SOLVIMUS
METERING SOLUTIONS

MBUS-M13
M-Bus-Master
OEM-Module

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Authors:
Remo Reichel, Frank Richter
solvimus GmbH
Ratsteichstr. 5
98693 Ilmenau
Germany

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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 Placing on the market

Manufacturer of the MBUS-M13 is the solvimus GmbH, Ratsteichstraße 5, 98693 Ilmenau, Germany.

1.2.2 Copyright protection

1.2.3 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

1.2.4 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 on the part of solvimus GmbH. Please send any requests for a modified or new hardware or software configuration to solvimus GmbH.

1.2.5 Exclusion of liability

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

The solvimus GmbH accepts no liability 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.

1.2.6 Disclaimer

All products, company names, trademarks and brands are the property of their respective holders. Their use serves only to describe and identify the respective company, product or service. Use of them does not imply any affiliation with, commercial relationship with or endorsement by them.

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.
e. g.: *Value*

1.5 Number notation

Numbers a noted 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.
- Study the instructions for the extinction of fire in electrical installations.
- The power supply must be switched off before replacing components and modules.

If the contacts are deformed, the affected 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.
- 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 Scope

This documentation describes the device manufactured by solvimus GmbH, Ilmenau, and stated on the title page.

1.8 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
CSV	Character-Separated Values

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Table 2 – *Continued from previous page*

Abbreviation	Meaning
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
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
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
PAP	Password Authentication Protocol
PEM	Privacy Enhanced Mail
PID	Product ID
PIN	Personal Identification Number
PKI	Public Key Infrastructure

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Table 2 – *Continued from previous page*

Abbreviation	Meaning
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
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
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 module MBUS-M13 and its variants are compact M-Bus (Meter-Bus) masters. It serves the power supply of the connected slaves and also the communication with them.

When handling the module MBUS-M13 observe the instructions regarding ESD in Chapter 1.

Especially in the scope of smart metering, the M-Bus is used for automated meter reading.

Additional information on the M-Bus can be found here:

http://www.m-bus.com/

2.2 Structure of the module

The module MBUS-M13 and its variants are populated single-sided. Pin headers with a spacing of 2.54 mm respectively the corresponding pads serve for the connection.

The following figure shows the module:

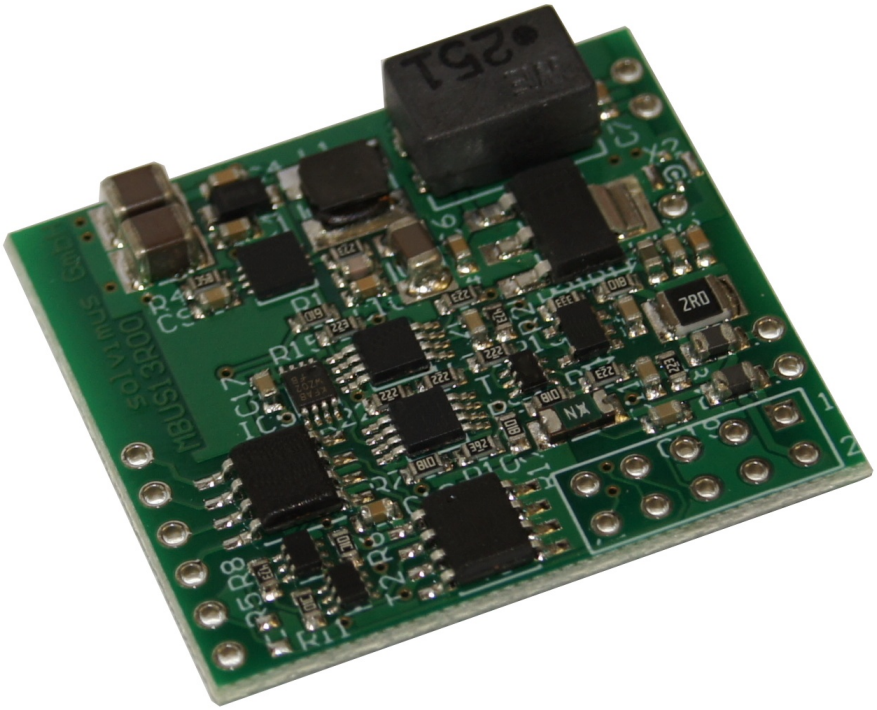

Figure 1: The module MBUS-M13

The module integrates all necessary components for the operation of the M-Bus. The internal power supply generates the bus voltages 24 V and 36 V, as well as 3.3 V for driving an external logic (e.g.: a microcontroller).

2.3 Delivery variants

There are three variants available.

The variant MBUS-M13-S is the standard variant. It serves as a fully integrated M-Bus master and level converter. The connection of the control logic is realized by using a simple TTL UART interface, which is galvanically isolated from the bus potential. The connection is established through the pads (pins) at the edge of the module.

The variant MBUS-M13-G has no unit for galvanic isolation. It is suitable for simple systems. The connection is established through the connector X1.

The variant MBUS-M13-M has no internal 3.3 V power supply and no galvanic isolation. The connection is established exclusively through the connector X1.

In the variants -S and –G, the internal 3.3 V power supply can also be used for direct connection of small logic modules (e.g.: a microcontroller with LCD display). In that way, certain compact applications such as a gateway or a data logger only need a single 24 VDC.

- ✔ The internal 3.3 V supply can handle loads with a maximum current consumption of 50 mA.

Variant	Article number
MBUS-M13-S	500325
MBUS-M13-G	500327*
MBUS-M13-M	500328*

*Available upon request

Table 3: Delivery variants

- ✔ Variants with population are available upon request.

2.4 Connectors

The module MBUS-M13 is connected via pin headers with a spacing of 2.54 mm. The following figure shows a top view:

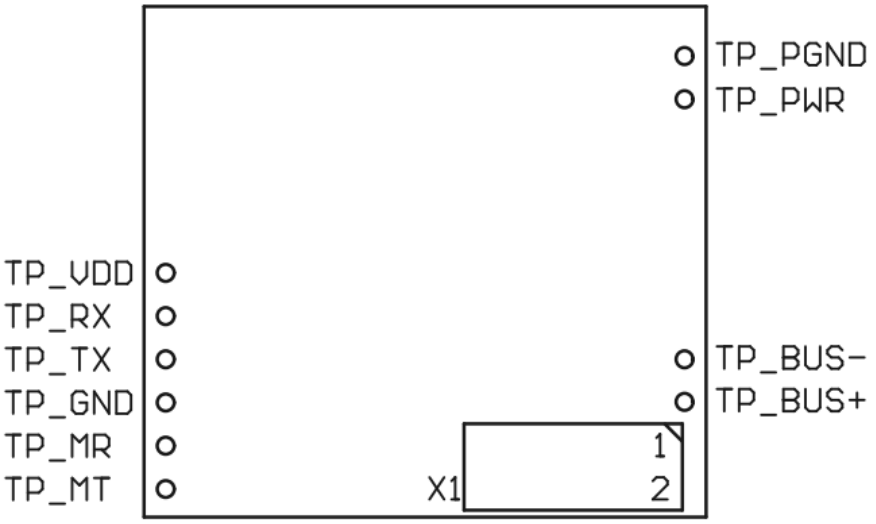

Figure 2: Top view on MBUS-M13 with connectors

The function of each pin will be explained in following tables.

2.4.1 Terminals at the edge for pin headers

Terminal	Description	-S	-G	-M
TP_VDD	galvanically isolated logic, supply 3,0 V...5,0 VDC	VDDiso	nc	nc
TP_RX	galvanically isolated logic, UART Receiver (to RX)	RXiso	nc	nc

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Table 4 – *Continued from previous page*

Terminal	Description	-S	-G	-M
TP_TX	galvanically isolated logic, UART Transmitter (from TX)	TXiso	nc	nc
TP_GND	galvanically isolated logic, supply (ground)	GNDiso	nc	nc
TP_MR	do not connect	nc	nc	nc
TP_MT	do not connect	nc	nc	nc
TP_PGND	M-Bus-side power supply, Ground (0 VDC)	GND	nc	nc
TP_PWR	M-Bus-side power supply (24 VDC)	24 VDC	nc	nc
TP_ANT	do not connect	nc	nc	nc
TP_BUS-	M-Bus, low-side	M-Bus-	M-Bus-	M-Bus-
TP_BUS+	M-Bus, high-side	M-Bus+	M-Bus+	M-Bus+

Table 4: Function of the terminals for the pin headers

2.4.2 Connector X1

Pin	Designation	Description	-S	-G	-M
1	MB+	M-Bus, high-side	nc	nc	M-Bus+
2	MB-	M-Bus, low-side	nc	nc	M-Bus-
3	VCC	power supply 3.3 VDC	nc	VDD	VDD
4	24V	power supply 24 VDC	nc	24 VDC	24 VDC
5	GND	power supply, Ground	nc	GND	GND
6	#COL	collision interrupt (see Section 2.6.2)	#COL	#COL	#COL
7	WRX	do not connect	nc	nc	nc
8	WTX	do not connect	nc	nc	nc
9	RX	UART Receiver (to RX)	nc	RX	RX
10	TX	UART Transmitter (from TX)	nc	TX	TX

Table 5: Pin assignment of the connector X1

2.4.3 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.

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):

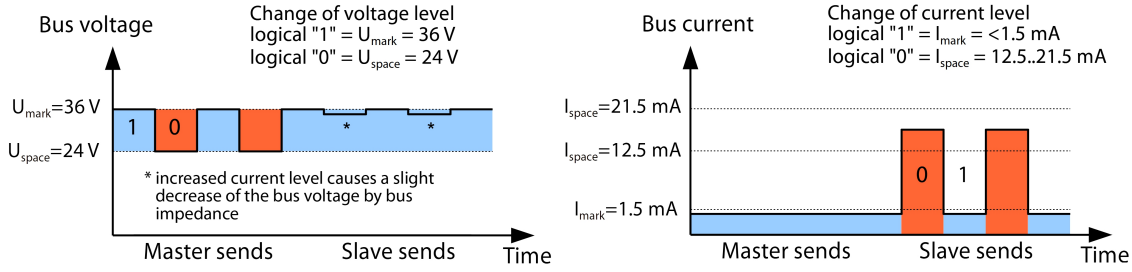


Figure 3: Signalling on the M-Bus

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).

Continued on next page

Table 6 – *Continued from previous page*

Term	Description
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.
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 Technical data

2.5.1 General specifications

Dimensions

The following drawing shows the dimensions of the module:

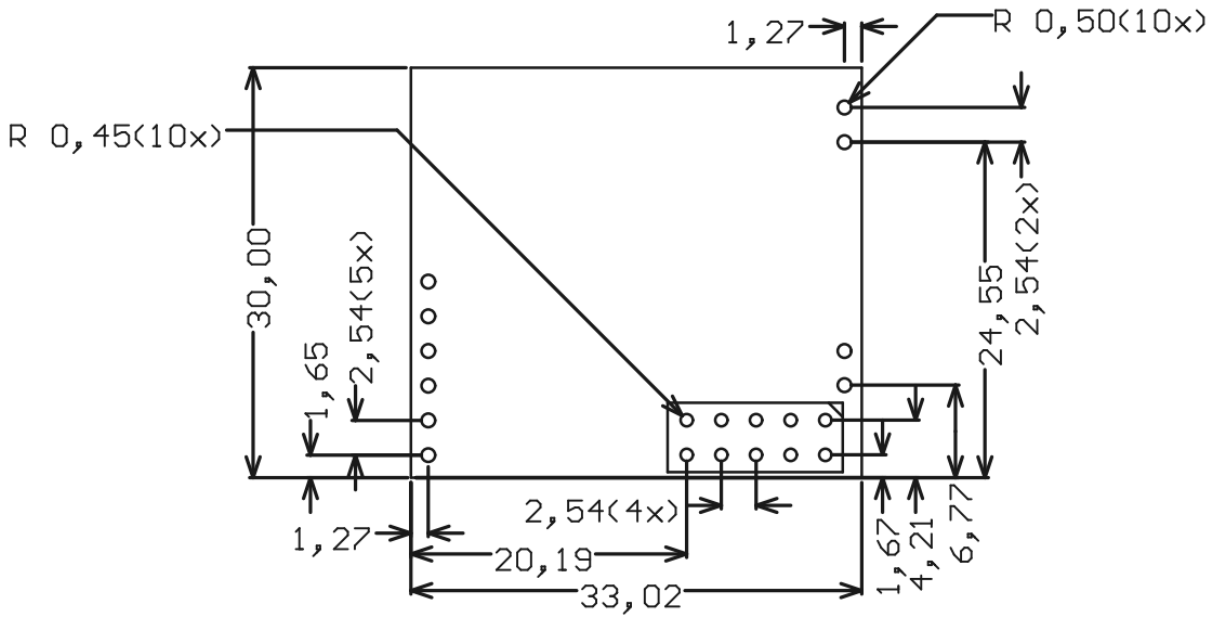


Figure 4: Dimensions and position of pads of MBUS-M13 (values are in mm)

Dimensions (without pin headers): 30 mm x 33 mm x 6.5 mm

Mounting

The device is intended for THT mounting.

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

2.5.2 Electrical specifications

Parameter	Value
Power supply	21.6..24.5 VDC (24VDC, +2/-10%)
Current consumption in idle state (without bus load)	approx. 27 mA
Power consumption in the idle state (without bus load)	<0.7 W
Power dissipation of internal power circuit (at maximum bus load)	<1.3 W
Voltages M-Bus	24 V (space) and 36 V (mark)
Current rating M-Bus	150 mA (approx. 60 unit loads)
Short circuit protection M-Bus	PTC resettable fuse at MB+
Trip point of resettable fuse (at 25°C ambient temperature), theoretical values according to the data sheet (without taking the internal impedance of the module into account)	approx. 900 ms @ 360 mA, approx. 450 ms @ 440 mA, approx. 220 ms @ 530 mA, approx. 50 ms @ 3300 mA
Reset behaviour of fuse (at 25 °C ambient temperature)	approx. 2.5 s @ 36 mA
Power supply for logic (isolated side, variant -S only) (TP_VDD)	3.0...5.0 VDC
Power supply for logic (non-isolated side) at X1 (VCC)	3.3 VDC
Current rating of logic power supply (variants -S and -G) at X1 (VCC)	50 mA
Internal pull-up pin #COL at X1 (to VCC, non-isolated part)	1 kΩ
Current rating pin #COL at X1 (sink current)	10 mA
Max. baud rate	19200 bps
Galvanic isolation (variant -S only)	1 kV
Peak inrush-current momentarily for <1 µs	>3 A

Table 7: Electrical specifications

2.6 Typical application scenarios

The module MBUS-M13 is an M-Bus master. In detail, it is a physical level converter, allowing the communication between a serial UART interface (TTL) and M-Bus slaves.

2.6.1 Wiring diagrams

The following examples give a brief overview on how to connect the module. It should be noted that the nomenclature is chosen according to typical interface transceivers (such as MAX232). *TX* is therefore *TXin*, data transmitted from the logic to the bus, and *RX* is *RXout*, data received from the bus to the logic.

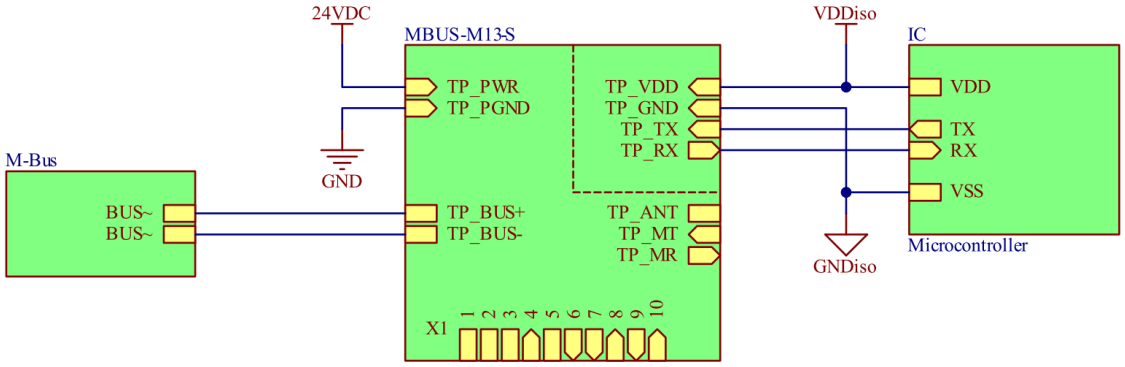


Figure 5: Variant MBUS-M13-S with galvanically isolated interface to external logic

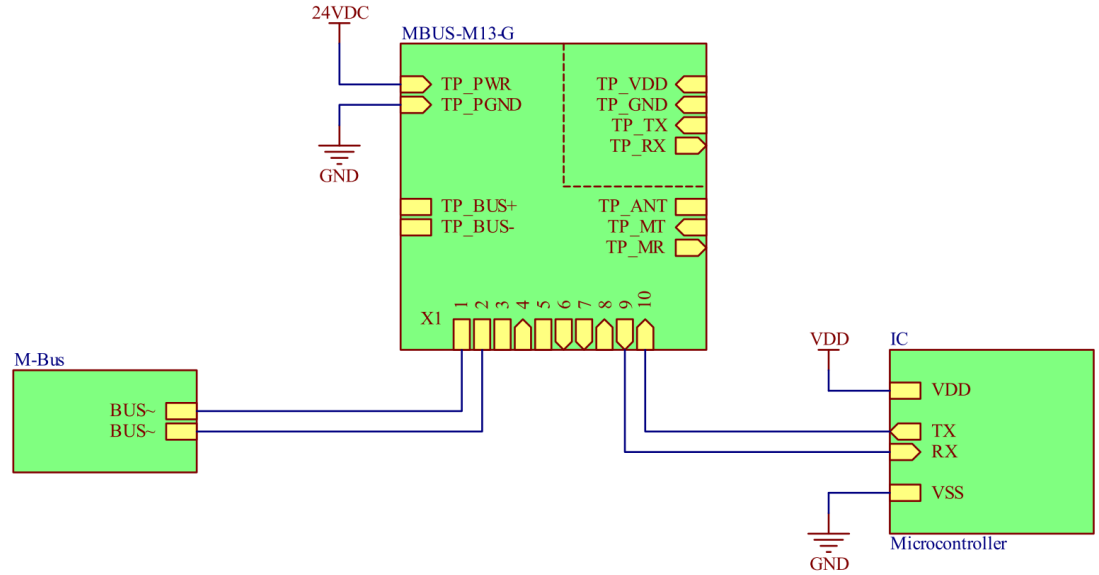


Figure 6: Variant MBUS-M13-G with direct connection to external logic

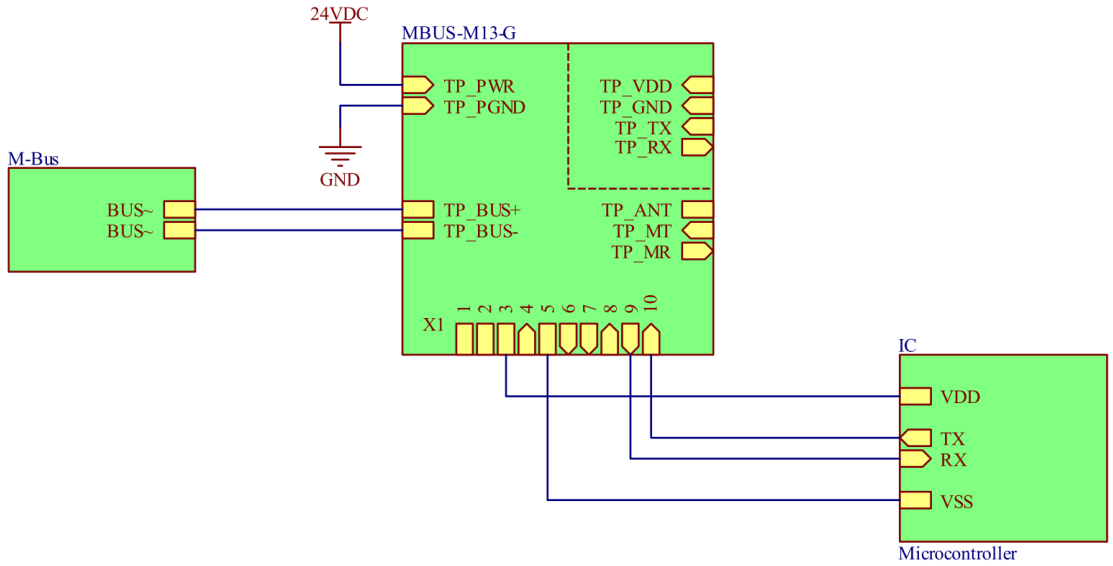


Figure 7: Variant MBUS-M13-G powering the external logic (3.3 VDC) on its own (max. 50 mA)

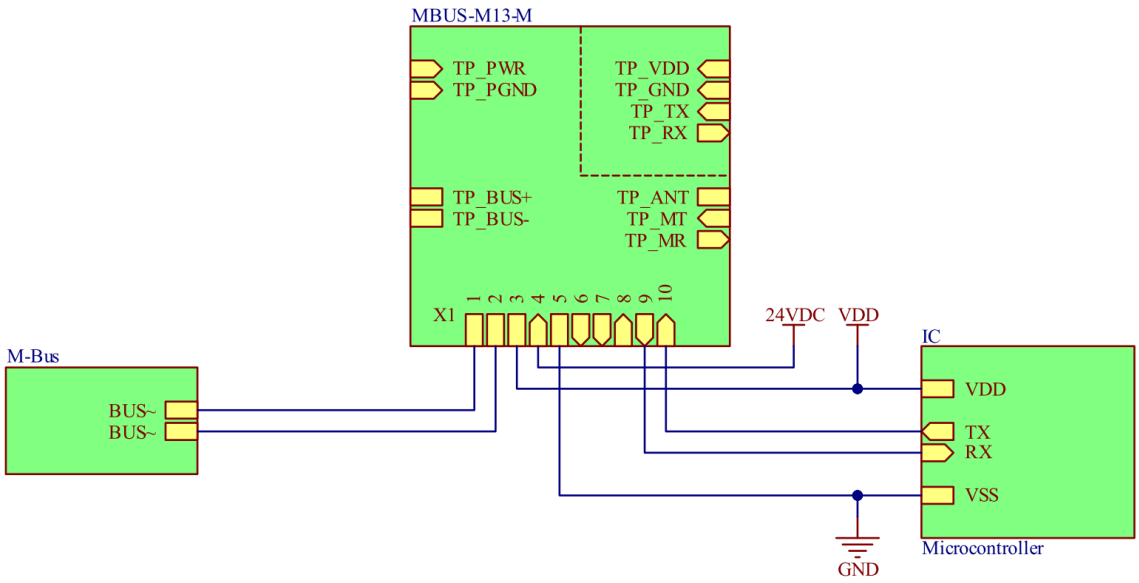


Figure 8: Variant MBUS-M13-M with exclusive usage of X1

2.6.2 Reference circuit with collision indication and EMC precautions

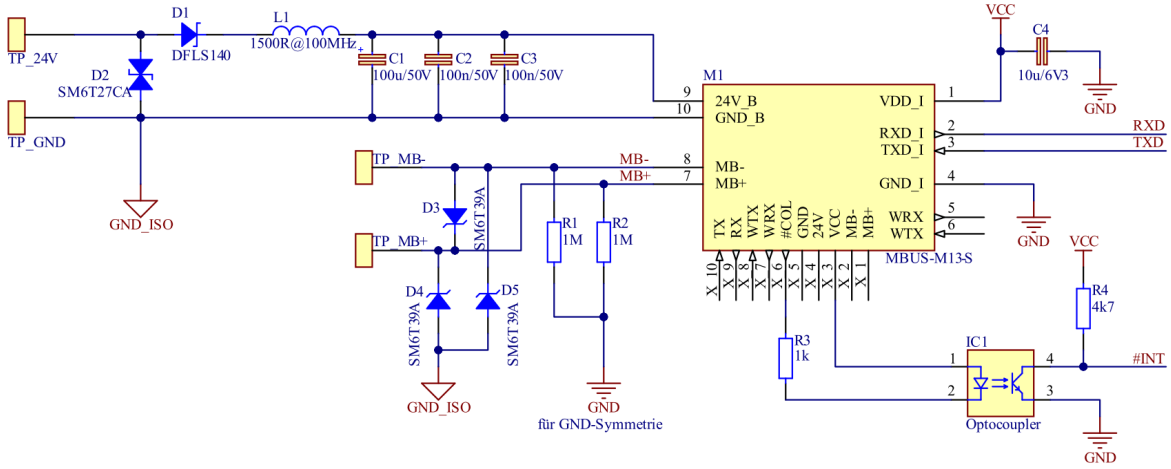


Figure 9: Reference circuit for MBUS-M13-S

2.6.3 Timing and performance diagrams

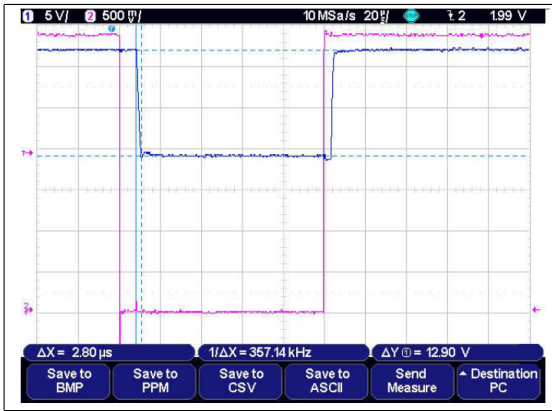
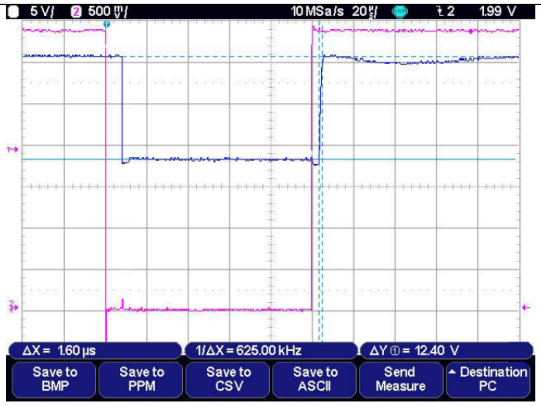
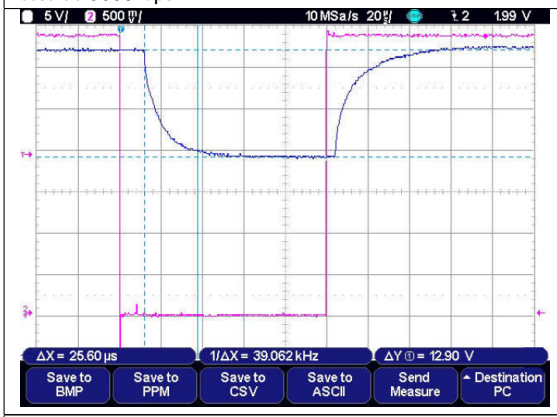
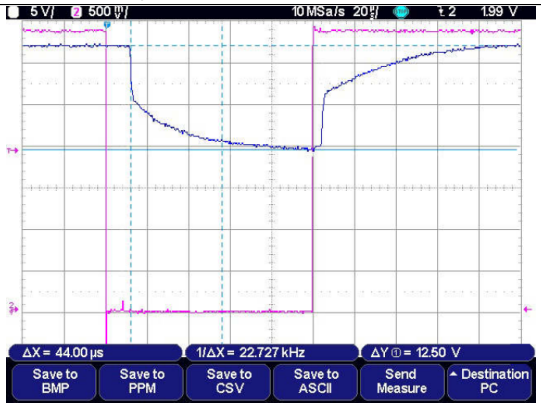
	
Bus voltage (blue) at the transition of the TXD signal (purple) on a load of 10 kΩ between the bus terminals, test at 9600 bps	Bus voltage (blue) at the transition of the TXD signal (purple) on a load of 200 Ω between the bus terminals, test at 9600 bps
	
Bus voltage (blue) at the transition of the TXD signal (purple) on a load of 10 kΩ and 1 µF between the bus terminals, test at 9600 bps	Bus voltage (blue) at the transition of the TXD signal (purple) on a load of 10 kΩ and 2.2 µF between the bus terminals, test at 9600 bps

Table 8: Oscillogram of signal transitions

Condition →		10 kΩ	200 Ω	10 kΩ || 1 µF	10 kΩ || 2.2 µF
Parameter	**Unit**				
Bus voltage high	V	36.8	35.6	36.8	36.8

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Table 9 – *Continued from previous page*

Condition →		**10 kΩ**	**200 Ω**	**10 kΩ || 1 µF**	**10 kΩ || 2.2 µF**
Bus voltage low	V	24	23.6	24.1	24.3
Fall time	µs	<3	<1	approx. 45	approx. 60
Rise time	µs	<3	<3	approx. 25	approx. 45
Delay at falling edge (approx.)	µs	8	8	12	12
Delay at rising edge (approx.)	µs	4	4	4	4

Table 9: Conditions and results of performance measurements