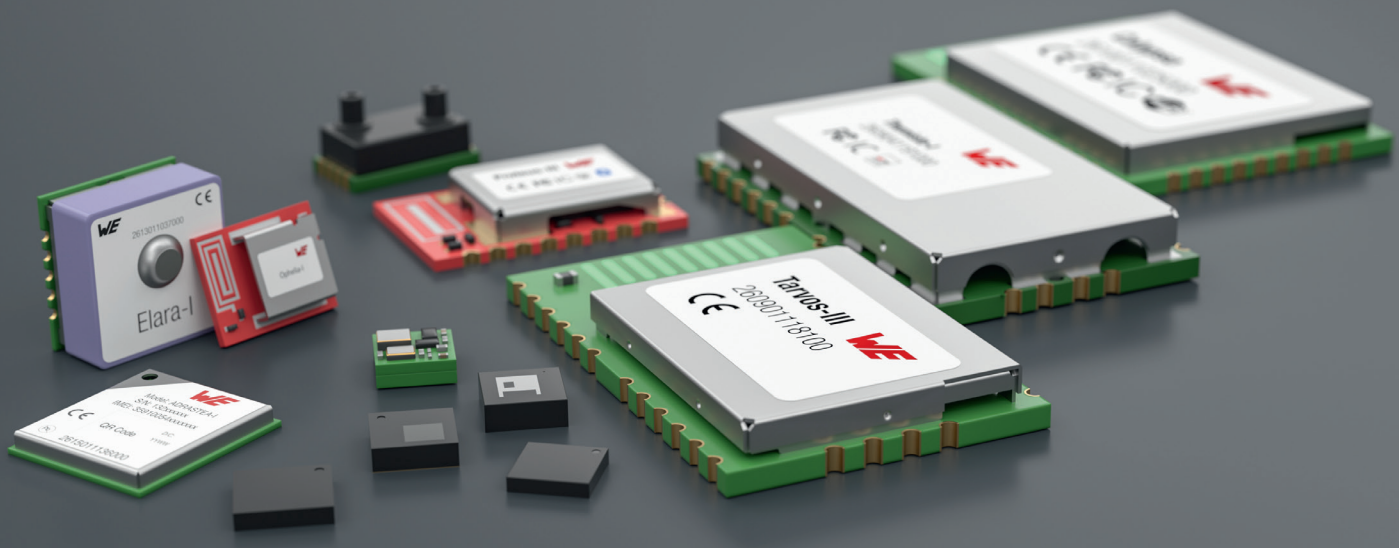

ANR001

Metis-II Repeater Mode

Version 1.4

July 19, 2023

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Revision history

Manual version	FW version	HW version	Notes	Date
1.0	2.8.0	2.0	• Initial version	November 2018
1.1	2.8.0	2.0	• Updated file name to new AppNote name structure. Updated important notes, legal notice & license terms chapters.	June 2019
1.2	2.8.0	2.0	• Updated address of Division Wireless Connectivity & Sensors location	October 2019
1.3	2.8.0	2.0	• Corrected typo's	November 2020
1.4	2.8.0	2.0	• Updated `Important notes`, meta data and document style	July 2023

Contents

1 Introduction

Starting with firmware version 2.8.0 the Metis-II include a feature to enable receiving, buffering, delaying and forwarding radio frames better known as single-hop unidirectional repeater functionality.

WE order code	Former order code	Description
260702118300x	AMB8626-M-TR	868 MHz wM-BUS module 14dBm, T&R, Firmware 2.7.0
2607021183010	AMB8626-M-RP-TR	868 MHz wM-BUS module 14dBm, T&R, Firmware 2.8.0

Table 1: Metis-II Ordering information

The European Standard EN13757 and the OMS Group Specification give information on how a single-hop unidirectional repeater shall be implemented and what radio frames shall be supported by the repeater.
Our implementation will enable the repeater mode only on a very specific configuration set of the wM-Bus module as introduced later.

Using the repeater mode requires careful attention of the user regarding local regulatory requirements. Especially the duty cycle requirements need to be adhered to.
For example by realizing a suiting host implementation in the user's end system that implements duty cycle restriction.

2 Motivation

By means of the repeater mode a module or USB stick can be utilized to enhance the effective radio range of wireless M-BUS meters within the repeater's range. This will happen for frames that follow EN13757-3:2013 and EN13757-4:2013 as well as OMS Specification Volume 2 Generation 4 V4.1.2. In essence this applies to all wM-BUS frames that have a hop counter field at a location described in the standard and also have a C-Field of either SND-NR or SND-IR, which are only to be used in direction meter to other (uplink).

As the size of the hop counter field is limited to 1 bit it is not possible to provide multiple hops in a standard compliant way. Therefore the hop counter must be '0' in the received frame and will be set to '1' by the repeater to indicate that the message was repeated.
A frame already having the hop counter '1' when being received by a repeater will be discarded.

To be able to find the hop counter inside a frame the repeater parses and checks parts of the radio frame upon reception. Currently the following frame structures and conditions are implemented in the firmware, listed in the order of priority they will be tested and applied:

- Frames that have an Extended Link Layer (ELL) as first Control Information Field (Ci-Field). This ELL has a Communication Control Field (CC-Field) which provides a Hop Count Subfield (H-Field). The first Ci-Field can be followed by one or multiple further Ci-Field(s).

- Frames that have exactly one Ci-Field in the entire frame, indicating either a "short data header" or a "long data header", with encryption modes in the Configuration Field being either 0 or 5 and the Configuration field providing a hop counter at a well-known location within the field.
  Note: Encryption mode 0 is not described in the standard but from our experience with different manufacturers mode 0 is used by them with the same structure as mode 5. This means the Configuration Field Bit 0 is the Hop Counter Field.

3 Using the included wireless M-BUS repeater

The repeater mode runs in parallel to the normal module functions as sending and receiving frames without interfering the normal operations of the module or the reachability of the module via UART. To archive this, the frames to be repeated are queued in a non-shared buffer so the normal shared buffer is not blocked by the repeater.

The repeater mode is enabled by setting the UserSetting (US) parameter `Repeater_Enable` at index 82 (0x52) from 0x00 (= disabled) to 0x01 (= enabled) via the `CMD_SET_REQ` as shown below in the example configuration in chapter `3.1`.

But even though this enables the repeater mode of the module there are further configurations required for the activation to take effect.

Please refer to the wM-Bus module user manual or the following example section on how to use `CMD_SET_REQ` and `CMD_GET_REQ` commands accordingly.

If any of the parameters or requirements are not fulfilled the unidirectional repeater functionality may cause critical malfunctions of the module.

The following table shows the UserSetting parameters to configure the module as a repeater:

US Parameter	Required value	US Offset
UART_CTL0	0x00	0x00
UART_CTL1	0x80	0x01
UART_BR0	0x34	0x02
UART_BR1	0x00	0x03
UART_MCTL	0x20	0x04
UART_CMD_Out_Enabled	0x01 (enabled)	0x05
APP_AES_Enable	0x00 (disabled)	0x0B
MBUS_B1_ADD_Disable	0x01 (disabled)	0x30
RF_AutoSleep	0x00 (disabled)	0x3F
Mode_Preselect	0x03 or 0x08 or 0x09 or 0x0E	0x46
Repeater_Enable	0x01 (enabled)	0x52

Table 2: UserSettings Requirements

An additional requirement is that no frame preloading shall be used when the repeater mode is enabled. If the preloading is or was used since the latest restart of the module the user is

required to use the `CMD_DATA_CLR_PRELOAD_REQ` command (`0xFF 31 00 CE`) in order to clear the preloaded frame from the queue.

Preloading is obsolete since firmware version 2.8.0 and shall not be used anymore.

The command `CMD_SET_MODE_REQ` shall never be used when the repeater mode is active. Doing so will disable the repeater function.

3.1 Configuration using CMD_SET_REQ

By using the following `CMD_SET_REQ` sequence followed by a `CMD_RESET_REQ` the settings to enable the repeater mode will be applied to the non-volatile memory of the module.

Because of the nature of the firmware design radio packets have the highest priority in the shared buffer. Please perform such setting sequences only in non radio polluted environments or by using the ACC PC Software.

You are encouraged to check the currently configured values by using `CMD_GET_REQ` before using a `CMD_SET_REQ` to avoid unnecessary flash erase/write cycles as this resource is limited by the hardware.

First check the firmware version of the module by executing `CMD_GET_FWVERSION_REQ` (`0xFF 0C 00 F3`). If the response indicates firmware version 2.8.0 (`0x02 08 00`) or higher you are good to proceed.
If you still have an old firmware version use ACC to update to the most recent firmware before proceeding.

Revert to factory defaults
`CMD_FACTORYRESET_REQ: 0xFF 11 00 EE`
All UserSettings are reverted to factory defaults.

Restart module to apply factory defaults
`CMD_RESET_REQ: 0xFF 05 00 FA`
The Factory defaults are loaded into RuntimeSettings, the UART is now using 9600 Baud 8n1.

Please adjust the UART baudrate of your host to 9600 Baud after the reset to be able to still communicate with the module.

Set the UART speed to 115200 Baud 8n1
`CMD_SETUARTSPEED_REQ: 0xFF 10 01 07 E9`
All UART speed related UserSettings are updated by this command accordingly.
Factory default: 9600 Baud 8n1

Revert to factory defaults
`CMD_RESET_REQ: 0xFF 05 00 FA`
The UART baudrate is now using 115200 Baud 8n1.

Please adjust the UART baudrate of your host to 115200 Baud after the reset to be able to still communicate with the module.

Set the Mode_Preselect to either S2 or C2_T2_Other
For using S2 mode a reconfiguration is not required.
For C2_T2_Other mode use `CMD_SET_REQ: 0xFF 09 03 46 01 09 BB`
Factory default: S2 mode

Enable Command Output mode
`CMD_SET_REQ: 0xFF 09 03 05 01 01 F0`
Factory default: disabled

Your host needs to implement the Command Interface as specified in the wM-BUS manual plus the additional command `CMD_RP_DATA_IND` defined in chapter 4 in this document.

Enable repeater mode
`CMD_SET_REQ: 0xFF 09 03 52 01 01 A7`
Factory default: disabled

Reset module
`CMD_RESET_REQ: 0xFF 05 00 FA`
This will reset the module and activate the settings done above.

3.2 Supported wireless M-BUS modes for the repeater

The single-hop unidirectional repeater requires to receive radio frames. For example all wM-BUS modes containing a "1" are send-only modes and can therefore not be used when the repeater mode shall be enabled.
Thus we limited the wM-BUS modes to the following set to provide the functionality of the repeater mode.

- S2 mode, Mode_Preselect value 0x03
- T2-Other mode, Mode_Preselect value 0x08
- C2-T2-Other mode, Mode_Preselect value 0x09
- C2-Other mode, Mode_Preselect value 0x0E

By using these modes the repeater receives as if it would be a data collector or Smart Meter Gateway and repeats the frames as if it would be a meter, so that the repeated frames (with hop counter changed to ’1’) can be received by other data collectors and Smart Meter Gateways.

3.3 Energy consumption

By its very nature the repeater has the radio receive mode activated permanently when not sending a frame. In regard to a battery operated device this means that the battery will be drained quite fast. The typical RX current is around 30 mA and the typical TX current is around 53 mA.
Therefore the recommendation for a repeater is to be used in mains-powered devices and products only.

4 CMD_RP_DATA_IND

This UART frame will indicate towards the host that a frame was successfully repeated.

4.1 Example 1

The indication will share further parameters that can be used by the host system to trace the utilization of the buffers as well as to trace the duty cycle used by the repeater mode. The 1 byte buffer ID is an unsigned buffer index number indicating which internal buffer of the module the repeated frame was using.
The 2 byte parameter duration states the TX duration in milliseconds of the repeated frame which successful transmission is indicated by this indication message. The module calculates this value dependent on the wireless M-BUS mode, radio frame length and frame format used to repeat this frame.
CS is as usual in the command mode the XOR concatenation of all preceding bytes starting with the start signal 0xFF.

start signal	command	length	buffer ID	duration	CS
0xFF	0x07	0x03	<buf ID>	<LSB, MSB>	<cs>

5 Duty cycle requirements

Citation from ETSI EN 300 220-1 V3.1.1 (Feb 2017) chapter 5.4.1, which is required to conform to the RED and CE, at the time this Application Note was written:

Duty cycle is the ratio expressed as a percentage, of the cumulative duration of transmissions T_{on_cum} *within an observation interval* T_{obs}. $DC = \left(\frac{T_{on\_cum}}{T_{obs}}\right)_{F_{obs}}$ *on an observation bandwidth* F_{obs}. *Unless otherwise specified,* T_{obs} *is 1 hour and the observation bandwidth* F_{obs} *is the operational frequency band. Each transmission consists of an RF emission, or sequence of RF emissions separated by intervals* $< T_{Dis}$.

The manufacturer of the end product has sole and ultimate responsibility for the conformity of the end product to the applicable directives, whether he designed and manufactured the product himself or is considered as a manufacturer because the product is placed on the market "under his name".

The following table shows the duty cycle for the frequency bands supported by our 868 MHz wireless M-BUS modules. The wireless M-BUS standard does specify the channel access to be random. But it does not not specify to implement any channel access methods and due to timing parameters this would cause a EN13757 compliance problems. Thus polite spectrum accesss (PSA) of the RED cannot be applied to increase the duty cycle.
For the repeater functionality only the role "meter to other" is used for TX operations.

wM-BUS mode	wM-BUS role	Frequency	Duty cycle	Time per hour
S	meter to other	868.300 MHz	1 %	36s
S	other to meter	868.300MHz	1 %	36s
T	meter to other	869.950 MHz	0.1 %	3.6s
T	other to meter	868.300 MHz	1 %	36s
C	meter to other	869.950 MHz	0.1 %	3.6s
C	other to meter	869.525 MHz	10 %	360s

Table 3: Duty cycle as required by ETSI EN 300 200-2 V3.1.1 for all wM-BUS modes in 868 MHz Bands

6 Important notes

The Application Note and its containing information ("Information") is based on Würth Elektronik eiSos GmbH & Co. KG and its subsidiaries and affiliates ("WE eiSos") knowledge and experience of typical requirements concerning these areas. It serves as general guidance and shall not be construed as a commitment for the suitability for customer applications by WE eiSos. While WE eiSos has used reasonable efforts to ensure the accuracy of the Information, WE eiSos does not guarantee that the Information is error-free, nor makes any other representation, warranty or guarantee that the Information is completely accurate or up-to-date. The Information is subject to change without notice. To the extent permitted by law, the Information shall not be reproduced or copied without WE eiSos' prior written permission. In any case, the Information, in full or in parts, may not be altered, falsified or distorted nor be used for any unauthorized purpose.

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