USER MANUAL

METIS-I WIRELESS M-BUS

AMB8426-M / 2605041183000

VERSION 3.4

MAY 22, 2023

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****

MUST READ

Check for firmware updates

Before using the product make sure you use the most recent firmware version, data sheet and user manual. This is especially important for Wireless Connectivity products that were not purchased directly from Würth Elektronik eiSos. A firmware update on these respective products may be required.

We strongly recommend to include in the customer system design, the possibility for a firmware update of the product.

Revision history

Manual version	FW version	HW version	Notes	Date
3.0	2.6.0	5.2	• New corporate design and structure • Added some new chapters and removed irrelevant and redundant information • Switched over to product specific manuals	November 2018
3.1	2.6.0	5.2	• Added chapter `Reference design` • Added chapter `Information for explosion protection`	March 2019
3.2	2.6.0	5.2	• Corrected description of memory address of user setting `CFG_Flags` • Corrected length field in chapters `CMD_FACTORYRESET_REQ`, `CMD_CLR_AES_KEY_REQ` and `CMD_SERIALNO_REQ` • Updated label in chapter `General labeling information` • Updated address of Division Wireless Connectivity & Sensors location	October 2019

3.3	2.6.0	5.2	• Updated the firmware update chapter. • Removed 2605041183009 from chapter `Ordering information` as there are no longer pre-cuts available. The modules are available in all quantities as cut tape. • Corrected sleep current in chapter `Electrical specifications`.	June 2020
3.4	2.6.0	5.2	• New corporate design and meta data.	May 2023

⋆ For Metis-I firmware history see chapter `Firmware history`

Abbreviations

Abbreviation	Name	Description
ALA	Application Layer Address	Aplication layer meter addresses in the wM-BUS frame, optional
Block1	first block of EN 13757-4 frame	Is always 10 bytes long, contains L field, C field and 8 byte LLA address
CS	Checksum	XOR checksum to check the correct transmission of the previous Bytes of the UART communication protocoll
CRC16		EN 13757-4 compliant checksum (2 byte)
DC	Duty cycle	Transmission time in relation to one hour duration. 1% means, channel is occupied for 36 seconds per hour by the sending device
Downlink		Transmission direction, i.e. when direction "other to meter" is intended
FSE	Field Sales Engineer	Support and sales contact person responsible for limited sales area
HIGH	Logic High signal level	Signal level equals VCC
LLA	Link Layer Address	Link layer meter addresses in the wM-BUS frame, required
L field	EN13757-4 length field	first byte of block1
LOW	Logic Low signal level	Signal levels equals 0 Volts
LPM	Low power mode	Operation mode for reduced power consumption
LSB	Least significant byte	
MSB	Most significant byte	
RF	Radio frequency	Describes everything relating to the wireless transmission.
SFD	Start frame delimiter	Start byte of a frame for the command interface.
SMGW	Smart meter gateway	Gateway receiving wM-BUS frames, wM-BUS role "other"
UART	Universal asynchronous receiver transmitter	The UART allows a communication of a host with the Metis-I module using a communication protocol
T&R		Tape and reel packaging with a minimum order quantity
Uplink		Transmission direction, i.e. when direction "meter to other" is intended

US	UserSettings	Non-volatile but changeable module configuration parameters
wM-BUS	wireless M-BUS	EN 13757 -3 and -4 standards

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Contents

Overview of helpful application notes

Application note ANR008 - Wireless Connectivity Software Development Kit

http://www.we-online.com/ANR008

To ease the integration of the Würth Elektronik eiSos radio modules into an application, Würth Elektronik eiSos offers the corresponding Software Development Kit (SDK) for most commonly used host processors. This SDK contains drivers and examples in C-code to communicate with the corresponding radio module. This application note shows which SDKs are available and describes how to download and use them.

Application note ANR010 - Range estimation

http://www.we-online.com/ANR010

This application note presents the two most used mathematical range estimation models, Friis and two ray ground reflection, and its implementation in the range estimation tool of the RED-EXPERT.

1 Introduction

For being able to understand this manual, using wireless M-BUS modules and USB dongles it is highly recommended to read the EN13757-3 and -4 in their most recent released version. This knowledge is required for creating and understanding wireless M-BUS compliant data, frame structures, radio configuration and communication schemes.

1.1 Operational description

The Metis-I is a radio module for wireless communication using the wM-Bus standard between devices such as meters and smart meter gateways. It complies with the requirements of EN13757 and can be used where ever radio communication in a metering background following the wireless M-BUS standard is required.

All Metis modules support the 868 MHz Band used in wM-BUS. That means S, T and C modes are supported with their corresponding sub-modes.

Wireless M-BUS is a quite complex standard which is not suitable to be used without understanding the standard itself. EN13757-3 and EN13757-4 are essential to be read and understood by users of wireless M-BUS modules in order to be able to operate these modules in the compliant way.

> The module performs checks on wM-BUS compliance (after EN13757-3:2013) and discards non compliant frames without any notification towards the host.

> This wireless M-BUS modules and USB dongles will enable you to read the raw radio data. This data does usually contain an encrypted payload which itself contains one or multiple coded meter reading values. Further steps are required to parse this raw data and gain human readable values out of a decrypted payload.

1.2 Block diagram
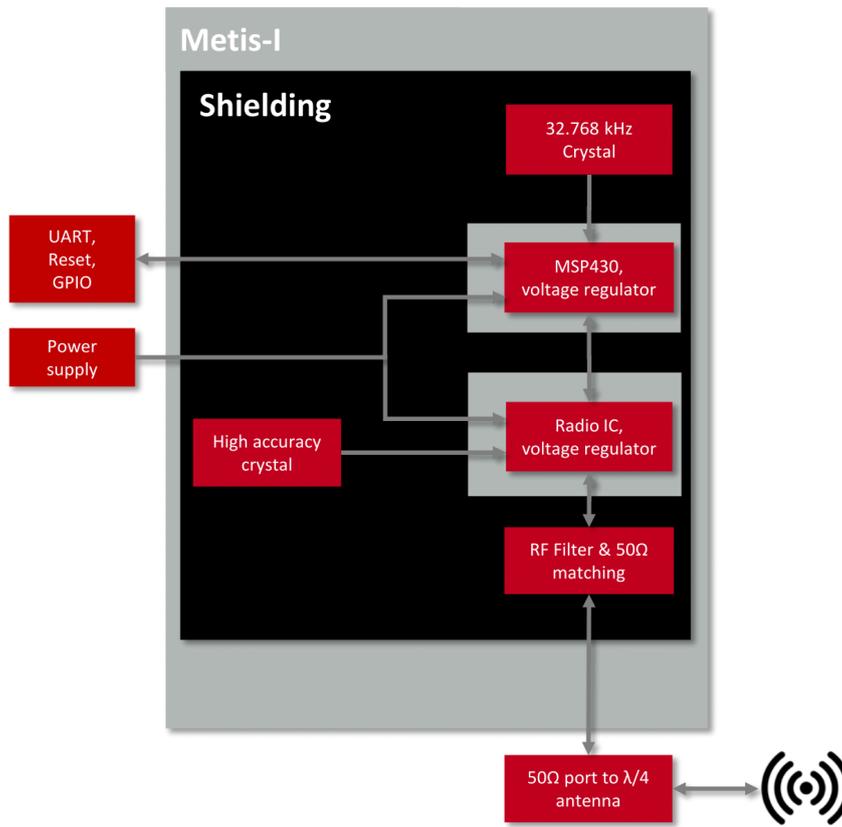
Figure 1: Block diagram of the Metis-I module

1.3 Ordering information

WE order code	Former order code	Description
2605041183000	AMB8426-M-TR	868 MHz wM-BUS module 10dBm, T&R
2605056083001	AMB8465-M	868 MHz wM-BUS USB stick, integrated chip antenna
2605049283001	AMB8426-M-EV	Evaluation kit for Metis-I module

Table 1: Ordering information

2 Electrical specifications

As not otherwise stated measured on the evaluation board Metis-I-EV terminated unused module pads and 50 Ω conducted.

2.1 Recommended operating conditions

Description	Min.	Typ.	Max.	Unit
Ambient temperature	-40	25	85	℃
Supply voltage (VDDS)	2.2	3.0	3.6	V

Table 2: Recommended operating conditions, Metis-I

2.2 Absolute maximum ratings

Description	Min.	Typ.	Max.	Unit
VCC	-0.3		3.9	V
Output RF level		11		dBm
Input RF level			10	dBm

Table 3: Absolute maximum ratings, Metis-I

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2.3 Power consumption

> The transmit and receive currents are depending on the impedance matching, and therefore may vary depending on antenna selection and matching.

> **STOP** A stable power supply is indispensable to ensure valid operating conditions for the module. Releasing the */RESET* pin before the VCC is stable may damage the module permanently.

> **STOP** A stable power supply and proper antenna design and matching is indispensable to achieve the stated radio characteristics.

2.3.1 Static

The stated current consumption is the sum of the CPU current and the radio current, depending on the active radio mode.
Conditions: Metis-I-EV with T = 25 °C, VCC = 3.3 V, terminated unused module pads and 50 Ω conducted.

Description	Typ.	Unit
TX current, 10 dBm output power	38	mA
RX current	24	mA
Low power (LPM3), radio off, UART via ACLK	0.3	µA

Table 4: Power consumption, Metis-I

2.4 Radio characteristics

The radio characteristics of wireless M-BUS products are specified by EN13757-4:2013 and were implemented in a standard compliant way into the Metis-I firmware.
Conditions: Metis-I-EV, T = 25 °C, VCC = 3.0 V, terminated unused module pads, 50 Ω conducted
The stated best RX sensitivity is linked to the stated "Min" data rate.

Description	Min	Typ.	Max	Unit
Frequency band	868.3		869.525	MHz
Data rate	16.384		100	kbps
Best RX sensitivity			-103	dBm
TX power	-5	7	11	dBm

Table 5: Radio characteristics, Metis-I

2.5 Pin characteristics

Conditions: T = 25 °C, VCC = 3.0 V

Property	Min	Typ.	Max	Unit
GPIO maximum current per pin		6		mA
GPIO maximum current over all		48		mA
Internal pull-up resistor	20	35	50	kΩ
Internal pull-down resistor	20	35	50	kΩ

Table 6: Pin characteristics, Metis-I

2.6 Integrated flash characteristics

The integrated flash memory has only a limited number cycles. This number of flash cycles has a guaranteed min. value of 10000 and a typical value of 100000.
Hosts shall implement methods to prevent their applications from excessively using flash cycles. This can be achieved by always performing a `CMD_GET_REQ` before any `CMD_SET_REQ` and other command that uses flash cycles.

3 Pinout

For the footprint information needed for the design-in please refer to chapter `18.4`.

Antenna — 1	23 — GND
GND	RESERVED
VCC	TX_IND
UTXD	RX_IND
URXD	/RESET
/RTS	
/CTS	RESERVED
DATA_IND	TEST
RESERVED	MOD_SEL3
RESERVED	MOD_SEL2
RESERVED	MOD_SEL1
RESERVED — 12	13 — MOD_SEL0

Figure 2: Pinout (top view)

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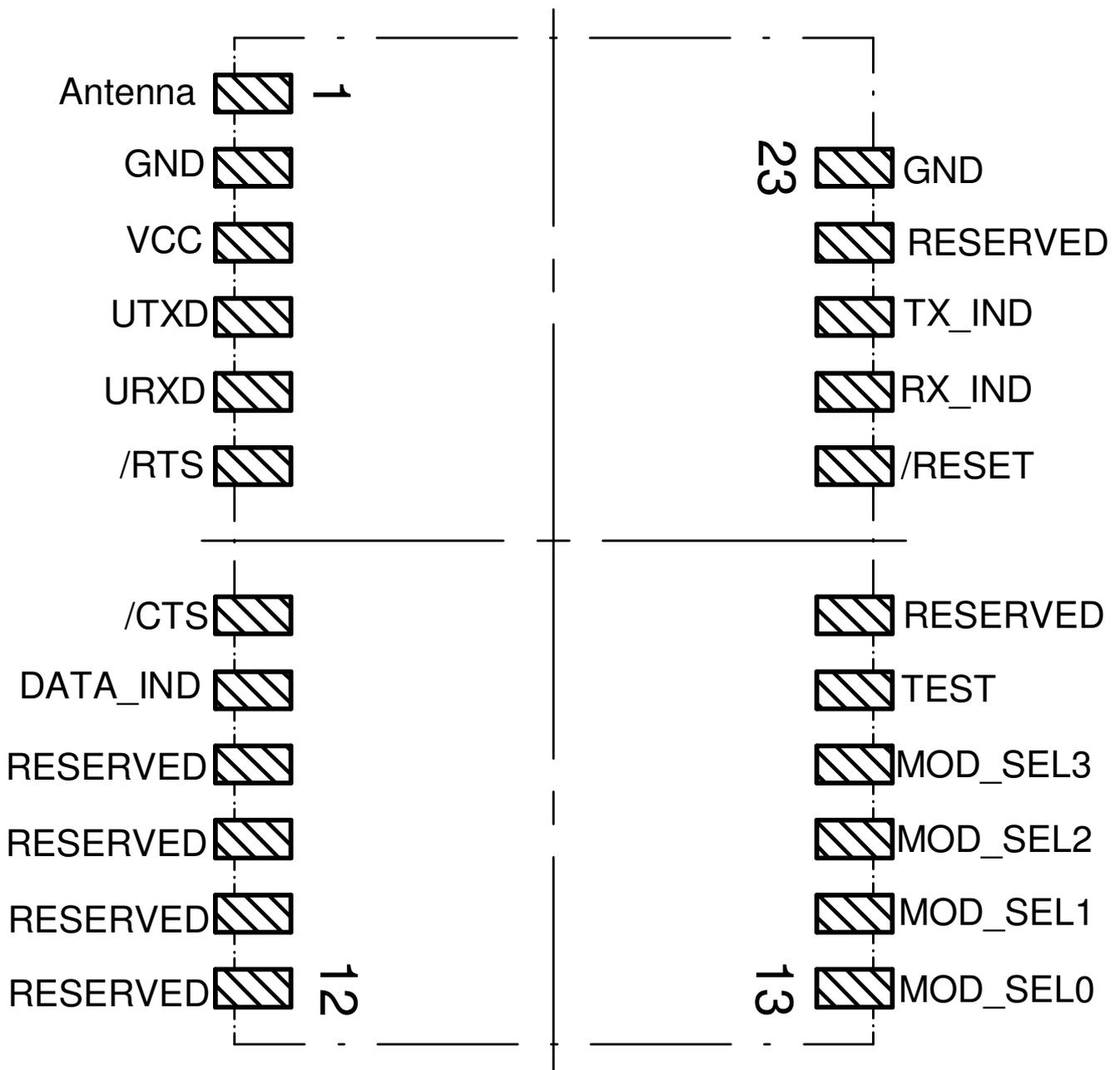
No	Designation	I/O	Description
1	*ANT*		Antenna connector 50Ω
2	*GND*	Supply	Ground
3	*VCC*	Supply	Supply voltage
4	*UTXD*	Output	UART (module transmit)
5	*URXD*	Input	UART (module receive)
6	*/RTS*	Output	Indicates that the module is busy when HIGH.
7	*/CTS*	Input	*/CTS* flow control pin. Can be enabled in UserSettings. Connect to *GND* disabled.
8	/Data_IND	Output	Data indication towards host. Do not connect if not needed.
9	Reserved	I/O	Reserved. Internal pull-down. Do not connect.
10	Reserved	I/O	Reserved. Internal pull-down. Do not connect.
11	Reserved	I/O	Reserved. Internal pull-down. Do not connect.
12	Reserved	I/O	Reserved. Internal pull-down. Do not connect.
13	MOD_SEL0	Input	Obsolete. Internal pull-down. Do not connect.
14	MOD_SEL1	Input	Obsolete. Internal pull-down. Do not connect.
15	MOD_SEL2	Input	Obsolete. Internal pull-down. Do not connect.
16	MOD_SEL3	Input	Obsolete. Internal pull-down. Do not connect.
17	TEST	Debug	Debug pin. Do not connect.
18	Reserved	I/O	Reserved. Internal pull-down. Do not connect.
19	*/RESET*	Input	See chapter `9.1.1`). Uses internal pull-up. LOW level holds module in reset state.
20	*RX_IND*	Output	Indicates RF data reception signaled by HIGH.
21	*TX_IND*	Output	Indicates RF data transmission signaled by HIGH.
22	Reserved	I/O	Reserved. Internal pull-down. Do not connect.
23	*GND*	Supply	Ground

Table 7: Pinout

4 Quickstart

4.1 Minimal pin configuration

In factory state the module is immediately ready for operation. The following pins are required in the minimal configuration:

/RESET, *VCC*, *GND*, *UTXD*, *URXD*, */RTS* and *ANT*.

If the module is to be connected to a PC a converter cable or IC (e.g. 3.3 V TTL to USB) is necessary to achieve interface compatibility. The Metis-I-EV already implements such a USB converter to be directly connected to a PC.

> Not interpreting the */RTS* line of the module as described in this manual may cause undefined behavior and data loss.

4.2 Power up

Recommended procedure for starting the module into normal operation:
After supply voltage is applied to the module, the */RESET* pin shall be hold to LOW level for another Δt of at least 1 ms after the *VCC* is stable to ensure a safe start-up.
Due to DCO calibration a startup may require a duration of up to 1000 ms.
If the module is used on a battery-powered system, using a matching reset-IC (or a discrete block for an according delay) it is highly recommended to ensure a stable module power up and ensures a safe behavior towards a battery getting empty.

> Applying a reset (e.g. a host temporarily pulling the */RESET* pin down for at least 1 ms and releasing it again) after the VCC is stable is also sufficient.
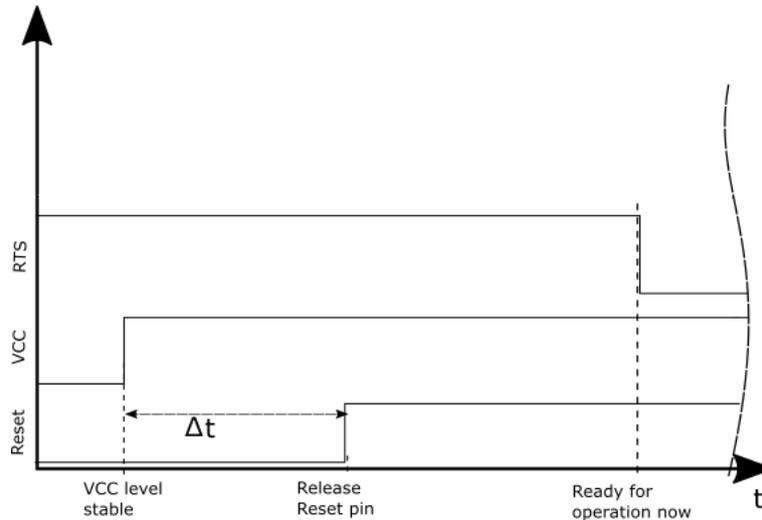
4.3 Quickstart example

Connect the two devices (modules, EV-boards or USB dongles) to a PC. You may need to install *FTDI* VCP drivers manually or by using windows update. A minimum distance of 2 meters between the two devices shall be kept at all time to avoid overmodulation of the receiver.

A terminal program, for example *hterm*, is used to perform the communication via COM ports. The two corresponding COM ports have to be selected and opened with a default configuration of 9600 Baud, 8 data bits, 1 stop bit and parity set to none (8n1).

Make sure the received data is shown also as "hex" by enabling the corresponding checkbox:

By default, the wireless M-BUS mode is S2 mode (`Mode_Preselect=0x03`), which means that S1-m and S2 mode frames can be received and S2 mode frames can be sent.

Sending and receiving a wM-BUS frame

To send a wM-BUS frame the so called transparent mode can be used. To do so, simply enter the frame into the input line of hterm. The "Type" field under input control in hterm needs to be changed from "ASC" to "HEX" before entering the first byte.

For advanced applications we encourage the user to prefer using `CMD_DATA_REQ` to request the module sending data as this command will provide a status "frame sent" or "frame not sent" with the `CMD_DATA_CNF` confirm message.

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> It is mandatory that for entering hex data the "Type: HEX" is selected in the hterm input control block.
> The default state of this field is "Type: ASC" indicated by a turquoise color background of the characters that are entered in the input line.

> The user must make sure that the frame content is wireless M-BUS compliant. See EN13757-3 and EN13757-4 for details.

In case the frame is:

0x93, 0x44, 0x79, 0x16, 0x94, 0x21, 0x42, 0x60, 0x10, 0x02, 0x8C, 0x00, 0x21, 0x90, 0x0F, 0x01, 0x2C, 0x25, 0xD7, 0x6D, 0x01, 0x00, 0x06, 0xB8, 0xB0, 0xDB, 0x18, 0x43, 0xBA, 0xD4, 0x7A, 0x21, 0x00, 0x70, 0x47, 0x10, 0xE9, 0x8A, 0x22, 0x7C, 0x34, 0x98, 0x56, 0x9F, 0x4D, 0xA1, 0xB1, 0xD8, 0x5C, 0x62, 0x56, 0xC4, 0x66, 0xC5, 0xB3, 0x6E, 0x6A, 0xB4, 0x30, 0x41, 0xB6, 0x9F, 0xA8, 0x23, 0x5C, 0xB3, 0x47, 0x21, 0x42, 0xF0, 0x99, 0x6C, 0x01, 0x93, 0x83, 0x95, 0x02, 0x27, 0xA0, 0x5E, 0x8E, 0x84, 0xD4, 0xA0, 0x2C, 0x04, 0x7E, 0x95, 0xFE, 0x47, 0x58, 0xBC, 0xFD, 0xA3, 0xBF, 0x7F, 0x9F, 0xB8, 0x50, 0x65, 0x0C, 0x95, 0x00, 0x37, 0xBC, 0xB3, 0x8A, 0x53, 0x92, 0x4E, 0x2B, 0x3D, 0x8D, 0x62, 0x9C, 0x33, 0xC6, 0x6F, 0xB5, 0xE6, 0xF6, 0x63, 0x3A, 0xC9, 0xF9, 0x39, 0x1C, 0x89, 0xE1, 0x8D, 0x80, 0x5F, 0x1A, 0x10, 0x0A, 0xC4, 0x78, 0xC2, 0x0B, 0xCB, 0x74, 0xB4, 0xBD, 0xB5, 0x27, 0x1A, 0xA9, 0x8C

It will look in hterm like this:
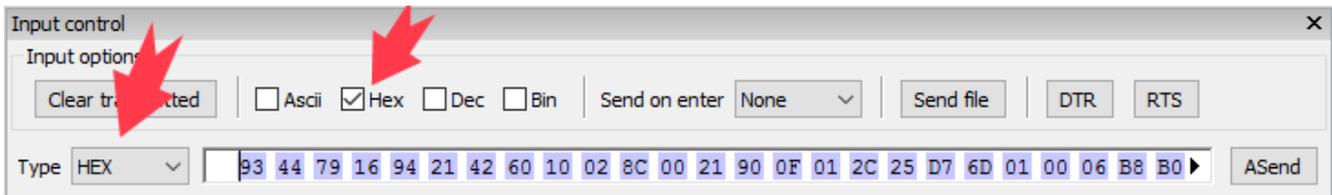
Using the "ASend" button followed by pushing the "Start" button sends the data once. The second module receiving this packet outputs the transmitted payload data.

Received Data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
93	44	79	16	94	21	42	60	10	02	8C	00	21	90	0F	01	2C	25	D7	6D	01	00	06	B8	B0	DB	18
43	BA	D4	7A	21	00	70	47	10	E9	8A	22	7C	34	98	56	9F	4D	A1	B1	D8	5C	62	56	C4	66	C5
B3	6E	6A	B4	30	41	B6	9F	A8	23	5C	B3	47	21	42	F0	99	6C	01	93	83	95	02	27	A0	5E	8E
84	D4	A0	2C	04	7E	95	FE	47	58	BC	FD	A3	BF	7F	9F	B8	50	65	0C	95	00	37	BC	B3	8A	53
92	4E	2B	3D	8D	62	9C	33	C6	6F	B5	E6	F6	63	3A	C9	F9	39	1C	89	E1	8D	80	5F	1A	10	0A
C4	78	C2	0B	CB	74	B4	BD	B5	27	1A	A9	8C														

In S2-mode the uplink and downlink radio settings are the same (i.e. 868.300 MHz and 32768 bps symbol rate with manchester coding). In case another wM-BUS-mode was selected, the suiting wM-BUS-mode must be selected on the other device, too (see table 24).

5 Functional description

5.1 System configuration parameters

The parameters that determine the functionality of the module can be organized into two categories: The non-volatile UserSettings parameters (see chapter 8) that can be modified using the `CMD_SET_REQ` command and retain their values after a power reset.

On the other hand, the volatile settings (called "RuntimeSettings") can be accessed by explicit commands and used to quickly (but temporarily) modify specific parameters without using flash cycles. These settings are only valid until a reset is performed and shall be used when frequent updates of settings are necessary.

> Please note that each `CMD_SET_REQ` will consume one flash cycle, which are limited due to the hardware.
>
> After modifying a UserSettings via `CMD_SET_REQ` a restart of the module must be performed so that the new parameter values are initialized correctly.
>
> Not performing a restart after changing any UserSetting may cause malfunctions of the module.

5.2 Configuring the radio

The Metis-I can be configured to use one of the following EN13757-4 wM-BUS modes. Please note that the chip rate of some modes is not equal to the data rate (bit rate) because of the coding.

Manchester will introduce a factor 1/2, resulting in: chip rate / 2 = data rate. 3 out of 6 coding will introduce a factor 2/3, resulting in: chip rate * (2 / 3) = data rate. In case of NRZ coding the factor is 1, resulting in chip rate = data rate.

wM-BUS Mode	Direction	Frequency [MHz]	Chip rate [kcps]	Coding
S1-m	TX only	868.300	32.768	Manchester
S2	RX	868.300	32.768	Manchester
S2	TX	868.300	32.768	Manchester
T1_meter	TX only	868.950	100	3 out of 6
T2_other	RX	868.950	100	3 out of 6
T2_other	TX	868.300	32.768	Manchester
C1_meter	TX only	868.950	100	NRZ
C2_other	RX	868.950	100	NRZ
C2_other	TX	869.525	50	NRZ
C2_T2_other	RX only	868.950	100	auto detect

Table 8: wM-BUS mode radio settings for 868 MHz

5.2.1 Transmission of frames

The following parameter(s) needs to be checked or adopted in case of sending frames to a meter or as a meter. This can be done by means of a `CMD_SET_REQ` or the configuration software ACC:

- `Mode_Preselect`: This parameter defines the mode to be used. It is sufficient to be able to communicate to any meter or SMGW. For corresponding wM-BUS mode selection see table 24.

- Perform a reset of the module using the */RESET* pin or by sending the command `CMD_RESET_REQ` to apply changes to UserSetting parameter(s).

- After updating these parameters, frames can be transmitted using the a `CMD_DATA_REQ` or the transparent mode. The minimum allowed packet length is a L field of 0x09 which represents a minimum frame containing only Block1.

5.2.2 Reception of frames

The following parameter(s) need to be checked or adopted in case of receiving frames from a meter or as a meter. For corresponding wM-BUS mode selection see table 24.

> Receiving is only possible in the modes containing a "2" in their name e.g. S2, T2_other, C2_other, C2_T2_other, F2, N2a, N2f

This can be done by means of a `CMD_SET_REQ` or the configuration software ACC:

- First, you need to look up the role (meter or other) and wM-BUS mode of the device you want to receive data from. Then take the corresponding wM-BUS mode value and role from table 24 and proceed by writing it into the `Mode_Preselect` parameter by using a `CMD_SET_REQ`.

- Perform a reset of the module using the */RESET* pin or by sending the command `CMD_RESET_REQ` to apply changes to UserSetting parameter(s).

> Please have in mind that meters are using a periodic interval to send frames, so you need to wait at least this period in order to receive a meter that is in range.
> In heavy duty environments with multiple meters, it is possible that packet collisions may happen. In this case you have to spend multiple periods to receive the expected meter.

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> ⓘ The module will perform some checks on wM-BUS compliance (EN13757-3:2013 & -4:2013) and will discard non compliant frames without notification to the host.

5.3 Recommended settings for data collectors 868 MHz

Besides the setting of the UserSetting `Mode_Preselect`, we highly recommend to perform the following steps if you desire to set up a data collector or receiver device. This settings assume unidirectional communication only (in this case: Receiver function only).
For bidirectional communication a custom firmware is required.

- Perform a `CMD_FACTORYRESET_REQ`: 0xFF1100EE

- Perform a `CMD_RESET_REQ`: 0xFF0500FA

- Your host UART needs to use 9600 Baud 8n1 UART (for the next couple steps)

- Set the `UART_CMD_OUT_ENABLE` = 1, using `CMD_SET_REQ`: 0xFF0903050101F0

- Set the `RSSI_Enable` = 1, using `CMD_SET_REQ`: 0xFF0903450101B0

- Set the UART baud rate to 115200 Baud, using `CMD_SETUARTSPEED_REQ`: 0xFF100107E9

- Set `Mode_Preselect` to the default receive mode you want to achieve.
  For S2 mode no change is required,
  for C2_T2_other (RX only mode) use `CMD_SET_REQ`: 0xFF0903460109BB

- Perform a `CMD_RESET_REQ`: 0xFF0500FA

- Now your host UART needs to use the configured UART baudrate (115200 Baud)

- The host shall not send `CMD_DATA_REQ` or transparent data to the module

> ⓘ A reset e.g. by means of a `CMD_RESET_REQ` (0xFF0500FA) is required to get the modified non-volatile UserSettings applied.
> After the reset the UART baud rate of the host must be set accordingly (in this example to 115200 Baud).

5.4 Recommended settings for meter emulation 868 MHz

Besides the setting of the UserSetting `Mode_Preselect`, we highly recommend to perform the following steps if you desire to set up a meter or emulate a meter. This settings assumes unidirectional communication only (in this case: Transmitter function only). For bidirectional communication a custom firmware is required. If the meter requires battery powered operation, refer to chapter 11 and use the special UART settings listed there.

- Perform a `CMD_FACTORYRESET_REQ`: 0xFF1100EE

- Perform a `CMD_RESET_REQ`: 0xFF0500FA

- Your host UART needs to use 9600 Baud 8n1 UART (for the next couple steps)

- Set `Mode_Preselect` to the meter sending mode you want to emulate.
  For S1-m mode use `CMD_SET_REQ`: 0xFF0903460102B0,
  for T1_meter use `CMD_SET_REQ`: 0xFF0903460105B7,
  for C1_meter use `CMD_SET_REQ`: 0xFF090346010CBE

- Set the UART baud rate to 115200 Baud, using `CMD_SETUARTSPEED_REQ`: 0xFF100107E9

- Perform a `CMD_RESET_REQ`: 0xFF0500FA

- Now your host UART needs to use the configured UART baudrate (115200 Baud)

- Use `CMD_DATA_REQ` and provide a wM-BUS compliant frame to the module in case your host wants to send data

6 Host connection

6.1 Serial interface: UART

The configuration in factory state of the UART is 9600 Baud with data format of 8 data bits, no parity and 1 stop bit ("8n1"). The baud rate of the UART can be configured by means of the command `CMD_SETUARTSPEED_REQ`.

The output of characters on the serial interface runs with low priority. For this reason, short interruptions may occur between the outputs of individual successive bytes of the same frame. The host must not implement too strict timeouts between two Bytes to be able to receive packets that have delays in between bytes.

The UART interface is low priority in comparison to the radio interface. Thus due to shared buffers the incoming radio frames will discard any UART command that is not yet completely received when a radio frame start is detected.

For the direction "host to module" the host must respect the line */RTS*, which will indicate that the next byte of the packet can be received by the module. If the line shows busy state during a UART frame the byte cannot be received and the complete UART rx buffer is discarded.

The module will automatically fill in the wireless M-BUS checksums, accordingly to the selected wM-BUS mode and frame format. A received frame will be checked for correct checksum and only be forwarded to the host if the checksums of the entire packet are correct. The checksums will be removed from the UART frame before it is sent to the host.

6.2 Transparent Mode

> ❗ It is not recommended to use the transparent mode for transmission in productive systems. The command mode should be used instead.

The transparent mode can be used to send radio frames according to the current runtime settings of the module (i.e. wireless M-BUS Mode). Per default all received frames are also put out as transparent frames.

These wM-BUS frames will start, as described in EN13757-4, with the L field giving the number of bytes to follow in the UART frame.
The transparent output will remove the wM-BUS link layer CRC from the radio packet and in case of a frame format B frame will correct its L field accordingly.

The disadvantage of this mode is that a distinct trigger byte for a new frame is not possible as it can be any valid L field (0x0A till `APP_MAXPacketLength`). So we recommend using the Command Mode for any operation towards the radio module and use 0xFF plus a timeout of at least one byte duration since the last received byte as a trigger for indications and confirms.

The module will not accept a pause in the order of a byte duration in between two bytes of a single frame, in this case all previous bytes will be discarded.

> ❗ The user must make sure that the frame content is wireless M-BUS compliant. See EN13757-3 and -4 for details and frame requirements. The module does not perform checks on the whole frame content for compliance.

One requirement is that any frame must start with "Block1" (in total 10 bytes) which consist of L field, C field and ALA address resulting in a minimum L field value of 0x09. As the 0xFF is reserved as commands start frame indicator the maximum L field supported is the lower value of 0xFE and `APP_MAXPacketLength` minus an overhead depending on the configured parameters of the UserSettings.

L field	Payload
[0x09.. `APP_MAXPacketLength`]	Payload value
1 byte	L field value bytes

Table 9: Transparent mode frame structure

When RSSI output is enabled (`RSSI_Enable` = 0x01) a 1 byte overhead is added and the structure changes to:

L field	Payload	RSSI
[0x09.. (`APP_MAXPacketLength - 1`)]	Payload value	RSSI value
1 byte	(L field value - 1) bytes	1 byte

7 The command interface

7.1 Overview

In this operating mode, the communication with the module is achieved by predefined command requests, responses and indications. These commands can be used to configure and operate the module as well as to execute special functions, trigger the transmission of frames and indicate received frames.

In this case, contrary to the transparent mode (where each telegram starts with a length byte), the telegram starts with the start frame identifier 0xFF as the first byte. This SFD is followed by the command identifier CMD, the length and the payload. The last byte transmitted in a command frame is the checksum byte. It is calculated using a XOR of all preceding bytes of this command including the SFD byte 0xFF.

Each command of type "REQ" (request) is followed by a confirmation of the module of type "CNF" (confirmation). In doing so, the respective command byte is complimented by bit 7 (mask 0x80) and returned by the module together with the respective data or status information.

Example:
The request "0x0D" produces a confirmation "0x8D" and a request "0x11" produces a confirmation "0x91".

While you did not receive a confirmation, hit a timeout of 1000 ms or got a "module busy" indicated by the /RTS pin you shall not send any further command or transparent message towards the module and expect that all received bytes were discarded. In this case you need to resend the entire command to the module.

The module also may send indication messages at any time, also in between a received command request and its confirmation message.

SFD	CMD	Lenth	Payload	CS
0xFF	CMD value	n	Payload value(s)	CS value
1 byte	1 byte	1 byte	n bytes	1 byte

Table 10: Command interface generic frame structure

7.2 Message overview

The following table lists the most commonly used commands followed by a second table completing the list with the less often used commands.

Command	Value [hex]	Description
CMD_DATA_REQ	0x00	Transmission of wM-BUS data
CMD_DATA_IND	0x03	Output of received data
CMD_SET_MODE_REQ	0x04	Set the wM-Bus mode of operation in the volatile settings (RuntimeSettings). Shall be used when the wM-BUS mode must be changed frequently.
CMD_RESET_REQ	0x05	Reset of the module
CMD_SET_REQ	0x09	Write parameters (UserSettings) to the non-volatile memory
CMD_SETUARTSPEED_REQ	0x10	Set the UART baud rate to a dedicated speed
CMD_GET_REQ	0x0A	Read parameters (UserSettings) from the non-volatile memory
CMD_SERIALNO_REQ	0x0B	Request serial number from module
CMD_FWV_REQ	0x0C	Request firmware version from module

Table 11: Frequently used commands

Command	Value [hex]	Description
CMD_DATARETRY_REQ	0x02	Obsolete command. Do not use
CMD_SET_CHANNEL_REQ	0x06	Obsolete command. Do not use
CMD_RSSI_REQ	0x0D	Read current RSSI value from the radio
CMD_DATA_PRELOAD_REQ	0x30	Obsolete command. Do not use
CMD_DATA_CLR_PRELOAD_REQ	0x31	Obsolete command. Do not use
CMD_SET_AES_KEY_REQ	0x50	Register AES key and primary address
CMD_CLR_AES_KEY_REQ	0x51	Unregister AES key and primary address
CMD_GET_AES_DEV_REQ	0x52	Read back registered AES keys and primary addresses
CMD_RESERVED	all other	Reserved, do not use

Table 12: Further commands

7.3 Commands for sending and receiving wM-BUS radio data

7.3.1 CMD_DATA_REQ: Send data via wireless M-BUS radio

This radio transmission command serves to perform a data transfer similar to the transparent mode. The wireless M-BUS mode currently set up in the RuntimeSettings of the module will be used as mode for transmission. Only the start byte, the command and the checksum must be added around the payload which is in this case the wM-BUS frame starting with its L field. The L field value needs to be in the range of 0x09 up to APP_MAXPacketLength.

> ! In any RX only mode the user shall not call CMD_DATA_REQ or use transparent data transmission.

Request:

SFD	CMD	wM-BUS Frame	CS
0xFF	0x00	(L field + 1) byte	CS value

Response (CMD_DATA_CNF):

SFD	CMD	Length	Status	CS
0xFF	0x80	0x01	1 byte	1 byte

Status:

0x00: Frame was sent successfully

Any other value: Command failed, e.g. transmission error or invalid wireless M-BUS frame

7.3.2 CMD_DATA_IND: Reception of wireless M-BUS frames

The output in a command is enabled by changing the UserSettings parameter UART_CMD_OUT_ENABLE to 0x01.

This telegram indicates the reception of data bytes and represents the counterpart to the command CMD_DATA_REQ.
The output is similar as in transparent mode, only the start byte, the command and the checksum are added by the module. In addition the output of the RSSI value can be activated (see RSSI_Enable). In this case the L field is increased by one byte by the module.
The command will remove the wM-BUS link layer CRC from the radio packet and in case of a Frameformat B frame will correct it's L field accordingly.

Indication, with RSSI appending disabled (default):

SFD	CMD	Length	Payload	CS
0xFF	0x03	L field value	Payload value	CS value
1 byte	1 byte	1 byte	L field value bytes	1 byte

Where the L field value plus the payload values are the wM-BUS frame.

Indication, with RSSI appending enabled:

SFD	CMD	Length	Payload	RSSI	CS
0xFF	0x03	L field value + 1	Payload value	RSSI value	CS value
1 byte	1 byte	1 byte	L field value bytes	1 byte	1 byte

Where the L field value (i.e. Length - 1) with the payload values bytes are the actual wM-BUS frame.

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7.4 Commands for module configuration

The configuration commands differ in their type of access. Some commands access Runtime-Settings which are volatile parameters, some access UserSettings which are non-volatile parameters and some commands access read-only parameters or simply perform certain actions.

7.4.1 CMD_SET_MODE_REQ: temporarily set a wM-BUS Mode

This command changes the wM-Bus mode in the volatile memory of the module, and temporarily overrides the parameter in the RuntimeSettings. After reboot this parameter is initialized by using the value of the non-volatile UserSettings parameter of `Mode_Preselect`.
This command is suitable when the wM-BUS mode is changed frequently.
Table 13 lists the supported wM-BUS modes.

Request:

SFD	CMD	Length	Mode	CS
0xFF	0x04	0x01	1 byte	1 byte

Response (`CMD_SET_MODE_CNF`):

SFD	CMD	Length	Status	CS
0xFF	0x84	0x01	1 byte	1 byte

Status:

0x00: Mode was set successfully

Any other value: Command failed

In any TX only modes the module will go into sleep until the user provides a frame to be sent via `CMD_DATA_REQ` or via transparent transmission. Please refer to chapter 11 for details towards current optimization.

The host shall not select any wireless M-BUS Mode values not listed in the following table. Selecting those unsupported values may set the module into a non operable state and may even prevent module access through the UART interface.

The following table lists all supported wireless M-BUS modes available for the use with `CMD_SET_MODE_REQ` command.

wM-BUS Mode	Mode value	Direction(s)	Role
S1-m	0x02	TX only	meter
S2	0x03	TX and RX	meter or gateway
T1_meter	0x05	TX only	meter
T2_meter	0x07	RX and TX	meter
T2_other	0x08	RX and TX	gateway
C2_T2_other	0x09	RX only	gateway
C1_meter	0x0C	TX only	meter
C2_meter	0x0D	RX and TX	meter
C2_other	0x0E	RX and TX	gateway

Table 13: wM-BUS Modes for `CMD_SET_MODE_REQ` command at 868 MHz

7.4.2 CMD_RESET_REQ: Reset the module

This command triggers a software reset of the module. The reset is performed after the confirmation message has been issued. When restarting the module all volatile RuntimeSettings are reset to default and any temporary changes are discarded.

Request:

SFD	CMD	Length	CS
0xFF	0x05	0x00	0xFA

Response (`CMD_RESET_CNF`):

SFD	CMD	Length	Status	CS
0xFF	0x85	0x01	1 byte	1 byte

Status:

0x00: Module will be reset

Any other value: Command failed

7.4.3 CMD_SET_REQ: Change non-volatile module settings

This command enables the direct manipulation of the parameters in the non-volatile memory of the module. The respective parameters (UserSettings, see table 16) are accessed via the memory position. Individual or multiple consecutive parameters in the memory can be modified concurrently.

STOP Please check the supported range before modifying a parameter. The validity of the values themselves is not verified. Incorrect values can result in serious device malfunction!

STOP To make sure the updated parameter(s) are adopted, a reset shall be applied after using one or multiple `CMD_SET_REQ` operations.

STOP To save the parameters in the flash memory of the module, the particular memory segment is erased entirely and then restored from the RAM.

If a reset or supply current drop occurs during this procedure, the entire memory area may be destroyed. In this case, the module may no longer be operable.

Recommendation: First read the current configuration of the module with `CMD_GET_REQ`; and only modify and write if necessary. For frequent changes (e.g. of wM-BUS mode) use the command modifying the volatile parameter.

Request:

SFD	CMD	Length	Memory position	Param. length	Parameter(s)	CS
0xFF	0x09	(Parameter length + 2) bytes	1 byte	1 byte	(Param. length) bytes	1 byte

Response (`CMD_SET_CNF`):

SFD	CMD	Length	Status	CS
0xFF	0x89	0x01	1 byte	1 byte

Status:

0x00: Parameter(s) set successfully

0x02: Command invalid, e.g. invalid memory position, invalid parameter length

Any other value: Command failed

> Any sequence of `CMD_SET_REQ` commands must be followed by a `CMD_RESET_REQ` to apply the changed values.

7.4.4 CMD_GET_REQ: Read out the non-volatile UserSettings

This command can be used to query individual or multiple non-volatile user parameters (User-Settings, see table 16). The requested number of bytes starting at the the specified memory position are returned.
Individual or multiple consecutive parameters in the memory can be queried concurrently.
The sum of the values of memory position and parameter length must be chosen to be smaller than 128.

Request:

SFD	CMD	Length	Memory position	Param. length	CS
0xFF	0x0A	0x02	1 byte	1 byte	1 byte

Response (`CMD_GET_CNF`):

SFD	CMD	Length	Memory position	Parameter length	Parameter(s)	CS
0xFF	0x8A	(Parameter length + 2) bytes	1 byte	1 byte	(Parameter length) bytes	1 byte

7.4.5 CMD_SERIALNO_REQ: Read out the module serial number

This command requests the serial number of the module.
Request:

SFD	CMD	Length	CS
0xFF	0x0B	0x00	0xF4

Response (`CMD_SERIALNO_CNF`):

SFD	CMD	Length	PID & Serial number	CS
0xFF	0x8B	0x04	4 bytes	1 byte

The most significant byte is returned first (MSB first). This byte identifies the product ("PID") and is followed by a 3 bytes serial number.

7.4.6 CMD_FWV_REQ: Read out the firmware version

This command serves to requests the firmware version. Herewith the major, minor and patch fields of the firmware version are returned.

Request:

SFD	CMD	Length	CS
0xFF	0x0C	0x00	0xF3

Response (CMD_FWV_CNF):

SFD	CMD	Length	Parameter(s)	CS
0xFF	0x8C	0x03	0x02 0x00 0x06	0x74

Where the Parameter 0x020006 is to be translated as firmware version 2.0.6.

7.4.7 CMD_RSSI_REQ: Read out the module rx level

This command returns the RX level as determined by the transceiver IC. Whenever a radio mode with reception is enabled this is a live value (i.e. noise floor level). If you want to have the receive strength of the last received packet you need to enable the RSSI output option in the UserSettings.
Request:

SFD	CMD	Length	CS
0xFF	0x0D	0x00	0xF2

Response (CMD_RSSI_CNF):

SFD	CMD	Length	RX level	CS
0xFF	0x8D	0x01	1 byte	1 byte

The command CMD_RSSI_REQ returns the current live RSSI value of the RF chip. The obtained value "RX level" can be used to calculate $RSSI_{dBm}$ as follows:

- Convert the hexadecimal value "RX level" as type unsigned character to a decimal $RSSI_{dec}$ value.

- if $(RSSI_{dec} \geq 128) : RSSI_{dBm} = (RSSI_{dec} - 256)/2 - 74$

- else $(RSSI_{dec} < 128) : RSSI_{dBm} = RSSI_{dec}/2 - 74$

The relation between the calculated value and the physical RX level in dBm is not linear across the entire operating range but can be assumed linear in a range from -107 dBm till -30 dBm.

7.4.8 CMD_SETUARTSPEED_REQ: Change the UART baudrate of the module

This command changes the non-volatile parameters of the serial user interface (`UART_CTL0`, `UART_CTL1`, `UART_BR0`, `UART_BR1`, `UART_MCTL`) to preset values for fixed transfer rates within one command.
The index of the transfer rate is listed in table 14. Internally this command is handled like a `CMD_SET_REQ` using a hard coded table for abstraction of the UART baud rate to CPU register values.

> ⓘ The change of the baud rate takes effect after a restart of the module. The host must also be toggled to the new UART baud rate.

Index	UART baud rate
0x00	1200
0x01	2400
0x02	4800
0x03	9600
0x04	19200
0x05	38400
0x06	56000
0x07	115200

Table 14: Preconfigured baud rates of the UART interface

Request:

SFD	CMD	Length	Index	CS
0xFF	0x10	0x01	1 byte	1 byte

Response (`CMD_SETUARTSPEED_CNF`):

---

[1]Only available for Metis-I with firmware 2.8.0 and newer. Be aware that the jitter of UART baud rate in this mode is up to $\pm 47\%$ and may cause problems with hosts not supporting this variation.

SFD	CMD	Length	Status	CS
0xFF	0x90	0x01	1 byte	1 byte

Status:

0x00: UART baud rate set successfully

0x02: Command invalid, e.g. invalid baudrate

Any other value: Command failed

7.4.9 CMD_FACTORYRESET_REQ: Restore factory defaults

This command resets all parameters to their factory settings. This command must be followed by a reset to apply the changes.

Request:

SFD	CMD	Length	CS
0xFF	0x11	0x00	0xEE

Response (`CMD_FACTORYRESET_CNF`):

SFD	CMD	Length	Status	CS
0xFF	0x91	0x01	1 byte	1 byte

Status:

0x00: Factory reset successfully

Any other value: Command failed

> The UART baud rate will be reset to 9600 Baud. So the host must also switch back to this baud rate.

> Registered AES keys with their relating addresses are retained.

7.5 EN13757 compliant encryption

> It is not recommended to use module internal encryption functionality in a system which has a host µC available. Using integrated AES128 encryption will block the radio and UART receive path of the Metis-I module thus meaning that frames cannot be received while any AES128 operation is processed.

The following functions will allow decrypting received frames. As part of the wireless M-BUS standard some encryption modes (also called Security profiles) are introduced. The module implements means to support encryption modes 0 and 5 using AES128 (AES128 CBC) encryption. Inside the module each 16 byte key must be assigned to a wireless M-BUS address of size 8 byte.

As a wireless M-BUS frame can contain more than one address the priority of addresses when available is as follows: ALA (application layer address) then LLA (link layer address). From hereon we will call this applicable address for encryption "primary address".

> The AES128 decryption is supported by the module in cases when the wM-BUS compliant frame only contains one single Ci field after Block1 introducing a short or long header (e.g. 0x5A or 0x7A as Ci field value). Frames containing more than one Ci field are not supported for en- or decryption. The encryption modes 7 and 13 as well as any encryption requiring more than one Ci field per wM-BUS frame are not supported in this Metis-I firmware. This is especially valid for not released encryption modes or encryption modes that will be introduced once the release of EN13757-7 took place.

The module has reserved storage area for up to 64 keys with their corresponding addresses.

For the management of the AES keys the command interface offers the following commands `CMD_SET_AES_KEY_REQ`, `CMD_CLR_AES_KEY_REQ` and `CMD_GET_AES_DEV_REQ`.

The following steps must be performed to decrypt a received frame, this scheme assumes that you are already receiving the encrypted frames of the meter you want to decrypt (i.e. the wireless M-BUS receive mode is already selected correctly). It is also assumed that you have the symmetric AES key of your meter as 16 byte hex and are able to perform a EN13757 compliant parsing of the raw meter data. Further the frame is assumed to have the recommended AES encryption verification bytes as the very first bytes of the first encrypted block. This bytes shall be 0x2F2F.

- perceive the "primary address" of the meter you want to receive.

- bring the meter's "primary address" into a format of an LLA (i.e. 2 bytes M field followed by 6 bytes A field, see table 15).

- locate the wM-BUS "configuration field" in a received (encrypted) frame of your meter.

- in this "configuration field": make sure that it is indicating encryption mode 5 and at least 1 block of encrypted data (i.e. sub-field "number of encrypted blocks" > 0).

- if required convert the meter's AES key into 16 bytes of hex coded values and order it as LSB first.

- register the key and primary address to the module using the `CMD_SET_AES_KEY_REQ` command.

- enable the global AES encryption support by setting `APP_AES_Enable` to 0x01.

- reboot the module by `CMD_RESET_REQ` or by using the */RESET* pin.

- upon a received frame of your meter:

  – if it shows "number of encrypted blocks" = 0 you have a decrypted frame which you now need to parse according to EN13757 to gain readable data.

  – the first decrypted data shall be 0x2f2F (two times idle filler) the so called AES encryption verification. This allows you to detect if the decryption was successful.

  – if it shows "number of encrypted blocks" > 0 you have either entered a wrong key, meter address or the wM-BUS frame does not match the requirements (described above) to be decrypted by the module.

7.5.1 CMD_SET_AES_KEY_REQ: Register a pair of key and address in the module

With this command an AES key (in hex notation) and a device address (in hex notation) can be stored in the non-volatile memory. The AES key is then used for encryption and decryption. The address fields of a device are to be transmitted exactly as shown below (i.e. in the LLA format). The AES key shall be transmitted LSB first.

Request:

SFD	CMD	Length	Primary address	Key	CS
0xFF	0x50	0x18	Address value	AES Key value	CS value
1 byte	1 byte	1 byte	8 byte	16 byte	1 byte

Response (`CMD_SET_AES_KEY_CNF`):

SFD	CMD	Length	Status	CS
0xFF	0xD0	0x01	1 byte	1 byte

Status:

0x00: Key and address set successfully

0x02: All 64 storage locations are already in use

Any other value: Command failed

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The fields of the primary address in LLA format are composed as follows.

Primary address							
M field LSB	M field MSB	ID LSB	ID (LSB+1)	ID (LSB+2)	ID (MSB)	Version	Device type
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte

Table 15: Content and order of primary address

7.5.2 CMD_CLR_AES_KEY_REQ: Clear AES key from list

This command can be used to delete a specific AES key and address pair from the list.

> **STOP** Using this command will consume one flash cycle. Therefore unnecessary use of this command shall be avoided.

Request:

SFD	CMD	Length	Primary address	CS
0xFF	0x51	0x08	8 bytes	1 byte

Please refer to table 15 for primary address order and content.
Response (`CMD_CLR_AES_KEY_CNF`):

SFD	CMD	Length	Status	CS
0xFF	0xD1	0x01	1 byte	1 byte

Status:

0x00: Key and address deleted successfully

0x02: Address or key not found

Any other value: Command failed

7.5.3 CMD_GET_AES_DEV_REQ: Read Back registered addresses

With this command the addresses of registered devices can be requested. The addresses are saved in 4 banks (0x00 - 0x03). Only one bank (containing up to 16 registered addresses) at a time can be requested to be read with this command. For security reasons the AES keys cannot be read back. Unused or uninitialized addresses can have either all 8 bytes 0x00 or all

8 bytes 0xFF.
Request:

SFD	CMD	Length	Bank index	CS
0xFF	0x52	0x01	1 byte	1 byte

Response (`CMD_GET_AES_KEY_CNF`):

SFD	CMD	Length	16 × Primary address	CS
0xFF	0xD2	0x80	Primary address values	1 byte

8 UserSettings - Module configuration values

The application's non-volatile parameters are listed in the following tables. They can be written by means of a `CMD_SET_REQ` and read back by a `CMD_GET_REQ` by any suitable terminal program or any host µC.
The Windows software "ACC" offers a GUI to conveniently modify these settings.

> Only the parameters described in tables `16` and `17` shall be adopted if required. Not described or obsolete parameters shall not be changed by the user.

These parameters are permanently (non-volatile) stored in the flash memory of the module. To apply these parameters after modification, a module restart is required. To avoid frequent writes a user shall first perform a `CMD_GET_REQ` and check if the value needs to be changed before sending a `CMD_SET_REQ`.

> If not notified otherwise any multi byte field with size > 1 shall be transmitted LSB first to the module

> The WOR function for a cyclic "wakeup - listen - sleep" applications shall not be used anymore as it will be removed in future firmware releases. For a stan-dalone functionality feel free to request a custom firmware through our sales channels.

Parameter	Description	Address offset (dec)	Size (bytes)	Value range (dec)	Default value (dec)
UART_CMD_OUT_ ENABLE	Enable `CMD_DATA_IND` output format	5	1	0, 1	0
RF_Power	Radio output power index	61	1	0 - 6	6
RSSI_Enable	Enable RSSI output	69	1	0, 1	0
Mode_Preselect	Default wM-BUS mode	70	1	1 - 15	3

Table 16: Table of UserSettings

In any normal application the following settings shall not be used or changed.
For changing the UART baudrate the dedicated command `CMD_SETUARTSPEED_REQ` or the ACC PC tool shall be used.

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Parameter	Description	Address offset (dec)	Size (bytes)	Value range (dec)	Default value (dec)
UART_CTL0	UART register	0	1	use ACC	use ACC
UART_CTL1	UART register	1	1	use ACC	use ACC
UART_BR0	UART register	2	1	use ACC	use ACC
UART_BR1	UART register	3	1	use ACC	use ACC
UART_MCTL	UART register	4	1	use ACC	use ACC
APP_MAXPacketLength	Maximum UART packet length	10	1	10 - 254	250
APP_AES_Enable	Enable encryption	11	1	0, 1	0
RF_AutoSleep	Sleep mode	63	1	0, 2	0
CFG_Flags	Configuration flags	80	2	0 - 65535	0

Table 17: Further UserSettings

8.1 UART parameters

The following sections describe the host communication interface specific settings of the wM-BUS module.

8.1.1 UART speed parameters

For changing the UART speed settings please only use either the dedicated `CMD_SET_REQ` shown here, the special command `CMD_SETUARTSPEED_REQ` or the ACC PC tool.

For enabling the full low power optimization of the wM-BUS radio modules a special host interface speed and setting must be configured. The UART needs to run at 9600 Baud 8n1 using ACLK. This can be achieved using the following command `CMD_SET_REQ` or if available for Metis-I the `CMD_SETUARTSPEED_REQ` with parameter 0x08 (see chapter 14).

`CMD_SET_REQ` with memory index 0x00, parameter length 0x05 and parameter value 0x0040030006:

SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x07	0x00	0x05	0x0040030006	0xB1

`CMD_SETUARTSPEED_REQ` with parameter 0x08 (see chapter 14):

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SFD	CMD	Length	Parameter(s)	CS
0xFF	0x10	0x01	0x08	0xE6

> ⓘ A `CMD_RESET_REQ` or pin reset is required to apply the changed settings. Your host must be also configured to 9600 Baud and allow up to 47% deviation in RX and TX directions.

8.1.2 UART_CMD_OUT_ENABLE

If this parameter is set to 0x01, all received radio frames will be transmitted by the UART as `CMD_DATA_IND`. The default value for this parameter is 0x00.

> ⓘ A `CMD_RESET_REQ` or pin reset is required to apply the changed settings.

Request, enable command output for received radio frames:

SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x03	0x05	0x01	0x01	0xF0

Request, disable command output for received radio frames:

SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x03	0x05	0x01	0x00	0xF1

Response, with status "success":

SFD	CMD	Length	Status	CS
0xFF	0x89	0x01	0x00	1 byte

8.2 Application and Radio Parameters

8.2.1 APP_MAXPacketLength

The maximum radio packet length can be set by means of this parameter. It limits the number of bytes usable for transparent communication and `CMD_DATA_REQ` as well as `CMD_DATA_IND`. The default value for this parameter equals 250 (0xFA).

> **!** Frames exceeding this value are discarded without notification.

> **!** A `CMD_RESET_REQ` or pin reset is required to apply the changed settings.

Request, set max. L field to size 250:

SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x03	0x0A	0x01	0xFA	0x04

Response, with status "success":

SFD	CMD	Length	Status	CS
0xFF	0x89	0x01	0x00	1 byte

8.2.2 APP_AES_Enable

This parameter enables or disables the integrated encryption function of the module. Additional to this parameter, a suitable 16 byte AES key with its primary address has to be registered in the module to run the frame decryption. Please also refer to chapter `7.5` for further commands needed for encryption.

> **!** A `CMD_RESET_REQ` or pin reset is required to apply the changed settings.

Request, AES enabled:

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SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x03	0x0B	0x01	0x01	0xFE

Request, AES disabled:

SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x03	0x0B	0x01	0x00	0xFF

Response, with status "success":

SFD	CMD	Length	Status	CS
0xFF	0x89	0x01	0x00	1 byte

> ! To avoid additional latency this option shall stay disabled. Decryption of longer frames may take several milliseconds. During this time radio reception cannot be active due to hardware restrictions.

8.2.3 RF_Power

Sets the level of the transmission power in the radio IC.

> STOP The user shall adopt this value for his or her design in such a way that the statutory regulations (e.g. in Europe the RED) is adhered to.
> The provided default values were verified on Metis-I-EV 50 Ω conducted. In customer hardware the behavior of the module will be different and therefore it is mandatory to adopt this setting.

Value	radio IC Power in dBm
1	-5
2	0
3	+5
4	+7
5	+10
6	+11

Table 18: Parameter `RF_Power` of wM-BUS modules with up to 10mW output power

> ! A `CMD_RESET_REQ` or pin reset is required to apply the changed settings.

Request minimum `RF_Power`:

SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x03	0x3D	0x01	0x01	0xC8

Request maximum `RF_Power`:

SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x03	0x3D	0x01	0x06	0xCF

Response, with status "success":

SFD	CMD	Length	Status	CS
0xFF	0x89	0x01	0x00	1 byte

8.2.4 RSSI_Enable

This parameter determines whether the RSSI value will be appended to the payload data or not (last byte before CS in a `CMD_DATA_IND` or very last byte in transparent output). The L field on the UART output will be increased by +1 when RSSI output is enabled. If enabled the wM-BUS frame itself is limited to a size of `APP_MAXPacketLength` -1.

> ! A `CMD_RESET_REQ` or pin reset is required to apply the changed settings.

Request, RSSI output enabled:

SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x03	0x45	0x01	0x01	0xB0

Request, RSSI output disabled:

SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x03	0x45	0x01	0x00	0xB1

Response, with status "success":

SFD	CMD	Length	Status	CS
0xFF	0x89	0x01	0x00	1 byte

8.2.5 Mode_Preselect

Default settings of the operating modes specified in wM-BUS Standard can be selected by means of this parameter. The value can be modified using the `CMD_SET_REQ` command.

The wM-BUS standard only allows frame format A for S, F and T mode in order to be compliant. The C and N modes support both frame format A and B reception and will automatically use the frame format of the last received frame for sending, which may be frame format A or B. The initial value is frame format A in case no frame was received yet.

> Selecting wM-BUS modes not listed in the following table shall not be used in this command.
> Selecting those invalid values may set the module into a non operable state and prevent module access through the UART interface.

wM-BUS mode	Mode value	Direction(s)	Role
S1-m	0x02	TX only	meter
S2	**0x03**	**TX and RX**	**meter or gateway**
T1_meter	0x05	TX only	meter
T2_meter	0x07	RX and TX	meter
T2_other	0x08	RX and TX	gateway
C2_T2_other	0x09	RX only	gateway
C1_meter	0x0C	TX only	meter
C2_meter	0x0D	RX and TX	meter
C2_other	0x0E	RX and TX	gateway

Table 19: wM-BUS modes for `Mode_Preselect` in the 868 MHz band

(!) Mode C2_T2_other (0x09) is only suited for receiving frames. In order to send frames either T2_other (0x08) or C2_other (0x0E) must be used.
This special mode 0x09 shall not be used for range critical applications as the receiver sensitivity is reduced in comparison to the single wM-BUS mode receive option T2_other and C2_other.

(!) A `CMD_RESET_REQ` or pin reset is required to apply the changed settings.

Request, select S2 mode:

SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x03	0x46	0x01	0x03	0xB1

Request, select C2_T2_other RX only mode:

SFD	CMD	Length	Memory index	Param.) length	Parameter(s)	CS
0xFF	0x09	0x03	0x46	0x01	0x09	0xBB

Request, Select C1_meter TX only mode:

SFD	CMD	Length	Memory index	Param. length	Parameter(s)	CS
0xFF	0x09	0x03	0x46	0x01	0x0C	0xBE

Response, with status "success":

SFD	CMD	Length	Status	CS
0xFF	0x89	0x01	0x00	1 byte

8.2.6 RF_AutoSleep

The parameter `RF_AutoSleep` supports 2 different settings.

(!) The WOR (periodic wakeup) function is obsolete and shall not be used anymore. We can offer this function in a customer specific firmware that can be requested through our sales team.

Value		Description
0x00	RX	The auto sleep function can be disabled. The module is permanently in RX mode if the selected `Mode_Preselect` has an RX mode. Data can be received at all times.
0x01	WOR	Obsolete. Do not use.
0x02	Sleep	Between the transmissions, the module is always in the sleep mode (no reception at all). In this mode, the module has the lowest power consumption, since the radio chip and µC are in the low-power state. This lowest current consumption can only be achieved when the UART Baud rate is 9600 or below and the UART clock is set to use the watch crystal. Higher baud rates require faster reaction thus leading to less efficient sleep modes resulting in higher current consumption. Consider using the settings described in chapter 11. By communication on the UART the module can be contacted at all times for transmitting data or for configuration purposes.

Table 20: Values for `RF_AutoSleep` parameter

8.2.7 CFG_Flags

This 2 byte parameter provides the ability to run different module configurations. It serves to activate various pin functions.

All pin functions are disabled in the factory state, so that the normal pin configuration is compatible with previous modules. For a description of the flags, see table 21.

Bit index	Mask	Description
0	0x0001	If set, this bit activates the function of the pin /RTS. This pin indicates whether the internal buffer is currently busy (/RTS = high) or not. When busy all received bytes (radio or UART) will be discarded without further user notification.
1	0x0002	If set, this bit activates the function of the pin /CTS. This pin will be queried by the UART driver before another byte is sent by the module. The host must use this pin accordingly (LOW = data will be sent to host, HIGH = data will be delayed till /CTS is low again, radio and uart rx will be disabled untill /CTS is low).
2	0x0004	Obsolete. If set, this bit activates the function of the pin /DATA IND. This pin will indicate whether data is ready for output via UART. It can be used, for example, to wake a host processor.
3 - 15	0xFFF8	Reserved. All bits must be '0'

Table 21: Parameters for `CFG_Flags`

8.3 Obsolete configuration parameters

The following parameters are not recommended to be used anymore. If your application requires those parameters you are encouraged to adopt your application or request a custom firmware version for your application through our sales team.

Parameter	Description	Address offset (dec)
UART_DIDelay	Configurable output delay	6
APP_WOR_PeriodH	WOR period factor msb	28
APP_WOR_PeriodL	WOR period factor lsb	29
APP_WOR_MultiplyerH	WOR multiplyer factor msb	30
APP_WOR_MultiplierL	WOR multiplyer factor lsb	31
APP_WOR_RX_Time	WOR listen active time in between sleep and wake-up	32
MBUS_RXTimeout	Time in ms that the module remains in the RX mode after transmitting data	43
MBUS_FrameFormat	RX frame Frameformat filter	44
Config_CRC_Disable	Accept any UART CS in commands	72

Table 22: Obsolete UserSettings

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9 Timing parameters

9.1 Reset behavior

Following a reset (by `CMD_RESET_REQ` or pin */RESET*), a stable LOW level over a duration of at least 5ms on the */RTS* pin signalizes that the module is ready for operation.
During restart the */RTS* may be pulled to *GND* level for a short time until it is configured accordingly by the application on the module.

9.1.1 Reset via /RESET pin

To force a module restart by means of the */RESET* pin, it must first be set to LOW for at least 1ms. After the pin is released, the module will reboot.
Recommended procedure: After the */RESET* pin is released, wait for up to 1000ms for the stable LOW level on the */RTS* pin.

> This section applies only to a situation where the VCC is stable and the module was already running. Additional timings are needed when VCC was just applied to the module, see chapter `4.2`.

10 Radio parameters

10.1 Wireless M-BUS radio parameters

The EN 13757-4 defines wireless M-BUS modes which are implemented by the modules for being able to send and receive conforming frames. Modules that support N mode (169 MHz) cannot support S, T or C mode (868 MHz) and vice versa. But they are exchangeable as they share the same footprint, pin functions and command interface.

The wM-BUS mode is mapped to the UserSettings parameter `Mode_Preselect`. It may be modified temporarily during runtime by using the command `CMD_SET_MODE_REQ` or be altered in a non-volatile way using the command `CMD_SET_REQ`.

Setting a corresponding `Mode_Preselect` with RX support is sufficient to receive wM-BUS frames complying to EN13757. For sending data a mode with TX support needs to be selected. The host must then transfer a wM-BUS conforming frame inside a `CMD_DATA_REQ` or in transparent mode via UART to the module which will then send this frame with the selected wM-BUS mode.

> The module performs some filtering of non EN13757-3:2013 compliant frames. Non compliant frames will be discarded without host notification.

> The C2_T2_other mode is not defined in the standard but was implemented to be able to receive both T and C mode meters in one mode. This receive only mode is suited for data collectors without communication back to the meter (no downlink support).

wM-BUS Mode	Direction	Frequency [MHz]	Chiprate [kcps]	Coding
S1-m	TX only	868.300	32.768	Manchester
S2	RX	868.300	32.768	Manchester
S2	TX	868.300	32.768	Manchester
T1_meter	TX only	868.950	100	3 out of 6
T2_other	RX	868.950	100	3 out of 6
T2_other	TX	868.300	32.768	Manchester
C1_meter	TX only	868.950	100	NRZ
C2_other	RX	868.950	100	NRZ
C2_other	TX	869.525	50	NRZ
C2_T2_other	RX only	868.950	100	auto detect

Table 23: wM-BUS mode radio settings

Transmit mode	Suitable receive mode
S1-m	S2
S2	S2
T1_meter	T2_other or T2_C2_other
T1_other	T2_meter
T2_meter	T2_other or T2_C2_other
T2_other	T2_meter
C1_meter	C2_other or T2_C2_other
C2_meter	C2_other or T2_C2_other
C2_other	C2_meter

Table 24: Compatible wM-BUS modes

The data rate can be calculated by combining chip rate and coding.
In Manchester coding the factor is $\frac{1}{2}$ meaning the data rate for uplink and downlink is $\frac{32.768}{2} = 16.384$ kbps
The 3 out of 6 coding will introduce a factor of $\frac{2}{3}$ so the T mode uplink data rate is $100 \times \frac{2}{3} = 66.667$ kbps.
NRZ coding has a factor of 1 resulting in 100 kbps uplink and 50 kbps downlink data rate for C mode and in 4.8 kbps and 2.4 kbps for the different N sub-modes.

10.2 EU regulation

> The module is tested through an accredited test lab to conform to the requirements of the RED. The module complies to receiver category 2.

That means at 50 Ω conducted on the corresponding evaluation board all requirements are met. Decisive for the end product is the effective radiated power. The power depends on the selected antenna, the wiring to the antenna, the quality of the power supply, possible disturbances etc., and should therefore be tested in the customer application.

An important aspect to comply with the radio regulatory is to adhere to the requirements of the duty cycle. The duty cycle is the ratio expressed as a percentage of the cumulative duration of transmission Ton_cum within an observation time interval of T_{obs}. $DC = (T_{on,cum}/T_{obs})F_{obs}$ on an observation bandwidth F_{obs}. Unless otherwise specified, T_{obs} is 1 hour and the observation bandwidth Fobs is the operational frequency band.

> **STOP** There are no mechanisms for constraining the duty cycle in the firmware. The customer is fully responsible for the compliance of the duty cycle.

The wireless M-Bus modes of the Metis-I fall into two sub bands of the EN 300 220:

- Band M
  868 MHz - 868.6 MHz
  Output power $\leq$ 14 dBm
  Duty cycle $\leq$ 1% or PSA

- Band N
  868.7 MHz - 869.2 MHz
  Output power $\leq$ 14 dBm
  Duty cycle $\leq$ 0.1% or PSA

> The EN 300 220 allows a specific tx duration when the standard complying PSA method is implemented in the module firmware. The standard Metis-I firmware does not implement PSA. With PSA a transmission time of 100 s/h (3.6%) is possible.

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11 Battery powered operation

If the parameter `RF_AutoSleep` is set to sleep (0x02), the module will be in sleep mode, if no data transmission is requested by the host. During this time, the reception of frames via radio is disabled.

If the listening shall be controlled by the host, the module can be set to the RX mode by reconfiguring this parameter to full actice mode (`RF_AutoSleep` = 0x00). As this will use a `CMD_SET_REQ` and therefore consume a flash cycle the host shall not perform this procedure too often.

If a message is received during this time, the module will forward this message to the host and subsequently go back to sleep again.

We highly recommend requesting a custom firmware for any battery operated system so optimizations can be implemented and tested accordingly to the system requirements and use cases.

STOP	UART baud rates of more than 9600 Baud or not using the ACLK as UART clock source result in higher current consumption as the sleep mode cannot be activated in the μC.

STOP	Non terminated module pads will introduce leakage current. Make sure you adopt the module design according to the corresponding chapters for design in and pinout.

Depending on the hardware platform some specific further steps are required as explained in the following section.

11.1 Metis-I (AMB8426-M)

Due to its implemented μC the Metis-I has specific requirements to be able to achieve an optimized sleep current:

- The firmware version must be at least 2.6.0

- The following UserSettings for UART (9600 Baud 8n1 with ACLK use) must be used
    - `UART_CTL0` = 0x00
    - `UART_CTL1` = 0x40
    - `UART_BR0` = 0x03
    - `UART_BR1` = 0x00
    - `UART_MCTL` = 0x06

Using a single `CMD_SET_REQ` for enabling UART settings can be achieved by sending the following command to the module.

SFD	CMD	Length	Memory index	Length	Parameter(s)	CS
0xFF	0x09	0x07	0x00	0x05	0x0040030006	0xB1

> A `CMD_RESET_REQ` or pin reset is required to apply the changed settings.

> Caution: Using this UART setting will introduce an inaccuracy of up to 45% (e.g. see Texas Instruments MSP430 F2xxx family user guide chapter 36, table 36-4). This is hardware related and cannot be avoided when the UART shall stay active using this HW-platform during efficient sleep state.

- The `RX_Timeout` must be 0x00 (which is the default setting)

- When `RF_AutoSleep` = 0x00 the parameter `Mode_Preselect` must be set to either of the following modes which are TX only modes (indicated by the "1" in the mode name).
    - S1-m
    - T1_meter
    - T1_other
    - C1_meter
    - C1_other

- As an alternative the parameter `RF_AutoSleep` must be set to 0x02 when any supported `Mode_Preselect` that also supports RX shall be used. Please have in mind that `RF_AutoSleep` = 0x02 will disable RX in this modes.

- `RF_AutoSleep` must not be set to 0x01 (WOR)

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12 Custom firmware

12.1 Custom configuration of standard firmware

The configuration of the standard firmware includes adoption of the non-volatile Usersettings (see chapter 8) to customer requirements and creating a customized product based on the standard product.

This variant will result in a customer exclusive module with a unique ordering number. It will also freeze the firmware version to a specific and customer tested version and thus results in a customer exclusive module with a unique ordering number.

Further scheduled firmware updates of the standard firmware will not be applied to this variant automatically. Applying updates or further functions require a customer request and release procedure.

12.2 Customer specific firmware

A customer specific firmware may include "Custom configuration of standard firmware" plus additional options or functions and tasks that are customer specific and not part of the standard firmware.

Further scheduled firmware updates of the standard firmware will not be applied to this variant automatically. Applying updates or further functions require a customer request and release procedure.

This also results in a customer exclusive module with a unique ordering number.

An example for this level of customization are functions like host-less operation where the module will perform data generation (e.g. by reading a SPI or I^2C sensor) and cyclic transmission of this data to a data collector, while sleeping or being passive most of the time.

Also replacing UART with SPI as host communication interface is classified such a custom specific option.

Certification critical changes need to be re-evaluated by an external qualified measurement laboratory. These critical changes may occur when e.g. changing radio parameters, the channel access method, the duty-cycle or in case of various other functions and options possibly used or changed by a customer specific firmware.

12.3 Customer firmware

A customer firmware is a firmware written and tested by the customer himself or a 3rd party as a customer representative specifically for the hardware platform provided by a module.

This customer firmware (e.g. in form of a Intel hex file) will be implemented into the module's production process at our production site.

This also results in a customer exclusive module with a unique ordering number.

The additional information needed for this type of customer firmware, such as hardware specific details and details towards the development of such firmware are not available for the public and can only be made available to qualified customers.

> **STOP** The qualification(s) and certification(s) of the standard firmware cannot be applied to this customer firmware solution without a review and verification.

12.4 Contact for firmware requests

Please contact your local field sales engineer (FSE) or *WCS@we-online.com* for quotes regarding these topics.

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13 Firmware updates

All products will experience maintenance, security and/or feature updates from time to time. For the standard products these maintained via the PCN process.

Customers can request the creation of a customized product including a "firmware freeze" to ensure that they will receive their verified product even if the standard product is updated.

13.1 Firmware flashing using the production interface

Most Würth Elektronik eiSos wireless connectivity modules offer a production interface (e.g. JTAG, SWD, Spy-Bi-Wire) for module flash access. Depending on the product, this interface can be used by customers to erase the entire chip and install their own firmware.

Using the production interface is not intended to perform updates of Würth Elektronik eiSos standard product firmware.

Production firmware images and binary files for Würth Elektronik eiSos wireless connectivity modules are not publicly available.

> **STOP** Any certification, declaration, listing and qualification becomes invalid if the production interface is used by a customer. Some products, in their documentation, state exceptions to this invalidation under certain conditions.

Customers shall make the product specific firmware update interface available to their application. These methods will use a wired (UART, SPI, etc.) or wireless (Bluetooth® LE, Wi-Fi, etc.) communication interface of the module to allow updating the product's firmware. Details are described in the next sections.

13.2 Update via ACC Software and UART

Only the *UTDX*, *URXD* and *GND* signals are needed for this connection. A suitable adapter/-converter is required for a PC connection (e.g. the FTDI TTL-323R-3V3 UART to USB converter).

> **STOP** None of the module pins are 5 V TTL compatible. Applying overvoltage to any pin may damage the hardware permanently. Ensure your levels are in the range of the electrical specification as shown in chapter 2

> **STOP** Users must make sure that their host is not accessing the Metis-I RX line (i.e. pulling it HIGH or LOW) as that will prevent ACC to access the module.

As long as our standard firmware is running on the module, it can be updated with the PC utility "ACC" via the serial interface. If the module is not directly connected to a PC, then at least the UART should be made accessible, e.g. by means of a suitable connector.

ACC can be downloaded from the Würth Elektronik eiSos homepage: *ACC*.

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14 Firmware history

14.1 Metis-I (AMB8426-M, AMB8465-M)

Version 2.5.4   "Release"

- Firmware maintenance

- Known issues:

  - In high traffic scenarios, bytes get lost due to the shared buffer. This can be caused by a too slow UART (i.e. not equal to 115200 Baud) or by to many radio traffic.

  - In high traffic scenarios, commands are not accepted. As described in the manual, the radio RX has the highest priority and therefore blocks the internal buffer. For module configuration use either ACC or avoid high traffic zones.

  - In C Mode with frame format B long (>16 byte) sequences of 0x00 or 0xFF cause the radio chip to loose bit-sync. This leads to CRC errors and the packet is lost. Make sure you either use frame format A, encrypt your frame or reorder your data blocks in a way such long sequences cannot occur.

Version 2.6.0   "Release"

- Added C field filter for Bit7. According to EN13757, packets will be discarded if this bit is not '0'.

- Unused pins are pulled to low level (i.e. configured to output low). This will optimize current consumption in the sleep mode by avoiding possible leakage current.

- Adopted new release revision numbering.

- Known issues:

  - In high traffic scenarios, commands are not accepted. As described in the manual, the radio RX has the highest priority and therefore blocks the internal buffer. For module configuration use either ACC or avoid high traffic zones.

  - In C Mode with frame format B long (>16 byte) sequences of 0x00 or 0xFF cause the radio chip to loose bit-sync. This leads to CRC errors and the packet is lost. Users shall generate proper test data instead of using big blocks of constant 0x00 or 0xFF data. This long constant data blocks will never occur when send by a standard compliant device.

15 Design in guide

15.1 Advice for schematic and layout

For users with less RF experience it is advisable to closely copy the relating evaluation board with respect to schematic and layout, as it is a proven design. The layout should be conducted with particular care, because even small deficiencies could affect the radio performance and its range or even the conformity.
The following general advice should be taken into consideration:

- A clean, stable power supply is strongly recommended. Interference, especially oscillation can severely restrain range and conformity.

- Variations in voltage level should be avoided.

- LDOs, properly designed in, usually deliver a proper regulated voltage.

- Blocking capacitors and a ferrite bead in the power supply line can be included to filter and smoothen the supply voltage when necessary.

No fixed values can be recommended, as these depend on the circumstances of the application (main power source, interferences etc.).

The use of an external reset IC should be considered if one of the following points is relevant:

- The slew rate of the power supply exceeds the electrical specifications.

- The effect of different current consumptions on the voltage level of batteries or voltage regulators should be considered. The module draws higher currents in certain scenarios like start-up or radio transmit which may lead to a voltage drop on the supply. A restart under such circumstances should be prevented by ensuring that the supply voltage does not drop below the minimum specifications.

- Voltage levels below the minimum recommended voltage level may lead to malfunction. The /Reset pin of the module shall be held on LOW logic level whenever the VCC is not stable or below the minimum operating Voltage.

- Special care must be taken in case of battery powered systems.

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- Elements for ESD protection should be placed on all pins that are accessible from the outside and should be placed close to the accessible area. For example, the RF-pin is accessible when using an external antenna and should be protected.

- ESD protection for the antenna connection must be chosen such as to have a minimum effect on the RF signal. For example, a protection diode with low capacitance such as the 8231606A or a 68 nH air-core coil connecting the RF-line to ground give good results.

- Placeholders for optional antenna matching or additional filtering are recommended.

- The antenna path should be kept as short as possible.

> **(!)** Again, no fixed values can be recommended, as they depend on the influencing circumstances of the application (antenna, interferences etc.).
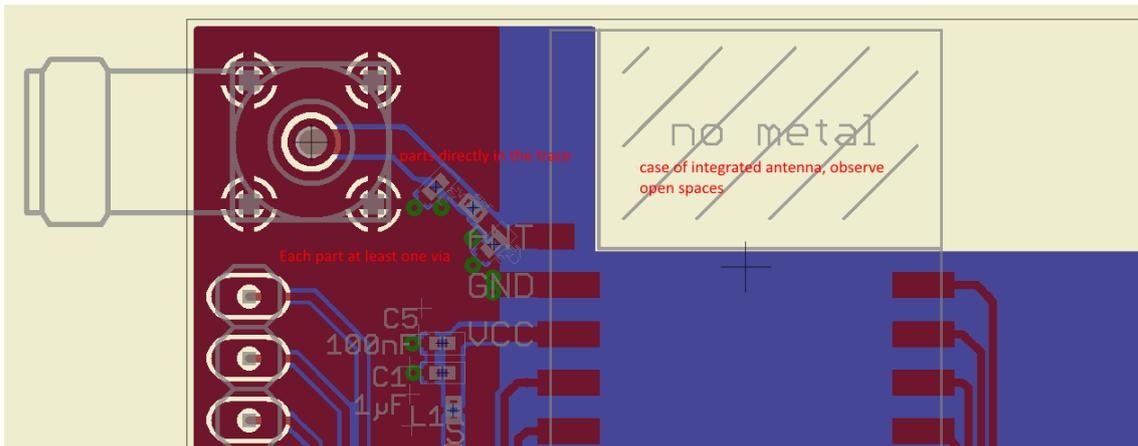

Figure 3: Layout

- To avoid the risk of short circuits and interference there should be no routing underneath the module on the top layer of the baseboard.

- On the second layer, a ground plane is recommended, to provide good grounding and shielding to any following layers and application environment.

- In case of integrated antennas it is required to have areas free from ground. This area should be copied from the evaluation board.

- The area with the integrated antenna must overlap with the carrier board and should not protrude, as it is matched to sitting directly on top of a PCB.

- Modules with integrated antennas should be placed with the antenna at the edge of the main board. It should not be placed in the middle of the main board or far away from the edge. This is to avoid tracks beside the antenna.

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- Filter and blocking capacitors should be placed directly in the tracks without stubs, to achieve the best effect.

- Antenna matching elements should be placed close to the antenna / connector, blocking capacitors close to the module.

- Ground connections for the module and the capacitors should be kept as short as possible and with at least one separate through hole connection to the ground layer.

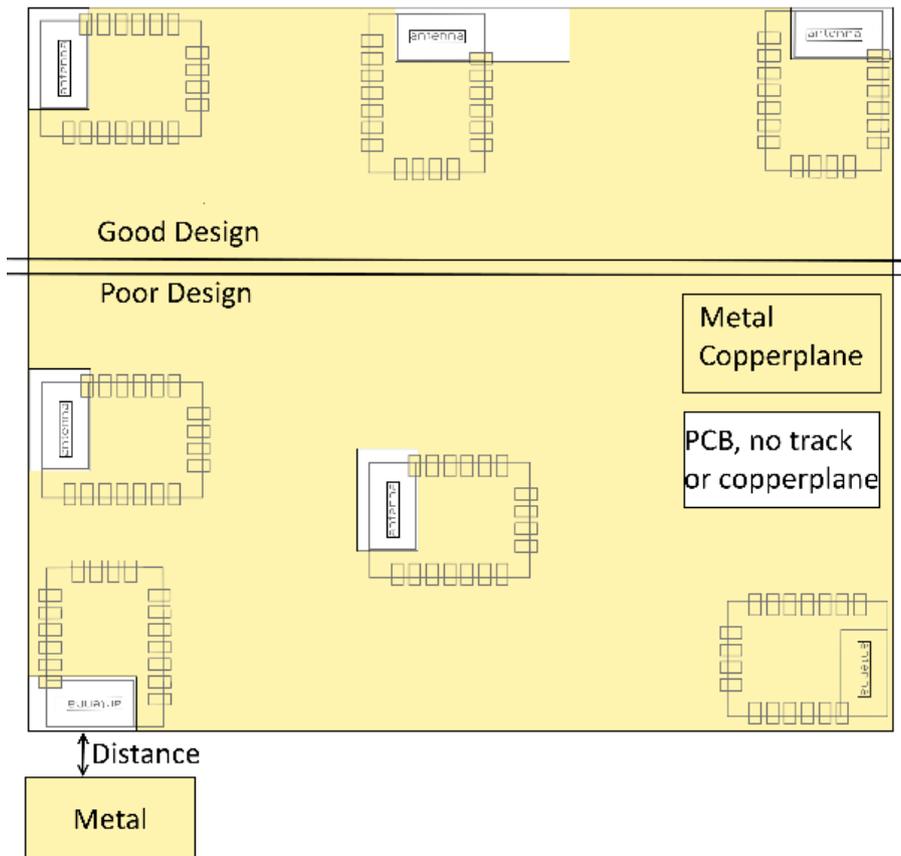- ESD protection elements should be placed as close as possible to the exposed areas.

Figure 4: Placement of the module with integrated antenna

15.2 Dimensioning of the micro strip antenna line

The antenna track has to be designed as a 50Ω feed line. The width W for a micro strip can be calculated using the following equation:

$$W = 1.25 \times \left(\frac{5.98 \times H}{e^{\frac{50 \times \sqrt{\epsilon_r + 1.41}}{87}}} - T_{met} \right) \qquad (1)$$

Example:
A FR4 material with ϵ_r = 4.3, a height H = 1000 µm and a copper thickness of T_{met} = 18 µm will

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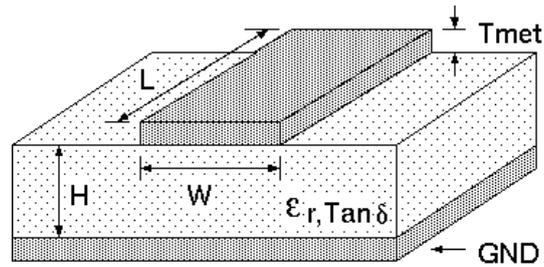**User manual Metis-I Wireless M-BUS**

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Figure 5: Dimensioning the antenna feed line as micro strip

lead to a trace width of W ~ 1.9 mm. To ease the calculation of the micro strip line (or e.g. a coplanar) many calculators can be found in the internet.

- As rule of thumb a distance of about 3×W should be observed between the micro strip and other traces / ground.

- The micro strip refers to ground, therefore there has to be the ground plane underneath the trace.

- Keep the feeding line as short as possible.

15.3 Antenna solutions

There exist several kinds of antennas, which are optimized for different needs. Chip antennas are optimized for minimal size requirements but at the expense of range, PCB antennas are optimized for minimal costs, and are generally a compromise between size and range. Both usually fit inside a housing.

Range optimization in general is at the expense of space. Antennas that are bigger in size, so that they would probably not fit in a small housing, are usually equipped with a RF connector. A benefit of this connector may be to use it to lead the RF signal through a metal plate (e.g. metal housing, cabinet).

As a rule of thumb a minimum distance of $\lambda/10$ (which is 3.5 cm @ 868 MHz and 1.2 cm @ 2.44 GHz) from the antenna to any other metal should be kept. Metal placed further away will not directly influence the behavior of the antenna, but will anyway produce shadowing.

> Keep the antenna as far as possible from large metal objects to avoid electro-magnetic field blocking.

> The choice of antenna might have influence on the safety requirements.

In the following chapters, some special types of antenna are described.

15.3.1 Wire antenna

An effective antenna is a $\lambda/4$ radiator with a suiting ground plane. The simplest realization is a piece of wire. It's length is depending on the used radio frequency, so for example 8.6 cm 868.0 MHz and 3.1 cm for 2.440 GHz as frequency. This radiator needs a ground plane at its feeding point. Ideally, it is placed vertically in the middle of the ground plane. As this is often not possible because of space requirements, a suitable compromise is to bend the wire away from the PCB respective to the ground plane. The $\lambda/4$ radiator has approximately 40 Ω input impedance. Therefore, matching is not required.

15.3.2 Chip antenna

There are many chip antennas from various manufacturers. The benefit of a chip antenna is obviously the minimal space required and reasonable costs. However, this is often at the expense of range. For the chip antennas, reference designs should be followed as closely as possible, because only in this constellation can the stated performance be achieved.

15.3.3 PCB antenna

PCB antenna designs can be very different. The special attention can be on the miniaturization or on the performance. The benefits of the PCB antenna are their small / not existing (if PCB space is available) costs, however the evaluation of a PCB antenna holds more risk of failure than the use of a finished antenna. Most PCB antenna designs are a compromise of range and space between chip antennas and connector antennas.

15.3.4 Antennas provided by Würth Elektronik eiSos

15.3.4.1 2600130081 - Hyperion-I - 868 MHz dipole antenna

Figure 6: 868 MHz dipole-antenna

Ideally suited for applications where no ground plane is available.

> ⓘ The 2600130081 antenna can be also used for 902MHz - 928MHz range.

Specification	Value
Center frequency [MHz]	868
Frequency range [MHz]	853 – 883
Wavelength	0.5 wave
VSWR	≤ 2.0
Impedance [Ω]	50
Connector	SMA (Male)
Dimensions (L x d) [mm]	142 x 10
Peak gain [dBi]	-2.3
Operating temp. [°C]	-30 – +80

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15.3.4.2 2600130082 - Hyperion-II - 868 MHz magnetic base antenna

Well suited for applications where the RF is lead through a metal wall that could serve as ground plane to the antenna.

Figure 7: 868 MHz magnet foot antenna with 1.5 m antenna cable

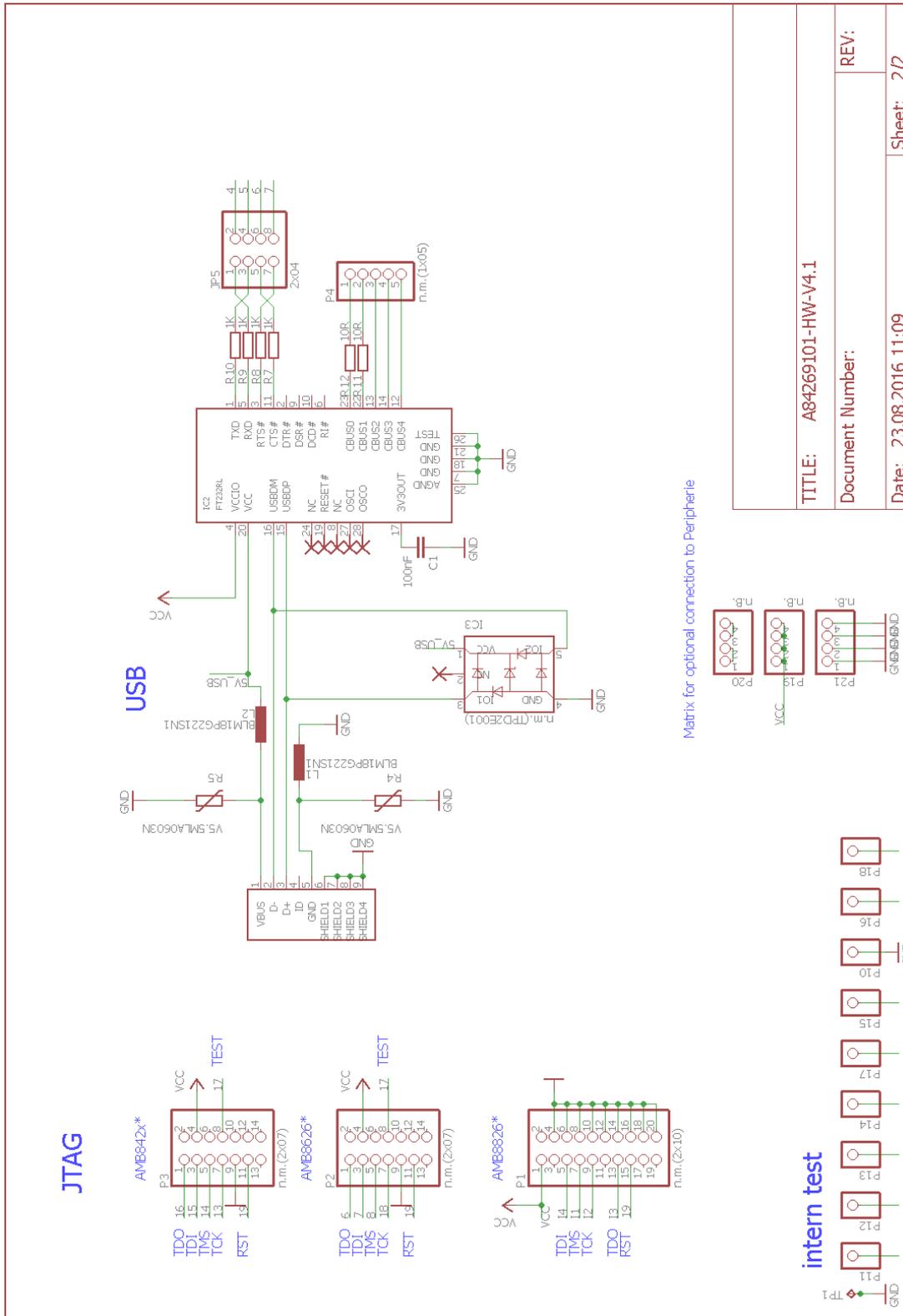> The 2600130082 is a kind of $\lambda/4$ radiator and therefore needs a ground plane at the feeding point.

Specification	Value
Frequency range [MHz]	824 – 894
VSWR	≤ 2.0
Polarisation	Vertical
Impedance [Ω]	50 ± 5
Connector	SMA (Male)
Dimensions (L x d) [mm]	89.8 x 27
Weight [g]	50 ± 5
Operating temp. [℃]	-30 – +60

16 Reference design

Metis-I was tested and certified on the corresponding Metis-I evaluation board. For the compliance with the EU directive 2014/53/EU Annex I, the evaluation board serves as reference design.
This is no discrepancy due to the fact that the evaluation board itself does not fall within the scope of the EU directive 2014/53/EU Annex I as the module is tested on the evaluation board, which is also the recommended use.

Further information concerning the use of the evaluation board can be found in the manual of the Metis-I evaluation board.
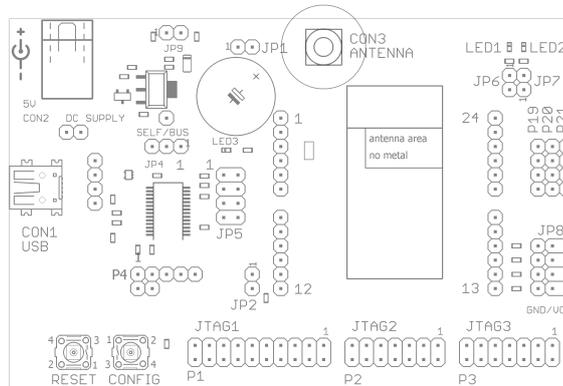
16.1 Schematic

16.2 Layout

Figure 8: Assembly diagram

Figure 9: Top and Bottom Layer

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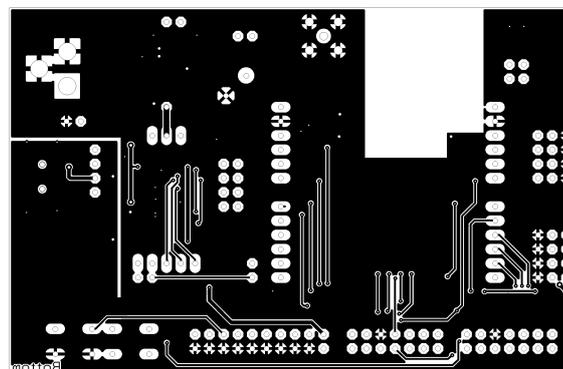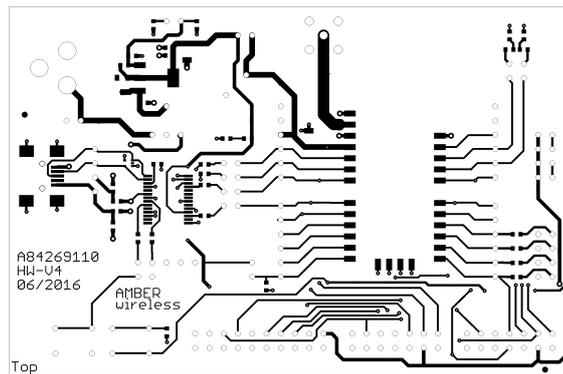MORE THAN
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17 Manufacturing information

17.1 Moisture sensitivity level

This wireless connectivity product is categorized as JEDEC Moisture Sensitivity Level 3 (MSL3), which requires special handling.

More information regarding the MSL requirements can be found in the IPC/JEDEC J-STD-020 standard on *www.jedec.org*.

More information about the handling, picking, shipping and the usage of moisture/reflow and/or process sensitive products can be found in the IPC/JEDEC J-STD-033 standard on *www.jedec.org*.

17.2 Soldering

17.2.1 Reflow soldering

Attention must be paid on the thickness of the solder resist between the host PCB top side and the modules bottom side. Only lead-free assembly is recommended according to JEDEC J-STD020.

Profile feature		Value
Preheat temperature Min	$T_{S\,Min}$	150 °C
Preheat temperature Max	$T_{S\,Max}$	200 °C
Preheat time from $T_{S\,Min}$ to $T_{S\,Max}$	t_S	60 - 120 seconds
Ramp-up rate (T_L to T_P)		3 °C / second max.
Liquidous temperature	T_L	217 °C
Time t_L maintained above T_L	t_L	60 - 150 seconds
Peak package body temperature	T_P	see table below
Time within 5 °C of actual peak temperature	t_P	20 - 30 seconds
Ramp-down Rate (T_P to T_L)		6 °C / second max.
Time 20 °C to T_P		8 minutes max.

Table 25: Classification reflow soldering profile, Note: refer to IPC/JEDEC J-STD-020E

Package thickness	Volume mm^3 <350	Volume mm^3 350-2000	Volume mm^3 >2000
< 1.6 mm	260 ℃	260 ℃	260 ℃
1.6 mm - 2.5 mm	260 ℃	250 ℃	245 ℃
> 2.5 mm	250 ℃	245 ℃	245 ℃

Table 26: Package classification reflow temperature, PB-free assembly, Note: refer to IPC/-JEDEC J-STD-020E

It is recommended to solder this module on the last reflow cycle of the PCB. For solder paste use a LFM-48W or Indium based SAC 305 alloy (Sn 96.5 / Ag 3.0 / Cu 0.5 / Indium 8.9HF / Type 3 / 89%) type 3 or higher.

The reflow profile must be adjusted based on the thermal mass of the entire populated PCB, heat transfer efficiency of the reflow oven and the specific type of solder paste used. Based on the specific process and PCB layout the optimal soldering profile must be adjusted and verified. Other soldering methods (e.g. vapor phase) have not been verified and have to be validated by the customer at their own risk. Rework is not recommended.
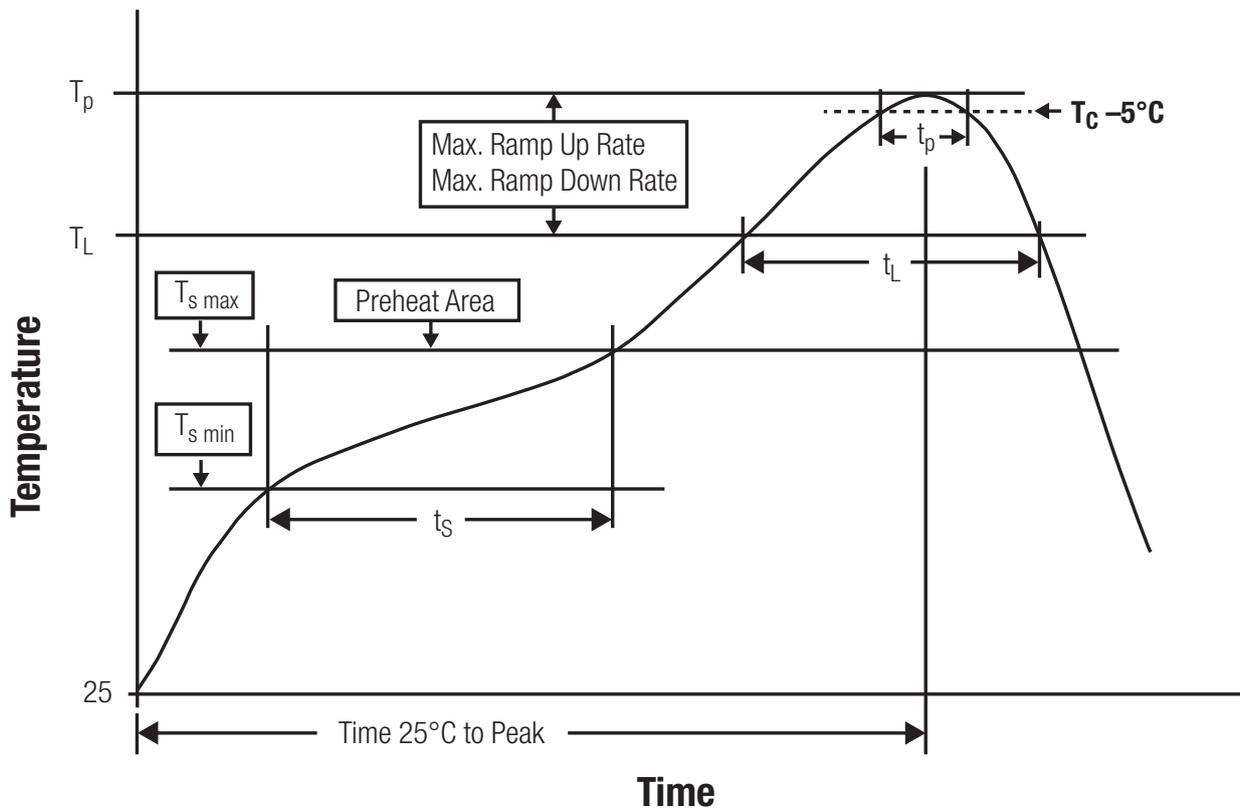

Figure 10: Reflow soldering profile

After reflow soldering, visually inspect the board to confirm proper alignment

17.2.2 Cleaning

Do not clean the product. Any residue cannot be easily removed by washing. Use a "no clean" soldering paste and do not clean the board after soldering.

- Do not clean the product with water. Capillary effects can draw water into the gap between the host PCB and the module, absorbing water underneath it. If water is trapped inside, it may short-circuit adjoining pads. The water may also destroy the label and ink-jet printed text on it.

- Cleaning processes using alcohol or other organic solvents may draw solder flux residues into the housing, which won't be detected in a post-wash inspection. The solvent may also destroy the label and ink-jet printed text on it.

- Do not use ultrasonic cleaning as it will permanently damage the part, particularly the crystal oscillators.

17.2.3 Potting and coating

- If the product is potted in the customer application, the potting material might shrink or expand during and after hardening. Shrinking could lead to an incomplete seal, allowing contaminants into the component. Expansion could damage components. We recommend a manual inspection after potting to avoid these effects.

- Conformal coating or potting results in loss of warranty.

- The RF shield will not protect the part from low-viscosity coatings and potting. An undefined amount of coating and potting will enter inside the shielding.

- Conformal coating and potting will influence the parts of the radio front end and consequently influence the radio performance.

- Potting will influence the temperature behaviour of the device. This might be critical for components with high power.

17.2.4 Other notations

- Do not attempt to improve the grounding by forming metal strips directly to the EMI covers or soldering on ground cables, as it may damage the part and will void the warranty.

- Always solder every pad to the host PCB even if some are unused, to improve the mechanical strength of the module.

- The part is sensitive to ultrasonic waves, as such do not use ultrasonic cleaning, welding or other processing. Any ultrasonic processing will void the warranty.

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17.3 ESD handling

This product is highly sensitive to electrostatic discharge (ESD). As such, always use proper ESD precautions when handling. Make sure to handle the part properly throughout all stages of production, including on the host PCB where the module is installed. For ESD ratings, refer to the module series' maximum ESD section. For more information, refer to the relevant chapter 2. Failing to follow the aforementioned recommendations can result in severe damage to the part.

- the first contact point when handling the PCB is always between the local GND and the host PCB GND, unless there is a galvanic coupling between the local GND (for example work table) and the host PCB GND.

- Before assembling an antenna patch, connect the grounds.

- While handling the RF pin, avoid contact with any charged capacitors and be careful when contacting any materials that can develop charges (for example coaxial cable with around 50-80 pF/m, patch antenna with around 10 pF, soldering iron etc.)

- Do not touch any exposed area of the antenna to avoid electrostatic discharge. Do not let the antenna area be touched in a non ESD-safe manner.

- When soldering, use an ESD-safe soldering iron.

17.4 Safety recommendations

It is your duty to ensure that the product is allowed to be used in the destination country and within the required environment. Usage of the product can be dangerous and must be tested and verified by the end user. Be especially careful of:

- Use in areas with risk of explosion (for example oil refineries, gas stations).

- Use in areas such as airports, aircraft, hospitals, etc., where the product may interfere with other electronic components.

It is the customer's responsibility to ensure compliance with all applicable legal, regulatory and safety-related requirements as well as applicable environmental regulations. Disassembling the product is not allowed. Evidence of tampering will void the warranty.

- Compliance with the instructions in the product manual is recommended for correct product set-up.

- The product must be provided with a consolidated voltage source. The wiring must meet all applicable fire and security prevention standards.

- Handle with care. Avoid touching the pins as there could be ESD damage.

Be careful when working with any external components. When in doubt consult the technical documentation and relevant standards. Always use an antenna with the proper characteristics.

Würth Elektronik eiSos radio modules with high output power of up to 500 mW, as for example the radio module Thebe-II, generate a high amount of warmth while transmitting. The manufacturer of the end device must take care of potentially necessary actions for his application.

18 Physical specifications

18.1 Dimensions

Dimensions
17 x 27 x 4 mm

Table 27: Dimensions

18.2 Weight

Weight
3g

Table 28: Weight
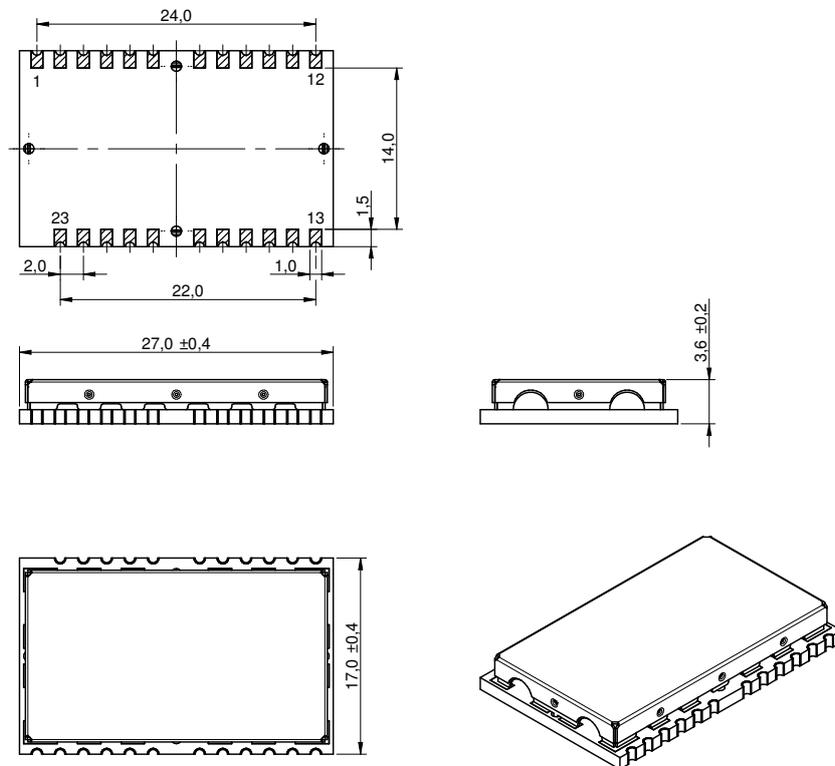
18.3 Module drawing

Figure 11: Module dimensions [mm]
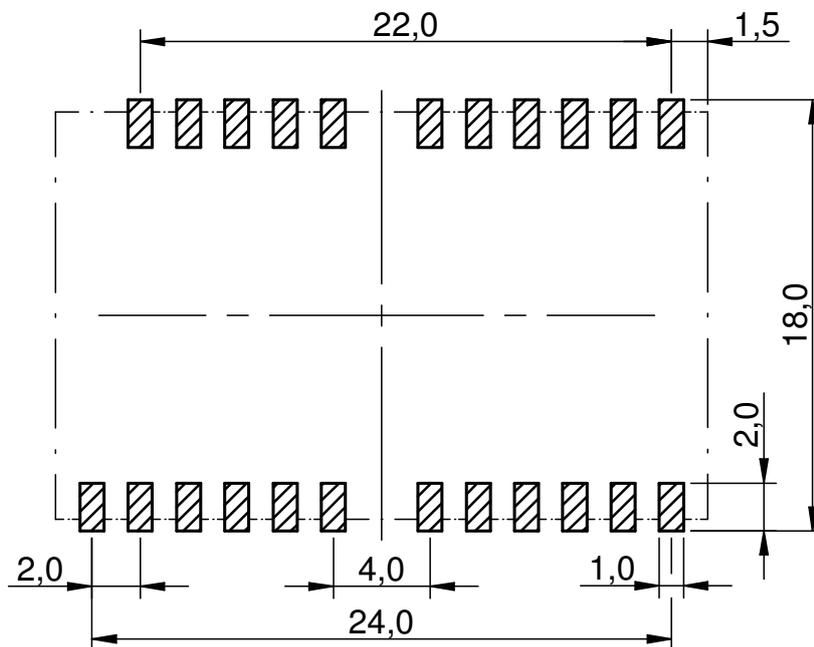
18.4 Footprint

Figure 12: Footprint and dimensions [mm]

The following points have to be considered:

- To avoid the risk of short circuits, a minimum clearance of at least 14 mm between the opposing pad rows has to be maintained!

- No routing on the top layer of a carrier PCB (i.e. "under" the module) shall be performed.

- The carrier PCB shall place no vias "under" the module to prevent shortcuts

- This footprint is also compatible to AMB8626, AMB8426, AMB4426 and AMB3626 hardware platforms.

18.5 Antenna free area

To avoid influence and mismatching of the antenna the recommended free area around the antenna should be maintained. As rule of thumb a minimum distance of metal parts to the antenna of $\lambda/10$ should be kept (see figure 12). Even though metal parts would influence the characteristic of the antenna, but the direct influence and matching keep an acceptable level.

19 Marking

19.1 Lot number

The 15 digit lot number is printed in numerical digits as well as in form of a machine readable bar code. It is divided into 5 blocks as shown in the following picture and can be translated according to the following table.
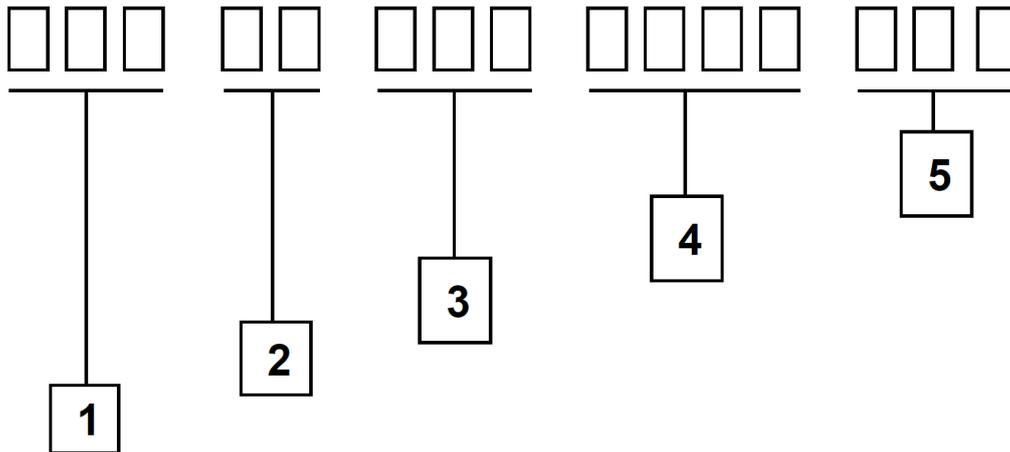

Figure 13: Lot number structure

Block	Information	Example(s)
1	eiSos internal, 3 digits	439
2	eiSos internal, 2 digits	01
3	Hardware version, 3 digits	V2.4 = 024, V12.2 = 122
4	Date code, 4 digits	1703 = week 03 in year 2017, 1816 = week 16 in year 2018
5	Firmware version, 3 digits	V3.2 = 302, V5.13 = 513

Table 29: Lot number details

As the user can perform a firmware update the printed lot number only shows the factory delivery state. The currently installed firmware can be requested from the module using the corresponding product specific command. The firmware version as well as the hardware version are restricted to show only major and minor version not the patch identifier.

19.2 General labeling information

The module labels may include the following fields:

- Manufacturer identification WE, Würth Elektronik or Würth Elektronik eiSos

- WE Order Code and/or article alias

- Serial number or MAC address

- Certification identifiers (CE, FCC ID, IC, TELEC,...)

- Bar code or 2D code containing the serial number or MAC address

If the module is using a Serial Number, this serial number includes the product ID (PID) and an 6 digit number. The 6 rightmost digits represent the 6 digit number, followed by the product ID (2 or 3 digits). Some labels indicate the product ID with a "." as marker in-between the 2 fields. The PID and the 6 digit number form together a unique serial number for any wireless connectivity product.

In case of small labels, the 3 byte manufacturer identifier (0x0018DA) of the MAC address is not printed on the labels. The 3 byte counter printed on the label can be used with this 0018DA to produce the full MAC address by appending the counter after the manufacturer identifier.

Figure 14: Label of the Metis-I

20 Information for explosion protection

In case the end product should be used in explosion protection areas the following information can be used:

- The module itself is unfused.

- The maximum output power of the module is 11 dBm.

- The total amount of capacitance of all capacitors is 320.9 nF.

- The total amount of inductance of all inductors is 1.042 µH.

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21 Regulatory compliance information

21.1 Important notice EU

The use of RF frequencies is limited by national regulations. The Metis-I has been designed to comply with the RED directive 2014/53/EU of the European Union (EU).
The Metis-I can be operated without notification and free of charge in the area of the European Union. However, according to the RED directive, restrictions (e.g. in terms of duty cycle or maximum allowed RF power) may apply.

21.2 Conformity assessment of the final product

The Metis-I is a subassembly. It is designed to be embedded into other products (products incorporating the Metis-I are henceforward referred to as "final products").
It is the responsibility of the manufacturer of the final product to ensure that the final product is in compliance with the essential requirements of the underlying national radio regulations.
The conformity assessment of the subassembly Metis-I carried out by Würth Elektronik eiSos does not replace the required conformity assessment of the final product.

21.3 Exemption clause

Relevant regulation requirements are subject to change. Würth Elektronik eiSos does not guarantee the accuracy of the before mentioned information. Directives, technical standards, procedural descriptions and the like may be interpreted differently by the national authorities. Equally, the national laws and restrictions may vary with the country. In case of doubt or uncertainty, we recommend that you consult with the authorities or official certification organizations of the relevant countries. Würth Elektronik eiSos is exempt from any responsibilities or liabilities related to regulatory compliance.

Notwithstanding the above, Würth Elektronik eiSos makes no representations and warranties of any kind related to their accuracy, correctness, completeness and/or usability for customer applications. No responsibility is assumed for inaccuracies or incompleteness.

21.4 EU Declaration of conformity

EU DECLARATION OF CONFORMITY

Radio equipment: 2605041183000 & 2605056083001

The manufacturer: Würth Elektronik eiSos GmbH & Co. KG
Max-Eyth-Straße 1
74638 Waldenburg

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Object of the declaration: 2605041183000 & 2605056083001

The object of the declaration described above is in conformity with the relevant Union harmonisation legislation: Directive 2014/53/EU and 2011/65/EU.
Following harmonised norms or technical specifications have been applied:

EN 300 220-1 V3.1.1 (2017-02)
EN 300 220-2 V3.1.1 (2017-02)
EN 301 489-1 V2.2.0 (Draft)
EN 301 489-3 V2.1.1 (Final draft)
EN 62479 : 2010
EN 60950-1: 2006 + A11: 2009 + A1: 2010 + A12: 2011

i.A. G. Eßhardt

Trier, 31th of October 2018
Place and date of issue

22 Important notes

The following conditions apply to all goods within the wireless connectivity product range of Würth Elektronik eiSos GmbH & Co. KG:

22.1 General customer responsibility

Some goods within the product range of Würth Elektronik eiSos GmbH & Co. KG contain statements regarding general suitability for certain application areas. These statements about suitability are based on our knowledge and experience of typical requirements concerning the areas, serve as general guidance and cannot be estimated as binding statements about the suitability for a customer application. The responsibility for the applicability and use in a particular customer design is always solely within the authority of the customer. Due to this fact, it is up to the customer to evaluate, where appropriate to investigate and to decide whether the device with the specific product characteristics described in the product specification is valid and suitable for the respective customer application or not. Accordingly, the customer is cautioned to verify that the documentation is current before placing orders.

22.2 Customer responsibility related to specific, in particular safety-relevant applications

It has to be clearly pointed out that the possibility of a malfunction of electronic components or failure before the end of the usual lifetime cannot be completely eliminated in the current state of the art, even if the products are operated within the range of the specifications. The same statement is valid for all software sourcecode and firmware parts contained in or used with or for products in the wireless connectivity and sensor product range of Würth Elektronik eiSos GmbH & Co. KG. In certain customer applications requiring a high level of safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health, it must be ensured by most advanced technological aid of suitable design of the customer application that no injury or damage is caused to third parties in the event of malfunction or failure of an electronic component.

22.3 Best care and attention

Any product-specific data sheets, manuals, application notes, PCN's, warnings and cautions must be strictly observed in the most recent versions and matching to the products firmware revisions. This documents can be downloaded from the product specific sections on the wireless connectivity homepage.

22.4 Customer support for product specifications

Some products within the product range may contain substances, which are subject to restrictions in certain jurisdictions in order to serve specific technical requirements. Necessary information is available on request. In this case, the field sales engineer or the internal sales person in charge should be contacted who will be happy to support in this matter.

22.5 Product improvements

Due to constant product improvement, product specifications may change from time to time. As a standard reporting procedure of the Product Change Notification (PCN) according to the JEDEC-Standard, we inform about major changes. In case of further queries regarding the PCN, the field sales engineer, the internal sales person or the technical support team in charge should be contacted. The basic responsibility of the customer as per section 22.1 and 22.2 remains unaffected. All wireless connectivity module driver software ¨wireless connectivity SDK¨ and it's source codes as well as all PC software tools are not subject to the Product Change Notification information process.

22.6 Product life cycle

Due to technical progress and economical evaluation we also reserve the right to discontinue production and delivery of products. As a standard reporting procedure of the Product Termination Notification (PTN) according to the JEDEC-Standard we will inform at an early stage about inevitable product discontinuance. According to this, we cannot ensure that all products within our product range will always be available. Therefore, it needs to be verified with the field sales engineer or the internal sales person in charge about the current product availability expectancy before or when the product for application design-in disposal is considered. The approach named above does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.

22.7 Property rights

All the rights for contractual products produced by Würth Elektronik eiSos GmbH & Co. KG on the basis of ideas, development contracts as well as models or templates that are subject to copyright, patent or commercial protection supplied to the customer will remain with Würth Elektronik eiSos GmbH & Co. KG. Würth Elektronik eiSos GmbH & Co. KG does not warrant or represent that any license, either expressed or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, application, or process in which Würth Elektronik eiSos GmbH & Co. KG components or services are used.

22.8 General terms and conditions

Unless otherwise agreed in individual contracts, all orders are subject to the current version of the "General Terms and Conditions of Würth Elektronik eiSos Group", last version available at *www.we-online.com*.

23 Legal notice

23.1 Exclusion of liability

Würth Elektronik eiSos GmbH & Co. KG considers the information in this document to be correct at the time of publication. However, Würth Elektronik eiSos GmbH & Co. KG reserves the right to modify the information such as technical specifications or functions of its products or discontinue the production of these products or the support of one of these products without any written announcement or notification to customers. The customer must make sure that the information used corresponds to the latest published information. Würth Elektronik eiSos GmbH & Co. KG does not assume any liability for the use of its products. Würth Elektronik eiSos GmbH & Co. KG does not grant licenses for its patent rights or for any other of its intellectual property rights or third-party rights.

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23.2 Suitability in customer applications

The customer bears the responsibility for compliance of systems or units, in which Würth Elektronik eiSos GmbH & Co. KG products are integrated, with applicable legal regulations. Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of Würth Elektronik eiSos GmbH & Co. KG components in its applications, notwithstanding any applications-related in-formation or support that may be provided by Würth Elektronik eiSos GmbH & Co. KG. Customer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences lessen the likelihood of failures that might cause harm and take appropriate remedial actions. The customer will fully indemnify Würth Elektronik eiSos GmbH & Co. KG and its representatives against any damages arising out of the use of any Würth Elektronik eiSos GmbH & Co. KG components in safety-critical applications.

23.3 Trademarks

AMBER wireless is a registered trademark of Würth Elektronik eiSos GmbH & Co. KG. All other trademarks, registered trademarks, and product names are the exclusive property of the respective owners.

23.4 Usage restriction

Würth Elektronik eiSos GmbH & Co. KG products have been designed and developed for usage in general electronic equipment only. This product is not authorized for use in equipment

where a higher safety standard and reliability standard is especially required or where a failure of the product is reasonably expected to cause severe personal injury or death, unless the parties have executed an agreement specifically governing such use. Moreover, Würth Elektronik eiSos GmbH & Co. KG products are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. Würth Elektronik eiSos GmbH & Co. KG must be informed about the intent of such usage before the design-in stage. In addition, sufficient reliability evaluation checks for safety must be performed on every electronic component, which is used in electrical circuits that require high safety and reliability function or performance. By using Würth Elektronik eiSos GmbH & Co. KG products, the customer agrees to these terms and conditions.

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24 License terms

These License terms will take effect upon the purchase and usage of the Würth Elektronik eiSos GmbH & Co. KG wireless connectivity products. You hereby agree that these license terms are applicable to the product and the incorporated software, firmware and source codes (collectively, "Software") made available by Würth Elektronik eiSos in any form, including but not limited to binary, executable or source code form.
The software included in any Würth Elektronik eiSos wireless connectivity product is purchased to you on the condition that you accept the terms and conditions of these license terms. You agree to comply with all provisions under these license terms.

24.1 Limited license

Würth Elektronik eiSos hereby grants you a limited, non-exclusive, non-transferable and royalty-free license to use the software and under the conditions that will be set forth in these license terms. You are free to use the provided software only in connection with one of the products from Würth Elektronik eiSos to the extent described in these license terms. You are entitled to change or alter the source code for the sole purpose of creating an application embedding the Würth Elektronik eiSos wireless connectivity product. The transfer of the source code to third parties is allowed to the sole extent that the source code is used by such third parties in connection with our product or another hardware provided by Würth Elektronik eiSos under strict adherence of these license terms. Würth Elektronik eiSos will not assume any liability for the usage of the incorporated software and the source code. You are not entitled to transfer the source code in any form to third parties without prior written consent of Würth Elektronik eiSos.
You are not allowed to reproduce, translate, reverse engineer, decompile, disassemble or create derivative works of the incorporated software and the source code in whole or in part. No more extensive rights to use and exploit the products are granted to you.

24.2 Usage and obligations

The responsibility for the applicability and use of the Würth Elektronik eiSos wireless connectivity product with the incorporated firmware in a particular customer design is always solely within the authority of the customer. Due to this fact, it is up to you to evaluate and investigate, where appropriate, and to decide whether the device with the specific product characteristics described in the product specification is valid and suitable for your respective application or not.
You are responsible for using the Würth Elektronik eiSos wireless connectivity product with the incorporated firmware in compliance with all applicable product liability and product safety laws. You acknowledge to minimize the risk of loss and harm to individuals and bear the risk for failure leading to personal injury or death due to your usage of the product.
Würth Elektronik eiSos' products with the incorporated firmware are not authorized for use in safety-critical applications, or where a failure of the product is reasonably expected to cause severe personal injury or death. Moreover, Würth Elektronik eiSos' products with the incorporated firmware are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. You

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shall inform Würth Elektronik eiSos about the intent of such usage before design-in stage. In certain customer applications requiring a very high level of safety and in which the malfunction or failure of an electronic component could endanger human life or health, you must ensure to have all necessary expertise in the safety and regulatory ramifications of your applications. You acknowledge and agree that you are solely responsible for all legal, regulatory and safety-related requirements concerning your products and any use of Würth Elektronik eiSos' products with the incorporated firmware in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by Würth Elektronik eiSos. YOU SHALL INDEMNIFY WÜRTH ELEKTRONIK EISOS AGAINST ANY DAMAGES ARISING OUT OF THE USE OF WÜRTH ELEKTRONIK EISOS' PRODUCTS WITH THE INCORPORATED FIRMWARE IN SUCH SAFETY-CRITICAL APPLICATIONS.

24.3 Ownership

The incorporated firmware created by Würth Elektronik eiSos is and will remain the exclusive property of Würth Elektronik eiSos.

24.4 Firmware update(s)

You have the opportunity to request the current and actual firmware for a bought wireless connectivity product within the time of warranty. However, Würth Elektronik eiSos has no obligation to update a modules firmware in their production facilities, but can offer this as a service on request. The upload of firmware updates falls within your responsibility, e.g. via ACC or another software for firmware updates. Firmware updates will not be communicated automatically. It is within your responsibility to check the current version of a firmware in the latest version of the product manual on our website. The revision table in the product manual provides all necessary information about firmware updates. There is no right to be provided with binary files, so called "firmware images", those could be flashed through JTAG, SWD, Spi-Bi-Wire, SPI or similar interfaces.

24.5 Disclaimer of warranty

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24.6 Limitation of liability

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If a provision of these license terms is or becomes invalid, unenforceable or null and void, this shall not affect the remaining provisions of the terms. The parties shall replace any such provisions with new valid provisions that most closely approximate the purpose of the terms.

24.9 Miscellaneous

Würth Elektronik eiSos reserves the right at any time to change this terms at its own discretion. It is your responsibility to check at Würth Elektronik eiSos homepage for any updates. Your continued usage of the products will be deemed as the acceptance of the change.
We recommend you to be updated about the status of new firmware and software, which is available on our website or in our data sheet and manual, and to implement new software in your device where appropriate.
By ordering a product, you accept these license terms in all terms.

WIRELESS CONNECTIVITY & SENSORS

User manual Metis-I Wireless M-BUS

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