MBUS-REP
Repeater
for the M-Bus

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1 Notes and conventions

1.1 About this document

This manual provides guidance and procedures for a fast and efficient installation and start-up of the units described in this manual. It is imperative to read and carefully follow the safety guidelines.

1.2 Legal basis

1.2.1 Copyright protection

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1.2.2 Personnel qualification

The product use described in this documentation is intended exclusively for qualified electricians or persons instructed by these. They must all have good knowledge in the following areas:

- Applicable standards
- Use of electronic devices
- Cybersecurity

1.2.3 Intended use

If necessary, the components or assemblies are delivered ex works with a fixed hardware and software configuration for the respective application. Modifications are only permitted within the scope of the possibilities shown in the documentation. All other changes to the hardware or software as well as the non-intended use of the components result in the exclusion of liability. Please direct any requests for a modified or new hardware or software configuration to the manufacturer.

1.2.4 Exclusion of liability

Study this manual and all instructions thoroughly prior to the first use and respect all safety warnings, even if you are familiar with handling and operating electronic devices.

No liability is accepted for damage to objects and persons caused by erroneous operation, inappropriate handling, improper or non-intended use or disregard for this manual, especially the safety guidelines, and any warranty is void.

1.2.5 Disclaimer

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1.3 Symbols

- Danger: It is essential to observe this information in order to protect persons from injury.
- Caution: It is essential to observe this information in order to prevent damage to the device.
- Notice: Boundary conditions that must always be observed to ensure smooth and efficient operation.
- ESD (Electrostatic Discharge): Warning of danger to components due to electrostatic discharge. Observe precautionary measures when handling components at risk of electrostatic discharge.
- Note: Routines or advice for efficient equipment use.
- Further information: References to additional literature, manuals, data sheets and internet pages.

1.4 Font conventions

Names of paths and files are marked in italics. According to the system the notation is using slash or backslash.
e. g.: *D: \ Data*

Menu items or tabs are marked in bold italics.
e. g.: ***Save***

An arrow between two menu items or tabs indicates the selection of a sub-menu item from a menu or a navigation process in the web browser.
e. g.: ***File*** → ***New***

Buttons and input fields are shown in bold letters.
e. g.: **Input**

Key labels are enclosed in angle brackets and shown in bold with capital letters.
e. g.: ⟨**F5**⟩

Programme codes are printed in Courier font.
e. g.: `ENDVAR`

Variable names, identifiers and parameter entries are marked in italics.
z. B.: *Value*

1.5 Number notation

Numbers are given according to this table:

Numbering system	Example	Comments
Decimal	100	Normal notation
Hexadecimal	0x64	C-like notation
Binary	'100' '0110.0100'	In apostrophes Nibbles separated by dots

Table 1: Numbering systems

1.6 Safety guidelines

- Observe the recognized rules of technology and the legal requirements, standards and norms, and other recommendations.

- Do not open the device. It does not contain any parts to be replaced or serviced by the user.
- Study the instructions for the extinction of fire in electrical installations.
- The power supply must be switched off before replacing components and modules.
- Use exclusively flame-retardant cables/electric lines complying with IEC 60332-1-2 and IEC 60332-1-3.
- Take appropriate lightning protection measures when using an external antenna.
- This device is not suitable for use in locations where children are likely to be present.

If the contacts are deformed, the aff ected module or connector must be replaced, as the function is not guaranteed in the long term.

The components are not resistant to substances that have creeping and insulating properties. These include e. g. aerosols, silicones, triglycerides (ingredient of some hand creams). If the presence of these substances in the vicinity of the components cannot be excluded, additional measures must be taken:

- Install the components in an appropriate casing.
- Handle components with clean tools and materials only.

- Only use a soft, wet cloth for cleaning. Soapy water is allowed. Pay attention to ESD precautions.
- Do not use solvents like alcohol, acetone etc. for cleaning.
- Do not use a contact spray, because in an extreme case the function of the contact point is impaired and may lead to short circuits.
- Assemblies, especially OEM modules, are designed for installation in electronic housings. Do not touch the assembly when it is live. In each case, the valid standards and directives applicable to the construction of control cabinets must be observed.
- The components are populated with electronic parts which can be destroyed by an electrostatic discharge. When handling the components, ensure that everything in the vicinity is well earthed (personnel, workplace and packaging). Do not touch electrically conductive components, e. g. data contacts.

1.7 Maintenance

Maintenance requires an annual inspection of the screw terminals and of the isolation of cables/electric lines and connectors. If need be, tighten screw terminals and replace damaged cables/electric lines.

1.8 Disposal

Note on EU Directive 2012/19/EU on the disposal of electrical and electronic equipment (Directive on Waste Electrical and Electronic Equipment, hence “WEEE Directive”), valid in the European Union and other countries with separate collection systems:

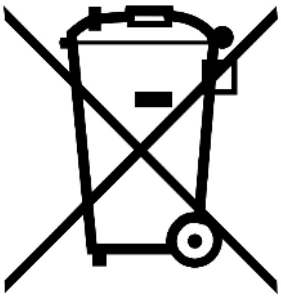


Figure 1: Symbol indicating separate collection for electrical and electronic equipment

This symbol of the crossed-out wheelie bin on the product, packaging, or in the user manual means that this electrical or electronic equipment must not be disposed of in general waste or with plastic waste at the end of its life, but must be collected separately for recycling of electrical and electronic equipment. Disposal via general waste or the yellow bin is prohibited by law. For disposal, free collection points are available, such as a recycling centre or a municipal collection point for old electrical appliances, as well as further acceptance points for devices if applicable. You can obtain the addresses of the collection points from the public disposal authorities from your city or municipal administration.

1.9 Scope

This manual describes the device by solvimus GmbH, Ilmenau, mentioned on the front page.

1.10 Abbreviations

Abbreviation	Meaning
2G	Mobile radio standard, synonym for GSM or GPRS
3G	Mobile radio standard, synonym for UMTS
4G	Mobile radio standard, synonym for LTE
ACK	Acknowledge
AES	Advanced Encryption Standard
AFL	Authentication and Fragmentation Layer
AI	Analog Input
ANSI	American National Standards Institute
AO	Analog Output
APN	Access Point Name
ASCII	American Standard Code for Information Interchange
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BACnet	Building Automation and Control networks
BBMD	BACnet Broadcast Management Device
BCD	Binary-coded decimal numbers
BDT	Broadcast Distribution Table
BMS	Building Management System
CA	Certification Authority
CHAP	Challenge Handshake Authentication Protocol
CI	Control Information
CLI	Command line interface
COSEM	COmpanion Specification for Energy Metering
CPU	Central processing unit
CRC	Cyclic redundancy check
CSR	Certificate Signing Request
CSV	Character-Separated Values
CTS	Clear to send
D0	D0 interface (optical interface, IEC 62056-21)
DDC	Direct Digital Control
DHCP	Dynamic Host Configuration Protocol
DI	Digital Input, digital input terminal
DIF	Data information field
DIFE	Data information field extensions
DIN	Deutsches Institut für Normung, German Institute for Standardization
DLDE	Direct Local Data Exchange (EN 62056-21, IEC 1107)
DLDERS	DLDE communication via RS-232 or RS-485
DLMS	Device Language Message Specification
DNS	Domain Name System
DO	Digital Output, digital output terminal
EEG	German Renewable Energy Sources Act
EIA/TIA	Electronic Industries Alliance/Telecommunications Industry Association
ELL	Extended Link Layer
EMC	Electromagnetic compatibility
EN	European norm
ESD	Electrostatic Discharge
FCB	Frame Count Bit
FCV	Frame Count Valid Bit
FNN	Forum Netztechnik/Netzbetrieb, subgroup of VDE
FSK	Frequency Shift Keying
FTP	File Transfer Protocol
FTPS	FTP via TLS
GB	Gigabyte
GMT	Greenwich Mean Time
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HCA	Heat cost allocator
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
I2C	Inter-Integrated Circuit
I/O	Input/Output
ICCID	Integrated Circuit Card Identifier
ICMP	Internet Control Message Protocol
ID	Identification, Identifier, unique marking

Continued on next page

Table 2 – *Continued from previous page*

Abbreviation	Meaning
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
IP	Internet Protocol or IP address
ISO	International Organization for Standardization
JSON	JavaScript Object Notation
LAN	Local area network
LCD	Liquid-crystal display
LED	Light-Emitting Diode
LSB	Least significant byte
LSW	Least significant word
LTE	Long Term Evolution
M2M	Machine-to-Machine
M-Bus	Meter-Bus (EN 13757, part 2, 3 and 7)
MAC	Medium Access Control or MAC-Adresse
MB	Megabyte
MCR	Multi Channel Reporting
MCS	Modulation and Coding Scheme
MDM	Meter Data Management
MEI	Modbus Encapsulated Interface
MHz	Megahertz
MQTT	Message Queuing Telemetry Transport
MSB	Most Significant Byte
MSW	Most Significant Word
MTU	Maximum Transmit Unit
MUC	Multi Utility Communication, MUC controller
NB-IoT	Narrow Band Internet of Things
OBIS	Object Identification System
OEM	Original Equipment Manufacturer
OMS	Open Metering System
OTP	One-time password
PAP	Password Authentication Protocol
PEM	Privacy Enhanced Mail
PID	Product ID
PIN	Personal Identification Number
PKI	Public Key Infrastructure
PLC	Programmable Logic Controller
PLMN	Public Land Mobile Network
PPP	Point-to-Point Protocol
PPPoE	Point-to-Point Protocol over Ethernet
PTC	Polymer with positive temperature coefficient
PUK	Personal Unblocking Key
RAM	Random Access Memory
REQ_UD	Request User Data (Class 1 or 2)
RFC	Requests For Comments
RSP_UD	Respond User Data
RSRP	Reference Signal Received Power
RSRQ	Reference Signal Received Quality
RSSI	Received Signal Strength Indicator
RTC	Real-Time Clock
RTOS	Real-Time Operating System
RTS	Request to send
RTU	Remote Terminal Unit
S0	S0 interface (pulse interface, EN 62053-31)
SCADA	Supervisory Control and Data Acquisition
SCP	Secure Copy
SFTP	SSH File Transfer Protocol
SIM	Subscriber Identity Module
SML	Smart Message Language
SMTP	Simple Mail Transfer Protocol
SND_NKE	Send Link Reset
SND_UD	Send User Data to slave
SNTP	Simple Network Time Protocol
SPST	Single Pole Single Throw Relay (closing switch)
SRD	Short Range Device
SSH	Secure Shell
SSID	Service Set Identifier
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol
THT	Through-Hole Technology
TLS	Transport Layer Security

Continued on next page

Table 2 – *Continued from previous page*

Abbreviation	Meaning
U	Unit width of the housing (1 U = 18 mm)
UART	Universal Asynchronous Receiver Transmitter
UDP	User Datagram Protocol
UL	Unit load for M-Bus
UMTS	Universal Mobile Telecommunications System
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
UTC	Universal Time Coordinated
VCP	Virtual COM port
VDE	Verband der Elektrotechnik Elektronik Informationstechnik e.V., German Association for Electrical, Electronic & Information Technologies
VHF	Very high frequency
VID	Vendor ID
VIF	Value information field
VIFE	Value information field extensions
VLAN	Virtual Local Area Network
VPN	Virtual Private Network
WAN	Wide Area Network
WLAN	Wireless Local Area Network
wM-Bus	Wireless Meter-Bus (EN 13757, part 3, 4 and 7)
XML	eXtensible Markup Language
XSLT	eXtensible Stylesheet Language Transformation

Table 2: Abbreviations

2 Introducing the device

2.1 General information

The M-Bus (Meter-Bus) is an established and well-known interface for automated meter reading. Especially the ease of installation (simple two-wire system with powering by the bus) and the robustness are important features. These are also special attributes that are of interest for use in industrial environments.

The M-Bus is defined in the standard EN 13757. It establishes an own physics as well as an own protocol.

The Repeater (in the sequel MBUS-REP for simplicity) acts on the M-Bus as slave and also as master, and is fully transparent for the communication and with respect to the baud rate. By the use of the MBUS-REP it is possible to extend an existing M-Bus network with further units. The device will supply power for up to 125, 250 or 500 unit loads (UL, mostly equivalent to the number of meters) on the extended M-Bus segment. The current drawn from the M-Bus at the slave connectors MBI1 and MBI2 (see Section 2.3) corresponds to 2 UL only.

The MBUS-REP comes in a housing 3 U (modules) wide and is intended for top hat rail mounting (DIN rail 35 mm).

The serial number of the devices of the solvimus GmbH can be read from the housing.

2.2 Delivery variants and scope of delivery

The MBUS-REP is offered in a range of variants, and so can easily be adapted to the requirements of the particular property.

Variant	Article number	M-Bus interface
MBUS-REP125	500414	max. 125 unit loads
MBUS-REP250	500417	max. 250 unit loads
MBUS-REP500	500402	max. 500 unit loads

Table 3: Delivery variants

The scope of delivery contains the device and a Quick Start Guide.

2.3 Connectors

The connectors and interfaces of the MBUS-REP are on the top and bottom sides of the device.

The master side is the one to which meters are connected using the M-Bus connectors MBUS+ and MBUS-. The MBUS-REP acts as master there.

The slave side is the one to which the superior master is connected using the M-Bus connectors MBI1 and MBI2. The MBUS-REP acts as slave there.

The following figure shows the device. All variants are similar in outward appearance.

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Figure 2: MBUS-REP125

The following connectors are available at the MBUS-REP:

Connector	Designation	Pin assignment	Comments
Power supply	24 VDC 0 VDC	24 VDC: positive power supply 0 VDC: negative power supply	24 VDC: 12..36 VDC screw terminal cross section 2.5 mm^2
M-Bus connector (master side)	MBUS+ MBUS-	MBUS+: positive bus line MBUS-: negative bus line	screw terminal cross section 2.5 mm^2
M-Bus connector (slave side)	MBI1 MBI2 nc	MBI1: first bus line MBI2: second bus line nc: not connected	screw terminal cross section 2.5 mm^2

Table 4: Pin assignment

2.4 Status LEDs

The MBUS-REP is equipped with 3 status LEDs. These indicate the following states:

LED	Colour	Description
COL	red (flashing)	Collision or excessive capacitive load on the M-Bus
TX	yellow	Reception of data from the M-Bus master and transmission on the M-Bus
RX	green	Reception of data from the M-Bus slaves and transmission to the M-Bus master

Table 5: Status LEDs

2.5 First steps

- ⚠ Only trained and appropriately qualified personnel are allowed to check the electric power supply (see Section 1.2.2).
- ⚠ De-energise the M-Bus or its master before connecting the device.
- ⚠ Connect exclusively the slave connectors (MBI1 and MBI2, see Section 2.3) of the MBUS-REP to the existing physical master. Otherwise, the device can be damaged.

The MBUS-REP is fully transparent to the data communication on the M-Bus. This means that the device is not visible as an M-Bus slave and baud rate changes of the M-Bus master do not need any user interaction.

2.5.1 Signalling on the M-Bus

The M-Bus is a single master multiple slave bus. Therefore, a single bus master controls the bus and the data traffic on the bus. Several slaves, i.e. meters, can be connected to the bus.

- ℹ A second physical master is not allowed on the M-Bus.

On a physical level, the M-Bus uses voltage and current modulation to transmit data. The master transmits telegrams by modulating the bus voltage, the slave transmits telegrams by modulating the current through the bus. This is shown schematically in the following figure (values of current and voltage may deviate):

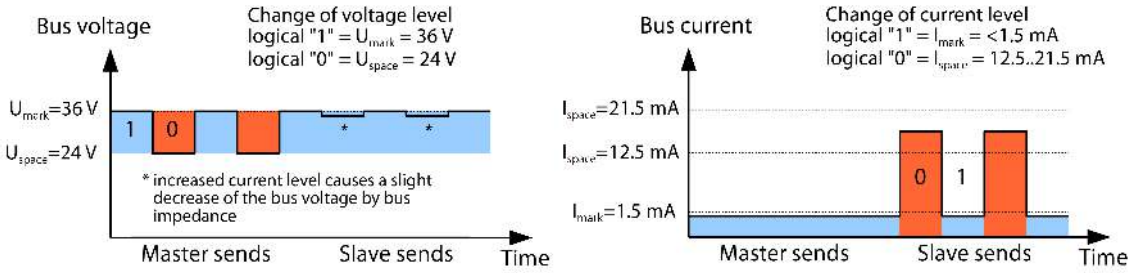


Figure 3: Signalling on the M-Bus

The M-Bus follows the principle of request-response, i.e. the master initiates the communication by a request/command which is then answered/confirmed by the slave. Spontaneous data transmission on the part of the slaves is not allowed.

Certain terms are used in the M-Bus standard. The basics of communication are taken from IEC 60870-5-101. Key terms are explained in the table below:

Term	Description
ACK	ACKnowledge, confirmation of a command, transmitted over the M-Bus as a single character telegram with content 0xE5.
Application reset	Reset of the application layer, command to reset the meter to the default state and to reset the meter for consecutive telegrams (multipaging).
Broadcast	Broadcast, command or request is sent to all slaves, special addresses 0xFE and 0xFF are used.
C-field	Command field, code that indicates the direction in which a telegram is exchanged and the meaning of the telegram.
Checksum	Check number for checking transmission errors, the checksum the M-Bus uses, results from the addition of the transmitted data (without telegram header, up to checksum).
Single character	One of the three telegram formats the M-Bus uses with a length of exactly 1 byte, telegram header and end, consisting of checksum and 0x16, are not present, used on the M-Bus for ACK.
FCB	Frame Count Bit, bit in the C field, which is alternately set to 1 or 0 in consecutive telegrams, consecutive telegrams can be retrieved when the bit changes in the request.
I_{mark}	Transmit current of the slave at logical 1, usually 1 UL.
I_{space}	Transmit current of the slave at logical 0, usually 12.5-21.5 mA.
Short frame	One of the three telegram formats the M-Bus uses with a length of exactly 5 bytes, is only sent from the master to the slave (e.g. commands and instructions), the telegram header is 0x10 and the telegram ends with the checksum and 0x16.
Long frame	One of the three telegram formats the M-Bus uses with a variable length, the telegram header consists of 0x68 LL LL 0x68 (LL is the length of the telegram in each case), the telegram ends with the checksum and 0x16.
Multipaging	M-Bus method of distributing large amounts of data into several logically consecutive telegrams, use of the FCB for sequence control.
Primary address	M-Bus Link layer Address, this is used to address the requests/commands, address space 0-250, special addresses 253 (0xFD), 254 (0xFE) and 255 (0xFF).
REQ_UD2	REQuest User Data type 2, request for consumption data, transmitted over the M-Bus by the master as a short frame telegram.
RSP_UD	ReSPond User Data, response of the meter to a request for data, transmitted over the M-Bus by the slave as a long frame telegram.
Secondary address	Worldwide unique identification number of the meter, consisting of manufacturer code, 8-digit serial number, medium ID and version number.
Slave select	Procedure for extending the address space to the secondary address of the meter, use of the SND_UD for selecting the meter via the application layer, then selected meter can be addressed via special address 0xFD.
Unit Load	Defined idle current that a meter may draw from the M-Bus, according to the standard 1 UL=1.5 mA.
SND_NKE	Send Link Reset, initialization command to the slave (reset FCB bit and selection), transmitted by the master as a short frame telegram on the M-Bus.
SND_UD	SeND User data, sending data or commands to the meter, transmitted by the master as a long frame telegram on the M-Bus.
U_{mark}	Mark voltage, upper voltage of the M-Bus signals at the master, representation of the logical 1, idle state, usually 24-42 V.

Continued on next page

Table 6 – *Continued from previous page*

Term	Description
U_{space}	Space voltage, lower voltage of the M-Bus signals at the master, representation of the logical 0, usually 12-30 V.
UL	Unit of unit load (see above)

Table 6: M-Bus specific terms

2.5.2 Extending an existing M-Bus network with a new bus segment

Connect the bus lines of the existing M-Bus to the connectors MBI1 and MBI2 (see Section 2.3).

The new M-Bus segment is to be connected to the connectors MBUS+ and MBUS- (see Section 2.3). The MBUS-REP is able to supply this new bus segment with up to 125, 250 or 500 UL (unit loads).

Connect the power supply connectors 24 VDC and 0 VDC to a suitable power supply.

2.5.3 Ripping up an existing M-Bus network

Rip up the M-Bus at an appropriate position. Make sure to connect at most 125, 250 or 500 UL (unit loads) in each wiring section of the new severed M-Bus.

Connect the bus lines that are connected to the original M-Bus master to the connectors MBI1 and MBI2 (see Section 2.3).

The second M-Bus segment is to be connected to MBUS+ and MBUS- (see Section 2.3). The MBUS-REP is able to supply this new bus segment with up to 125, 250 or 500 UL (unit loads).

Connect the power supply connectors 24 VDC and 0 VDC to a suitable power supply.

2.6 Specific troubleshooting

In case the MBUS-REP does not work as described in this document, it is useful to locate the malfunction in order to resolve the issue and to recover the full functionality again.

2.6.1 The device does not respond.

⚠ Only trained and appropriately qualified personnel are allowed to check the electric power supply (see Section 1.2.2).

The device does not respond after powering on. The current consumption is about 0 mA.

Check the power supply:

- Is there a voltage of about 24VDC between the connectors 24VDC and 0VDC?
- Is there a voltage of about 40VDC between the connectors MBUS+ and MBUS-?
- Is there a voltage of about 20-40 VDC between the connectors MBI1 and MBI2?

If errors could not be eliminated, please contact our customer support:
E-Mail: support@solvimus.de
Phone: +49 3677 7613065

2.6.2 The existing master is unable to read the connected meters.

⚠ Only trained and appropriately qualified personnel are allowed to check the electric power supply (see Section 1.2.2).

2.6.2.1 Checking the M-Bus slave interface

Check if the bus voltage between MBI1 and MBI2 is 20-40 VDC. If it is considerably lower, the bus should be disconnected and checked again. Also, the current consumption of the slave interface between MBI1 and MBI2 should be measured. The value should be inferior to 10 mA.

2.6.2.2 Checking the M-Bus master interface

Check if the collision LED is flashing red. If so, an overload of the interface is detected. Possible causes are:

- Short circuit between MBUS+ and MBUS-: In this case disconnect all M-Bus wires. The collision LED should be off now.
  - If not, the interface is faulty.
  - If it is, then the voltage on the M-Bus should be checked as explained in Section 2.6.1. If it is in the indicated range, you can try to delimit the cause by connecting individual wires.
- Too many meters connected: the quantity of unit loads that can be connected depends on the Repeater hardware. Check the meters and their quantity. A meter may require more than one unit load.

If errors could not be eliminated, please contact our customer support:
E-Mail: support@solvimus.de
Phone: +49 3677 7613065

2.7 Technical data

2.7.1 General specifications

2.7.1.1 Dimensions/Mass

The devices have the following dimensions and the following mass:

- Width: 54 mm
- Height: 90 mm
- Depth: 60 mm
- Mass: approx. 130 g

2.7.1.2 Mounting

The device is intended for mounting in a control cabinet or a distribution board:

- Temperature range for operation: 0..50 °C (daily average); -20..70 °C (short-time)
- Temperature range for transport and storage: -20..70 °C
- Air humidity: 0..95 % relH, non-condensing
- Degree of protection: IP30 (IEC 60529)

The device is intended for installation on a DIN rail 35 mm with top hat profile (so-called „top hat rail“; IEC 60715). To this end, the device is equipped with moveable profile elements („snap-in noses“) which are located on the back of the housing when installed.

Mounting:

- Hinge the device on the rail with its upper section. Hold the device in an inclined position, the lower section points towards you.
- Exert a pressing force on the lower section of the housing, till the snap-in nose snaps on the rail.

Demounting:

- Put the tip of a flat-head screwdriver in the opening of the snap-in nose.
- Pull the snap-in nose out of the housing.
- Incline the device.
- The device can now be removed from the rail.

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2.7.2 Electrical specifications

2.7.2.1 Power supply

The device is powered by an external power supply (pin assignment see Section 2.3):

- Voltage: 12..36 VDC
- Screw terminals ($\leq$2.5 mm^2, tightening torque 0.5..0.6 Nm)
- Power consumption: <1 W (idle state), max. 40 W
- Safety: reverse polarity protected M-Bus, overvoltage protection (transients), protection class III (IEC 61140), electronic resettable fuse
- Peak inrush-current: approx. 4 A

2.7.2.2 Meter interfaces

The device comes with an M-Bus slave interface and an M-Bus master interface (pin assignment see Section 2.3):

- M-Bus master: compliant to EN 13757-2, Umark=40 V, Uspace=27 V, screw terminals ($\leq$2.5 mm^2, tightening torque 0.5..0.6 Nm)
  - max. 125 unit loads (UL) for MBUS-REP125
  - max. 250 unit loads (UL) for MBUS-REP250
  - max. 500 unit loads (UL) for MBUS-REP500
  - Max. current rating permanent: 1500 mA
- M-Bus slave: compliant to EN 13757-2, current consumption approx. 3 mA (2 UL), screw terminals ($\leq$1.5 mm^2, tightening torque 0.5..0.6 Nm)
- Baud rate: 300..9600 bps

2.7.3 Further specifications

2.7.3.1 Galvanic isolation

M-Bus master and M-Bus slave are galvanically isolated:

- Galvanic isolation: 1000 V

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3 Accessory

The solvimus GmbH recommends the external power supply PHOENIX CONTACT STEP-PS/1AC/24DC/1.75, article number of the solvimus GmbH: 103960.

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