Telit Wireless M-Bus User Guide

1vv0300828 Rev.3 – 2010/11/18

License-Free System
for Frequencies ‹1 GHz

Embedded

TinyOne™ Lite 868 MHz
RF modules

38.4 Kbps - 10 mW

License-Free System
for Frequencies ‹1 GHz

Wireless M-Bus EN13757

Embedded

ME 50 - 868
RF modules

100 Kcps - 25 mW
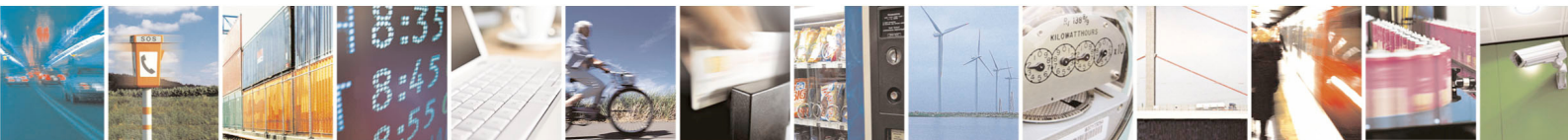
DISCLAIMER

The information contained in this document is the proprietary information of Telit Communications S.p.A. and its affiliates ("TELIT"). The contents are confidential and any disclosure to persons other than the officers, employees, agents or subcontractors of the owner or licensee of this document, without the prior written consent of Telit, is strictly prohibited.

Telit makes every effort to ensure the quality of the information it makes available. Notwithstanding the foregoing, Telit does not make any warranty as to the information contained herein, and does not accept any liability for any injury, loss or damage of any kind incurred by use of or reliance upon the information.

Telit disclaims any and all responsibility for the application of the devices characterized in this document, and notes that the application of the device must comply with the safety standards of the applicable country, and where applicable, with the relevant wiring rules.

Telit reserves the right to make modifications, additions and deletions to this document due to typographical errors, inaccurate information, or improvements to programs and/or equipment at any time and without notice. Such changes will, nevertheless be incorporated into new editions of this document.

Copyright: Transmittal, reproduction, dissemination and/or editing of this document as well as utilization of its contents and communication thereof to others without express authorization are prohibited. Offenders will be held liable for payment of damages. All rights are reserved.

© Copyright Telit RF Technologies 2010.

CONTENTS

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 and xE50 family. It is applicable for:
- TinyOne Lite 868MHz OEM module
- ME50-868 module

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

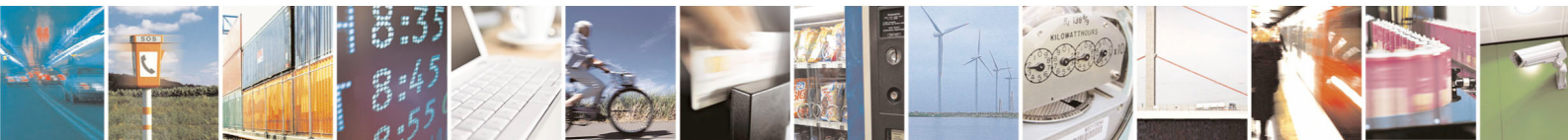| [1] EN 300 220-2 v2.1.1	ETSI Standards for SRD , April 2006
[2] ERC Rec 70-03	ERC Recommendation for SRD, May 2007
[3] EN 13757- part 1 to 4	Communication systems for meters and remote reading of meters
[4] TinyOne Lite 868MHz User Guide	1vv0300825
[5] TinyOne Lite USB Dongle User Guide	1vv0300871
[6] ME50_868 Module User Guide	1vv0300892

I.3. Software license

The Wireless M-Bus firmware of ME50-868 uses avr-libc, which is an implementation of the standard C library for Atmel AVR microcontrollers. The contents of avr-libc are licensed with a Modified BSD License. The full text of the license can be obtained from the web address http://www.nongnu.org/avr-libc/LICENSE.txt.

I.4. 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
ISSUE # 3	18/11/10	Added new Wireless M-Bus product (ME50-868)

I.5. 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 Telecommunications Standards 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'.

- *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.

- *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.

- *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.

- *Radio Link A*

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

- *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".

- *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
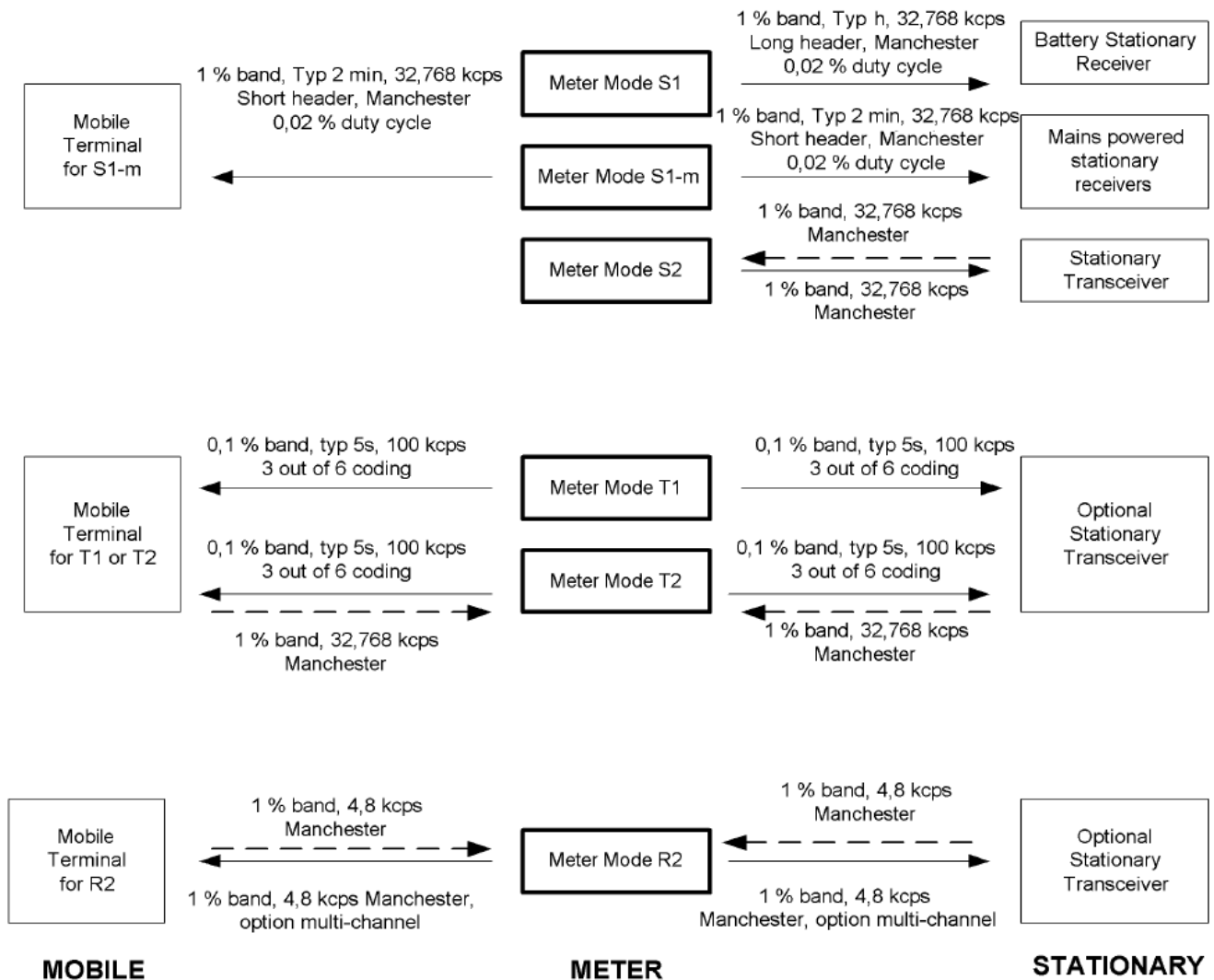**A-Field** is the unique address of the device
CI-Field is the Control Information to indicates the protocol used to the upper layer
CRC-Field is the Cyclic Redundancy Check

II.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 and xE50 families. It is applicable for:
- TinyOne Lite 868MHz RF module
- ME50-868 module

Within this chapter, we will focus on hardware description of RF modules and necessary specification for integration in a final application. For module detailed information, please refer to appropriate user guide (**[4], [6]**).

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. ME50-868MHz Modules

Below is a summary of ME50-868 RF module specifications for Wireless M-Bus:

		Min.	Typ.	Max.	Unit	Note
Center frequency	Mode S	868.278	868.3	868.322	MHz	~ 25 ppm
	Mode T	868.90	868.95	869.00		~ 60 ppm
	Mode R	868.313	868.330	868.347		~ 20 ppm
Radio channel	Mode S	-	1	-	-	-
	Mode T	-	1	-		-
	Mode R	-	10	-		868.03 + (n x 0.06) (868.03 to 868.57 MHz)
Output power	Mode S				dBm	▪ ETSI EN 300 220 V2.3.1 (2009-12) ▪ NF EN 13757-4 (2005-12)
	Mode T	- 5	+ 10	+ 13		
	Mode R					
Radio chip rate	Mode S	-	32.768	-	kcps	± 1.5%
	Mode T	90	100	110		-
	Mode R	-	4.8	-		± 1.5%
FSK deviation	Mode S	± 40	± 50	± 80	kHz	▪ NF EN 13757-4 (2005-12)
	Mode T	± 40	± 50	± 80		
	Mode R	± 4.8	± 6	± 7.2		
Duty cycle	Mode S	-	0.02	1	%	▪ ETSI EN 300 220 V2.3.1 (2009-12) ▪ NF EN 13757-4 (2005-12)
	Mode T	-	-	0.1		
	Mode R	-	-	1		
Sensitivity	Mode S	- 100	-	- 105	dBm	▪ NF EN 13757-4 (2005-12)
	Mode T	- 100	-	- 103		
	Mode R	- 105	-	- 108		
Rx BW	Mode S	-	80	-	kHz	-
	Mode T	-	200	-		
	Mode R	-	10	-		
Blocking	Mode S	28 min @ ± 2 MHz 53 min @ ± 10 MHz			dB	▪ ETSI EN 300 220 V2.3.1 (2009-12) ▪ NF EN 13757-4 (2005-12)
	Mode T	24 min @ ± 2 MHz 49 min @ ± 10 MHz				

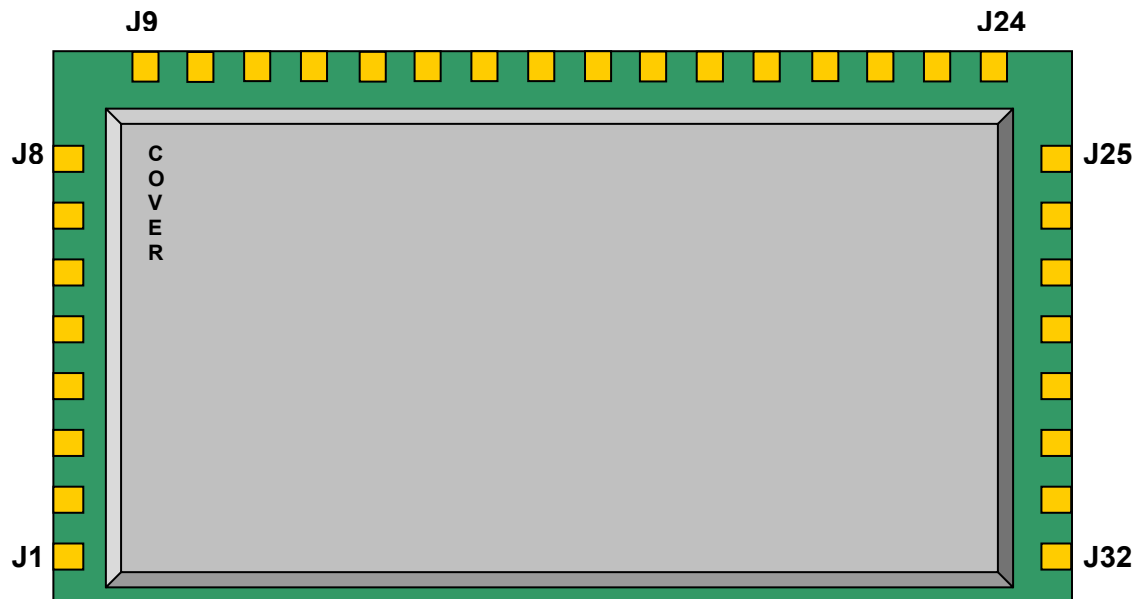|	Mode R	37 min @ ± 2 MHz		
		62 min @ ± 10 MHz		

III.3. Hardware Description
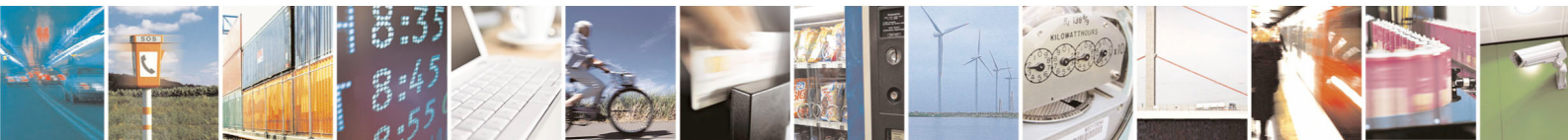
- *Views of the module : TinyOne Lite*
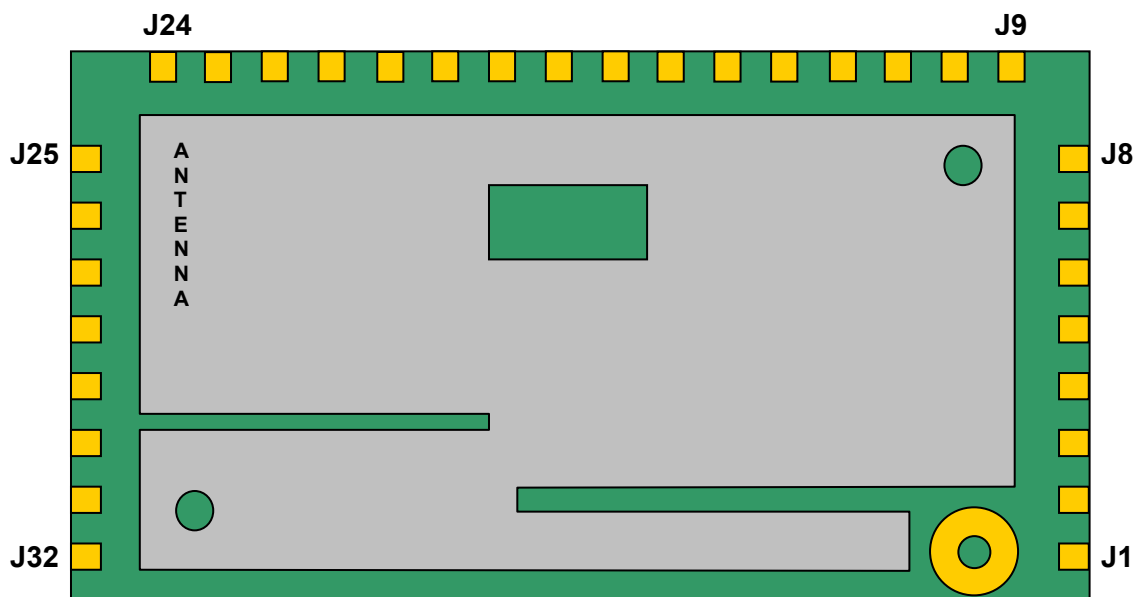
Top view of the radio module (with or without antenna upside)

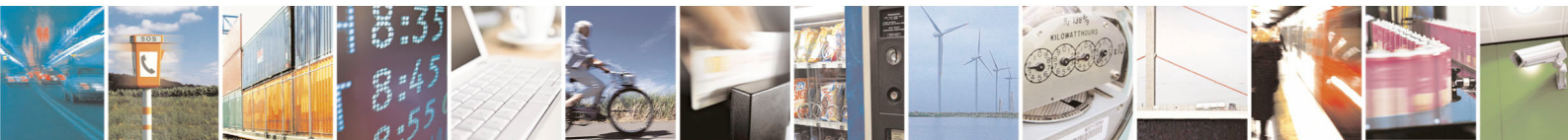*Bottom view of the radio module (with metallic cover upside)*

- *Pin-out TinyOne Lite 868*

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	STANDBY 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

- ***Typical application circuit***

Below is given a typical application circuit using TinyOne module.
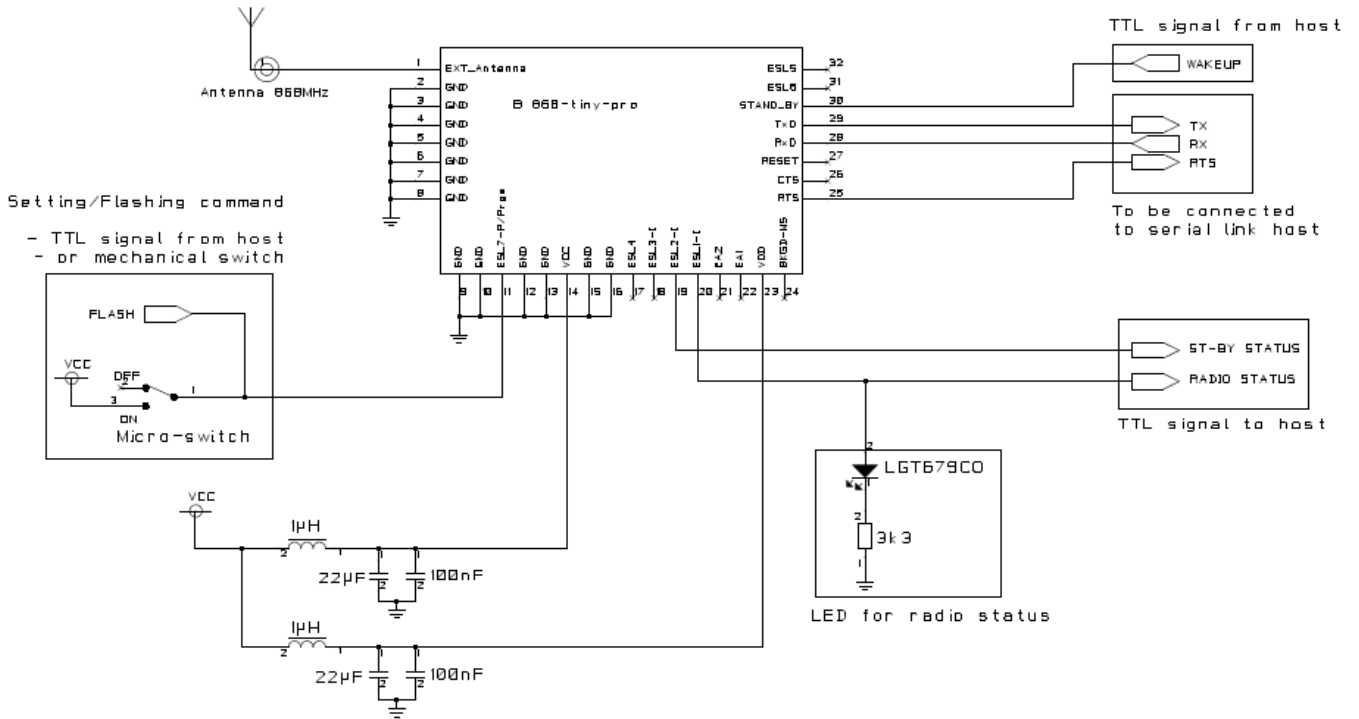
- ***Views of the module : ME50-868***
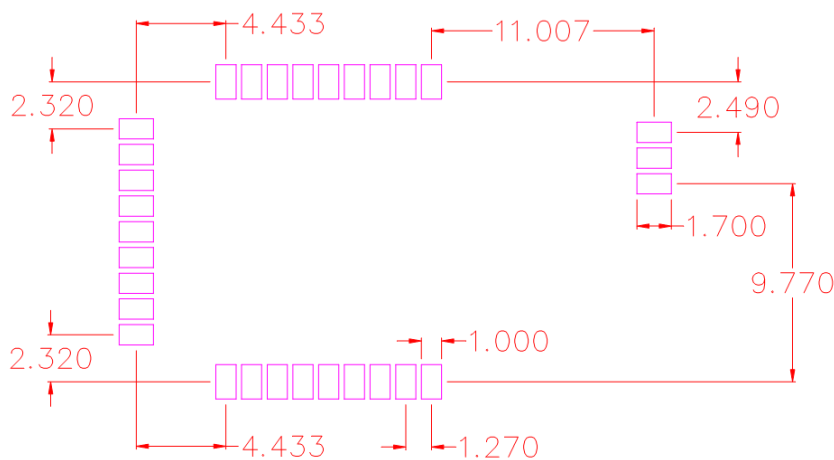
- *Pin-out ME50-868*

Pin	Pin name	Pin type	Signal level	Function
J30	GND	Gnd		RF Ground connection for external antenna
J29	Ext_Antenna	RF		RF I/O connection to external antenna
J28	GND	Gnd		RF Ground connection for external antenna
J27	GND	Gnd		Ground
J26	GND	Gnd		Ground
J25	VDD	Power		Digital and Radio part power supply pin
J24	CTS	I	TTL	Clear To Send
J23	RESET	I	TTL	µC reset (Active low with internal pull-up)
J22	RTS	O	TTL	Request To Send
J21	RXD	I	TTL	RxD UART – Serial Data Reception
J20	GND	Gnd		Ground
J19	TXD	O	TTL	TxD UART – Serial Data Transmission
J18	WAKEUP	I	TTL	Signal to wake-up the module in stand-by mode (Active high with internal pull-down)
J17	GND	Gnd		Ground
J16	PROG	I	TTL	Signal for serial µC flashing (Active high with internal pull-down)
J15	GND	Gnd		Ground
J14	PDI_DATA	I/O	TTL	Program and Debug Interface DATA
J13	GND	Gnd		Ground
J12	GND	Gnd		Ground
J11	GND	Gnd		Ground
J10	PDI_CLK	I/O	TTL	Program and Debug Interface CLOCK
J9	IO9[1]	I/O	-	Digital I/O N°9 with interrupt
J8	IO8_AD_DA[2]	I/O	-	A to D and D to A I/O N°8 with interrupt (Logic I/O capability)
J7	IO7_A	I/O	analog	Analog Input N°7 (Logic I/O capability)
J6	IO6_A	I/O	analog	Analog Input N°6 (Logic I/O capability)
J5	IO5_A	I/O	analog	Analog Input N°5 (Logic I/O capability)
J4	IO4_A	I/O	analog	Analog Input N°4 (Logic I/O capability)
J3	IO3_A	I/O	analog	Analog Input N°3 (Logic I/O capability)

[1, 2] In case you want to use in the same application Telit ZE51 or ZE61 modules J9 and J8 should not be connected, since reserved on these modules.

J2	STANDBY STATUS	O	TTL	Signal indicating stand-by status
J1	RADIO STATUS	O	TTL	Signal indicating reception or transmission of radio frame

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>

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.

Note: If TinyOne Lite is used, the delay between two characters of an AT command must be less than 10 seconds; if ME50-868 is used, commands are parsed by the module only after <CR> is sent, except for the escape sequence '+++' which is acted upon when the serial timeout expires after the last character of the sequence.

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 S431 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 S400 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: pp.UP0.MM.mm-Bbbb<CR>pp.B00.NN.nn With: pp indicating the hardware platform (DX for TinyOne Lite, GD for ME50-868) 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. ATS400=4<CR> enters the value '4' in the register S400. 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.*

<table>
<tr><td><u>IMPORTANT</u>
Some registers may be accessible in read and write without any control. The values entered may not be checked.

<i>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.</i></td></tr>
</table>

IV.2. Registers List
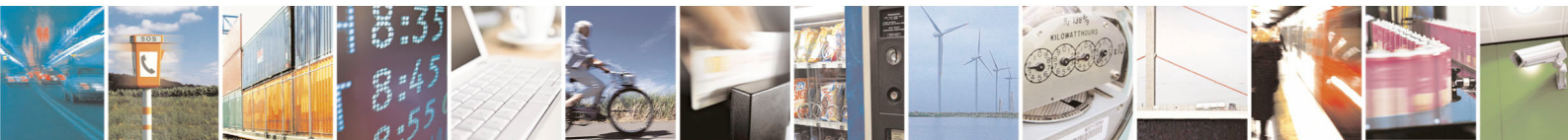
Numbers in **bold** indicate the default value

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 • '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.
R/W	S401	Serial Rx Format	Indicates the serial format options for serial frame sent from user to the RF module

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)

R/W	S402	Serial Tx Format	Indicates the serial format options for serial frame sent from RF module to user

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved (Write 0)	0xFF Wake Up Char	RSSI	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)
- 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)

		Field	
R/W	S410	C Field	Indicates the C Field value (Byte 0) when not activated on serial format (Bit 1 of S401 register). From 0 to 255. **Default : 68**
R/W	S411	M Field_Byte0	Indicates the M Field value (Byte 0) when not activated on serial format (Bit 2 of S401 register). From 0 to 255. **Default : 174**
R/W	S412	M Field_Byte1	Indicates the M Field value (Byte 1) when not activated on serial format (Bit 2 of S401 register). From 0 to 255. **Default : 12**
R/W	S413	A Field Byte0	Indicates the A Field value (Byte 0) when not activated on serial format (Bit 3 of S401 register). From 0 to 255. **Default : 120**
R/W	S414	A Field Byte1	Indicates the A Field value (Byte 1) when not activated on serial format (Bit 3 of S401 register). From 0 to 255. **Default : 86**
R/W	S415	A Field Byte2	Indicates the A Field value (Byte 2) when not activated on serial format (Bit 3 of S401 register). From 0 to 255. **Default : 52**
R/W	S416	A Field Byte3	Indicates the A Field value (Byte 3) when not activated on serial format (Bit 3 of S401 register). From 0 to 255. **Default : 18**

R/W	S417	A Field Byte4	Indicates the A Field value (Byte 4) when not activated on serial format (Bit 3 of S401 register). From 0 to 255. **Default : 1**
R/W	S418	A Field Byte5	Indicates the A Field value (Byte 5) when not activated on serial format (Bit 3 of S401 register). From 0 to 255. **Default : 7**
R/W	S419	CI Field	Indicates the CI Field value when not activated on serial format (Bit 4 of S401 register). From 0 to 255. **Default : 120**
		Radio	
R/W	S420	Radio Channel	Indicates the radio channel (for R2 mode only). From 0 to 9 **Default : 0**
R/W	S421	Preamble Length	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).
R/W	S422	Radio Output Power	Indicates the output power of the RF module : • '0': 0 dBm • '1': +5 dBm • **'2': +10 dBm (default)**
		Serial	
R/W	S430	Serial Speed	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
R/W	S431	Serial Time-Out	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. | Min. time-out	Serial Speed
---	---
17 ms	1200 bits/s
9 ms	2400 bits/s
5 ms	4800 bits/s
3 ms	9600 bits/s
2 ms	≥19200 bits/s	

| R/W	S432	Serial Type	Selects the type of serial link used (only for Terminal) : • **'0' : RS232 (default)** • '1' : RS422 • '2' : RS485 • '3' : RS485 full duplex
	Stand-by		
R/W	S440	Wake-Up options	Indicates the different way to wake-up the RF module. **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) Note: 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 for TinyOne Lite and J18 for ME50-868). If one of bits 1 and 2 is set, bit 0 must also be set, otherwise an error response is returned.
R/W	S441	Wakeup Time Out	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**

The table within the S440 cell:

Bit 2	Bit 1	Bit 0
Timer	Serial	Low Power enable

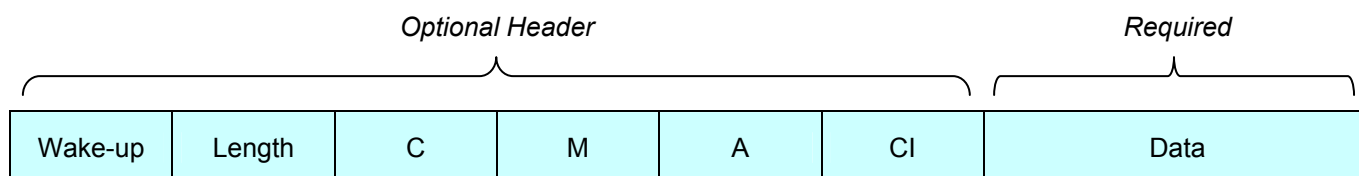| R/W	S442	Sleep Time	Defines sleep time in seconds between 2 wake-up events when wake-up timer option is activated in S440 register. Between 0 and 255. 0 indicates a sleep duration of 500 milliseconds. Other values indicate directly the sleep duration in seconds. **Default : 1**

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.

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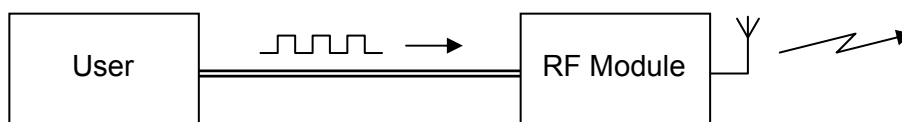
Serial frame arriving on the serial link of the RF module can have one of these formats:

Optional Header   *Required*

Wake-up	Length	C	M	A	CI	Data

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** It specifies the role of the frame (Request, ACK, ...).
_M_	2	**Manufacturer and Address fields**

A	6	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 increases the work duration (more power consumption). M and A can be activated separately.
CI	1	**Control Information field.** Option to be used if several applicative layers use the wireless M-Bus link. If only one application is running, the CI field can be fixed and specified in the corresponding register.
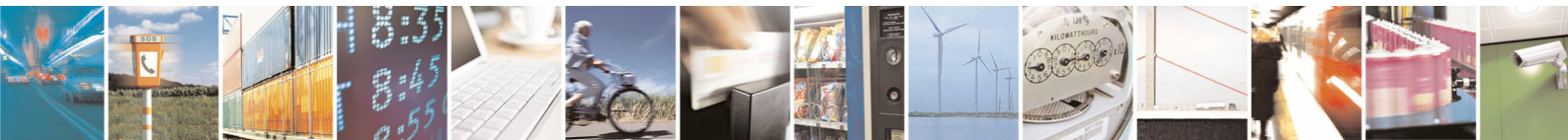
The optional header depends on the different settings of module registers:

- **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 = 3 or 7
Serial frame must have this format:

Wake-up	Length	C	M	A	CI	Data

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

Wake-up	C	M	A	CI	Data

S401 = 17 and S440 = 3 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 in §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)

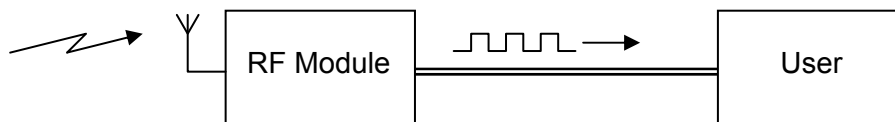On the RF link, data will have the following format:

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

- · **_Serial frame on reception_**

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

Optional Header						*Required*	*Optional Footer*
0xFF	Length	C	M	A	CI	Data	RSSI
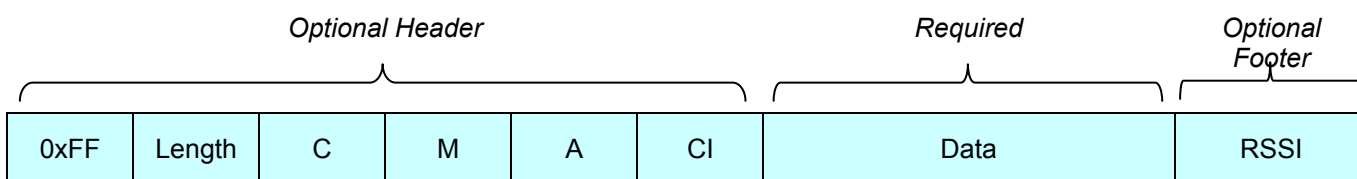
With :

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 STANDBY 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** It specifies the role of the frame (Request, ACK, ...).
M	2	**Manufacturer and Address fields** It indicates the sender or receiver ID of the received frame. M and A can be activated separately.
A	6	
CI	1	**Control Information 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.
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.

- _**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 for TinyOne Lite and J18 for ME50-868): 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 :

WAKEUP

RX input   DATA

t

T1 > 200µS   T2 < 1000µS
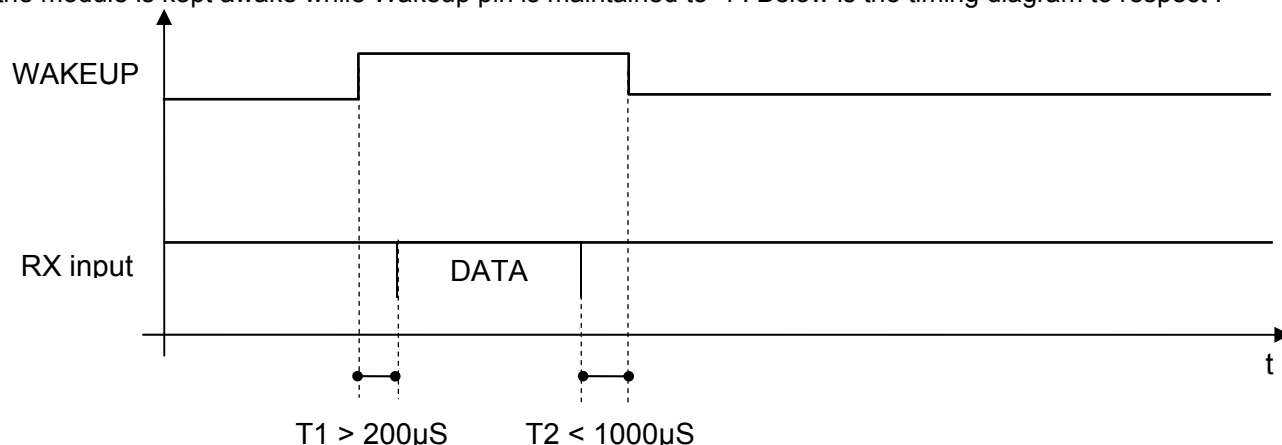
2. Wake-up on serial character: it is possible to wake-up the module by sending a wake-up character at the beginning of the serial frame to send (refer to §IV.3); either 0xFF or 0x00 must be used as wake-up character, otherwise the module serial port might receive corrupted bytes. After sending this 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:

200µS < T1 < Serial time-out

RX input   0xFF   DATA

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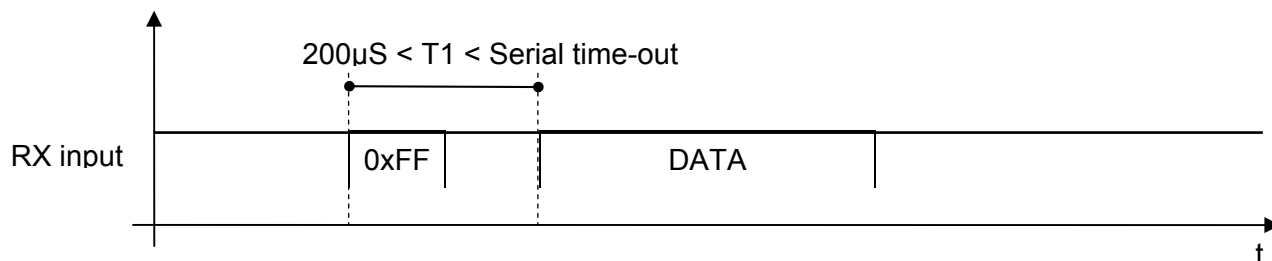
For serial data rate up to 57.6 kbps, the 0xFF duration is enough, so there is no need to have a delay between this character and the data frame. For serial data rate 115.2 kbps, a delay is needed to achieve 200µS.

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 frame preamble. 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

- **_Wake-up of the external user equipment_**

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

1. Through 'STANDBY STATUS' output signal (J19 for TinyOne Lite and J2 for ME50-868): 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".
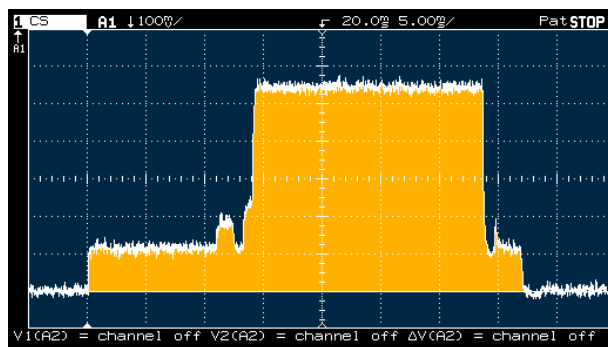
CHAPTER V.   EXAMPLE OF APPLICATION

V.1. Power consumption on S1 mode

The following example is using the S1 mode (stationary) of Wireless M-Bus with a TinyOne Lite module. 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.
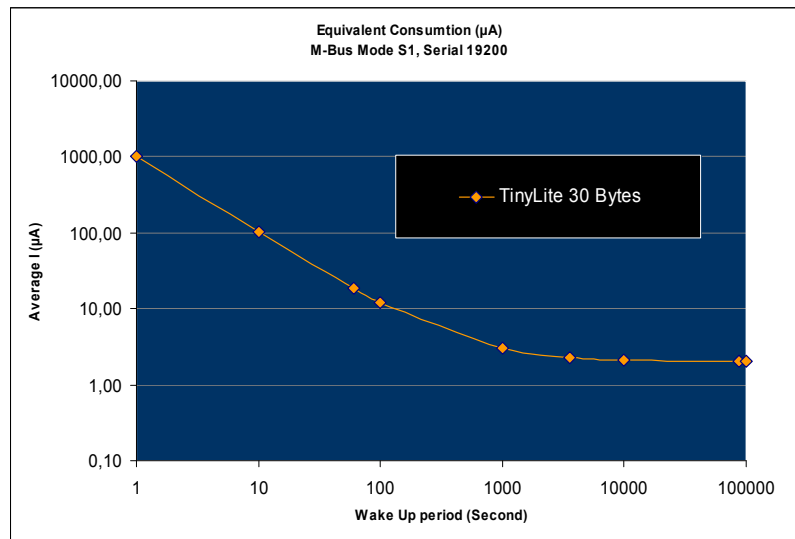
Horizontal scale: 5ms / division.
Vertical scale: 6.5 mA / division.

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

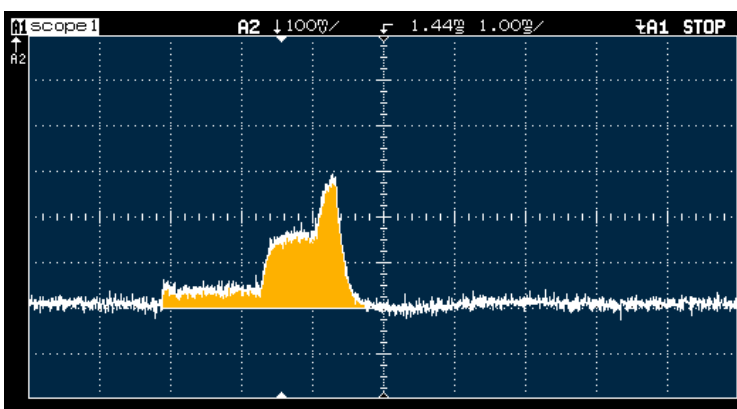| Sleep Time	Equivalent Consumption (µA)
1 second	996,96
10 seconds	101,50
1 Minute	18,58
1 Hour	11,95
1 Day	2,99

V.2. Power consumption on R2 Mode

The following example is using the R2 mode (frequent receive) of Wireless M-Bus with a TinyOne Lite module. 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