabled. The device executes the enabled blocks one after another from **bit 7** to **bit 0**
command executed	5 MSB	R RAM		The set bit indicates the executed block, **bit 0** = **block 0** etc.
DALI command block 0	6 LSB	R,W RAM		DALI command for block 0 according to the tables
DALI address block 0	6 MSB	R,W RAM		DALI address for block 0

D0 block 0	7 LSB	R,W RAM	if the request is performed by a single DALI command which contains answer, the answer is in this block	additional data 0 for block 0 -> tables
D1 block 0	7 MSB	R,W RAM	If the request is performed by a single DALI command, then: **0x00** – no reply returned **0x55** – valid DALI reply returned, and stored in register **7LSB** **0x02 –** bus error **0x03** – DALI reply returned but damaged (data unrecognized) **0x04** - bus permanently short-circuited **0x05** – device is busy	***Note 1*** additional data 1 for block 0 -> tables
D2 block 0	8 LSB	R,W RAM		additional data 2 for block 0 -> tables
Trigger block 0	8 MSB	R,W RAM	By setting value of bit 0 from log 0 to log 1 the command will be executed. The value remains unchanged after command is finished, must be reset by the Modbus client. Reg. 5 indicates command in queue /executed command.	The command is equivalent to command in the corresponding bit of register 5 LSB.
DALI command block 1	9 LSB	R,W RAM		
DALI address block 1	9 MSB	R,W RAM		
D0 block 1	10 LSB	R,W RAM		
D1 block 1	10 MSB	R,W RAM		
D2 block 1	11 LSB	R,W RAM		
Trigger block 1	11 MSB	R,W RAM		
DALI command block 2	12 LSB	R,W RAM		
DALI address block 2	12 MSB	R,W RAM		
D0 block 2	13 LSB	R,W RAM		
D1 block 2	13 MSB	R,W RAM		
D2 block 2	14 LSB	R,W RAM		
Trigger block 2	14 MSB	R,W RAM		
DALI command block 3	15 LSB	R,W RAM		
DALI address block 3	15 MSB	R,W RAM		
D0 block 3	16 LSB	R,W RAM		

D1 block 3	16 MSB	R,W RAM		
D2 block 3	17 LSB	R,W RAM		
Trigger block 3	17 MSB	R,W RAM		
DALI command block 4	18 LSB	R,W RAM		
DALI address block 4	18 MSB	R,W RAM		
D0 block 4	19 LSB	R,W RAM		
D1 block 4	19 MSB	R,W RAM		
D2 block 4	20 LSB	R,W RAM		
Trigger block 4	20 MSB	R,W RAM		
DALI command block 5	21 LSB	R,W RAM		
DALI address block 5	21 MSB	R,W RAM		
D0 block 5	22 LSB	R,W RAM		
D1 block 5	22 MSB	R,W RAM		
D2 block 5	23 LSB	R,W RAM		
Trigger block 5	23 MSB	R,W RAM		
DALI command block 6	24 LSB	R,W RAM		
DALI address block 6	24 MSB	R,W RAM		
D0 block 6	25 LSB	R,W RAM		
D1 block 6	25 MSB	R,W RAM		
D2 block 6	26 LSB	R,W RAM		
Trigger block 6	26 MSB	R,W RAM		
DALI command block 7	27 LSB	R,W RAM		
DALI address block 7	27 MSB	R,W RAM		
D0 block 7	28 LSB	R,W RAM		
D1 block 7	28 MSB	R,W RAM		
D2 block 7	29 LSB	R,W RAM		
Trigger block 7	29 MSB	R,W RAM		

enable functions for simple control	30 LSB, MSB	R,W EEPROM default 0x7F hex (all enabled)	**bit0** – enable round for error states and status readout **bit1** – enable analogue intensity control – ballasts **bit2** – enable analogue intensity control - groups **bit3** – enable analogue intensity control - broadcast **bit4** – enable bit (on/off) control - ballasts **bit5** – enable bit (on/off) control – groups **bit6** – enable bit (on/off) control broadcast (central on/off) **bit7** – enable Modbus exception handler **bit8** – enable record 2B dali events in address event log (601 → 793) **bit9** – enable record 3B dali events in address event log (601 → 793) **bit10** – enable record 3B dali events in address event log (601 → 793)	
status of ballast 0	31 LSB	R RAM	**bit 0** - Status of ballast; "0" = OK **bit 1** -Lamp failure; "0" = OK **bit 2** - Lamp arc power on; "0" = OFF **bit 3** - Query: Limit Error; "0" = Last requested arc power level is between MIN..MAX LEVEL or OFF **bit 4** - Fade ready; "0" = fade is ready; "1" = fade is running **bit 5** - Query: "RESET STATE"? "0" = "No" **bit 6** - Query: Missing short address? "0" = "No" **bit 7** - Query: "POWER FAILURE"? "0" = "No"; "RESET" or an arc power control command has been received since last power-on. The "STATUS INFORMATION" shall be available in the RAM of the ballast and shall be updated regularly by the ballast according to the actual situation. The responses are same as command 144 responses from the standard DALI table.	See DALI standard.
status of ballast 0	31 MSB	R RAM	If **bit x = 1** **bit 0** - ballast comm failure **bit 1** - DALI bus busy **bit 2** - data frame error **bit 3** - DALI answer timeout **bit 4** - DALI short circuit **bit 5** - LPC processor comm timeout **bit 6** - FIFO full **bit 7** - repeated error	
status of ballast 1	32 LSB	R RAM	See status of ballast 0, LSB	
status of ballast 1	32 MSB	R RAM	See status of ballast 0, MSB	

…	…	…	…	…
status of ballast 63	94 LSB	R RAM	See status of ballast 0, LSB	
status of ballast 63	94 MSB	R RAM	See status of ballast 0, MSB	
ballast 0 intensity	95 LSB, MSB	R,W RAM	Analogue intensity value for ballast 0 (0...254). The telegram is sent on Modbus writing. Function must be enabled in register 30 bit 1.	***Note 2***
ballast 1 intensity	96 LSB, MSB	R,W RAM		
ballast 2 intensity	97 LSB, MSB	R,W RAM		
...	...	....		
ballast 63 intensity	158 LSB, MSB	R,W RAM		
error and status readout round trip	159 LSB, MSB	R,W EEPROM	Value is in sec. (0 – 65535). If the value is 0, status and error are not read.	default 600 sec
group intensity 0	160 LSB, MSB	R,W RAM	Analogue value of group 0 intensity (0-254). The telegram is sent on Modbus writing. Function must be enabled in register 30 bit 2.	
group intensity 1	161 LSB, MSB	R,W RAM		
group intensity 2	162 LSB, MSB	R,W RAM		
...	...	...		
group intensity 15	175 LSB, MSB	R,W RAM	see above	
analogue broadcast value	176 LSB, MSB	R,W RAM	Analogue value of all ballasts intensity (0-254) – central command	
bit control of ballasts 0-15	177 LSB, MSB	R,W RAM	0– switch off 1– switch on The telegram is sent on Modbus writing. Function must be enabled in register 30 bit 4.	**bit 0** –ballast 0 **bit 1** – ballast 1 **bit 2** – ballast 2 ...
bit control of ballasts 16-31	178 LSB, MSB	R,W RAM		
bit control of ballasts 32-47	179 LSB, MSB	R,W RAM		
bit control of ballasts 48-63	180 LSB, MSB	R,W RAM		

bit control of groups 0-15	181 LSB, MSB	R,W RAM	0– switch off 1– switch on The telegram is sent on Modbus writing. Function must be enabled in register 30 bit 5. Note that all groups are sent in each telegram.	***Note 3*** **bit 0** – group 0 **bit 1** – group 1 **bit 2** – group 2 etc.
bit broadcast control	182 LSB, MSB	R,W RAM	The telegram is sent on Modbus writing. Function must be enabled in register 30 bit 6.	**bit 0** – 0 = central OFF, 1 = central ON
DALI baudrate	183 LSB, MSB	R,W, EEPROM	DALI baudrate correction setting Default value is 1200 bps. Only change if ballasts require minor baudrate correction.	1056...1440 bps
reserved	184 - 500			
status	501 LSB, MSB	R, RAM	see reg. 3	mirror of register 3
reserved	502 LSB, MSB			
uptime LSW	503 LSB, MSB	R, RAM	device uptime in 0.1 s, LSW	
uptime MSW	504 LSB, MSB	R, RAM	device uptime in 0.1 s, MSW	
reserved	505 - 510			
command mask 2	511 LSB, MSB	R,W RAM	**bit 0** = block 8 **bit 1** = block 9 **bit 2** = block 10 **bit 3** = block 11 **bit 4** = block 12 **bit 5** = block 13 **bit 6** = block 14 **bit 7** = block 15	By setting the bit (rising edge), executing of the corresponding block is enabled. The module executes the enabled blocks one after another from **bit 7** to **bit 0.** Blocks 8 to 15 are used especially for sending commands of non-standard length. Unlike in reg. 5, there is no automatic reset of reg. 511 after command execution.
command 2 busy	512 LSB, MSB	R, RAM	**bit 0** = block 8 **bit 1** = block 9 **bit 2** = block 10 **bit 3** = block 11 **bit 4** = block 12 **bit 5** = block 13 **bit 6** = block 14 **bit 7** = block 15	A bit indicates a currently processed block. The Modbus master shall write into reg. 511, and then read regs. 511 and 512. Log. 1 in reg. 512 indicates that the command has been queued and is being executed. As soon as the corresponding bit in reg. 512 is reset, the command has been completed. At the same time, the RX area is updated (**dali RX data 0** to **dali RX num of bits**, reg. 561 and on). The Modbus master may then get the R091 ready for another execution of the block by writing 0 to reg. 511.

reserved	513 - 515			
dali TX data 0 block 8	516 LSB	R,W RAM	First byte of transmitted DALI message, block 8	
dali TX data 1 block 8	516 MSB	R,W RAM	Second byte of transmitted DALI message, block 8	
dali TX data 2 block 8	517 LSB	R,W RAM	Third byte of transmitted DALI message, block 8	
dali TX data 3 block 8	517 MSB	R,W RAM	Fourth byte of transmitted DALI message, block 8	Value of 0x80 sends 1 in 25. bit
dali TX flags block 8	518 LSB	R,W RAM	TX attributes for the transmitted message, block 8	**bit 0** ... send twice **bits 1 to 3** ... send priority (0 = default - priority 5; value of 1 to 5 = priority 1 to 5, i.e. setting time 13,5 to 19,5 ms)
dali TX No.of bits block 8	518 MSB	R,W RAM	No. of bits of the transmitted message, block 8	0 ... 16 bits 1 ... 24 bits 2 ... 8 bits 3 ... 25 bits
reserved	519 LSB			
reserved	519 MSB			
dali TX data 0 block 9	520 LSB	R,W RAM	First byte of transmitted DALI message, block 9	
dali TX data 1 block 9	520 MSB	R,W RAM	Second byte of transmitted DALI message, block 9	
dali TX data 2 block 9	521 LSB	R,W RAM	Third byte of transmitted DALI message, block 9	
dali TX data 3 block 9	521 MSB	R,W RAM	Fourth byte of transmitted DALI message, block 9	Value of 0x80 sends 1 in 25. bit
dali TX flags block 9	522 LSB	R,W RAM	TX attributes for the transmitted message, block 9	**bit 0** ... send twice **bits 1 to 3** ... send priority (0 = default - priority 5; value of 1 to 5 = priority 1 to 5, i.e. setting time 13,5 to 19,5 ms)
dali TX No.of bits block 9	522 MSB	R,W RAM	No. of bits of the transmitted message, block 9	0 ... 16 bits 1 ... 24 bits 2 ... 8 bits 3 ... 25 bits
reserved	523 LSB			
reserved	523 MSB			
dali TX data 0 block 10	524 LSB	R,W RAM	First byte of transmitted DALI message, block 10	
dali TX data 1 block 10	524 MSB	R,W RAM	Second byte of transmitted DALI message, block 10	

dali TX data 2 block 10	525 LSB	R,W RAM	Third byte of transmitted DALI message, block 10	
dali TX data 3 block 10	525 MSB	R,W RAM	Fourth byte of transmitted DALI message, block 10	Value of 0x80 sends 1 in 25. bit
dali TX flags block 10	526 LSB	R,W RAM	TX attributes for the transmitted message, block 10	**bit 0** ... send twice **bits 1 to 3** ... send priority (0 = default - priority 5; value of 1 to 5 = priority 1 to 5, i.e. setting time 13,5 to 19,5 ms)
dali TX No.of bits block 10	526 MSB	R,W RAM	No. of bits of the transmitted message, block 10	0 ... 16 bits 1 ... 24 bits 2 ... 8 bits 3 ... 25 bits
reserved	527 LSB			
reserved	527 MSB			
dali TX data 0 block 11	528 LSB	R,W RAM	First byte of transmitted DALI message, block 11	
dali TX data 1 block 11	528 MSB	R,W RAM	Second byte of transmitted DALI message, block 11	
dali TX data 2 block 11	529 LSB	R,W RAM	Third byte of transmitted DALI message, block 11	
dali TX data 3 block 11	529 MSB	R,W RAM	Fourth byte of transmitted DALI message, block 11	Value of 0x80 sends 1 in 25. bit
dali TX flags block 11	530 LSB	R,W RAM	TX attributes for the transmitted message, block 11	**bit 0** ... send twice **bits 1 to 3** ... send priority (0 = default - priority 5; value of 1 to 5 = priority 1 to 5, i.e. setting time 13,5 to 19,5 ms)
dali TX No.of bits block 11	530 MSB	R,W RAM	No. of bits of the transmitted message, block 11	0 ... 16 bits 1 ... 24 bits 2 ... 8 bits 3 ... 25 bits
reserved	531 LSB			
reserved	531 MSB			
dali TX data 0 block 12	532 LSB	R,W RAM	First byte of transmitted DALI message, block 12	
dali TX data 1 block 12	532 MSB	R,W RAM	Second byte of transmitted DALI message, block 12	
dali TX data 2 block 12	533 LSB	R,W RAM	Third byte of transmitted DALI message, block 12	
dali TX data 3 block 12	533 MSB	R,W RAM	Fourth byte of transmitted DALI message, block 12	Value of 0x80 sends 1 in 25. bit

dali TX flags block 12	534 LSB	R,W RAM	TX attributes for the transmitted message, block 12	**bit 0** ... send twice **bits 1 to 3** ... send priority (0 = default - priority 5; value of 1 to 5 = priority 1 to 5, i.e. setting time 13,5 to 19,5 ms)
dali TX No.of bits block 12	534 MSB	R,W RAM	No. of bits of the transmitted message, block 12	0 ... 16 bits 1 ... 24 bits 2 ... 8 bits 3 ... 25 bits
reserved	535 LSB			
reserved	535 MSB			
dali TX data 0 block 13	536 LSB	R,W RAM	First byte of transmitted DALI message, block 13	
dali TX data 1 block 13	536 MSB	R,W RAM	Second byte of transmitted DALI message, block 13	
dali TX data 2 block 13	537 LSB	R,W RAM	Third byte of transmitted DALI message, block 13	
dali TX data 3 block 13	537 MSB	R,W RAM	Fourth byte of transmitted DALI message, block 13	Value of 0x80 sends 1 in 25. bit
dali TX flags block 13	538 LSB	R,W RAM	TX attributes for the transmitted message, block 13	**bit 0** ... send twice **bits 1 to 3** ... send priority (0 = default - priority 5; value of 1 to 5 = priority 1 to 5, i.e. setting time 13,5 to 19,5 ms)
dali TX No.of bits block 13	538 MSB	R,W RAM	No. of bits of the transmitted message, block 13	0 ... 16 bits 1 ... 24 bits 2 ... 8 bits 3 ... 25 bits
reserved	539 LSB			
reserved	539 MSB			
dali TX data 0 block 14	540 LSB	R,W RAM	First byte of transmitted DALI message, block 14	
dali TX data 1 block 14	540 MSB	R,W RAM	Second byte of transmitted DALI message, block 14	
dali TX data 2 block 14	541 LSB	R,W RAM	Third byte of transmitted DALI message, block 14	
dali TX data 3 block 14	541 MSB	R,W RAM	Fourth byte of transmitted DALI message, block 14	Value of 0x80 sends 1 in 25. bit
dali TX flags block 14	542 LSB	R,W RAM	TX attributes for the transmitted message, block 14	**bit 0** ... send twice **bits 1 to 3** ... send priority (0 = default - priority 5; value of 1 to 5 = priority 1 to 5, i.e. setting time 13,5 to 19,5 ms)

dali TX No.of bits block 14	542 MSB	R,W RAM	No. of bits of the transmitted message, block 14	0 ... 16 bits 1 ... 24 bits 2 ... 8 bits 3 ... 25 bits
reserved	543 LSB			
reserved	543 MSB			
dali TX data 0 block 15	544 LSB	R,W RAM	First byte of transmitted DALI message, block 15	
dali TX data 1 block 15	544 MSB	R,W RAM	Second byte of transmitted DALI message, block 15	
dali TX data 2 block 15	545 LSB	R,W RAM	Third byte of transmitted DALI message, block 15	
dali TX data 3 block 15	545 MSB	R,W RAM	Fourth byte of transmitted DALI message, block 15	Value of 0x80 sends 1 in 25. bit
dali TX flags block 15	546 LSB	R,W RAM	TX attributes for the transmitted message, block 15	**bit 0** ... send twice **bits 1 to 3** ... send priority (0 = default - priority 5; value of 1 to 5 = priority 1 to 5, i.e. setting time 13,5 to 19,5 ms)
dali TX No.of bits block 15	546 MSB	R,W RAM	No. of bits of the transmitted message, block 15	0 ... 16 bits 1 ... 24 bits 2 ... 8 bits 3 ... 25 bits
reserved	547 LSB			
reserved	547 MSB			
reserved	548 ... 560			
dali RX data 0 block 8	561 LSB	R, RAM	first byte of received DALI reply, block 8; valid after the corresponding bit in **command 2 finished** is set	in this version, only 8 bit replies are supported
reserved	561 MSB			
dali RX flags block 8	562 LSB	R, RAM	attributes for the sent message and received reply, block 8; valid after the corresponding bit in **command 2 finished** is set	**bit 0** ... cmd successfully sent **bit 1** ... valid reply received **bit 2** ... bus busy (message could not be sent until timeout) **bit 3** ... answer violation (the reply was received as damaged) **bit 4** ... timeout no_answer (no reply received)
dali RX num of bits block 8	562 MSB	R, RAM	number of bits of the received reply, block 8; valid after the corresponding bit in **command 2 finished** is set	number = number of bits, 0 = no or damaged reply 8 = valid reply
reserved	563 LSB, MSB			
dali RX data 0 block 9	564 LSB	R, RAM	first byte of received DALI reply, block 9; valid after the corresponding bit in **command 2 finished** is set	in this version, only 8 bit replies are supported

...	...	...	...	
dali RX num of bits block 15	583 MSB	R, RAM	number of bits of the received reply, block 15; valid after the corresponding bit in **command 2 finished** is set	number = number of bits, 0 = no or damaged reply 8 = valid reply
reserved	584 - 600			
input device 0 event byte 0	601 LSB	R, W, RAM	event from the input device 0 (button, sensor), byte 0 (MSB)	
input device 0 event byte 1	601 MSB	R, W, RAM	event from the input device 0 (button, sensor), byte 1	
input device 0 event byte 2	602 LSB	R, W, RAM	event from the input device 0 (button, sensor), byte 2 (LSB)	
input device 0 event counter	602 MSB	R, W, RAM	ring counter of events of input device 0	every incoming telegram from this input device increases the counter value; after reaching 255 it goes to 0, 1, ...
reserved	603 LSB, MSB			
input device 1 event byte 0	601 LSB	R, W, RAM	event from the input device 1 (button, sensor), byte 0 (MSB)	
...	...	...	...	
input device 63 event counter	791 MSB	R, W, RAM	ring counter of events of input device 63	
reserved	792			
input Broadcast event byte 0	793 LSB	R, W, RAM	event with broadcast address (button, sensor), byte 0-MSB	
input Broadcast event byte 1	793 MSB	R, W, RAM	event with broadcast address (button, sensor), byte 1-MSB	
input Broadcast event byte 0	794 LSB	R, W, RAM	event with broadcast address (button, sensor), byte 2-LSB	
input Broadcast event counter	794 MSB	R, W, RAM	See reg. input broadcast event counter	
reserved	795 - 799			
Event log index	800 LSB	R, RAM	Shows position of the latest record in the array addressed 801 ... 1001. The value is in range 0...99.	The incoming events from input devices are recorded also into this 100-records array, with cyclic overwrite.
reserved	800 MSB			
event record 0, byte 0	801 LSB	R, RAM	First record in the event log. Contains the first captured byte.	The first byte should contain the input device address. The value must be shifted to left by 1 bit.
event record 0, byte 1	801 MSB	R, RAM	First record in the event log. Contains the second captured byte.	
event record 0, byte 2	802 LSB	R, RAM	First record in the event log. Contains the third captured byte.	

event record 0, length	802 MSB	R, RAM	First record in the event log. Contains the captured packet length.	
event record 1, byte 0	803 LSB	R, RAM	Second record in the event log. Contains the first captured byte.	
event record 1, byte 1	803 MSB	R, RAM	Second record in the event log. Contains the second captured byte.	
event record 1, byte 2	804 LSB	R, RAM	Second record in the event log. Contains the third captured byte.	
event record 1, length	804 MSB	R, RAM	Second record in the event log. Contains the captured packet length.	
...	...	...	...	
event record 99, byte 0	999 LSB	R, RAM	100th record in the event log. Contains the first captured byte.	
event record 99, byte 1	999 MSB	R, RAM	100th record in the event log. Contains the second captured byte.	
event record 99, byte 2	1000 LSB	R, RAM	100th record in the event log. Contains the third captured byte.	
event record 99, length	1000 MSB	R, RAM	100th record in the event log. Contains the captured packet length.	
reserved	1001 - 1002			
serial number low	1003	R	Serial number of the device, LSW	
serial number high	1004	R	Serial number of the device, MSW	

LSB – lower byte
MSB – higher byte
LSW – lower word
MSW – higher word

Notes ***Note 1***: Possible reasons of error messages:
0x00 No reply: Bad R091 hardware, wiring problems, ...
0x02 Bus error: Appears when the bus is short-circuited. If there is no traffic on the bus, the microcontroller checks the bus every second. If a short-circuit is detected, the red LED goes on and the bus power is switched off. After 1 s the bus power is switched on again and the check is repeated. If there is no short-circuit, the converter goes to normal. If the problem persists, the check is performed again after 1 s. The problem may also be in the damaged analogue output circuits of the converter, which the processor can not distinguish from a real bus short-circuit.
0x03 Unrecognized reply: It may happen that at installations where the bus contains 50 – 60 ballasts more ballasts reply at the same time, or if there is a signal interference.

Note 2: For all analogue values, the maximum settable value depends on the particular ballast type. Some ballasts allow e.g. to set the analogue value in range of 80 to 250 only. If the current value is 80 and a command to set to 254 is sent, the new value of 254 is displayed in the Modbus map and sent to the ballast, but the ballast does not accept this value and keeps its previous setting of 80.

Note 3: Even if a single bit is changed only, the register to control all 16 groups is always set as a whole (Modbus function F16). If, for example, a ballast is assigned to groups 14 and 15, both groups are off, and there is a command issued to set group 14 to on and group 15 to off, the ballast just blinks shortly and goes to off.

Tab. 2: Standard DALI commands

Nr.	DALI command (bin)	DALI address	D0	D1	D2	Function
Commands 0 – 31: Indirect arc power control commands						
0	0000 0000	YAAA AAA 1	0	0	0	OFF - Extinguish the lamp immediately without fading.
1	0000 0001	YAAA AAA 1	0	0	0	UP – Dim up for 200 ms (execution time) using the selected 'FADE RATE', if this command is received again while it is been executed, the execution time shall be retriggered. This command shall only affect ballasts with burning lamps. No lamp shall be ignited (from 0) with this command. No change if the arc power output is already at the "MAX LEVEL".
2	0000 0010	YAAA AAA 1	0	0	0	DOWN – Dim down for 200 ms (execution time) using the selected 'FADE RATE', if this command is received again while it is been executed, the execution time shall be retriggered Lamp shall not be switched off via this command. No change if the arc power output is already at the "MIN LEVEL".
3	0000 0011	YAAA AAA 1	0	0	0	STEP UP - Set the actual arc power level one step higher immediately without fading. This command shall only affect ballasts with burning lamps. No lamp shall be ignited with this command. No change if the arc power output is already at the "MAX LEVEL".
4	0000 0100	YAAA AAA 1	0	0	0	STEP DOWN - Set the actual arc power level one step lower immediately without fading. Lamp shall not be switched off via this command. No change if the arc power output is already at the "MIN LEVEL".
5	0000 0101	YAAA AAA 1	0	0	0	RECALL MAX LEVEL - Set the actual arc power level to the "MAX LEVEL" without fading. If the lamp is off it shall be ignited with this command.
6	0000 0110	YAAA AAA 1	0	0	0	RECALL MIN LEVEL - Set the actual arc power level to the "MIN LEVEL" without fading. If the lamp is off it shall be ignited with this command.
7	0000 0111	YAAA AAA 1	0	0	0	STEP DOWN AND OFF - Set the actual arc power level one step lower immediately without fading.

						If the actual arc power level is already at the "MIN LEVEL", the lamp shall be switched off by this command.
8	0000 1000	YAAA AAA 1	0	0	0	ON AND STEP UP - Set the actual arc power level one step higher immediately without fading. If the lamp is switched off, the lamp shall be ignited with this command and shall be set to the "MIN LEVEL".
9-15	0000 1XXX					reserved
16-31	0001 XXXX	YAAA AAA 1	0	0	0	GO TO SCENE - the actual arc power level to the value stored for scene XXXX using the actual fade time. If the lamp is off, it shall be ignited with this command. If the value stored for scene XXXX is zero and the lamp is lit then the lamp shall be switched off by this command after the fade time.
Commands 32 – 128: Configuration commands These commands are automatically sent twice within 100 ms.						
32	0010 0000	YAAA AAA 1	0	0	0	RESET – After the second reception of the command, the variables in the persistent memory shall be changed to their reset values. It is not guaranteed that any commands are received properly within the next 300 ms by a ballast acting on this command.
33	0010 0001	YAAA AAA 1	0	0	0	STORE ACTUAL LEVEL IN THE DTR Store actual arc power level in the DTR without changing the current light intensity. If the ballast is in the process of fading it is the instantaneous level, not the target level that is stored.
34-41	0010 XXXX					reserved
42	0010 1010	YAAA AAA 1	0	0	0	STORE THE DTR AS MAX LEVEL - Save the value in "Data Transfer Register" as new "MAX LEVEL".
43	0010 1011	YAAA AAA 1	0	0	0	STORE THE DTR AS MIN LEVEL - Save the value in "Data Transfer Register" as new "MIN LEVEL". If this value is lower as the "PHYSICAL MIN. LEVEL" of the ballast, then store the "PHYSICAL MIN. LEVEL" as new "MIN LEVEL".
44	0010 1100	YAAA AAA 1	0	0	0	STORE THE DTR AS A SYSTEM FAILURE LEVEL - Save the value in "Data Transfer Register" as new "SYSTEM FAILURE LEVEL".
45	0010 1101	YAAA AAA 1	0	0	0	STORE THE DTR AS POWER ON LEVEL - Save the value in "Data Transfer Register" as new "POWER ON LEVEL".

46	0010 1110	YAAA AAA 1	0	0	0	STORE THE DTR AS FADE TIME - Save the value in "Data Transfer Register" as new "FADE TIME". FADE TME range is 0-15, where 0 means no FADE. The fade time specifies the time for changing the arc power level from the actual level to the requested level. In case of lamp off, the preheat and ignition time is not included in the fade time.
47	0010 1111	YAAA AAA 1	0	0	0	STORE DTR AS FADE RATE - Save the value in "Data Transfer Register" as new "FADE RATE". FADE RATE range is 1-15, where 1 means fastest dimming and 15 slowest dimming.
48-63	0011 XXXX					reserved
64-79	0100 XXXX	YAAA AAA 1	0	0	0	STORE DTR AS SCENE - Save the value in Data Transfer Register as a new level of the scene 0-15 (XXXX).
80-95	0101 XXXX	YAAA AAA 1	0	0	0	REMOVE FROM SCENE - Remove the ballast from scene 0-15 - XXXX. Removing the ballast from scene XXXX means storing 0xFF in scene register XXXX.
96-111	0110 XXXX	YAAA AAA 1	0	0	0	ADD TO GROUP - Add the ballast to group 0-15 - XXXX.
112-127	0111 XXXX	YAAA AAA 1	0	0	0	REMOVE FROM GROUP - Remove the ballast from group 0-15 - XXXX. Removing the ballast from group XXXX means storing "0" in the group register.
128	1000 0000	YAAA AAA 1	0	0	0	STORE DTR AS SHORT ADDRESS - Save the value in the DTR as new short address. The structure of the DTR shall be: XXXX XXXX = 0AAA AAA1 or 1111 1111 shall remove the short address.
129-143	1000 XXXX					reserved
Commands 144 – 155: Query commands						
144	1001 0000	YAAA AAA 1	0	0	0	QUERY STATUS – Answer is the following „STATUS INFORMATION“ byte: **bit 0** - Status of ballast; 0 = OK **bit 1** – Lamp failure; 0 = OK **bit 2** – Lamp arc power on; 0 = OK **bit 3** - Query: Limit Error; "0" = Last requested arc power level is between MIN..MAX LEVEL or OFF **bit 4** – Fade ready; "0" = fade is ready; "1" = fade is running **bit 5** – Query: "RESET STATE"? "0" = "No" **bit 6 –** Query: Missing short address? "0" = "No" **bit 7** – Query: "POWER FAILURE"? "0" = "No";

						"RESET" or an arc power control command has been received after last power-on.
145	1001 0001	YAAA AAA 1	0	0	0	QUERY BALLAST - Ask if there is a ballast with the given address that is able to communicate. Answer shall be "Yes" or "No".
146	1001 0010	YAAA AAA 1	0	0	0	QUERY LAMP FAILURE - Ask if there is a lamp problem at the given address. Answer shall be "Yes" or "No".
147	1001 0011	YAAA AAA 1	0	0	0	QUERY LAMP POWER ON - Ask if there is a lamp operating at the given address. Answer shall be "Yes" or "No".
148	1001 0100	YAAA AAA 1	0	0	0	QUERY LIMIT ERROR - Ask if the last requested arc power level at the given address could not be met, because it is above the MAX LEVEL or below the MIN LEVEL. Answer shall be "Yes" or "No".
149	1001 0101	YAAA AAA 1	0	0	0	QUERY RESET STATE - Ask if the ballast is in "RESET STATE". Answer shall be "Yes" or "No".
150	1001 0110	YAAA AAA 1	0	0	0	QUERY MISSING SHORT ADDRESS - Ask if the ballast has no short address. Answer shall be "Yes" or "No". The answer shall be "Yes" if the ballast has no short address.
151	1001 0111	YAAA AAA 1	0	0	0	QUERY VERSION NUMBER - Ask for the version number of the IEC standard document met by the software and the hardware of the present ballast. The "VERSION NUMBER" shall be stored in a ROM. Answer shall be the 'VERSION NUMBER' as an 8 bit number 'XXXX 0000'. The first 4 bits (XXXX) represent the version number of this standard.
152	1001 1000	YAAA AAA 1	0	0	0	QUERY CONTENT DTR Answer shall be the content of the DTR as an 8 bit number.
153	1001 1001	YAAA AAA 1	0	0	0	QUERY DEVICE TYPE - Answer shall be an 8 bit number (x = 0 to 255). The standard device type shall return the answer 0 (this device type shall not react on the application extended commands 224 to 255). For the list of device types see command 272.
154	1001 1010	YAAA AAA 1	0	0	0	QUERY PHYSICAL MINIMUM LEVEL - Answer shall be the "PHYSICAL MIN. LEVEL" as an 8 bit number. The "PHYSICAL MIN. LEVEL" shall be stored in a ROM.
155	1001 1011	YAAA AAA 1	0	0	0	QUERY POWER FAILURE - Answer shall be "YES" if the ballast has not received a "RESET" or one of the following arc power control commands since the last power-on: "DIRECT ARC POWER CONTROL", "OFF", "RECALL MAX LEVEL", "RECALL MIN LEVEL", "STEP DOWN AND OFF", "ON AND STEP UP", "GO TO SCENE"

156-159	1001 11XX					reserved
Commands 160 – 165: Queries related to arc power parameter settings						
160	1010 0000	YAAA AAA 1	0	0	0	QUERY ACTUAL LEVEL - Answer shall be this level as an 8 bit number. During preheating and if a lamp error occurs the answer shall be "MASK".
161	1010 0001	YAAA AAA 1	0	0	0	QUERY MAX LEVEL - Answer shall be this level as an 8 bit number.
162	1010 0010	YAAA AAA 1	0	0	0	QUERY MIN LEVEL - Answer shall be this level as an 8 bit number.
163	1010 0011	YAAA AAA 1	0	0	0	QUERY POWER ON LEVEL - Answer shall be this level as an 8 bit number.
164	1010 0100	YAAA AAA 1	0	0	0	QUERY SYSTEM FAILURE LEVEL - Answer shall be this level as an 8 bit number.
165	1010 0101	YAAA AAA 1	0	0	0	QUERY FADE TIME / FADE RATE - Answer shall be XXXX YYYY where XXXX corresponds with the number of command 46 and where YYYY corresponds with the number of command 47.
166-175	1010 XXXX					reserved
Commands 176– 196: Queries related to system parameter settings						
176-191	1011 XXXX	YAAA AAA 1	0	0	0	QUERY SCENE LEVEL Answer shall be the arc power level of scene 0-15 - XXXX as an 8 bit number.
192	1100 0000	YAAA AAA 1	0	0	0	QUERY GROUPS 0-7 - One bit for each group in back channel data byte. Bit 0 = group 0. Bit1 = group 1 … "0" = not belonging to group. "1" = belonging to group.
193	1100 0001	YAAA AAA 1	0	0	0	QUERY GROUPS 8-15 - One bit for each group in back channel data byte. Bit 0 = group 8. Bit 1 = group 9 … "0" = not belonging to group. "1" = belonging to group.
194	1100 0010	YAAA AAA 1	0	0	0	QUERY RANDOM ADDRESS (H) - The 8 high bits of the random address
195	1100 0011	YAAA AAA 1	0	0	0	QUERY RANDOM ADDRESS (M) - The 8 mid bits of the random address.
196	1100 0100	YAAA AAA 1	0	0	0	QUERY RANDOM ADDRESS (L) - The 8 low bits of the random address.
197-223	110X XXXX					reserved
224-255	11XX XXXX	YAAA AAA 1	0	0	0	QUERY APPLICATION EXTENDED COMMANDS

256	0000 0000	1010 0001	0	0	0	TERMINATE – All special mode processes shall be terminated.
257	XXXX XXXX	1010 0011	0	0	0	DATA TRANSFER REGISTER (DTR) - Store 8 bit value XXXX XXXX to DTR.

Tab. 3: Address types

Short address	0-63	0AAAAAA1
Group address	0-15	100AAAA1
Broadcast		11111111
Direct control	0-63	0AAAAAA0
Direct control of one ballast	0-63	1AAAAAA0
Direct control of group	0-15	100AAAA0

Tab. 4: Advanced DALI commands

Nr.	DALI command	DALI address	D0	D1	D2	Function
258	1010 0101	XXXX XXXX				INITIALISE – This command shall be received a second time in the next 100 ms. No other commands addressing the same ballast shall be received between these two commands, otherwise these commands and command 258 shall be ignored. The command shall start or re-trigger a timer for 15 minutes; the addressing commands 259 to 270 shall only be processed within this period. All other commands shall still be processed during this period. This time period shall be aborted with the "TERMINATE" command. This command is sent automatically twice within 100ms. 0000 0000 – All ballasts shall react 0AAA AAA1 – Ballasts with the address AAA AAA shall react 1111 1111 – Ballasts without short address shall react
259	1010 01111	0000 0000				RANDOMISE – This command shall be received a second time in the next 100 ms. No other commands addressing the same ballast shall be received between these two commands, otherwise these commands and command 259 shall be ignored. The ballast shall generate a new random address on the request of this command. The new random address shall be available within a time period of 100 ms. This command is sent automatically twice within 100 ms.
260	1010 1001	0000 0000				COMPARE – The ballast shall compare its random address with the combined search address stored in SEARCHADDRH, SEARCHADDRM and SEARCHADDRL. If its random address is smaller or equal to the combined search address stored in SEARCHADDRH, SEARCHADDRM and SEARCHADDRL and the ballast is not withdrawn then the ballast shall generate a query ”YES”.
261	1010 1011	0000 0000				WITHDRAW – The ballast with its random address that is equal to the combined search address stored in SEARCHADDRH, SEARCHADDRM and SEARCHADDRL shall no longer respond to the COMPARE command. This ballast shall not be excluded from the

						initialization process.
262	1010 1101	0000 0000				reserved
263	1010 1111	0000 0000				reserved
264	1011 0001	HHHH HHHH				SEARCHADDRH
265	1011 0011	MMMM MMMM				SEARCHADDRM
266	1011 0101	LLLL LLLL				SEARCHADDRL
The final address is formatted as HHHHHHHHMMMMMMMMLLLLLLLL						
267	1011 0111	0AAA AAA1				PROGRAM SHORT ADDRESS – The ballast shall store the received 6 bit address as its short address if it is selected.
268	1011 1001	0AAA AAA1				VERIFY SHORT ADDRESS - The ballast shall give an answer ”YES” if the received short address is equal to its own short address.
269	1011 1011	0000 0000				QUERY SHORT ADDRESS – The ballast shall send the short address if the random address is the same as the search address or the ballast is physically selected. The structure of the answer shall have the format 0AAA AAA1. If no short address is stored the answer shall be "MASK".
270	1011 1101	0000 0000				PHYSICAL SELECTION – If a ballast receives this command, it shall cancel its physical selection and shall set the ballast to "Physical Selection Mode". In this mode the comparison of SEARCH and RANDOM ADDRESS shall be disabled.
271	1011 1111					reserved
272	1100 0001	XXXX XXXX				ENABLE DEVICE TYPE X - X = 0 to 255. This command shall be sent before an application extended command (224 – 255). This command can be processed without the use of the INITIALISE command. This command shall not be used for device type 0, because the application extended commands 224-255 are not used for this device type. X=0 – device for fluorescent lamps X=1 – device for emergency lighting X=2 – device for HID lamps X=3 - device for low voltage halogen lamps X=4 – device for dimming of incandescent lamps X=5 – device for conversion of digital signals according to E.4 into d.c. signals according to E.2 X=6 – LED X=7 – 255 - reserved
273	1100 0011					reserved
274	1100 0101					reserved
275	1100 0111					reserved
276	1100 1001				0x13	reserved
277	1101 0001				0x14	reserved

278	1101 0101				0x15	reserved
279	1101 0111				0x16	reserved

Tab. 5: Responses to advanced DALI commands

Nr.	DALI command	DALI address	D0	D1	D2	Function
260	1010 1001	0000 0000	Response	-	-	COMPARE – The ballast shall compare its random address with the combined search address stored in SEARCHADDRH, SEARCHADDRM and SEARCHADDRL. If its random address is smaller or equal to the combined search address stored in SEARCHADDRH, SEARCHADDRM and SEARCHADDRL and the ballast is not withdrawn then the ballast shall generate a query ”YES”.
268	1011 1001	0AAA AAA1	Response			VERIFY SHORT ADDRESS - The ballast shall give an answer ”YES” if the received short address is equal to its own short address.
269	1011 1011	0000 0000	Response			QUERY SHORT ADDRESS – The ballast shall send the short address if the random address is the same as the search address or the ballast is physically selected. The structure of the answer shall have the format 0AAA AAA1. If no short address is stored the answer shall be "MASK".

R091 converter special functions

The R091 converter contains 22 preprogrammed functions that are not part of the DALI standard. These functions trigger sequences of other commands.

Functions are controlled by registers that are normally used to control DALI functions.

The following table shows example of using these functions by block 0 (reg. 6, 7, 8).

However, any block can be used to activate them, so e.g. for block 1 registers 9, 10, 11 will be used, for block 2 registers 12, 13, 14, etc.

Triggering of these functions is done by setting the corresponding bits in register 5 – command mask.

Tab. 6: R091 converter special functions

No.	6 LSB	6 MSB	7 LSB	7 MSB	8 LSB	Function
1	-	YAAA AAA1	0100 XXXX	Value [0-254]	0000 0001	Store value as new parameter of scene XXXX (group address can be used as well)
2	-	0AAA AAA1	0110 XXXX 0111 XXXX	-	0000 0010	0110 XXXX = Add ballast to group XXXX 0111 XXXX = Remove ballast from group XXXX
3	-	YAAA AAA1	-	Value [0-15]	0000 0011	Store value as „FADE TIME“ (group address can be used as well)
4	-	YAAA AAA1	-	Value [1-15]	0000 0100	Store value as „FADE RATE“ (group address can be used as well)
5	-	YAAA AAA1	-	Value [0-254]	0000 0101	Store value as „MAX LEVEL“ (group address can be used as well)
6	-	YAAA AAA1	-	Value [0-254]	0000 0110	Store value as „MIN LEVEL“ (group address can be used as well)
7	-	YAAA AAA1	-	Value [0-255]	0000 0111	Store value as „SYSTEM FAILURE LEVEL“ (group address can be used as well)
8	-	YAAA AAA1	-	Value [0-254]	0000 1000	Store value as „POWER ON LEVEL“ (group address can be used as well)
9	-				0000 1001	Completely new addressing
10	-		Address to start with	0AAA AAA1	0000 1010	New addressing of all ballasts with given address
11	-		Address to start with		0000 1011	New addressing of ballasts without short address
12	-	0AAA AAA1	-	-	0000 1100	Deletes given short address of ballast
13	-	0AAA AAA1 (current address)	-	0AAA AAA1 (new address)	0000 1101	Changes current address to new address

14	-	YAAA AAA1	number of winks [1-255]	wink time [1-255]	0000 1110	winks the addressed ballast; wink values must not be 0! (group address can be used as well)
15	-				0000 1111	Short addresses request [0-31]
16	-				0001 0000	Short addresses request [32-63]
17	-				0001 0001	Ballast status request [0-31]
18	-				0001 0010	Ballast status request [32-63]
19	-				0001 0011	“Lamp failure“ request [0-31]
20	-				0001 0100	“Lamp failure“ request [32-63]
21	-				0001 0101	“Lamp power on“ request [0-31]
22	-				0001 0110	“Lamp power on“ request [32-63]

Tab. 7: Answers for R091 converter special functions

No.	6 LSB	6 MSB	7 LSB	7 MSB	8 LSB	Function
1	-	-	-	-		
2	-	-	-	-	-	
3	-	-	-	-	-	
4	-	-	-	-	-	
5	-	-	-	-	-	
6	-	-	-	-	-	
7	-	-	-	-	-	
8	-	-	-	-	-	
9	-	-	Number of addressed ballasts [0-63]	-	-	Completely new addressing
10	-	-	Number of addressed ballasts [0-63]	-	-	New addressing of all ballasts with given address
11	-	-	Number of addressed ballasts [0-63]	-	-	New addressing of all ballasts without short address
12	-	-	-	-	-	
13	-	-	-	-	-	
14	-	-	-	-	-	
15	Addresses 0-7	Addresses 8-15	Addresses 16-22	Addresses 23-31	-	1 – Yes 0 - No
16	Addresses 32-39	Addresses 40-47	Addresses 48-55	Addresses 56-63	-	1 – Yes 0 - No
17	Addresses 0-7	Addresses 8-15	Addresses 16-22	Addresses 23-31	-	1 - Error 0 - OK

18	Addresses 32-39	Addresses 40-47	Addresses 48-55	Addresses 56-63	-	1 - Error 0 - OK
19	Addresses 0-7	Addresses 8-15	Addresses 16-22	Addresses 23-31	-	1 - Error 0 - OK
20	Addresses 32-39	Addresses 40-47	Addresses 48-55	Addresses 56-63	-	1 - Error 0 - OK
21	Addresses 0-7	Addresses 8-15	Addresses 16-22	Addresses 23-31	-	1 - On 0 - Off
22	Addresses 32-39	Addresses 40-47	Addresses 48-55	Addresses 56-63	-	1 - On 0 - Off

Light level control

It is possible to control the light level using two different ways. DALI recognizes direct and indirect light level control.

Indirect light level control
The command consists of 2 bytes.

Byte 1 DALI address (short address / group address / broadcast)
Byte 2 Standard or Extended DALI command – see tables above.

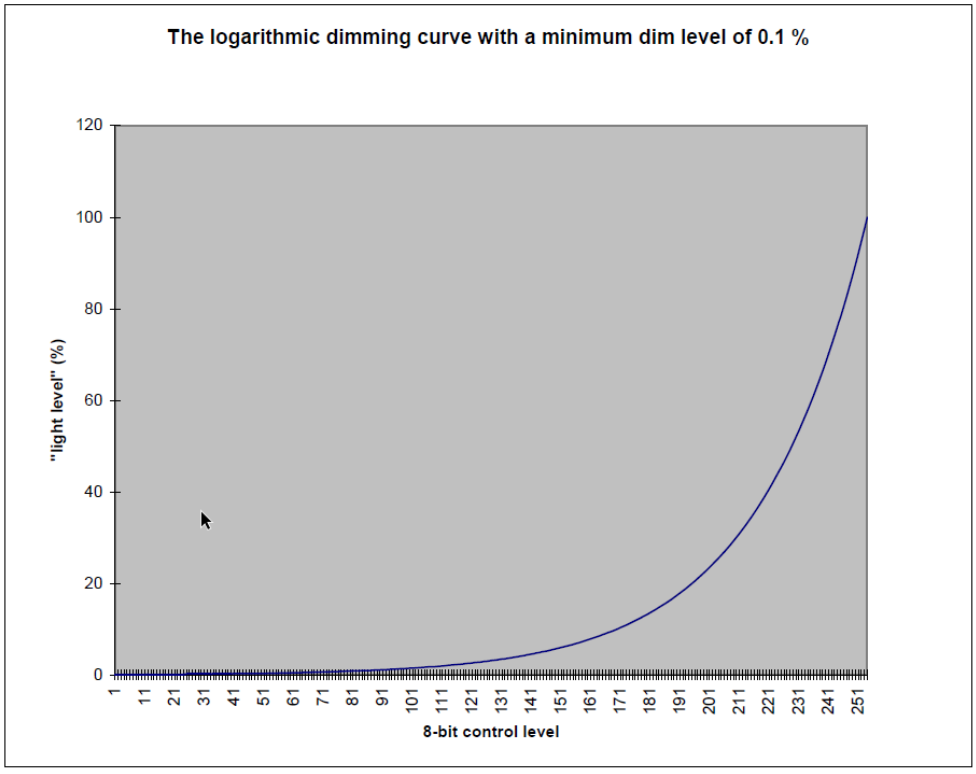
Direct light level control
The command consists of 2 bytes.

Byte 1 DALI address; this is the DALI ballast short address, with the first bit of 0.
Byte 2 Light level: a number in the range of 0...254 (note that the maximum range depends on the manufacturer setting).

This is a way how to control the light level directly without using of groups, scenes etc.

Scene control can use also percentage values. It is calculated using the following formula:

$$X(n) = 10^{\frac{n-1}{253/3}-1}, \left|\frac{X(n)-X(n+1)}{X(n)}\right| = const. = 2.8\%$$



Source: EN 60929

Examples of Modbus TCP commands

There are 8 "blocks" - (0 to 7) – which represent positions for the DALI commands. To execute a command:

- the block(s) must be filled with the data representing the command(s)
- bit(s) in Register 5 LSB which corresponds to the block to be executed must be set.

After executing of the command, the info bit in register 5 MSB is set so that the Modbus master can read that the execution was OK.

If a command is generating a response, the response is stored in the D0..D2 registers of the particular block.

More blocks may be filled at the same time and executed all together by writing a corresponding bit pattern into register 5 LSB.

Example 1:
Tx: 00 07 00 00 00 0D 01 10 00 05 00 03 06 0B 05 00 00 00 00

A Modbus TCP example telegram for **ballast Adr 6: set to max (DALI function 5)**. It is written in command block 0 (Modbus register 6, which is Modbus address 5).

00 07 00 00 00 0D 01	Details see Modbus TCP frame structure
10	Modbus F16, write multiple registers
00 05	Modbus address to be written to, address 5 = register 6
00 03	Number of 16bit registers to be written
06	Number of bytes to follow
0B 05 00 00 00 00	The data is 0B 05 for command block 0, other command blocks 1 and 2 are empty (00 00 00 00) - (this is how the client software, with which the example was done, is communicating: it writes three blocks at a time; other clients may only send the first couple of bytes).

The most important data is **0B 05**.

05: LSB = DALI command, see Tab 2 No.5
0B: MSB = 0000 1011 - the structure of a standard DALI command - see Tab 2:

Y AAA AAA 1, where
Y = 0 for Short address (see Tab 3), and
AAA AAA = 000 101 = 5 = DALI address of the ballast starting at 0, i.e. the 6th ballast.

In a similar way more command blocks may be filled, and then activated at the same time.

Another Modbus TCP telegram has to activate (execute) this command:

Address 6: execute block 0 (write 1 into Modbus register 5, or Modbus address 4)

00 08 00 00 00 09 01	Details see Modbus TCP frame structure
10	Modbus F16, write multiple registers
00 04	Modbus address to be written to, address 4 = register 5
00 01	Number of 16bit registers to be written

02	Number of bytes to follow
00 01	1 at Bit 0 means **Execute command block 0**. At this time the commands from Block D0 are sent to the DALI bus.

Example 2:

Sending the *Central On* command using data block 0

- Write 0xFF05 to register 6 (0xFF is broadcast address, 0x05 the *Recall Max Level* command)
- Write 0x01 to register 5. This starts executing the command. The command is in the queue or being executed until the bit 0x01 in register 5 is reset
- In case of error, the error code of 0x02 or 0x03 is readable in register 7 MSB. If the ballast responded correctly, the reply will be in register 7 LSB, and register 7 MSB will have value of 0x55.

Sending the *Central Off* command using data block 1

- Write 0xFF00 to register 9 (0xFF is broadcast address, 0x00 the *Off* command)
- Write 0x02 to register 5. This starts executing the command. The command is in the queue or being executed until the bit 0x02 in register 5 is reset
- In case of error, the error code of 0x02 or 0x03 is readable in register 10 MSB. If the ballast responded correctly, the reply will be in register 10 LSB, and register 10 MSB will have value of 0x55.

Sending the *Central Off* command using data block 8

- Write 0x00FF to register 516 (0xFF is broadcast address, 0x00 the *Off* command)
- Write 0x0000 to register 518. This will set a 16 bit packet, Send only once, and lowest priority.
- Write 0x0001 to register 511. This starts executing the command. The command is in the queue or being executed until the bit 0x01 in register 512 is reset
- In case of error, the error code is readable in register 562 MSB. If the ballast responded correctly, the reply will be in register 561 LSB, and register 562 LSB will have value of 0x03.

Sending the *Central On* command using data block 9

- Write 0x05FF to register 520 (0xFF is broadcast address, 0x05 the *Recall Max Level* command)
- Write 0x0000 to register 522. This will set a 16 bit packet, Send only once, and lowest priority.
- Write 0x0002 to register 511. This starts executing the command. The command is in the queue or being executed until the bit 0x02 in register 512 is reset
- In case of error, the error code is readable in register 564 MSB. If the ballast responded correctly, the reply will be in register 563 LSB, and register 564 LSB will have value of 0x03.

Sending a 24bit packet containing data (example: 01, 02, 03) using data block 8

- Write 0x0201 to register 516 (first two data bytes)
- Write 0x0003 to register 517 (third data byte)

- Write 0x0100 to register 518. This will set a 24 bit packet, Send only once, and lowest priority.
- Write 0x0001 to register 511. This starts executing the command. The command is in the queue or being executed until the bit 0x01 in register 512 is reset. The data [01, 02, 03] are sent.
- In case of error, the error code is readable in register 562 MSB. If the ballast responded correctly, the reply will be in register 561 LSB, and register 562 LSB will have value of 0x03.

Registers for simple control and status monitoring

To make Modbus communication easier, it is possible to read out statuses and control the ballasts also **using a simple Modbus read / write commands to dedicated Modbus registers 30 to 182**. These commands are converted to DALI commands in the converter, and sent to the DALI bus (unlike the standard commands, where the Modbus client actually has to compile the DALI telegrams and send them over Modbus). The Modbus client then may assign a separate register or bit to each ballast which makes the Modbus client engineering easier.

It is necessary to enable the required functions in Register 30 (see table above) for two reasons:

- this communication may bring extra load to the DALI bus, it is advisable to set e.g. the status update interval to the longest acceptable time

- only enabled command types are sent to the DALI bus – for security reason.

If these functions are not used, they should be disabled in register 30 or over the web interface.

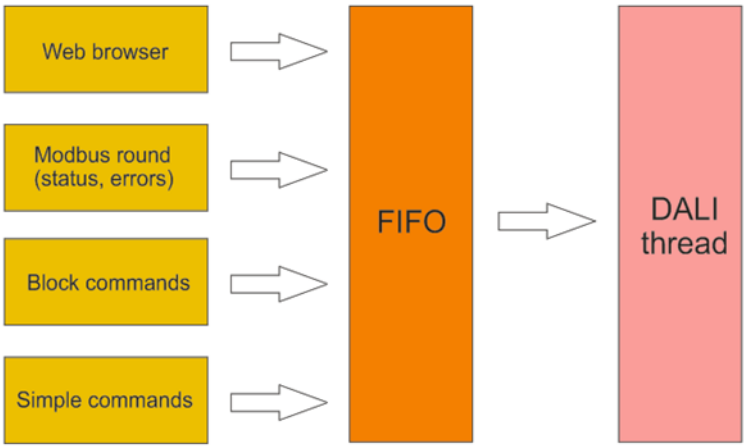
Note that if more commands to control a single DALI ballast are set over different registers, the last one is active. Make sure that the Modbus client does not send ambiguous commands over different registers which could spoil the intended DALI functionality.

To use the simple control commands in a proper way, it is necessary to understand the principle of command processing within the R091. There is an internal FIFO queue of 96 commands. The commands are read over the Modbus TCP interface or web pages, and put into the queue. On the queue output, the commands are translated into DALI telegrams, and sent to the DALI interface. **There is no feedback between the DALI command execution and the respective Simple command.** The Modbus server response to confirm a Simple command receipt only means that the command has been received by the R091, not that the command has been queued or executed at the DALI bus.

There are no exceptions, priorities, nor any other internal rules in the queue. As the DALI bus communication speed is 1200 bps while the Modbus TCP commands travel at the speed of Ethernet, it may happen that the queue gets full in case that the Simple commands are sent in a fast sequence.

If the queue is full, all incoming Modbus Simple commands are discarded. At the *Statistics* web page, there is a **Dali failure counter** item which counts the discarded commands. If this value is increasing steadily, it means that the Simple commands queue is permanently full and the Modbus communication should be less frequent.

In register 30 or over web can be set that when a command is discarded, the Modbus server returns a Modbus error 06 (Slave device busy).



Always select only the relevant simple command types at the *Conf* page. It is advised to disable the types of commands which are not used.

CGI commands

A CGI interface is available at the web server. Using CGI commands, all functions which are executable over the web pages can also be activated over CGI commands. The *ctrl.cgi* script must be called using a GET request with parameters which specify the operation type as well as arguments.

Example of a CGI request: ***ctrl.cgi?SrchShortAddr=0***
where ***ctrl.cgi*** is the CGI script
SrchShortAddr is the CGI command
=0 is the command argument.

Most of the commands are executed in several steps:

1. processing of input arguments and sending of the command to the DALI bus
2. periodical requesting if the command has been completed
3. after completion, the response with data is being assembled.

To simplify the implementation, the steps above are entered as command parameters (with the only exception, which is the *CentralOn* command).

Status	Code example	Response	Description
Trigger execution	*ctrl.cgi?SrchShortAddr=**0***	*{Status“:{"Code":01}}*	Starts executing a command.
Check end	*ctrl.cgi?SrchShortAddr=**1***	*{Status“:{"Code":01}}*	The command is being executed.
Check end	*ctrl.cgi?SrchShortAddr=**1***	*{Status“:{"Code":00}, data:{"d0":00, "d1":00}}*	Command executed successfully, the response with data is assembled if the command returns data.

GetLastData	*ctrl.cgi?SrchShortAddr=**2***	*{Status":{"Code":00}, data:{"d0":00, "d1":00}}*	Returns the last data immediately, no command is executed.

Not all commands do send or return data; see the command table below.

Every CGI command returns the operation status and also may return data. The reply is always formated as JSON and always contains the *Status* node (e.g. *{"Status":{"Code":00}}*). The Status node informs if the GET request was accepted and how the command, launched by the request, is being executed.

Status code table:

Description	**Code**
WEB_OK	0x00
WEB_OK_CMD_NOT_FINISHED	0x01
WEB_ERR_CMD_FIFO_FULL	0x81
WEB_ERR_CMD_IN_PROGRESS	0x82
WEB_ERR_UNKNOWN	0xFE
WEB_ERR_INVALID_GET_REQUEST	0xFF

The following table contains the list of all available CGI commands.
The values (...***=00000001*** etc.) are for illustration only, and must be replaced by the intended parameters and addresses.

Function	***Code***	**Response**	**Description**
Check if command was completed, used at Central On/Off	*ctrl.cgi?CheckFinished=1*	Status	To check repeatedly if the previous command has been completed
Central On/Off	*ctrl.cgi?CentralOn=1* *ctrl.cgi?CentralOn=0*	Status	Sends a central On or Off command to the bus
Search of short address	*ctrl.cgi?SrchShortAddr=x*	Status,SrchShortAddr: {d0:00,d1:00}	Launches searching of a ballast, the found addresses are returned as 64 bits in d0 and d1 which are 32bits variables as hex
Readdressing of all ballasts	*ctrl.cgi?TotReAddress=x*	Status	Returns status only. Use the *SrchShortAddr* command to get the new data
Addressing without short address	*ctrl.cgi?d0=000000001 &BalAddrWithoutShortAddr=x*	Status	d0 is the starting address. Use the *SrchShortAddr* command to get the new data
Addressing with short address	*ctrl.cgi?d0=000000001 &d1=000000002 &BalAddrWithShortAddr=x*	Status	d0 is the starting address, d1 is the starting address of the new range. Example: Old addressing 1...10, d0=3, d1=12, the result is 1, 2, 12, 13, 14, 15, 16, 17, 18, 19.
Change address	*ctrl.cgi?d0=000000001 &d1=000000002 &ChangeShortAddr=x*	Status	Change short address d0 to new address d1.
Delete address	*ctrl.cgi?d0=000000001 &DeleteShortAddr=x*		Delete the short address d0.

Read ballast status	*ctrl.cgi?GetLampStat=x*	Status,GetLampStatOn:{d0:00,d1:00},GetLampStatErr:{d0:00,d1:00}	Returns statuses of all ballasts in 2 nodes (On and Error) as 64 bits in d0 and d1 which are 32bits variables as hex
Read scenes	*ctrl.cgi?d0=00000001 &ReadScenes=x*	Status,GetScenes:{d0:00,d1:00,d2:00,d3:00}	d0 in the request is the address to read from, the response is in d0 to d3 as 16 scenes, 1 byte (0...255) each
Write scenes	*ctrl.cgi?d0=00000001 &d1=00000001 &d2=00000001 &d3=00000001 &d4=00000001 &WriteScenes=x*	Status	Writes to address in d0 the scenes pattern given in d1 to d4 as 16 scenes, 1 byte (0...255) each
Read groups	*ctrl.cgi?d0=00000001 &ReadGroups=x*	Status,GetGroups:{d0:00}	Reads configuration of groups for a ballast with short address set in d0; the response is returned in d0 as 32bit variable in hex
Write groups	*ctrl.cgi?d0=00000001 &d1=00000001 &WriteGroups=x*	Status	Writes group configuration to a ballast with short address set in d0, group configuration is in d1, d0 and d1 are 32 bit variables in hex
Read values from the ECG page	*ctrl.cgi?d0=00000001 &ReadEcg=x*	Status,GetGroups:{d0:00, d1:00}	Reads ECG parameters from a ballast with short address in d0, the response is in d0 to d1 as follows: d0:"Min level", "Max level", "System failure level", "Power on level"; d1:"Fade time", "Fade rate"; d0 and d1 are 32 bit variables in hex
Write values to the ECG page	*ctrl.cgi?d0=00000001 &d1=00000001 &d2=00000001 &WriteEcg=x*	Status	Writes ECG parameters to a ballast with short address in d0, the parameters must be in d1 to d2 as follows: d1:"Min level", "Max level", "System failure level", "Power on level"; d2:"Fade time", "Fade rate"; d0 to d2 are 32 bit variables in hex
Set a light to On	*ctrl.cgi?d0=00000001 &AddrOn=x*	Status	Sets a ballast with short address of d0 to On
Set a light to Off	*ctrl.cgi?d0=00000001 &AddrOff=x*	Status	Sets a ballast with short address of d0 to Off
Set a light to Min level	*ctrl.cgi?d0=00000001 &MinLevelAddr=x*	Status	Sets a ballast with short address of d0 to Min Level
Set scene	*ctrl.cgi?d0=00000001 &d1=00000001 &SetScene=x*	Status	Sets a ballast with short address of d0 to scene d1
Set a light to light level	*ctrl.cgi?d0=00000001 &d1=00000001 &SetActLevel=x*	Status	Sets a ballast with short address of d0 to level d1
Set a group to On	*ctrl.cgi?d0=00000001 &GrpOn=x*	Status	Sets a group with address of d0 to On
Set a group to Off	*ctrl.cgi?d0=00000001 &GrpOff=x*	Status	Sets a group with address of d0 to Off
Set a group to Min level	*ctrl.cgi?d0=00000001 &MinLevelGrp=x*	Status	Sets a group with address of d0 to Min level

Set a group to level	*ctrl.cgi?d0=00000001 &d1=00000001 &SetGrpActLevel=x*	Status	Sets a group with address of d0 to level d1
Read R091 configuration	*ctrl.cgi?ReadConfig=x*	Status,GetConfig:{d0:00 , d1:00}	Returns ballast configuration. d0 – period of status readout in seconds d1 – configuration bits: bit 0 - "Status loop enable" bit 1 - "Analog driving ballast" bit 2 - "Analog driving group" bit 3 - "Analog driving broadcast" bit 4 - "Digital driving ballast" bit 5 - "Digital driving group" bit 6 - "Digital driving broadcast"
Write R091 configuration	*ctrl.cgi?d0=00000001 &d1=00000001 &WriteConfig=x*	Status	Writes ballast configuration. d0 – period of status readout in seconds d1 – configuration bits: bit 0 - "Status loop enable" bit 1 - "Analog driving ballast" bit 2 - "Analog driving group" bit 3 - "Analog driving broadcast" bit 4 - "Digital driving ballast" bit 5 - "Digital driving group" bit 6 - "Digital driving broadcast"

Note that the CGI access is not protected. To disable CGI access for security reasons, use the WEB switch (see above). It is recommended to use the web services in closed networks only.

Firmware update

In case that firmware cannot be updated properly by web interface, try this:

The last firmware version is available on web link:
http://domat-int.com/en/downloads/software Section Firmware for Domat devices.

- Open the web page of the R091, go to *Administration*, and upload the new firmware file (*R091_fw_x_x_x.bin*)
- power off / on the R091
- connect to the R091 over FTP (name / password: root / root99)
- delete all web pages which are in the R091
- copy the new web pages from your PC to the R091
- disconnect the FTP server
- power off / on the R091

Changes in versions

11/2016 – The first datasheet version (M090).
12/2016 – Updated information about DALI commands, Modbus table and firmware update information.
01/2017 – Design notes merged with Bus design notes and all moved above the Technical data table.
01/2017 – New table “R091 converter special functions” added, minor updates to DALI functions tables.
01/2017 – New information about commands that have to be sent twice within 100ms
01/2018 – R091 datasheet splitted from R090. Modbus table enhanced – reg. 516 and on, CGI control added,
08/2018 – Typos fixed, minor Modbus table corrections, Modbus table enhanced – reg. 793, 794 and on, new schema and DIP switch description.
09/2018 – Adding registers (Trigger) to Modbus table, new web screenshots and screenshot description.
09/2018 – Compatibility section added.
08/2019 – Minor description modification.
07/2020 – Fixed: Swapped values (address / value) in commands 256 and 257.
10/2020 – Fixed: Wrong switch number (1) in “Set the DIP switch 2 (INIT) to ON.”
03/2021 – Description for register 7 MSB enhanced.
06/2021 – Default value of reg. 159 corrected, logo changed.
07/2021 – *Settings*: added option to secure web interface wth username and password.
10/2021 – Addition of specification for PoE.
02/2022 – Description for register 7 MSB enhanced.

R095, R096 M-Bus / RS232 converter

Summary **R095 and R096 are microprocessor-controlled M-Bus converters for energy and media meter readouts over RS232. The converters facilitate automatic baud rate switching, galvanic separation of power part and both interfaces, and they can host up to 25 and 60 M-Bus devices. These converters are successors of the previous types M095 and M096.**

Application

- **integration of M-Bus water, electricity, gas, and heat meters into PLC or SCADA over RS232 interface**

Function

The R095 converter connects up to 25 M-Bus devices to a process station or supervisory system over RS232. The R096, which provides stronger power supply, may host up to 60 M-Bus meters. Maximum communication speed is 9600 bps, with fully automatic baud rate switching – it is not necessary to set anything at the converter.

All interfaces are mutually separated up to 1000 V DC. It is a very important feature which provides high reliability even in harsh industry environment with high EMC pollution. The M-Bus power source is protected against short-circuit and overvoltage.

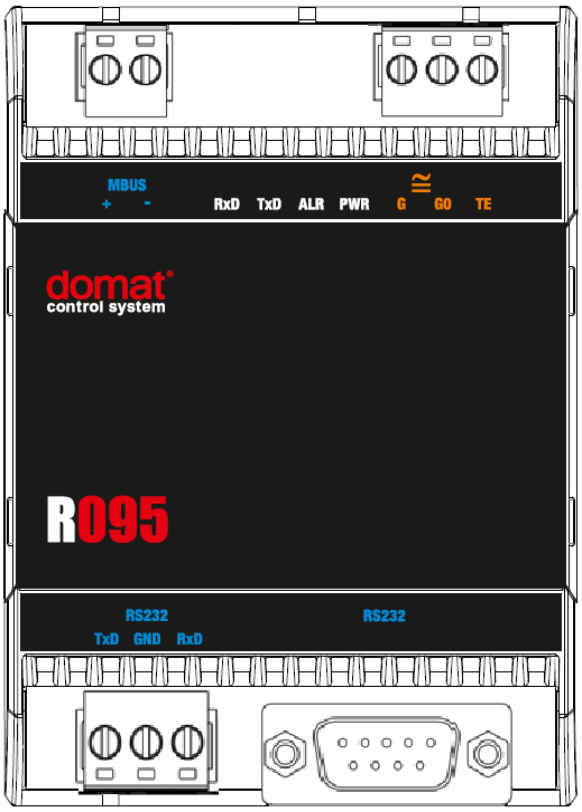
The M-Bus devices are connected over a 2-pole connector, regardless of polarity. The RS232 bus is connected over a CANNON 9 M connector with cross (zero-modem) cable or over three terminals TxD, GND and RxD. Do not connect RS232 in both ways.

The module is 70.4 mm wide and mounts on a standard DIN rail.

Technical data

Power	20…24 V DC, 14…24 V AC; 6 W
RS232	CANNON 9 male; (1- DCD, 2 - RXD, 3 - TXD, 4 - DTR, 5 - GND, 6 - DSR, 7 – RTS, 8 - CTS) terminals TxD, GND, RxD 300...9600 bit/s
M-Bus	standard EN 1434-3, EN 13757-2; 300, 2400, and 9600 bps, automatic baud rate; support of secondary addressing (detection of collision RTS signal) maximum bus length is 1000 m for 300 baud rate and 350 m for 9600 baud rate. Maximum number of devices on the bus is R095 – 25; R096 – 60 devices. has permanent protect against short-circuit and overvoltage.
Galvanic separation	power part, RS232, and M-Bus are separated from each other up to 1000 V DC
4x LED	PWR, ALR, TxD, RxD
Housing	polycarbonate box (certification UL94V0)
Dimensions	see below
Protection degree	IP21 (EN 60529)
Terminals	screw terminals M3, maximum wire cross-section 2.5 mm^2 (recommended wire cross-section is 0.35…1.5 mm^2)
Ambient conditions	5…40 °C; 5…85 % relative humidity; non-condensing gases and chemically non-aggressive conditions (according EN 60721-3-3 climatic class 3K3)
Storage conditions	5…40 °C; 5…85 % relative humidity; non-condensing gases and chemically non-aggressive conditions (according EN 60721-3-1 climatic class 1K2)
Standards conformity	EMC EN 61000-6-2 ed.3:2005, EN 55022 ed.3:2010 EN 60950-1 ed.2:2006 + A11:2009 + A12:2011 + A1:2010 + A2:2014 EN 50581:2012

Schema



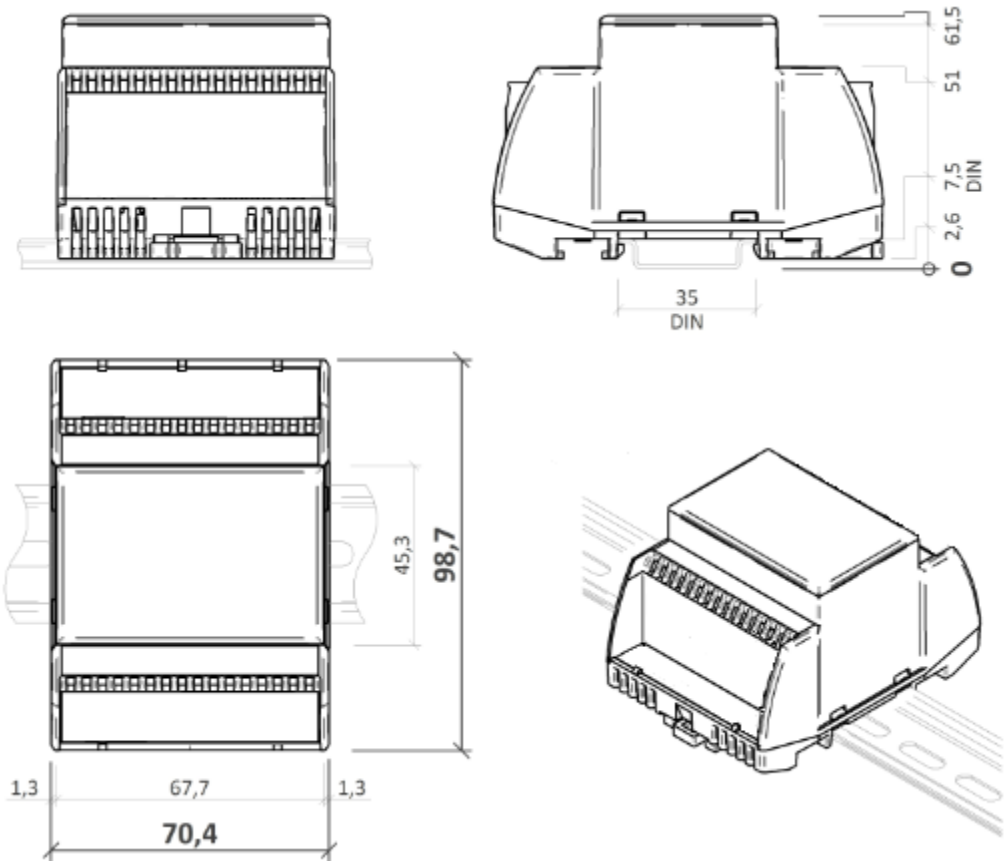
Terminals and connectors

MBUS	interface for bus with M-bus meters; terminals +, -
G	power
G0	power
TE	optional connection for shielding
RS232	serial line RS232; CANNON 9 male (1- DCD, 2 - RXD, 3 - TXD, 4 - DTR, 5 - GND, 6 - DSR, 7 – RTS, 8 - CTS)
RS232 TxD, GND, RxD	serial line RS232; only signals TxD, GND a RxD, in the case when the other side not used CANNON 9; Do not connect RS232 simultaneously CANNON 9 and terminals TxD, GND, RxD.

LED indication

RxD	green LED – M-bus receiving data (flashing: receiving data; OFF: no data traffic)
TxD	red LED – M-bus transmitting data (flashing: transmitting data; OFF: no data traffic)
PWR	green LED – power (ON: power OK; OFF: no power applied, weak or damaged power supply, …)
ALR	yellow LED – short circuited or overloaded bus (M-bus)

Dimensions



All dimensions are in *mm*.

Changes in versions	12/2016 – First version of the datasheet. 02/2017 – Minor typo corrections (Power: AC, DC). 02/2021 – Added info about protection against short-circuit and overvoltage on bus. 08/2021 – Stylistic adjustments, change of logo.