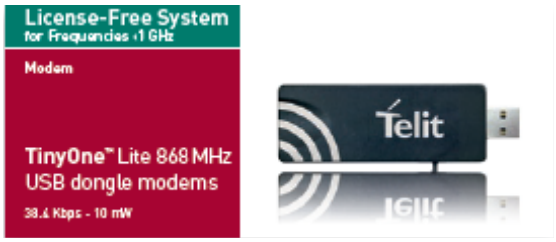
Telit Wireless M-Bus User Guide

1vv0300828 Rev.2 – 30/03/2010

This document is related to the following products:



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CHAPTER I. INTRODUCTION

I.1. Aim of the Document

The aim of this document is to present the features and the application of the Wireless M-Bus embedded stack available on some references of TELIT TinyOne LITE family. It is applicable for:

- TinyOne Lite 868MHz OEM module
- TinyOne Lite 868MHz USB Dongle

After the introduction, the characteristics of Wireless M-Bus will be described within the following distinct chapters:

- general description
- hardware consideration
- detailed functioning
- application

I.2. Reference documents

[1] EN 300 220-2 v2.1.1	ETSI Standards for SRD , April 2006
[2] ERC Rec 70-03	ERC Recommendation for SRD, May 2007
[3] EN 13757- part 1 to 4	Communication system for meters and remote reading of meters
[4] TinyOne Lite 868MHz User Guide	1vv0300825
[5] TinyOne Lite USB Dongle User Guide	1vv0300871

I.3. Document change log

Revision	Date	Changes
ISSUE # 0	04/05/09	First Release
ISSUE # 1	17/09/09	Updated product applicability Updated graphics in Chapter V
ISSUE # 2	30/03/10	Added information on activation of S1-m mode Updated format of firmware version string Updated S440 register description

I.4. Glossary

ACP	Adjacent Channel Power
BER	Bit Error Rate
Bits/s	Bits per second (1000 bits/s = 1Kbps)
CER	Character Error Rate
dBm	Power level in decibel milliwatt (10 log (P/1mW))
EMC	Electro Magnetic Compatibility
EPROM	Electrical Programmable Read Only Memory
ETR	ETSI Technical Report
ETSI	European Telecommunication Standard Institute
FM	Frequency Modulation
FSK	Audio Frequency Shift Keying
GFSK	Gaussian Frequency Shift Keying
GMSK	Gaussian Minimum Shift Keying
IF	Intermediate Frequency
ISM	Industrial, Scientific and Medical
kbps	kilobits/s
kcps	kilochips/s
LBT	Listen Before Talk
LNA	Low Noise Amplifier
M-Bus	Meter Bus
MHz	Mega Hertz (1 MHz = 1000 kHz)
PLL	Phase Lock Loop
PROM	Programmable Read Only Memory
NRZ	Non return to Zero
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RSSI	Receive Signal Strength Indicator
Rx	Reception
SRD	Short Range Device
Tx	Transmission
SMD	Surface Mounted Device
VCO	Voltage Controlled Oscillator
VCTCXO	Voltage Controlled and Temperature Compensated Crystal Oscillator

CHAPTER II. GENERAL DESCRIPTION OF WIRELESS M-BUS

II.1. Definition of Wireless M-Bus

M-Bus (Meter-Bus) is a European Standard (**[3]**) for the remote reading of gas, water or electricity meters. M-Bus is also usable for other types of consumption meters. The M-Bus interface is made for communication on two wires, making it very cost effective.

This protocol exists with several physical layers such as paired wires, optical fiber or radio link.

The radio variant of M-Bus is called Wireless M-Bus and is specified in EN 13757-4. It is dedicated to the European ISM frequency band at 868MHz. It means that modules embedding the Wireless M-bus stack must comply with the general SRD standard EN 300-220 (**[1]**).

II.2. Wireless M-Bus Presentation

The Wireless M Bus specification defines 3 different ways to exchange data with remote meters:

- mode S 'Stationary'
- mode T 'frequent Transmit'
- mode R 'frequent Receive'.

1. Mode T

In mode T, the meter sends spontaneously data, either periodically or stochastically.

- In Mode T1, the meter doesn't care if any receiver is present or not. The meter sends data and returns immediately in IDLE without waiting for an ACK. This is a unidirectional communication.
- In mode T2 the meter sends its data and stays awake during a short time immediately after transmission to listen to a possible ACK. If no ACK is received, the meter returns in IDLE. If an ACK is received, then a bidirectional communication link is opened between meter and concentrator.

2. Mode R2

In mode R2, the meter doesn't send spontaneously data. The meter wakes up periodically in RX mode and waits for a wakeup frame received from concentrator. If no frame is received, the meter returns in IDLE. If a valid wakeup frame is received, a bidirectional link is then opened between meter and concentrator.

3. Mode S

- Mode S1 operates exactly as mode T1 (unidirectional spontaneous transmission) but uses a different radio link described below.
- Mode S2 has the same behaviour as mode R (periodic wake up and wait for a wakeup frame before transmitting) but also with a different physical link.

II.3. Physical link

Wireless M-Bus can use 3 different radio links, depending on baud rate and coding format. Moreover short or long preamble can be used depending of used mode.

4. Radio Link A

This radio link operates at 868.3 MHz, the radio baud rate is 32.768 kcps and data coding is Manchester.

5. Radio Link B

This radio link operates at 868.95 MHz, the baud rate is 100 kcps and data coding is “3 out of 6”.

6. Radio Link C

This radio link operates at 868.03 MHz, the baud rate is 4.8 kcps and data coding is Manchester.

This paper is software oriented to describe the stack behaviour and features, for details about radio such as modulation, deviation etc. please refer to EN13757-4 documentation.

II.4. Data format on RF Link

For all modes and whatever is the radio link used, the packet format is always the same:

Preamble	Block 1	Block 2	Optional Block(s) n	Postamble

Packet format

L-Field	C-Field	M-Field	A-Field	CRC-Field
1 byte	1 byte	2 byte	6 byte	2 bytes

Block 1 format

CI-Field	Data-Field	CRC-Field
1 byte	15 bytes or (((L-9) mod 16) -1) bytes	2 bytes

Block 2 format

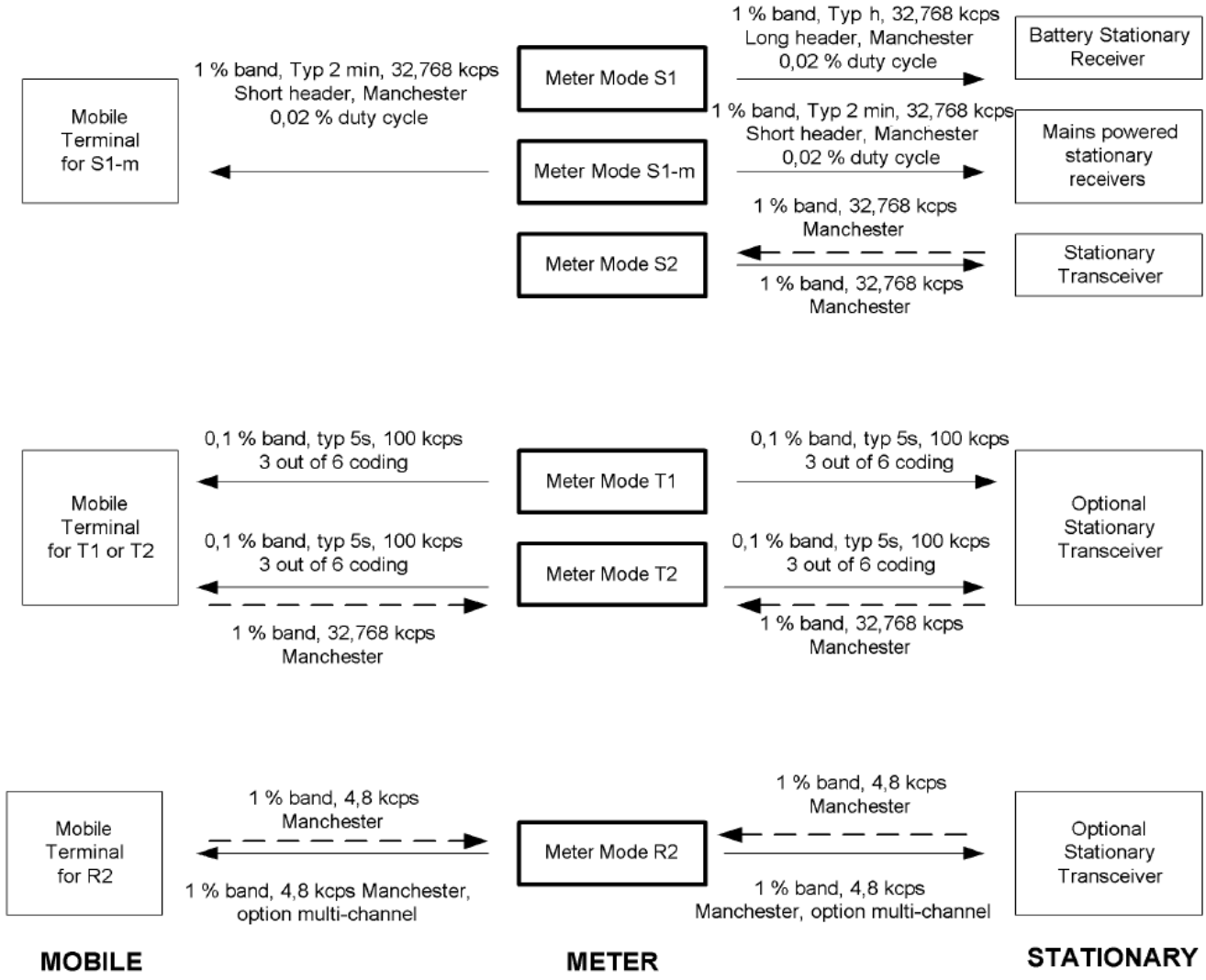
Data-Field	CRC-Field
16 bytes or ((L-9) mod 16) bytes	2 bytes

Block(s) n format

L-Field is the Length indication
C-Field is the communication indication (request, send, response expected, ACK…)
M-Field is the Manufacturer ID
A-Field is the unique address of the device
CI-Field is the Control Information to indicates the protocol used to the upper layer
CRC-Field is the Cyclic Redundancy Check

11.5. Summary

This drawing from EN13757-4 clearly summarizes the different Wireless M-Bus modes and the link details used in each case.



CHAPTER III. HARDWARE CONSIDERATION

As specified earlier, the Wireless M-Bus stack is available on some references of TELIT TinyOne family. It is applicable for:

- TinyOne Lite 868MHz (RF module and USB Dongle)

Within this chapter, we will focus on hardware description of RF modules and necessary specification for integration in a final application. For Terminal and USB Dongles, please refer to appropriate user guide (**[5]**).

III.1. TinyOne Lite 868MHz Modules

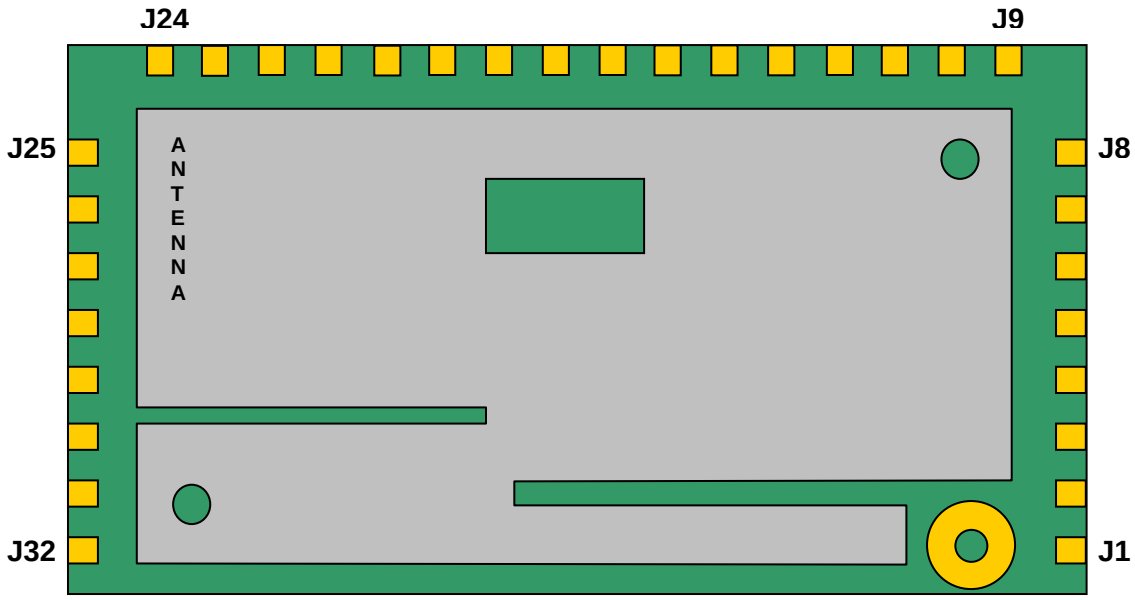
Below is a summary of TinyOne Lite 868MHz RF module specifications for Wireless M-Bus:

Characteristics	
Power Supply	2.2 to 3.6 V
Frequency band :	868.0 – 868.6 MHz (Radio Link A) 868.7 – 869.2 MHz (Radio Link B) 868.0 – 868.6 MHz (Radio Link C)
Radio channels	1 (Radio Link A) 1 (Radio Link B) 10 (Radio Link C)
Radio bit rate :	32.768 kcps (Radio Link A) 100 kcps (Radio Link B) 4.8 kcps (Radio Link C)
Output Power @3.6V :	Adjustable : from 1mW to 10mW
Sensitivity	-100dBm ± 2dB (@ 32.768 kcps)
Tx Power consumption @10mW	45 mA
Rx Power consumption	30mA
Stand-by consumption ***- External wakeup (interrupt)*** ***- Cyclic wakeup (internal timer running)***	 2µA 4µA

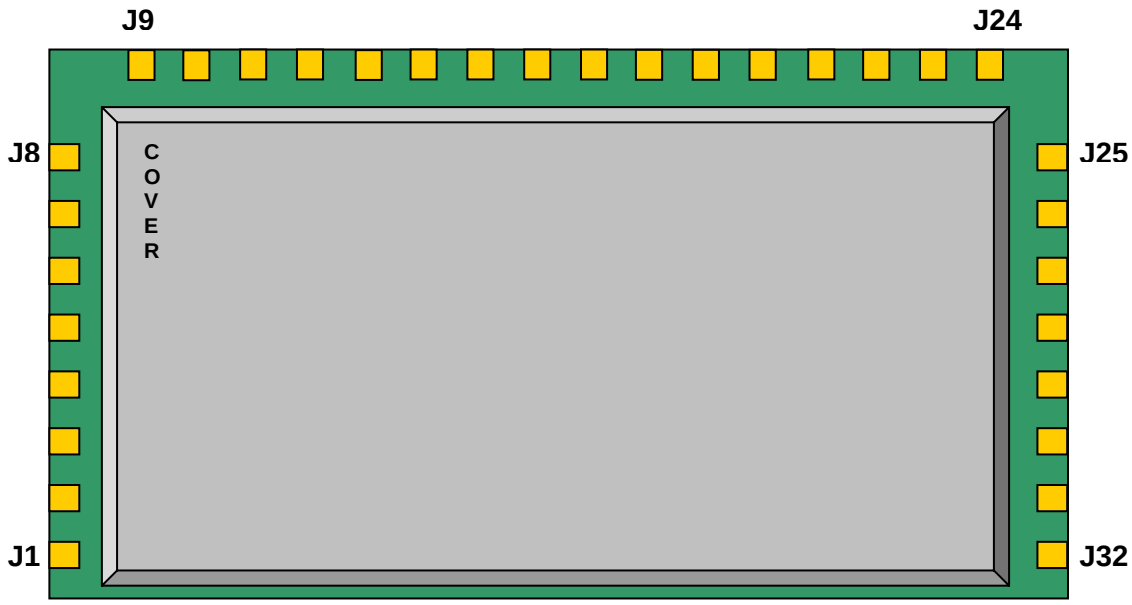
The TinyOne Lite 868MHz RF module is available either with an integrated antenna or without antenna.
For detailed information about power consumption of the module into a Wireless M-Bus application, please refer to the chapter V.

III.2. Hardware Description

7. Views of the module : TinyOne Lite



Top view of the radio module (with or without antenna upside)



Bottom view of the radio module (with metallic cover upside)

8. Pin-out

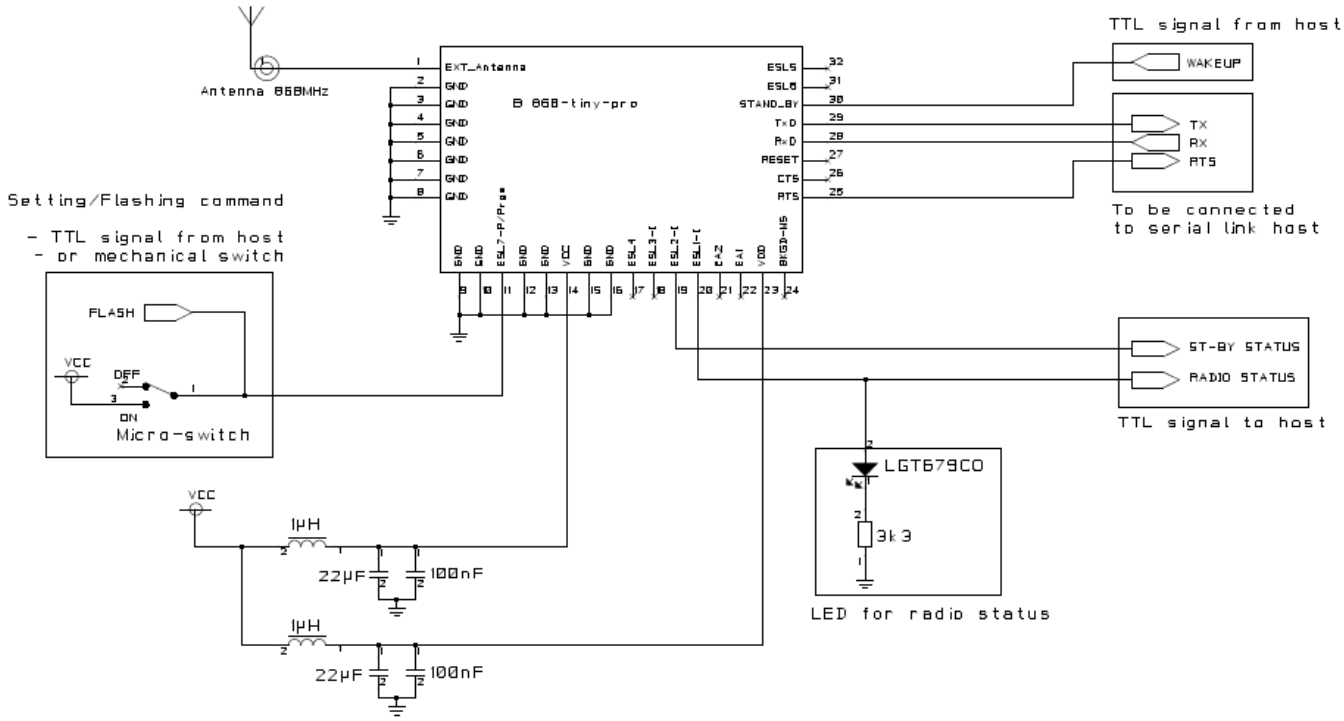
This list below must be taken as a reference for Wireless M-Bus stack. Some signals are renamed compared to the module with standard firmware (**[4]**).

Pin	Interface function	I/O	Signal level	Function
J32	I/O6	I/O	TTL	Digital I/O, interrupt Input capable By default, configured as output to ground *(not connected if not used)*
J31	I/O5	I/O	TTL	Digital I/O, interrupt Input capable By default, configured as output to ground *(not connected if not used)*
J30	WAKEUP	I	TTL	Signal to wake-up the module in stand-by mode *(not connected if not used)*
J29	TXD	O	TTL	TxD UART – Serial Data Transmission
J28	RXD	I	TTL	RxD UART – Serial Data Reception
J27	RESET	I	TTL	Signal for resetting the module
J26	-	-	-	*Not connected*
J25	RTS	O	TTL	Request To Send *(not connected if not used)*
J24	-	-	-	*Not connected*
J23	V_{DD}	-	-	Digital part supply
J22	I/O4	I/O	analog	Digital I/O, Analog Input (10 bits) capable By default, configured as output to ground *(not connected if not used)*
J21	I/O3	I/O	analog	Digital I/O, Analog Input (10 bits) capable By default, configured as output to ground *(not connected if not used)*
J20	RADIO STATUS	-	-	Signal indicating reception or transmission of radio frame *(not connected if not used)*
J19	STAND BY STATUS	O	TTL	Signal indicating stand by status. *(not connected if not used)*

J18	I/O2	I/O	TTL	Digital I/O, interrupt Input capable By default, configured as output to ground *(not connected if not used)*
J17	I/O1	I/O	analog	Digital I/O, Analog Input (10 bits) capable By default, configured as output to ground *(not connected if not used)*
J16	GND	-	-	Ground
J15	GND	-	-	Ground
J14	V_{CC}	-	-	Radio part supply
J13-J12	GND	-	-	Ground
J11	PrgS	I	TTL	Signal for serial setting or flashing.
J10-J02	GND	-	-	Ground
J01	RF_Antenna	O	-	RF connection to external antenna

9. Typical application circuit

Below is given a typical application circuit using TinyOne module.



CHAPTER IV. DETAILED FUNCTIONING

There are 2 different modes :

- The ***configuration mode*** which allows to parameter the module. It is set through the use of Hayes commands sent on the serial link.
- The ***operating mode*** which is the functional mode for data transmission.

IV.1. Configuration Mode

Hayes or 'AT' commands comply with Hayes protocol used in PSTN modem standards. This ‘AT’ protocol or Hayes mode is used to configure the modem parameters, based on the following principles:

- A data frame always begins with the two ASCII ’AT’ characters, standing for ‘ATtention’
- Commands are coded over one or several characters and may include additional data
- A given command always ends with a <CR> Carriage Return

A	*T*	*Command*	*Additional data*	*<CR>*

Note: The delay between 2 characters of the same command must be less than 10 seconds

The only exception to this data-framing rule is the switching command from the operating/communication mode to ‘AT Mode’. In this case only, the escape code (‘+++’) must be started and followed by a silent time at least equal to the serial time out. In this case only <AT> and <CR> shall not be used.

Below is the complete list of the 'AT' commands available on the module.

Command	Description
+++	***Hayes Mode Activation*** '+++' command gives an instant access to the modem's parameters configuration mode (Hayes or AT mode), whatever the current operating mode in process might be. '+++' command should be entered as one string, i.e. it should not be preceded by 'AT' and followed by <CR> but two silent times whose duration is configurable via S214 register (Serial time-out). The time between two '+' must not exceed the time-out value. Hayes mode inactivates radio functions. Answer : OK
ATO	***Communication mode activation*** 'ATO' command gives an instant access to the modem's operating mode, configured in S220 register. 'ATO' command is used to get out of Hayes mode. Answer : OK or ERROR if the configuration is not complete
AT/V	***Modem's firmware version*** 'AT/V' command displays the modem's firmware and bootloader version number as follows: DX.UP0.MM.mm-Bbbb<CR>DX.B00.NN.nn With: DX indicating the Tiny Lite platform UP0: U means M-Bus stack, P=0 for OEM boards, P=1 for USB dongle MM: major version number of firmware mm: minor version number of firmware Bbbb: build number of firmware NN: major version number of bootloader nn: minor version number of bootloader Example: DX.U10.01.02-B011<CR>DX.B00.01.10 indicates an M-Bus stack V1.02 (Build 011) for Tiny Lite in USB dongle casing, plus a bootloader V1.10
ATSn?	***Register interrogation*** 'ATSn?' command displays the content of Hayes register number n (Refer to the register description table). Some registers are standard for every Telit modems while others are specific to some products. Answer : Sn=x or ERROR if syntax problem or invalid register
ATSn=m	***Register modification*** 'ATSn=m' command configures Hayes register number n with the value m, e.g. ATS200=4<CR> enters the value '4' in the register S200. The value is automatically stored in the EEPROM memory. Answer : OK or ERROR
ATR	***Parameters reset*** 'ATR' command resets all modem's parameters to their default values. Answer : OK or ERROR
ATBL	***Switch to Bootloader***

	'ATBL' command exits from the main program and runs the bootloader. This command is useful to update the firmware by serial or radio link. See the dedicated part for details. Answer : OK or ERROR
ATT	***Modulated carrier transmission*** Continuous modulated carrier, simulating transmission of '010101' data. Answer : OK or ERROR This command is stopped by sending a character on the serial link Answer: No answer when exiting ATT

Note 1: *After an AT command (ended by <CR>), the serial link gives back result code, "OK" or "ERROR".*

Note 2: *"+++" command gives back OK.*

Note 3: *These commands are effective after a maximum delay of 10 mS; the result code OK indicates the good execution of the command, and another command can be sent right after the result code.*

IMPORTANT
All registers are accessible in read and write without any control. The values entered are not checked.

It is the responsibility of the user to enter correct value in correct register and to perform only authorized access according 'R' or 'R/W' mentioned in the list below.

IV.2. Registers List

Numbers in **bold** indicate the default value

Access	Register	Name	Description
		General	
R	S192	Serial Number	Serial number of the module, the one present on the sticker. Read-only register. Ex: *DXCG5100729<CR>*
		Functional	
R/W	S400	M-Bus Mode	Indicates the M-Bus mode on which the module works : • **'0': mode S1-meter (default)** • '1': mode S1-other • '2': mode S2-meter • '3': mode S2-other • '4': mode T1-meter • '5': mode T1-other • '6': mode T2-meter • '7': mode T2-other

<table>
<tr><td></td><td></td><td></td><td>

- '8': mode R2-meter
- '9': mode R2-other

Note: To activate S1-m mode, select S1 in this register and then act on preamble length in S421 register.
</td></tr>
<tr><td rowspan="2">R/W</td><td rowspan="2">S401</td><td>Serial Rx Format</td><td>Indicates the serial format options for serial frame sent from user to the RF module</td></tr>
<tr><td colspan="2">

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved (Write 0)	Reserved (Write 0)	Reserved (Write 0)	CI Field	A Field	M Field	C Field	Length

Default value : 0

- Bit 0: indicates if Length Field is activated (1) or not (0)
- Bit 1: indicates if C Field is activated (1) or not (0)
- Bit 2: indicates if M Field is activated (1) or not (0)
- Bit 3: indicates if A Field is activated (1) or not (0)
- Bit 4: indicates if CI Field is activated (1) or not (0)
</td></tr>
</table>

<table>
<tr><td>R/W</td><td>S402</td><td>Serial Tx Format</td><td>Indicates the serial format options for serial frame sent from RF module to user</td></tr>
<tr><td colspan="4">
<table>
<tr><th>Bit 7</th><th>Bit 6</th><th>Bit 5</th><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Bit 1</th><th>Bit 0</th></tr>
<tr><td>Reserved (Write 0)</td><td>0xFF Wake Up Char</td><td>RSSI</td><td>CI Field</td><td>A Field</td><td>M Field</td><td>C Field</td><td>Length</td></tr>
</table>
Default value : 0

- Bit 0: indicates if Length Field is activated (1) or not (0)
- Bit 1: indicates if C Field is activated (1) or not (0)
- Bit 2: indicates if M Field is activated (1) or not (0)
- Bit 3: indicates if A Field is activated (1) or not (0)
- Bit 4: indicates if CI Field is activated (1) or not (0)
- Bit 5: indicates if RSSI Field is activated (1) or not (0)
- Bit 6: indicates if Wake-up Character is activated (1) or not (0)
</td></tr>
<tr><td colspan="4"><u>Field</u></td></tr>
<tr><td>R/W</td><td>S410</td><td>C Field</td><td>Indicates the C Field value (Byte 0) when not activated on serial format (Bit 1 of S401 register). From 0 to 255.
Default : 68</td></tr>
<tr><td>R/W</td><td>S411</td><td>M Field_Byte0</td><td>Indicates the M Field value (Byte 0) when not activated on serial format (Bit 2 of S401 register). From 0 to 255.
Default : 174</td></tr>
<tr><td>R/W</td><td>S412</td><td>M Field_Byte1</td><td>Indicates the M Field value (Byte 1) when not activated on serial format (Bit 2 of S401 register). From 0 to 255.
Default : 12</td></tr>
<tr><td>R/W</td><td>S413</td><td>A Field Byte0</td><td>Indicates the A Field value (Byte 0) when not activated on serial format (Bit 3 of S401 register). From 0 to 255.
Default : 120</td></tr>
<tr><td>R/W</td><td>S414</td><td>A Field Byte1</td><td>Indicates the A Field value (Byte 1) when not activated on serial format (Bit 3 of S401 register). From 0 to 255.
Default : 86</td></tr>
<tr><td>R/W</td><td>S415</td><td>A Field Byte2</td><td>Indicates the A Field value (Byte 2) when not activated on serial format (Bit 3 of S401 register). From 0 to 255.
Default : 52</td></tr>
<tr><td>R/W</td><td>S416</td><td>A Field Byte3</td><td>Indicates the A Field value (Byte 3) when not activated on serial format (Bit 3 of S401 register). From 0 to 255.
Default : 18</td></tr>
</table>

<table>
<tr><td>R/W</td><td>S417</td><td>A Field Byte4</td><td>Indicates the A Field value (Byte 4) when not activated on serial format (Bit 3 of S401 register). From 0 to 255.
Default : 1</td></tr>
<tr><td>R/W</td><td>S418</td><td>A Field Byte5</td><td>Indicates the A Field value (Byte 5) when not activated on serial format (Bit 3 of S401 register). From 0 to 255.
Default : 7</td></tr>
<tr><td>R/W</td><td>S419</td><td>CI Field</td><td>Indicates the CI Field value when not activated on serial format (Bit 4 of S401 register). From 0 to 255.
Default : 120</td></tr>
<tr><td colspan="4"><u>Radio</u></td></tr>
<tr><td>R/W</td><td>S420</td><td>Radio Channel</td><td>Indicates the radio channel (for R2 mode only). From 0 to 9
Default : 0</td></tr>
<tr><td>R/W</td><td>S421</td><td>Preamble Length</td><td>Indicates if the preamble of the radio frame is short or long (for S mode only) :
'0': short preamble (default)
'1': long preamble
Note: When using S1 mode, this register allows the module to work either in sub-mode S1-m (short preamble) or in normal S1 mode (Long preamble).</td></tr>
<tr><td>R/W</td><td>S422</td><td>Radio Output Power</td><td>Indicates the output power of the RF module :
'0': 0 dBm
'1': +5 dBm
'2': +10 dBm (default)</td></tr>
<tr><td colspan="4"><u>Serial</u></td></tr>
<tr><td>R/W</td><td>S430</td><td>Serial Speed</td><td>Indicates the speed on the serial link :
'1': 1200 bits/s
'2': 2400 bits/s
'3': 4800 bits/s
'4': 9600 bits/s
'5': 19200 bits/s (default)
‘6’: 38400 bits/s
‘7’: 57600 bits/s
'8': 115200 bits/s</td></tr>
<tr><td>R/W</td><td>S431</td><td>Serial Time-Out</td><td>Indicates the value of the time-out on the serial link when Length Field is not activated.
Between 2 and 100 milliseconds
Default : 5
The time out value must be compatible with the serial speed.
<table>
<tr><th>Min. time-out</th><th>Serial Speed</th></tr>
<tr><td>17 ms</td><td>1200 bits/s</td></tr>
<tr><td>9 ms</td><td>2400 bits/s</td></tr>
<tr><td>5 ms</td><td>4800 bits/s</td></tr>
<tr><td>3 ms</td><td>9600 bits/s</td></tr>
<tr><td>2 ms</td><td>⩾19200 bits/s</td></tr>
</table></td></tr>
</table>

<table>
<tr><td>R/W</td><td>S432</td><td>Serial Type</td><td>Selects the type of serial link used (only for Terminal) :
• '0' : RS232 (default)
• '1' : RS422
• '2' : RS485
• '3' : RS485 full duplex</td></tr>
<tr><td colspan="4"><u>Stand-by</u></td></tr>
<tr><td>R/W</td><td>S440</td><td>Wake-Up options</td><td>Indicates the different way to wake-up the RF module.</td></tr>
<tr><td></td><td></td><td colspan="2">
<table>
<tr><th>Bit 2</th><th>Bit 1</th><th>Bit 0</th></tr>
<tr><td>Timer</td><td>Serial</td><td>Low Power enable</td></tr>
</table>
Default value : 0 (No stand-by)

- Bit 0: Set this bit to ‘1’ to activate low power
- Bit 1: activates wake-up on serial character
- Bit 2: activates wake-up on timer (Period set in S442)

<u>Note:</u> if bit 0 is set while bits 1 and 2 are both reset to ‘0’, the only way to wake up the module is to use hardware wakeup pin J30. If one of bits 1 and 2 is set, bit 0 must also be set, otherwise an error response is returned.
</td></tr>
<tr><td>R/W</td><td>S441</td><td>Wakeup Time Out</td><td>Defines the duration between the end of an event (radio or serial exchange) and the return to stand-by. This is useful to keep the module awake between frames during a bidirectional session as defined in mode S2, T2, R2. For modes S1 and T1 this register may set to a low value to save power.

Each time a new event happens, the timer is restarted with the specified value.

More details in §IV.4

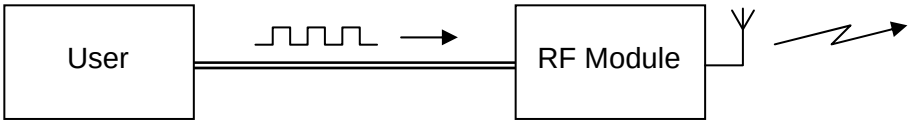
Between 0 and 255 milliseconds.
Default : 0</td></tr>
</table>

R/W	S442	Sleep Time	Defines sleep time in seconds between 2 wake-up events when wake-up timer option is activated in S440 register. Between 0 and 255. 0 indicates a sleep duration of 500 milliseconds Other values indicate directly the sleep duration in seconds. **Default : 1**

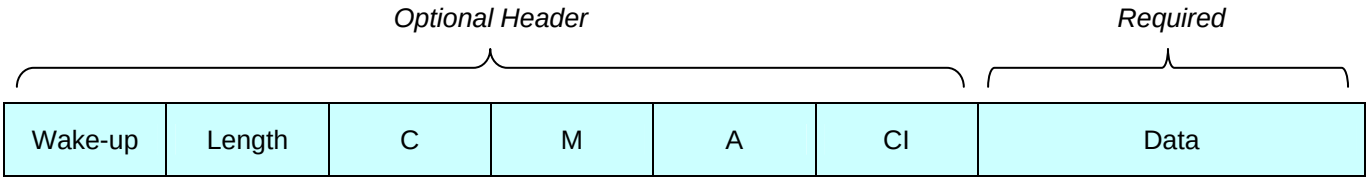
IV.3. Operating Mode

When the module is in operating mode, each frame arriving on the serial link is sent on the radio link, and each valid wireless M-Bus frame received on the radio link is sent on the serial link.
These serial data (Tx or Rx) will have a specific format depending on the module configuration defined through the different registers. It allows a high flexibility in the use of our module in a wireless M-Bus application.

10. Serial frame on transmission



Serial frame arriving on the serial link of the RF module can have one of these formats:



With:

Field	*Length (Bytes)*	*Description*
Wake-up	1	**Wake-up character** If wake up on serial character is activated, the RF module can be triggered by starting the serial frame with a 0xFF or 0x00 character
Length	1	**Length of frame** Giving the serial frame length to the RF module shortcuts the serial time out at the end of RX, leading in a very short wake up duration and very low power results. Using this field allow to save at least 2 ms for each wake up cycle. The RF module considers that the serial frame is complete as soon as the specified length is reached or until the serial time out is spent. Length value should count all subsequent bytes, including other serial options fields if any. Only Wake-up and Length bytes don't enter in the calculation of Length.
C	1	**C field** Option to be used if several applicative layers use the wireless M-Bus link. If only one application is running, the C field can be fixed and specified in the corresponding register
M	2	**Manufacturer and Address fields** Use this option to simplify the maintenance: in case of radio module replacement, the ID is already specified in the host and doesn't need to be set through registers. However this option makes the serial frame longer and increase the work duration (more power consumption). M and A can be activated separately.
A	6	
CI	1	**Control Information field.** It specifies the role of the frame (Request, ACK, ...)

The optional header depends on the different settings of module registers:

- **Wake-up** is necessary if S440-Bit 1 is set to 1
- **Length** is necessary if S401-Bit 0 is set to 1
- **C** is necessary if S401-Bit 1 is set to 1
- **M** is necessary if S401-Bit 2 is set to 1
- **A** is necessary if S401-Bit 3 is set to 1
- **CI** is necessary if S401-Bit 4 is set to 1

Examples:

S401 = 31 and S440 = 2 or 3 or 6 or 7
Serial frame must have this format:

Wake-up	Length	C	M	A	CI	Data

S401 = 30 and S440 = 2 or 3 or 6 or 7
Serial frame must have this format:

Wake-up	C	M	A	CI	Data

S401 = 17 and S440 = 2 or 3 or 6 or 7
Serial frame must have this format:

Wake-up	Length	CI	Data

S401 = 31 and S440 = 1 or 5
Serial frame must have this format:

Length	C	M	A	CI	Data

Whatever is the serial frame format, data on RF link will always have the same format, described §II.4. In case of one or several fields (except Wake-up) is not activated on the serial frame, the RF module will use the value defined in the corresponding register.

Examples:

If serial frame has this format:

Length	Data (10 Bytes)

On the RF link, data will have the following format:

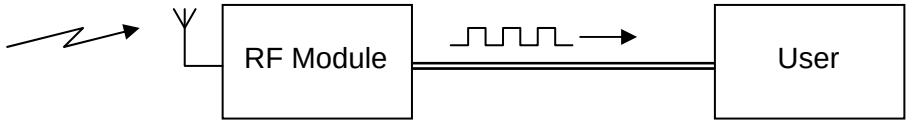
Preamble

L-Field	*C-Field*	*M-Field*	*A-Field*	*CRC-Field*
Length	S410 value	S411-412 value	S413-414-415-416-417-418 value	2 bytes

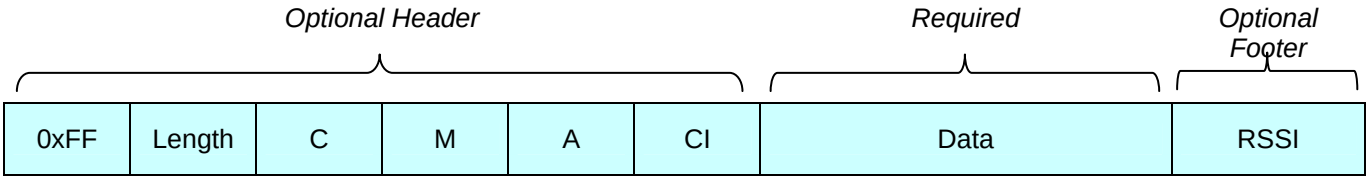
CI-Field	*Data-Field*	*CRC-Field*
S419 value	Data (10 Bytes)	2 bytes

Postamble

11. Serial frame on reception



Serial frame sent on the serial link by the RF module will have one of these formats:



With :

Field	Length (Bytes)	Description
0xFF	1	**Wake-up character** Very useful especially in mode S2 and R2 to work as “Wake On Radio” way. In these modes the user can be woken up by serial if a valid radio frame is received. This option comes in addition to the “Stand-by Status” signal.
Length	1	**Length of frame** Indicates to the user the length of serial frame he is receiving. Length value takes into account all subsequent bytes, including other serial options fields if any. Only Wake-up (0xFF) and Length bytes don’t enter in the calculation of Length.
C	1	**C field** Option to be used if several applicative layers use the wireless M-Bus link. If only one application is running, the C field can be fixed and specified in the corresponding register
M	2	**Manufacturer and Address fields** It indicates the sender ID of the received frame. M and A can be activated separately.
A	6	
CI	1	**Control Information field.** It specifies the role of the frame (Request, ACK, ...)
RSSI	1	**RSSI** This byte placed at the end of the serial frame indicates the level of radio reception, from 0 (poor) to 3 (excellent).

The optional header and footer depend on the different settings of module registers:

- **Wake-up** will be added if S402-Bit 6 is set to 1
- **Length** will be added if S402-Bit 0 is set to 1
- **C** will be added if S402-Bit 1 is set to 1
- **M** will be added if S402-Bit 2 is set to 1
- **A** will be added if S402-Bit 3 is set to 1
- **CI** will be added if S402-Bit 4 is set to 1
- **RSSI** will be added if S402-Bit 5 is set to 1

Examples:

S402 = 127
Serial frame will have this format:

Wake-up	Length	C	M	A	CI	Data	RSSI

S402 = 126
Serial frame will have this format:

Wake-up	C	M	A	CI	Data	RSSI

S402 = 113
Serial frame will have this format:

Wake-up	Length	CI	Data	RSSI

S402 = 31
Serial frame will have this format:

Length	C	M	A	CI	Data

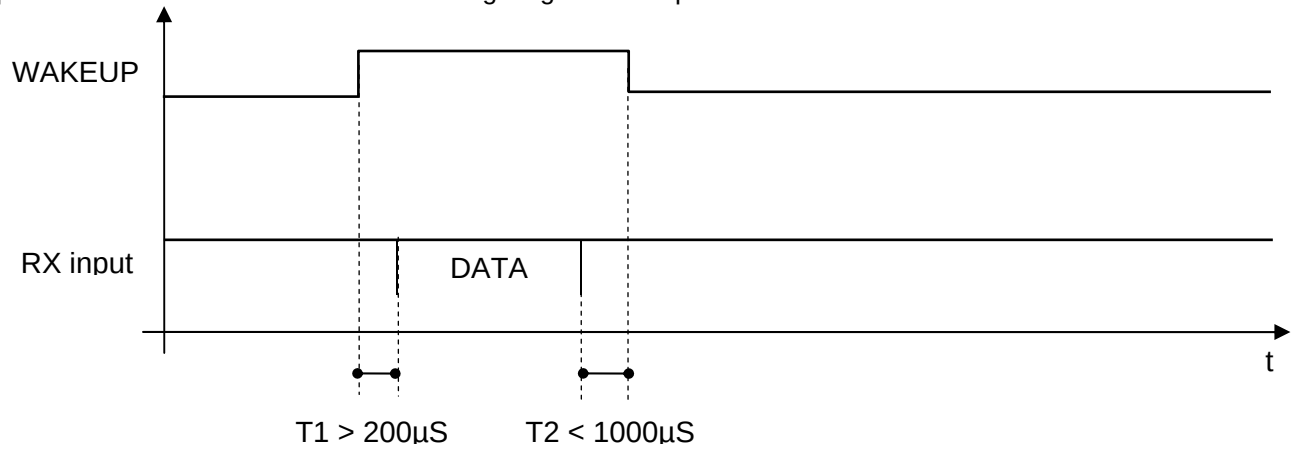
IV.4. Stand-by mode

A key functionality available into the Wireless M-Bus stack is the ability to have RF modules in stand-by mode. During this mode, the RF module has a very low power consumption.

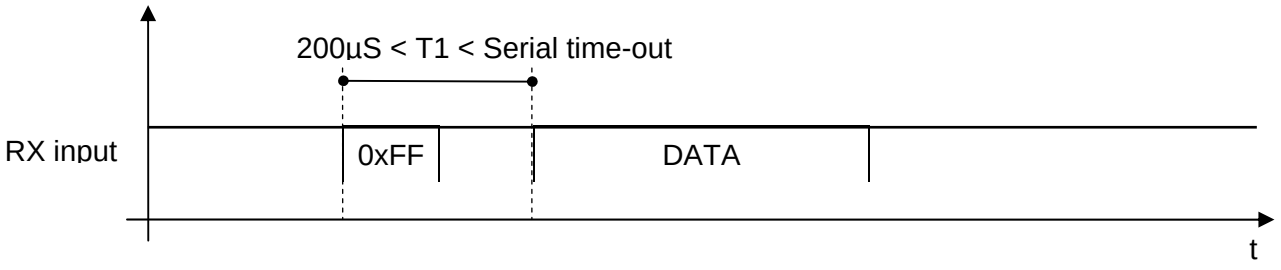
12. Wake-up of the module

There are 3 different ways to wake-up the module, defined by S440 register value.

1. Wake-up on hardware, using wake-up signal (J30): it is always possible to wake-up the module by applying a logical '1' to the 'WAKEUP' signal. When serial transmission is finished, 'WAKEUP' signal must be put back to a logical '0' to allow the module returning in stand-by; else the module is kept awake while Wakeup pin is maintained to '1'. Below is the timing diagram to respect :



2. Wake-up on serial character: it is possible to wake-up the module by sending a 0xFF or 0x00 character at the beginning of the serial frame to send (refer to §IV.3). After sending this frame on the air, the module will stay awake until a new radio or serial event occurs or until timeout defined by S441 is reached. Below is the timing diagram to respect when wakeup by serial char:



For serial data rate up to 57.6 kbps, the 0xFF duration is enough, so there is no need to have a delay between this character and the data frame. For serial data rate 115.2 kbps, a delay is needed to achieve 200µS.

3. Wake-up on timer: it is possible to force the module to wake-up periodically. This cyclic wakeup option is activated by bit 2 of S440 register and the time between 2 wake-up is defined by S442 register value. When wake-up, the module will check the radio link for a valid carrier. If nothing is detected on the air, the module returns immediately to standby. Otherwise, it will wait for a valid frame and then automatically go back to stand-by after a while defined by S441 register value.

Note: When timer is enabled, the stand-by consumption of the RF module is higher (refer to electrical specifications in §III.1 and examples of consumption in §V).

These different wake-up and stand-by modes are strongly related to the wireless M-Bus mode chosen. So that, the user has to correctly set the different registers in accordance with the usage. The following truth table can help for configuration:

	S1	S2	T1	T2	R2
S440 bit 1	✓	✘	✓	✓	✘
S440 bit 2	✘	✓	✘	✘	✓
S441	✓	✓	✓	✓	✓
S442	✘	✓	✘	✘	✓

✓ : to be configured

✘ : not used

13. Wake-up of the external user equipment

There are 2 different ways to wake-up the external user equipment:

1. Through ‘STAND BY STATUS’ output signal (J19): this signal is set to logical ‘1’ while the module is operating and return to ‘0’ during stand-by periods.

2. Through serial character: when the module receives a valid RF frame, it can add a 0xFF character at the beginning of the serial frame to wake-up the external user equipment. This type of functioning is so called “Wake on Radio”.

CHAPTER V. EXAMPLE OF APPLICATION

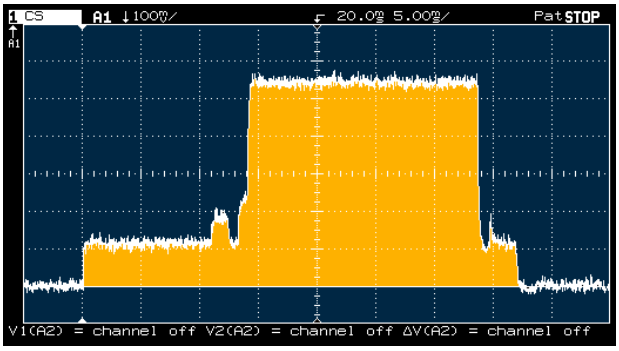
V.1. Power consumption on S1 mode

The following example is using the S1 mode (stationary) of Wireless M-Bus. The stand-by mode is activated, with serial wake-up.

Let suppose that user equipment wakes-up the module to send a 30 bytes frame with serial data rate at 19200bps.

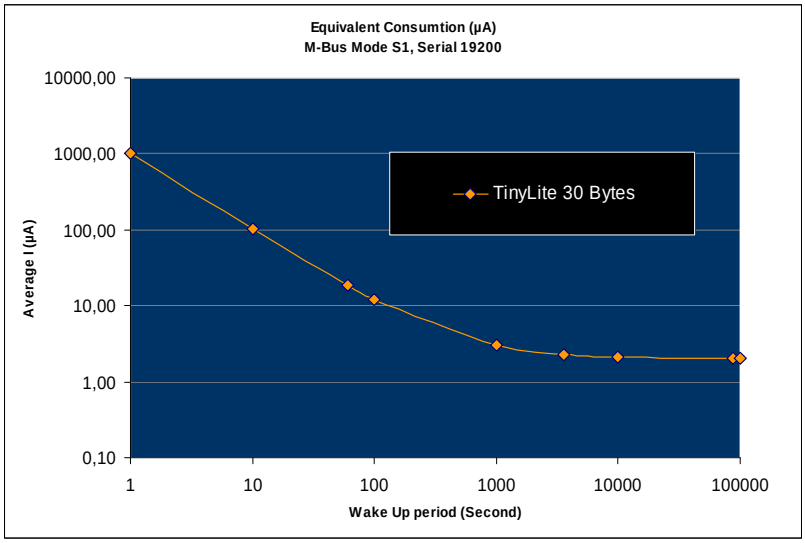
Here is a picture of consumption during transmission cycle. The power supply voltage is 3V. Each such transmission cycle spends typically 628 µA.S.

Horizontal scale: 5ms / division.
Vertical scale: 6.5 mA / division.



Here is a table of average consumption versus the period of transmission period.

Sleep Time	Equivalent Consumption (µA)
1 second	996,96
10 seconds	101,50
1 Minute	18,58
1 Hour	11,95
1 Day	2,99



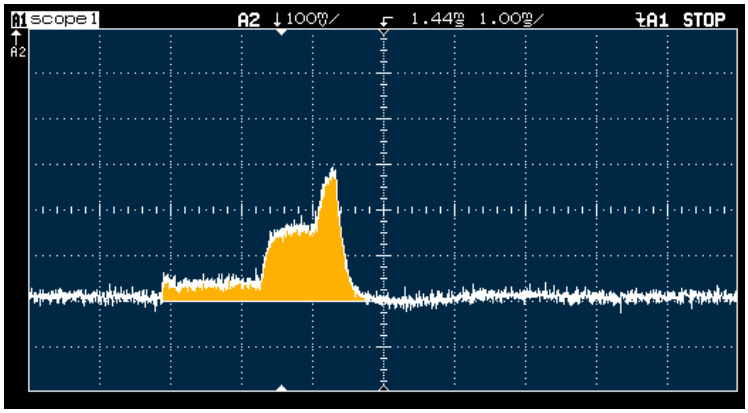
V.2. Power consumption on R2 Mode

The following example is using the R2 mode (frequent receive) of Wireless M-Bus. The stand-by mode is activated, with cyclic wake-up.

With this functioning mode, the meter module wakes up periodically to listen to the radio channel during a very short time. If some activity is detected, the module stays awake to receive the frame, else returns quickly in stand-by mode.

Assuming that the concentrator is rarely present and considering that this band is clear (duty cycle < 1% as requested by ETSI rules [1]), the main current consumption is due to wake up cycles without detection of energy.

Here is a picture of consumption during wake-up cycle. The power supply voltage is 3V. In this case, Wakeup Time Out register S441 has no influence since no event is detected. Each such wake-up cycle spends typically 17 µA.S



Horizontal scale: 1ms / division.
Vertical scale: 6.7 mA / division.
Integration: 17 µA.S

Here is a table of average consumption versus wake-up period (S442 register) when no exchanges are done and no radio perturbation occurs.

Sleep Time	Equivalent Consumption (µA)
1 second	21,0
5 seconds	12,5
10 seconds	7,4
20 seconds	5,7
30 seconds	4,9
1 minute	4,6
2 minutes	4,3