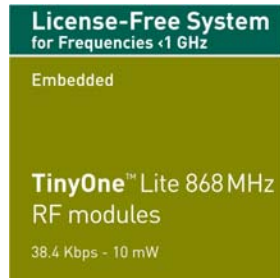


# TinyOne Lite 868MHz Module User Guide

1vv0300825 Rev.3 – 29/06/2010



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## CONTENTS

CHAPTER I. INTRODUCTION .....	6
I. 1. AIM OF THE DOCUMENT.....	6
I. 2. REFERENCE DOCUMENTS.....	6
I. 3. DOCUMENT CHANGE LOG .....	7
I. 4. GLOSSARY .....	7
CHAPTER II. REQUIREMENTS .....	8
II. 1. GENERAL REQUIREMENTS .....	8
II. 2. FUNCTIONAL REQUIREMENTS.....	10
II. 3. TEMPERATURE REQUIREMENTS .....	10
CHAPTER III. GENERAL CHARACTERISTICS .....	11
III. 1. MECHANICAL CHARACTERISTICS .....	11
III. 2. DC CHARACTERISTICS .....	13
III. 3. TIMING CHARACTERISTICS .....	13
III. 4. FUNCTIONAL CHARACTERISTICS .....	14
III. 5. DIGITAL CHARACTERISTICS .....	15
III. 6. ABSOLUTE MAXIMUM RATINGS .....	16
III. 7. ORDERING INFORMATION .....	17
CHAPTER IV. TECHNICAL DESCRIPTION .....	19
IV. 1. BLOCK DIAGRAM AND PIN-OUT OF THE SMD MODULE.....	19
IV. 1. BLOCK DIAGRAM AND PIN-OUT OF THE DIP MODULE.....	23
IV. 2. DESCRIPTION OF THE SIGNALS.....	24
CHAPTER V. STANDARD FIRMWARE : DESCRIPTION OF THE FUNCTIONALITY .....	25
V. 1. CONFIGURATION MODE.....	26
V. 2. OPERATING MODE .....	28
V. 3. REGISTERS DETAILED USE.....	30
V. 4. REGISTERS.....	38
V. 5. CONFIGURATION EXAMPLE .....	42
V. 6. CONFIGURATION AND DOWNLOAD OVER THE AIR (DOTA) .....	43
CHAPTER VI. PROCESS INFORMATION .....	44
VI. 1. DELIVERY.....	44
VI. 2. STORAGE.....	46
VI. 3. SOLDERING PAD PATTERN.....	46
VI. 4. SOLDER PASTE (ROHS PROCESS) .....	47
VI. 5. PLACEMENT .....	47
VI. 6. SOLDERING PROFILE (ROHS PROCESS) .....	47
CHAPTER VII. BOARD MOUNTING RECOMMENDATION.....	48



VII.1. ELECTRICAL ENVIRONMENT ..... 48

VII.2. POWER SUPPLY DECOUPLING ON B868-TINYLITE MODULE ..... 49

VII.3. RF LAYOUT CONSIDERATIONS..... 50

VII.4. B868-TINYLITE INTERFACING : FULL RS-232 CONNECTION ..... 52

**CHAPTER VIII. ANTENNA CONSIDERATIONS ..... 53**

VIII.1. ANTENNA RECOMMENDATIONS ..... 53

VIII.2. ANTENNA MATCHING..... 54

VIII.3. ANTENNA TYPES..... 55

VIII.4. EXTERNAL ANTENNA..... 55

VIII.5. EMBEDDABLE ANTENNAS ..... 57

**CHAPTER IX. ANNEXES ..... 62**

IX.1. ETSI 300-220 STANDARDS (SUMMARY) ..... 62

IX.2. EXAMPLES OF PROPAGATION ATTENUATION..... 65

IX.3. DECLARATION OF CONFORMITY ..... 66



## CHAPTER I.

## INTRODUCTION

### I.1. Aim of the Document

The aim of this document is to present the features and the application of the B868-TinyLite radio module. After the introduction, the characteristics of the B868-TinyLite radio module will be described within the following distinct chapters:

- Requirements
- General Characteristics of the B868-TinyLite Module
- Technical description of the B868-TinyLite Module
- Functional description of the B868-TinyLite Module
- Process information
- Board Mounting Recommendations
- Antenna Considerations

### I.2. Reference documents

<b>[1] EN 300 220-2 v2.1.2</b>	ETSI Standards for SRD , June 2007
<b>[2] ERC Rec 70-03</b>	ERC Recommendation for SRD, June 2009
<b>[3] 2002/95/EC</b>	Directive of the European Parliament and of the Council, 27 January 2003
<b>[4] TinyTools : User Manual</b>	1v0300824 Tiny Tools User Guide
<b>[5] Mesh Lite : User Manual</b>	1v0300819 M-ONE Protocol Stack User Guide
<b>[6] 2006/771/EC</b>	Harmonization of the radio spectrum for use by short-range devices
<b>[7] 2009/381/EC</b>	Amending Decision 2006/771/EC on harmonization of the radio spectrum for use by short-range devices



### I.3. Document change log

Revision	Date	Changes
ISSUE # 0	24/04/09	First Release
ISSUE # 1	29/05/09	Update of electrical characteristics Update of mechanical schematics
ISSUE # 2	28/01/10	Update of default value for S206 Updated Reference documents table Updated ERC 70-30 recommendation table
ISSUE # 3	29/06/10	Update National Restrictions Table Updated pin-out table

### I.4. Glossary

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



## CHAPTER II.

## REQUIREMENTS

### II.1. General Requirements

The B868-TinyLite module is a multi-band radio board, delivering up to 10 mW in the 868 MHz ISM band (unlicensed frequency band).

As part of the TinyOne family, the B868-TinyLite module has the same form factor than the other TinyOne modules (same PCB format, half-moons connectors, metallic cover, ...).

It allows 'point-to-point', 'multipoint' or 'network' functioning modes.

The "ERC recommendation 70-03" describes the different usable sub-bands in the 868 MHz license free band, in terms of bandwidth, maximum power, duty cycle and channel spacing. It gives the following limitations :

<b>ERC recommendation 70-03</b>				
<b>Band</b>	<b>Frequency band (MHz)</b>	<b>Maximum radiated power (mW)</b>	<b>Channel spacing (kHz)</b>	<b>Duty cycle (%)</b>
Annex1 g1	868.0 – 868.6	25	No channel spacing specified	1
Annex7 a	868.6 - 868.7	10	25	1
Annex1 g2	868.7 - 869.2	25	No channel spacing specified	0,1
Annex7 d	869.2 – 869.25	10	25	0.1
Annex7 b	869.25 – 869.3	10	25	0.1
Annex7 e	869.3 – 869.4	10	25	1
Annex1 g3	869.4 - 869.65	500	25 (for 1 or more channels)	10
Annex7 c	869.65 – 869.7	25	25	10
Annex1 g4	869.7 – 870.0	5	No channel spacing specified	100

These bands are free to use but the module and the user must respect some limitations. Most of these restrictions are integrated in the conception of the module, except the duty cycle. For example, the 869.400 to 869.650 MHz band is limited to a 10% duty cycle. This means that each module is limited to a total transmit time of 6 minutes per hour. It is the responsibility of the user to respect the duty cycle.

Furthermore, the module complies with the ETSI 300-220-2 v2.3.1 standards (specific for SRD). The main requirements are described in Appendix 1.

Finally, the module complies with the new European Directive 2002/95/EC concerning the Restrictive Usage of Hazardous Substances (RoHS).





▪ ***National Restrictions for non specific SR devices Annex 1 band g1-g4:***

Country	Restriction	Reason/Remark
<b>Band G1</b>		
Russian Federation	No info	
<b>Band G3</b>		
Russian Federation	No info	
<b>Band G4</b>		
Finland	Audio not allowed	
Hungary	Audio applications are excluded	
Russian Federation	No info	

▪ ***National Restrictions for non specific SR devices Annex 7 band a-e:***

Country	Restriction	Reason/Remark
<b>Band A</b>		
France	Duty cycle limited to 0.1%	
Russian Federation	Limited implementation	868-868.2 MHz
<b>Band B</b>		
Russian Federation	No info	
<b>Band C</b>		
Russian Federation	No info	
<b>Band D</b>		
Russian Federation	No info	
<b>Band E</b>		
France	Not implemented	
Greece	Not implemented	
Macedonia	Not implemented	Planned
Russian Federation	No info	
Sweden	Not implemented	



## II.2. Functional Requirements

The B868-TinyLite module has a digital part and a RF part. The radio link is a Half Duplex bi-directional link.

The digital part has the following functionalities:

- Communications interface.
- Analog inputs and Logic I/O.
- Micro controller with embedded software

The RF part has the following functionalities:

- Frequency synthesis.
- Front-end.
- Low noise reception

## II.3. Temperature Requirements

	<i>Minimum</i>	<i>Typical</i>	<i>Maximum</i>	<i>Unit</i>
<b><i>Operating</i></b>				
Temperature	- 40	25	+ 85	°C
Relative humidity	20		75	%
<b><i>Storage</i></b>				
Temperature	- 40	25	+ 85	°C
Relative humidity	0		95	%



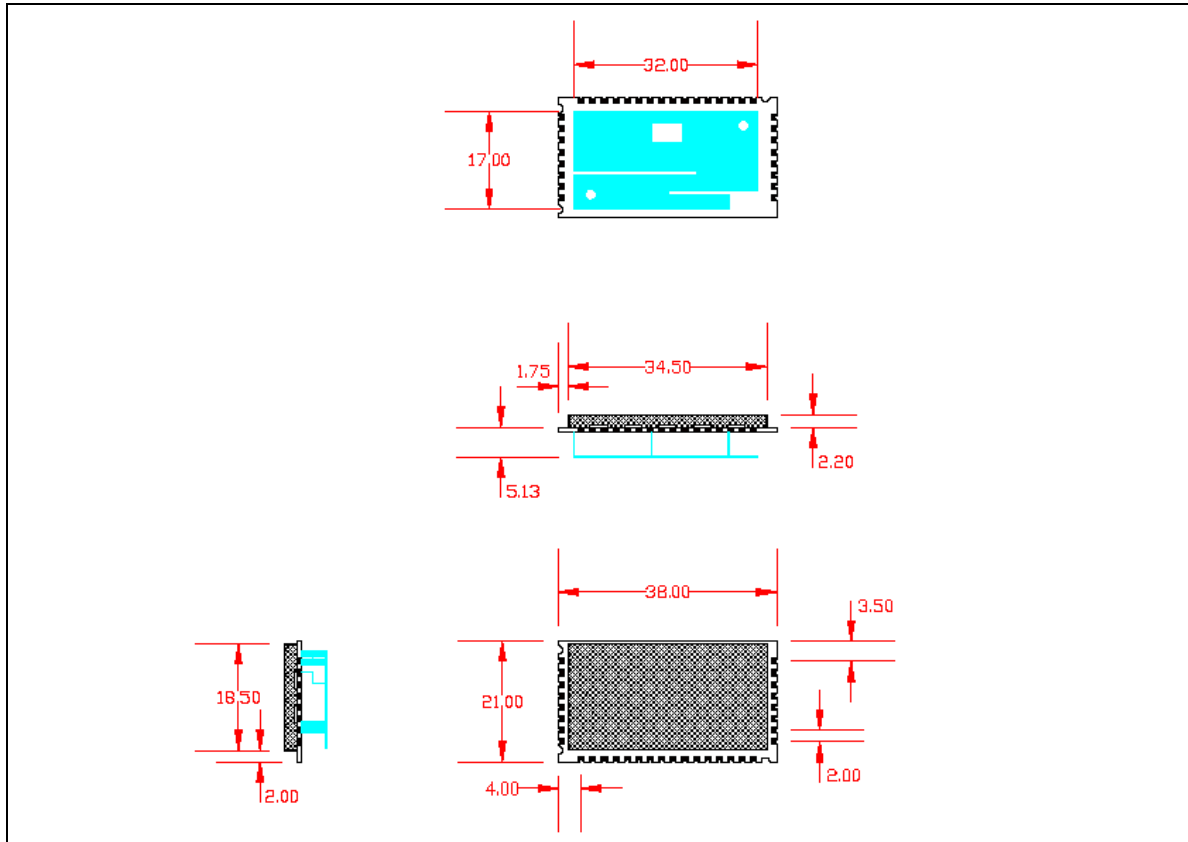
## CHAPTER III.

## GENERAL CHARACTERISTICS

### III.1. Mechanical Characteristics

<b>Size :</b>	Rectangular 38x 21 mm
<b>Height :</b>	<ul style="list-style-type: none"> <li>• 3 mm without antenna</li> <li>• 7.3 mm with antenna</li> </ul>
<b>Weight :</b>	20 g
<b>PCB :</b>	<ul style="list-style-type: none"> <li>• 4 layers circuit</li> <li>• epoxy FR4</li> <li>• thickness : 0.8mm</li> </ul>
<b>Cover :</b>	<p>Due to high radiated power, the board is protected by a metallic cover mounted on the bottom side of the board.</p> <ul style="list-style-type: none"> <li>• dimensions : 34.5 x 18.5 x 2.2mm</li> <li>• thickness : 200µm</li> </ul>
<b>Components :</b>	All SMD components, on both side of the PCB.
<b>Connectors :</b>	The terminals allowing conveying I/O signals are half-moons located around.
<b>Mounting :</b>	<ul style="list-style-type: none"> <li>• SMD</li> <li>• Half moons on 3 external sides</li> </ul>
<b>Number of I/O pins :</b>	32





### III.2. DC Characteristics

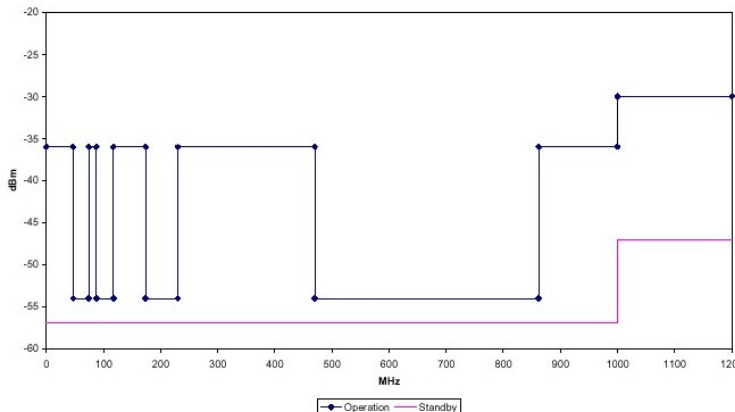
<b>Characteristics</b>	<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>
<b>Power Supply</b> ( $V_{cc}$ , $V_{DD}$ ) :	+2.2V	+3.3V	+3.7V
<b>Consumption @3.3V :</b>			
Transmission (10mW) :	-	40mA	47mA
Reception :	-	30mA	35mA
Stand-by :	-	2 $\mu$ A	-
<b>I/O low level :</b>	GND	-	0.2x $V_{DD}$
<b>I/O high level :</b>	0.8x $V_{DD}$	-	$V_{DD}$

### III.3. Timing Characteristics

<b>Characteristics</b>	<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>
<b>Power Up Sequence :</b>	-	135 ms	150 ms
<b>Stand by :</b>			
Enter in Hard Stand-by :	-	700 $\mu$ s	900 $\mu$ s
Enter in Serial Stand-by :	-	3.2 ms	-
Wake Up from Hard Stand-by :	-	2.85 ms	3.0 ms
Wake Up from Serial Stand-by :	-	5.5 ms	-



### III.4. Functional characteristics

<b>Global</b>	
<b>Temperature range :</b>	Functioning : -40°C to +85 °C Storage : -40°C to +85 °C
<b>Relative humidity :</b>	Functioning : 20% to 75% RH Storage : 0% to 95%
<b>Transmission</b>	
<b>Frequency band :</b>	1 g1, 1 g2, 1 g3, 1 g4
<b>Center frequency :</b>	band 1 g1 : 868.300MHz band 1 g2 : 868.950MHz band 1 g3 : 869.525MHz band 1 g4 : 869.850MHz
<b>Channel Bandwidth</b>	band 1 g1 : 600kHz band 1 g2 : 500kHz band 1 g3 : 250kHz band 1 g4 : 300kHz
<b>Radio bit rate :</b>	9.6 or 38.4 kbps
<b>Output Power @3.6V :</b>	band 1 g1 : 10mW band 1 g2 : 10mW band 1 g3 : 5mW band 1 g4 : 5mW
<b>Modulation :</b>	GFSK
<b>ACP :</b>	-37dBm max.
<b>Spurious out of the band :</b>	Under the following limits : 



<b>Reception</b>	
<b>Sensitivity for CER&lt;10<sup>-3</sup> :</b>	-100dBm ± 2dB (@ 38.4kbps)
<b>Saturation for CER&lt;10<sup>-3</sup> :</b>	up to -15 dBm under 50 Ohms
<b>Remaining CER :</b>	< 1.10 <sup>-6</sup> at -50 dBm
<b>Selectivity :</b>	30 dB protection between channels
<b>Immunity :</b>	
against adjacent channels jammer at -20 dBm :	20 dB min.
against other channels jammer at -20 dBm :	30 dB min.
against out of the band spurious :	40 dB typ.
<b>Spurious leakage :</b>	
Below 1 GHz :	-57 dBm max.
Over 1 GHz :	-47 dBm max.

### III.5. Digital Characteristics

<b>Processor :</b>	Micro-controller RISC 8 bits with Flash memory
<b>Memory :</b>	Flash 16KB, RAM 2KB
<b>Serial link :</b>	<ul style="list-style-type: none"> <li>• Full Duplex, from 1200 to 115200 bauds</li> <li>• 8 bits, with or without parity, 1 or 2 stop bits</li> <li>• Protocol Type : RS-232, TTL level</li> </ul>
<b>Flow control :</b>	None, software (Xon/Xoff) or hardware (RTS/CTS)
<b>Specific signals :</b>	<ul style="list-style-type: none"> <li>• <i>Serial</i> : Tx, Rx, RTS, CTS</li> <li>• <i>Outputs</i> : Ack_Tx, Status Tx/Rx, Frame Detect</li> <li>• <i>Inputs</i> : Reset, Stand-By, PrgS</li> <li>• <i>I/O</i> : 10 I/O (among those 3 analog inputs with 10 bits resolution)</li> </ul>
<b>Flashing :</b>	<ul style="list-style-type: none"> <li>• <i>Through serial</i></li> <li>• <i>Through the air</i> : DOTA (Download Over The Air) functionality</li> </ul>



### III.6. Absolute Maximum Ratings

<i>Voltage applied to Vcc, V<sub>DD</sub> :</i>	-0.3V to +3.8V
<i>Voltage applied to “TTL” Input :</i>	-0.3V to V <sub>DD</sub> +0.3V



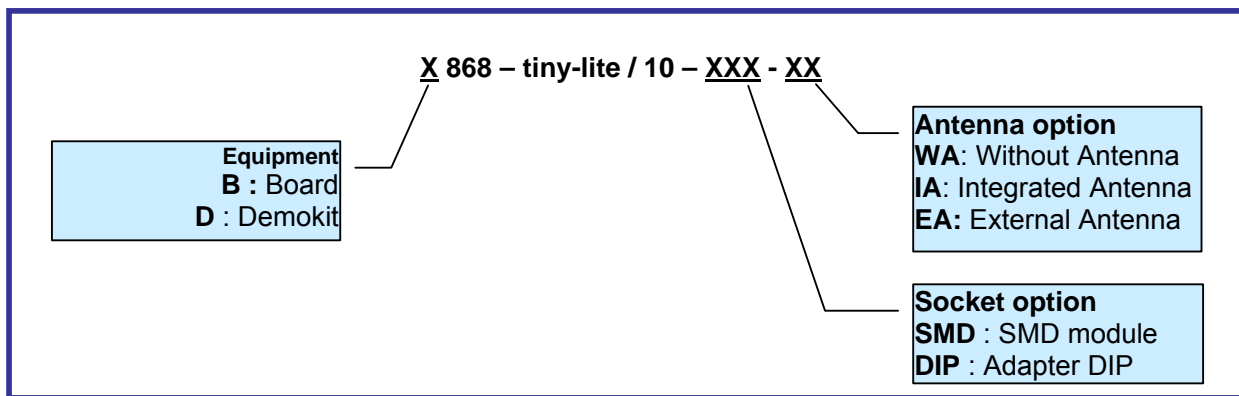


### III.7. Ordering information


Three different equipments can be ordered :

- The SMD version
- The DIP interface version
- The Demokit



Select the desired options from the list below to identify the appropriate Telit part number you need.



The versions below are considered standard and should be readily available. For other versions, please contact Telit. Please make sure to give the complete part number when ordering.

	<i>Equipment</i>	<i>Part Number</i>
 <b>SMD Version</b>	without antenna	<b>B868-TINY-LITE/10-SMD-WA</b>
	with integrated antenna	<b>B868-TINY-LITE/10-SMD-IA</b>



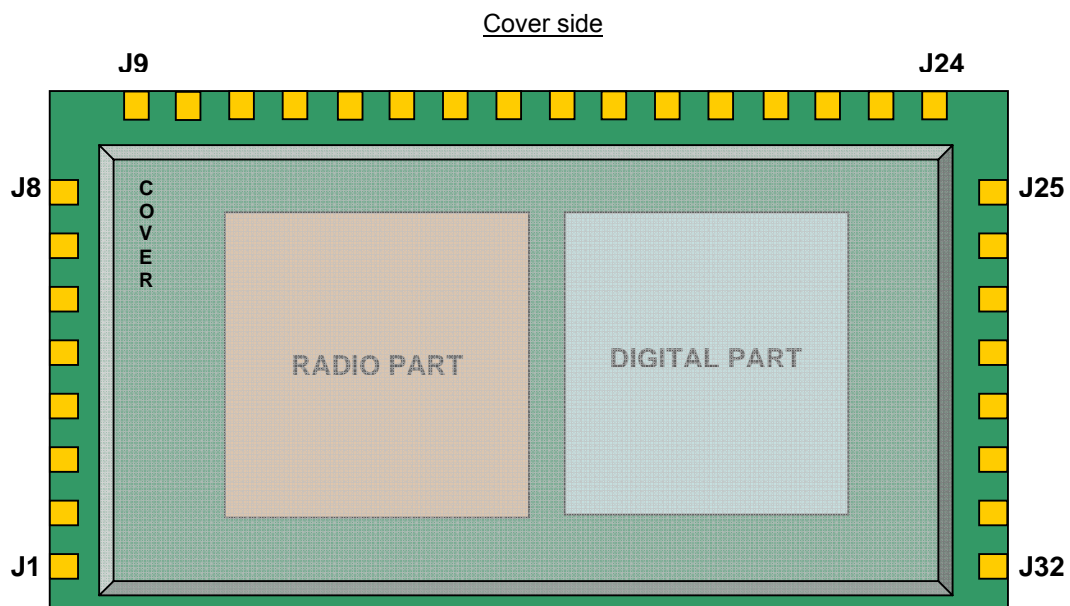
<p><b>DIP Version</b></p> 	with external antenna	<b>B868-TINY-LITE/10-DIP-EA</b>
	with integrated antenna	<b>B868-TINY-LITE/10-DIP-IA</b>
<p><b>Demokit</b></p> 	with external antenna	<b>D868-TINY-LITE/10-DIP-EA</b>
	with integrated antenna	<b>D868-TINY-LITE/10-DIP-IA</b>



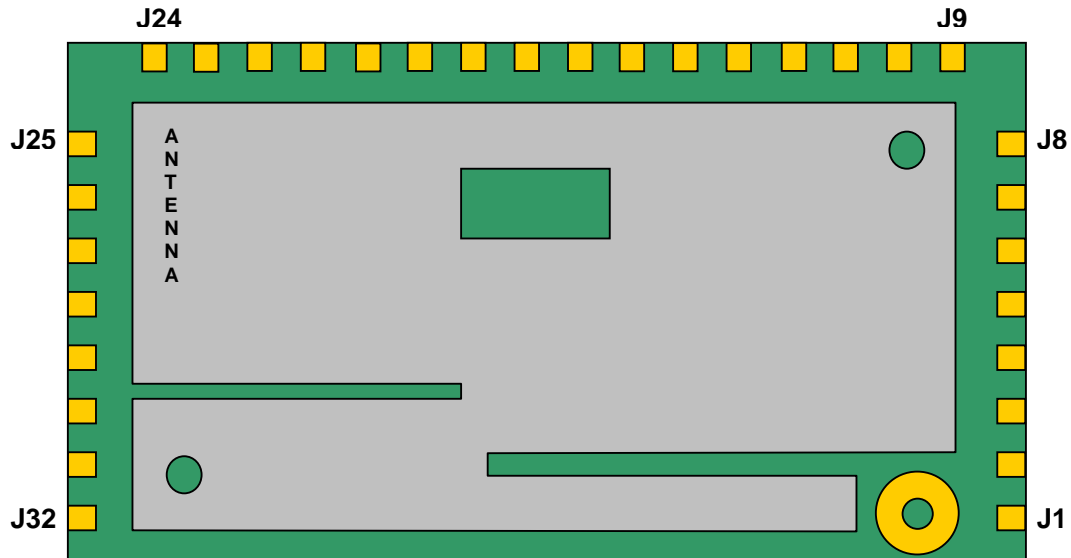
CHAPTER IV.

TECHNICAL DESCRIPTION

IV.1. Block diagram and Pin-out of the SMD Module



Antenna side (in case of integrated antenna)



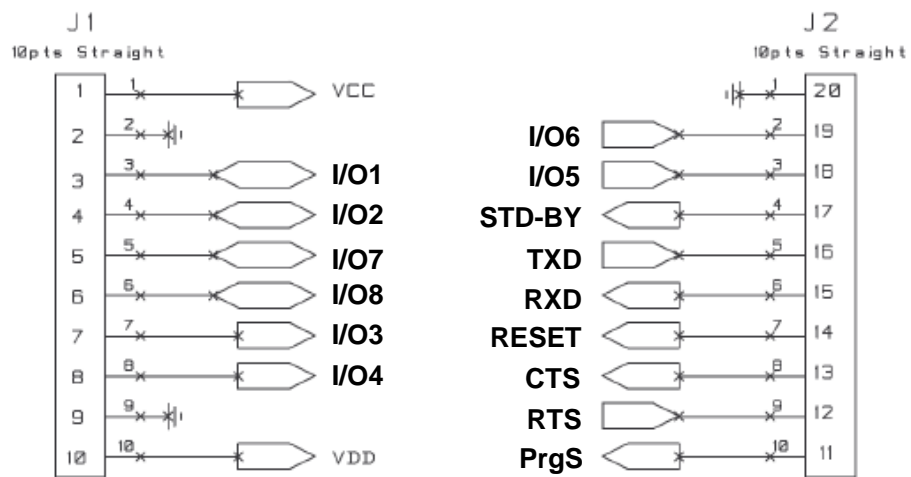
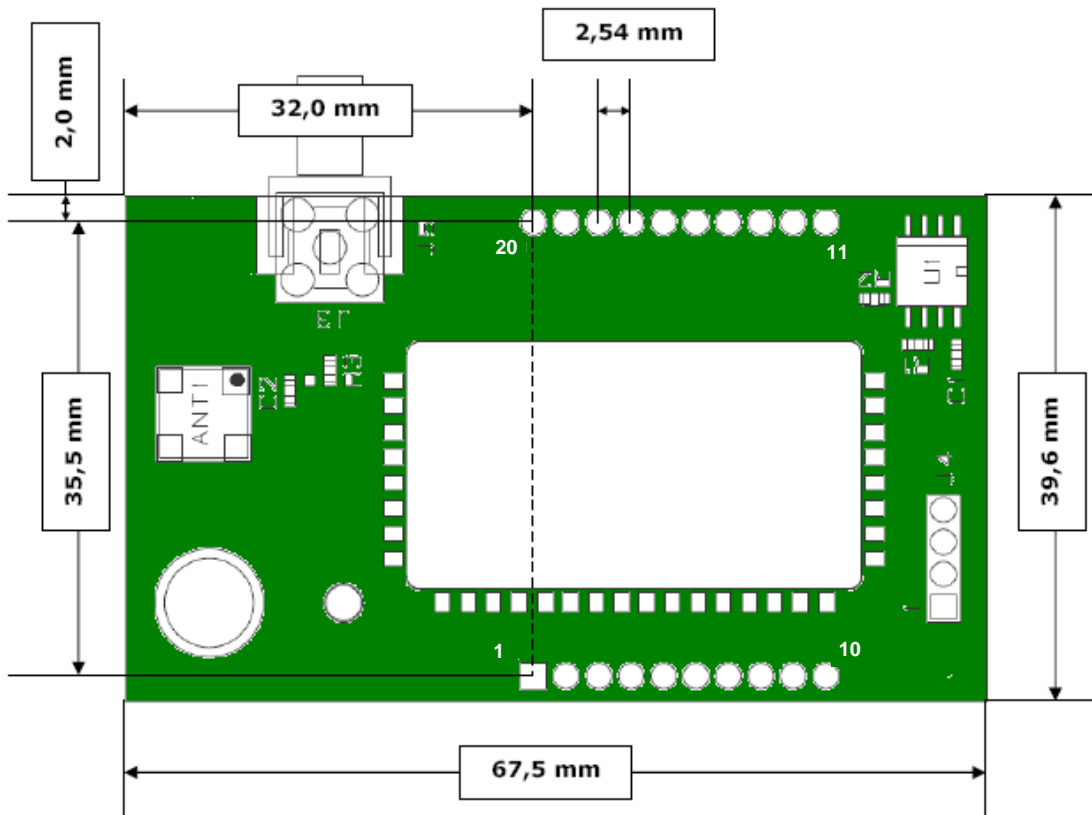
Pin	Interface function	I/O	Signal level	Function
J32	I/O6	I/O	TTL	Digital I/O, interrupt Input capable
J31	I/O5	I/O	TTL	Digital I/O, interrupt Input capable
J30	STAND-BY	I	TTL	Signal for stand-by
J29	TXD	O	TTL	TxD UART – Serial Data Transmission
J28	RXD	I	TTL	RxD UART – Serial Data Reception
J27	RESET	I	TTL	Signal for reset
J26	CTS	I	TTL	Clear To Send
J25	RTS	O	TTL	Request To Send
J24	BKGD-MS	I/O	TTL	Single wire background debug interface pin + Flash $\mu$ C programming
	ACK-TX	O	TTL	Indicate radio transmission is OK
J23	V <sub>DD</sub>	-	-	Digital part supply
J22	I/O4	I/O	analog	Digital I/O, analog Input (10 bits) capable
J21	I/O3	I/O	analog	Digital I/O, analog Input (10 bits) capable
J20	I/O8	I/O	TTL	Digital I/O, interrupt Input capable
	STATUS TX-RX	O	TTL	Indicate if the serial link is on transmission or reception
J19	I/O7	I/O	TTL	Digital I/O, interrupt Input capable
J18	I/O2	I/O	TTL	Digital I/O, interrupt Input capable
	Frame Detect	O	TTL	Indicates if valid Carrier + Synchro word is received
J17	I/O1	I/O	analog	Digital I/O, analog Input (10 bits) capable
	Frame Detect	O	TTL	Indicates if valid Carrier + Synchro word is received



J16	GND	-	-	Ground
J15	GND	-	-	Ground
J14	V <sub>CC</sub>	-	-	Radio part supply
J13	I/O9	I/O	TTL	Digital I/O, high current capable
J12	I/O10	I/O	TTL	Digital I/O, high current capable
J11	PrgS	I	TTL	Signal for serial $\mu$ C flashing
J10- J02	GND	-	-	Ground
J01	RF_Antenna	O	-	RF connection to external antenna



### IV.1. Block diagram and Pin-out of the DIP Module



## IV.2. Description of the Signals

<i>Signals</i>	<i>Description</i>
<b>Reset</b>	External hardware reset of the radio module. Active on low state.
<b>TxD, RxD</b>	Serial link signals, format NRZ/TTL: TxD is for outgoing data. RxD is for incoming data. The '1' is represented by a high state
<b>CTS <sup>(1)</sup></b>	Incoming signal. Indicates whether the module can send serial data to user (Active, on low state) or not (inactive, on high state).
<b>RTS <sup>(1)</sup></b>	Outgoing signal. Indicates whether the user can transmit serial data (active, on low state) or not (inactive, on high state). The signal switches either when the serial buffer is full or when the user's serial transmission is finished.
<b>ACK-TX</b>	Indicates that the buffer transmission was done correctly. The signal is activated at the end of a message transmission on the radio (active RTS) and stays active until RTS switches to inactive state. Active (transmitted buffer) on low state.
<b>I/Ox</b>	I/O available upon request.
<b>Stand-By <sup>(2)</sup></b>	Indicates to the module to switch to low power mode. Active on high state.

<sup>(1)</sup> : used only if Hardware Flow Control (RTS/CTS) is selected (S216=0).

<sup>(2)</sup> : used only if Hardware Stand-By is selected (S240=1).





## CHAPTER V. STANDARD FIRMWARE : DESCRIPTION OF THE FUNCTIONALITY

Telit modems and boards are provided with an embedded software which allows to choose between different communication protocols and to play on numerous parameters.

B868-TinyLite module is available with the following firmwares :

- **S-ONE protocol stack:**
  - o **Standard firmware.**; working in transparent or address secured mode.
- **M-ONE protocol stack:**
  - o **Mesh Lite firmware**, allowing mesh networking : refer to dedicated manual ([5]) for detailed explanation.

This Chapter is dedicated to the S-ONE protocol stack.

There are 2 different modes available for S-ONE protocol stack that are described in following paragraphs :

- 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 use for data transmission



## V.1. Configuration Mode

Hayes or 'AT' commands complies 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 up 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 B868-TinyLite module.

Command	Description
+++	<p><b>Hayes Mode Activation</b></p> <p>'+++' 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.</p> <p>'+++' command should be entered as one string, i.e. it should not be preceded by 'AT' and followed by &lt;CR&gt; but two silent times which duration is configurable via S214 register (Serial time-out). The time between two '+' must not exceed the time-out value.</p> <p>Hayes mode inactivates radio functions.</p>
ATO	<p><b>Communication mode activation</b></p> <p>'ATO' command gives an instant access to the modem's operating mode, configured in S220 register.</p> <p>'ATO' command is used to get out of Hayes mode.</p> <p>Answer : <b>OK</b> or <b>ERROR</b> if the configuration is not complete</p>
ATV	<p><b>Modem's firmware version</b></p> <p>'ATV' command displays the modem's firmware version number as follows:</p> <p><b>Version &lt;Product&gt;: vX.YZn</b></p>
AT/S	<p><b>Modem's registers status</b></p> <p>'AT/S' command displays status of all relevant registers of the modem</p>



ATSn?	<p><b>Register interrogation</b></p> <p>'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&lt;CR&gt;</p>
ATSn=m	<p><b>Register modification</b></p> <p>'ATSn=m' command configures Hayes register number n with the value m, e.g. ATS200=4&lt;CR&gt; enters the value '4' in the register S200. The value is automatically stored in the EEPROM memory. Answer : OK or ERROR</p>
ATN	<p><b>RSSI interrogation</b></p> <p>'ATN' command runs the received RF level measurement. This RSSI reading is continuously displayed each second until a new character arrives on the serial link. 4 levels are available :  <ul style="list-style-type: none"> <li>- '0' : received level &lt; -87dBm</li> <li>- '1' : received level between -87 and -82dBm</li> <li>- '2' : received level between -82 and -77dBm</li> <li>- '3' : received level &gt; -77dBm</li> </ul> </p>
ATR	<p><b>Parameters reset</b></p> <p>'ATR' command resets all modem's parameters to their default values. Answer : OK</p>
ATP	<p><b>Stand By Activation</b></p> <p>When serial stand by is set, the 'ATP' command put the module in stand by mode. To wake up the module, send a NULL (0x00) character.</p>
ATBL	<p><b>Switch to Bootloader</b></p> <p>'ATBL' command escape from the main program and run the bootloader. This command is useful to update the firmware by serial or radio link. See the dedicated part for details.</p>

Specific 'AT' commands have been integrated in order to make measurements in continuous mode. These commands are stopped by the sending of a character.

Command	Description
ATT0	<b>Pure carrier transmission</b> at center frequency
ATT1	<b>Pure carrier transmission</b> representing '0'
ATT2	<b>Pure carrier transmission</b> representing '1'
ATT3	<b>Max modulated carrier transmission</b>
ATT6	<b>Min modulated carrier transmission</b>

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

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

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



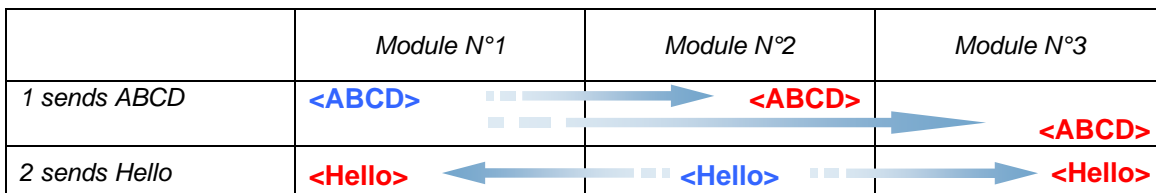
## V.2. Operating Mode

There are 4 communication protocols available on the B868-TinyLite module :

- Transparent mode : this is the default communication protocol of the module. The module transmits the data transparently, without encapsulation or addressing. It acts as a half duplex wired serial link (type RS485).
- Addressed Secured mode : it is a kind of multipoint network protocol. Each module can communicate with every module in the same network. All the frames are addressed, checked through a CRC and acknowledged.
- Downloader over the air : this is a specific communication protocol allowing re-flashing of remote module.
- Auto-repeat mode : this is a specific communication protocol in which the module sends back the frames it has received (radio or serial) without echoing. It allows the user to easily test the module remotely.

For the classical communication protocols (Transparent and Addressed Secured), an additional functionality is available : LBT (Listen Before Talk). It means that the transmitting module will scan the radio link and verify it is free (no radio activity) before sending its data to avoid collision.

### ▪ **Basic Illustration of Transparent mode**

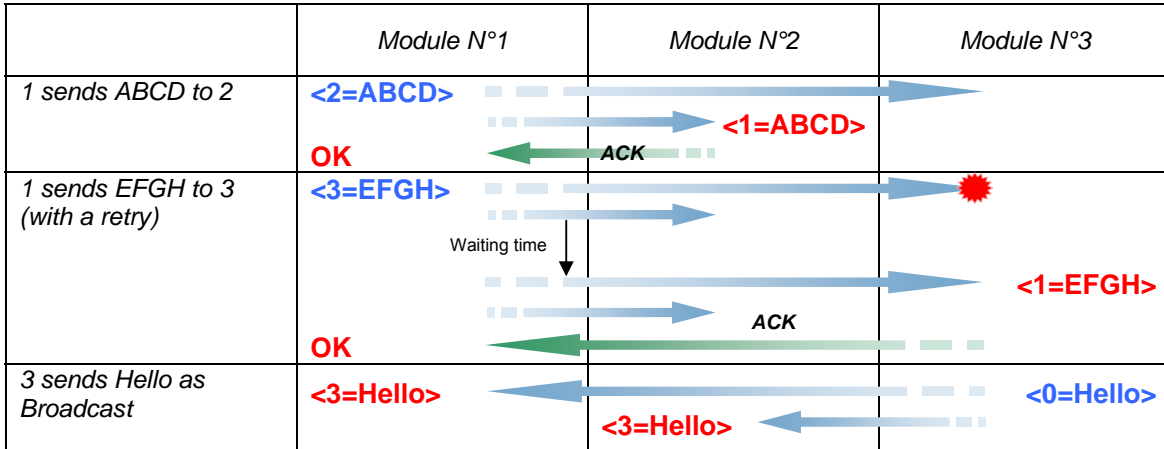



<in blue> : data sent

<in red> : data received

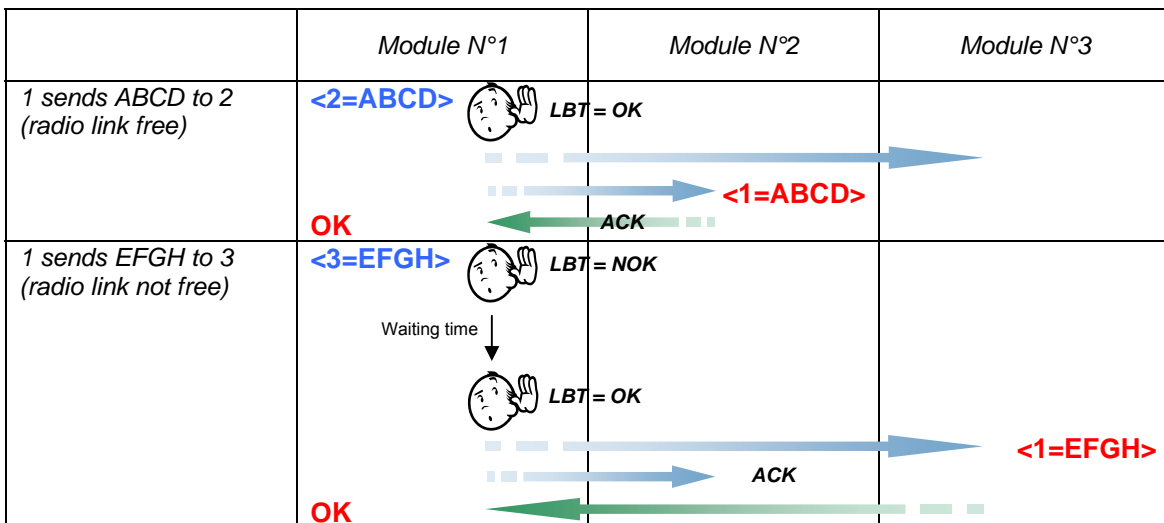


▪ **Basic Illustration of Addressed Secured mode**



 Collision or error  
 <in blue> : data sent  
 <in red> : data received

▪ **Basic Illustration of Addressed Secured mode with LBT**



### V.3. Registers Detailed Use

The parameters to be configured via Hayes mode are stored in the module permanent memory, called S registers. Those registers are always listed as follow:

- S20x registers correspond to the radio parameters
- S21x registers correspond to the serial parameters
- S22x registers correspond to the operating parameters
- S24x registers correspond to the stand by parameters
- S25x registers correspond to the network parameters

#### ▪ Radio Configuration

The Radio configuration is set via the S20x registers. Through them, you can:

- ↕ Change the radio baud rate : S201,
- ↕ Change the radio Output Power : S202,
- ↕ Modify the carrier length : S204,
- ↕ Change Radio Frequency Sub-Band : S206,

The radio parameters are preferably set in the following order :

#### 1. Frequency Sub-band assignment : S206

This register sets the Frequency Sub-band used for the communication.

S206 value	Band	Frequency Sub-Band
0	1g1	868-868.6 MHz
1	<i>not used</i>	
2	1g2	868.7-869.2 MHz
3	<i>not used</i>	
4	<i>not used</i>	
5	<i>not used</i>	
6	1g3	869.4-869.65 MHz
7	<i>not used</i>	
<b>8 (default)</b>	<b>1g4</b>	<b>869.7-870 MHz</b>

#### 2. Output power : S202

This register allows changing the radio output power. The default value (in **bold**) is set to the maximum output power authorized in each Sub-Band.

Frequency Sub-Band	Band 1g1	Band 1g2	Band 1g3	Band 1g4
S202 Value	0: 5mW <b>1: 10mW</b>	0: 5mW <b>1: 10mW</b>	<b>0: 5mW</b>	<b>0: 5mW</b>



**3. Radio baud rate : S201**

This register allows changing the radio baud rate.

<i>S201 value</i>	<i>Radio baud rate</i>
0	<i>not used</i>
1	9.6 kbps
2	<i>not used</i>
<b>3 (default)</b>	<b>38.4 kbps</b>

**4. Radio carrier length : S204**

This register sets the duration (in bytes) of the radio carrier sent before the data. It serves as synchronization frame for the receiver(s).

<i>S204 value</i>	<i>Carrier length</i>
<b>0 (default)</b>	<b>16 bytes</b>
1	24 bytes

Usually, this register isn't modified. However, in some hostile environment (metallic parts, vibrations...), it can be raised to 24 bytes to have a more reliable synchronization. This will lower the over air throughput as it increase the non-data use of the radio.



▪ **Serial link configuration**

The serial link configuration is set via the S21x registers. Through them, you can:

- ↪ Set the serial baud rate : S210,
- ↪ Set the parity : S212,
- ↪ Set the number of stop bits: S213,
- ↪ Set the serial time-out : S214,
- ↪ Set the flow control type : S216,

After each modification in the serial settings, the B868-TinyLite will answer 'OK' with the current configuration, and the changes will be effective immediately after.

The Serial parameters are preferably set in the following order :

**1. Serial Baud rate : S210**

This register selects the serial baud rate value. It is linked to the time-out register S214. They can be set with the following values :

<i>S210 value</i>	<i>Serial baud rate</i>	<i>S214 minimum value</i>
1	1 200 bps	17
2	2 400 bps	9
3	4 800 bps	5
4	9 600 bps	3
<b>5 (default)</b>	<b>19 200 bps</b>	<b>2</b>
6	38 400 bps	2
7	57 600 bps	2
8	115 200 bps	2





## 2. Serial timeout : S214

The B868-TinyLite is not able to know when a frame reception is finished on the serial link, but it needs this information to stop radio transmission in transparent mode, or to start sending data in the other modes.

This timeout is the indicator used to decide when the data frame is finished : if no character is received for a time equal to this timeout, the data frame is seen as finished and the modem acts accordingly.

The default value is 5 milliseconds.

The Timeout value is of course in accordance with the serial baud rate : it must be at least equal to the length of 2 characters. See the table in the baud rate (S210) part of this chapter. For example, for a 19200 bps baud rate, the time to send 1 character (1 start bit + 8 data bits + 1 stop bit) is 521  $\mu$ s, giving a squared up timeout value of 2 ms.

You can set a higher value to this timeout if you have some gaps in the sending of a frame.

## 3. Serial data format: S212 and S213

These registers set the format of the characters sent on the serial link :

- ↪ S212 : Parity. It can take three values : '1' for No Parity, '2' for Even Parity, or '3' for Odd Parity. The default value is '1'.
- ↪ S213 : Number of Stop bits: 1 bit or 2 bits. Default value is '1'.

The settings for the available configurations are :

<i>Format type</i>		<i>Parity S212</i>	<i>Stop Bits S213</i>
8/N/1	8 data bits, no parity, 1 stop bit	1	1
8/E/1	8 data bits, even parity, 1 stop bit	2	1
8/O/1	8 data bits, odd parity, 1 stop bit	3	1
8/N/2	8 data bits, no parity, 2 stop bits	1	2
8/E/2	8 data bits, even parity, 2 stop bits	2	2
8/O/2	8 data bits, odd parity, 2 stop bits	3	2
7/N/2	These configurations are only possible in transparent using the same settings as 8/N/1		
7/E/1			
7/O/1			



#### 4. Flow control management : S216

In all the modes, the data coming from the serial link are stored in a buffer and then sent. Thus, it is necessary to have a flow control on the serial link to avoid a buffer overflow and the loss of data.

The B868-TinyLite manages three types of flow control :

- ↪ Hardware or CTS/RTS (S216=0) : the RTS signal from the B868-TinyLite will authorize the host to transmit data. The other way will be controlled by the CTS signal entering the modem.
- ↪ Software or Xon/Xoff (S216=1) : the B868-TinyLite sends a Xoff character on the serial link to interrupt the transmission from the host, and a Xon character to resume. This control will only work from the B868-TinyLite to the host.
- ↪ None (**S216=2, default**) :the host must manage its outgoing data frames in order not to overflow the buffer.

This flow control is available for our virtual RS232 serial link .

N.B. : in Hayes mode, the flow control is not active so as to be able to modify these registers without locking the serial link.



▪ **Operating Mode configuration**

The Operating mode configuration is set via the S22x registers. Through them, you can:

- ↔ Set the operating mode : S220,
- ↔ Set the number of retries: S223,
- ↔ Set the LBT: S226
- ↔ Set the random waiting time : S227

The Operating Mode parameters are preferably set in the following order :

**1. Operating Mode : S220**

This is the most significant register : it tells how the B868-TinyLite must run. The available operating modes are :

<i>Value</i>	<i>Mode</i>
<b>1</b>	<b>Transparent Mode (default)</b>
9	Addressed Secured Mode
12	Downloader over the air
14	Auto-repeat Mode

**2. LBT : S226**

This register allows activating and setting up the LBT functionality. The LBT sensitivity refers to the detected RF level over which the RF link is considered as occupied.

<i>Value</i>	<i>LBT</i>	<i>Comment</i>
<b>0</b>	<b>OFF (default)</b>	<b>no LBT</b>
1	ON with high sensitivity	LBT with detection for RF >-95dBm
2	ON with medium sensitivity	LBT with detection for RF >-90dBm
3	ON with low sensitivity	LBT with detection for RF >-85dBm

**3. Number of repetitions : S223**

This register is used in Addressed Secured mode. It is the number of times the message will be repeated in case of non acknowledgement, or the number of times the module will try to send the message in case of the radio link is not free (when LBT functionality is activated).

This register is set to 2 as default. It is enough in most of the configurations.

**4. Random waiting time : S227**

This register activates a random waiting time before every radio transmission (except for acknowledge). Particularly when LBT functionality is activated, it will define the time between 2 LBT. The random waiting time is comprised between 0 and 64mS.

<i>S227 value</i>	<i>Random Waiting Time</i>
<b>0 (default)</b>	<b>OFF</b>
1	ON



## ▪ Network mode Configuration

The configuration to use the B868-TinyLite in Addressed Secured mode is done with the S25x registers. Through them, you can:

- ↵ Set the Network address : S250,
- ↵ Set the Client Address : S252,
- ↵ Set the Network options : S255,
- ↵ Set a default address for transmission : S256.

The parameters are preferably set in the following order:

### 1. Network ID : S250

When in Addressed Secured operation, B868-TinyLite modules can communicate only if they are parts of the same 'network'.

There can be up to 65535 networks defined, but only one can work in a given area in each radio channel. If you want to place more than one network in the same area, use different radio channels and not different network numbers.

The default value is 0.



## 2. Network Options : S255

When running in Addressed and Secured mode, this register contains the option flags used to configure the operation.

This register is a group of 4 flag bits :

Bits	7	6	5	4	3	2	1	0
Name	-	ACK	2B	Ret	-	NH	CR	N°

- ↪ **Header (Bit 0, default 1)** : if set to 1, the frames sent on the serial link will be preceded with a header showing the sender address. This frame will be as follows, for each settings of the bit 2:  
 "1=data" if the header is ASCII  
 "<0x01>data" if the header is numeric  
 If set to 0, the receiver will not know where the frame comes from
- ↪ **Carriage Return (Bit 1, default 0)** : if set to 1, the frame sent on the serial link will be followed by a CR character (<0x0D>).
- ↪ **Numeric Header (Bit 2, default 0)** : Used when bit 0 is set to 1, it selects the type of header for transmission or reception to ASCII (0) or numeric (1).
- ↪ **Status answer (Bit 4, default 0)** : defines if the B868-TinyLite returns a transmission status after sending a frame. If set to 1 (no answer), the modem will give no information if the frame has been received on the remote side or not. If set to 0 (answer), it returns OK if the acknowledgment has been received, ERROR otherwise.
- ↪ **2 bytes Numeric Header (Bit 5, default 0)** : Used when bit 2 is set to 1, it defines if the numeric header is on 1 byte (0) for less than 255 modems, or 2 bytes (1) for up to 65535 modems. This bit has no effect if the header is ASCII (Bit 2 = 0). The frames sent and received will be as follows :  
 "<0x01>Data" if this bit is set to 0  
 "<0x00><0x01>Data" if this bit 5 is set to 1
- ↪ **ACK (Bit 6, default 0)** : Radio Acknowledge disable: if '1', the radio Ack is disable and any secured radio frames are not acknowledged. This is useful when several clients have the same ID in a network.

## 3. Client Address: S252

The user can set a Client number between 1 and 65535. The client numbers must all be different in a network.

The default value is 0.

## 4. Default transmission Address: S256

If this register is different from 0, the frames received on the serial link will be sent to this address, without any header detection done.

This register is useful to set a Network-like system with up to 65534 clients and one server, and/or when the clients are not able to manage the frame header.



## V.4. Registers

Numbers in **bold** indicate the default value

Access	Register	Name	Description
<b>Radio</b>			
R/W	S201	Radio Baud-Rate	Indicates the radio link rate. <ul style="list-style-type: none"> <li>• 0 : <i>not used</i>,</li> <li>• 1 : 9.6 Kbits/s,</li> <li>• 2 : <i>not used</i>,</li> <li>• <b>3 : 38.4 Kbits/s. (default)</b></li> </ul>
R/W	S202	Output Power	Radio power output in milliwatts. <ul style="list-style-type: none"> <li>• <b>0 : 5 mW, (default)</b></li> <li>• 1 : 10 mW</li> </ul>
R/W	S204	Radio Carrier Length	Indicates the radio carrier length in bytes: <ul style="list-style-type: none"> <li>• <b>0 : 16 bytes (default)</b></li> <li>• 1 : 24 bytes</li> </ul>
R/W	S206	Frequency Sub-Band	Indicates the frequency Sub-Band in use. <ul style="list-style-type: none"> <li>• 0 : band 1g1,</li> <li>• 1 : <i>not used</i>,</li> <li>• 2 : band 1g2,</li> <li>• 3 : <i>not used</i></li> <li>• 4 : <i>not used</i>,</li> <li>• 5 : <i>not used</i>,</li> <li>• 6 : band 1g3,</li> <li>• 7 : <i>not used</i></li> <li>• <b>8 : band 1g4 (default)</b></li> </ul>



Access	Register	Name	Description												
<b>Serial Link</b>															
R/W	S210	Serial Speed.	<p>Indicates the speed on the Serial Connection</p> <p>'1': 1200 bits/s      <b>'5': 19200 bits/s (default)</b>            '2': 2400 bits/s      '6' : 38400 bits/s            '3': 4800 bits/s      '7' : 57600 bits/s            '4': 9600 bits/s      '8' : 115200 bits/s</p> <p>The time out value must be compatible with the serial speed:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Min. time-out (S214)</th> <th>Serial Speed (S210)</th> </tr> </thead> <tbody> <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> </tbody> </table>	Min. time-out (S214)	Serial Speed (S210)	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
Min. time-out (S214)	Serial Speed (S210)														
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	S212	Parity	<p>Serial Link Parity Type:</p> <ul style="list-style-type: none"> <li>• <b>'1': None (default)</b> ,</li> <li>• '2': Even,</li> <li>• '3': Odd.</li> </ul>												
R/W	S213	Number of Stop bits	<p>Serial Link Stop Bits :</p> <ul style="list-style-type: none"> <li>• <b>1 bit (default)</b>,</li> <li>• 2 bits.</li> </ul>												
R/W	S214	Serial Link Time Out	<p>Indicates the value of the time-out on the serial link. The time out value must be compatible with the serial speed: (see S210 register description).            Between 2 and 100 milliseconds  <b>Default : 5.</b></p>												
R/W	S216	Flow Control	<p>Indicates flow control type:</p> <ul style="list-style-type: none"> <li>• '0': Hardware: CTS/RTS</li> <li>• '1': Software: Xon/Xoff</li> <li>• <b>'2': None (default)</b></li> </ul>												



Access	Register	Name	Description
<b><u>Operation</u></b>			
R/W	S220	Function Mode	Operating mode of the Modem : <b>'1' : Transparent (default)</b> '9' : Addressed Secured '12' : Downloader over the air '14' : Auto-repeat
R/W	S223	Number of Retries	Number of retries in case of non-Ack response to a message (addressed secured mode) mode, or in case of non free radio link (LBT). Included between 0 and 255 (255 means retry until success). <b>Default value: 2</b>
R/W	S226	LBT	LBT ON / OFF, and sensitivity <b>'0' : OFF (default)</b> '1' : ON with high sensitivity '2' : ON with medium sensitivity '3' : ON with low sensitivity
R/W	S227	Random Waiting Time	Random waiting Time ON / OFF <b>'0' : OFF (default)</b> '1' : ON
<b><u>Low Power</u></b>			
R/W	S240	Type of Low-power	Indicates whether the low power control pin is used or not <b>'0' : No Low Power (default),</b> '1' : Stand-By activated by Hardware pin, '2' : Stand-By activated by Serial





Access	Register	Name	Description																		
<b>Network Control</b>																					
R/W	S250	Network ID	Network Number on 2 Bytes. <b>Default : 0</b>																		
R/W	S252	Client Number	Client Number on 2 Bytes. Between 0 and 65535. <b>Default : 0</b>																		
R/W	S255	Network Options	Indicates the Network options. 4 bits are used :  <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Bits</th> <th>7</th> <th>6</th> <th>5</th> <th>4</th> <th>3</th> <th>2</th> <th>1</th> <th>0</th> </tr> </thead> <tbody> <tr> <td></td> <td>-</td> <td>ACK</td> <td>2B</td> <td>Ret</td> <td>-</td> <td>NH</td> <td>CR</td> <td>N°</td> </tr> </tbody> </table> <p><b>Default value : 01.</b></p> <ul style="list-style-type: none"> <li>➤ Bit '<b>N°</b>': indicates whether the received frame begins with the Client ID (1) or not (0).</li> <li>➤ Bit '<b>CR</b>': indicates whether the received frame ends with the 'Carriage Return' character (0x0D) (1) or not (0).</li> <li>➤ Bit '<b>NH</b>': indicates whether the format in Transmission (and in reception, if the Bit 'N°' is activated) is ASCII (1=Data) (0) or Numeric (&lt;0x01&gt;Data) (1).</li> <li>➤ Bit '<b>Ret</b>': Indicates if the 'OK' should be returned after each radio transmission (0) or not (1).</li> <li>➤ Bit '<b>2B</b>': In case of a Numeric Header (bit 'NH'=1) indicates if the header is on 1 bytes (0) or 2 bytes (1). Used if you have more than 255 modems in your system.</li> <li>➤ Bit '<b>ACK</b>' : Disable the radio acknowledgement (1) or enable (0).</li> </ul>	Bits	7	6	5	4	3	2	1	0		-	ACK	2B	Ret	-	NH	CR	N°
Bits	7	6	5	4	3	2	1	0													
	-	ACK	2B	Ret	-	NH	CR	N°													
R/W	S256	Default Address	Indicates the default address to which every radio frame will be sent. <b>Default : 0</b> (inactive)																		



## V.5. Configuration Example

We will describe in this paragraph how to parameter the modules in order to set up 2 different Addressed Secured configurations :

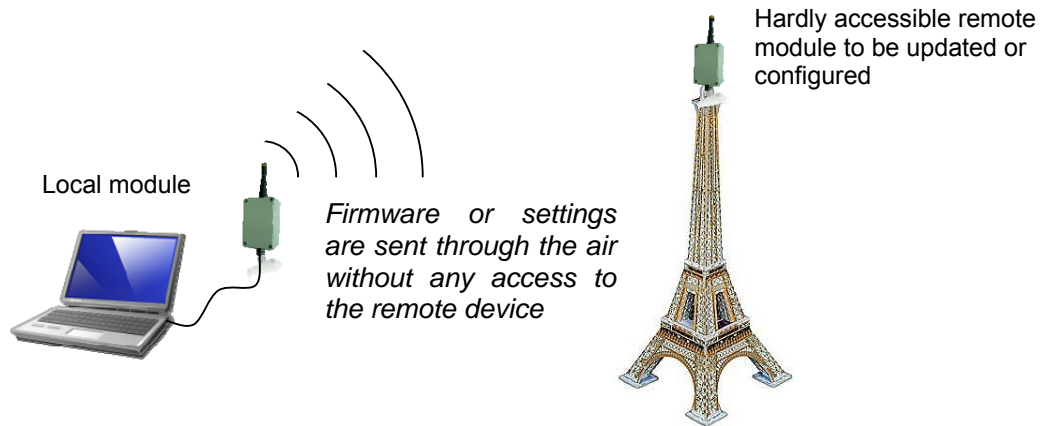
- One classical configuration where all the modules in the network can communicate to each others.
- One specific configuration equivalent to a Client/Server configuration, also called “Star” network, where communications are able only between the Server and the Clients.

CLASSICAL	CLIENT/SERVER	
All	Server	Clients
ATS220=9	ATS220=9	ATS220=9
ATS223=X (up to customer choice)	ATS223=X (up to customer choice)	ATS223=X (up to customer choice)
ATS226=X (up to customer choice)	ATS226=1, 2 or 3 (up to customer choice)	ATS226=1, 2 or 3 (up to customer choice)
ATS227=X (up to customer choice)	ATS227=1	ATS227=1
ATS250≠0	ATS250≠0	ATS250≠0
ATS252=1 to N	ATS252=255 or 65535	ATS252=1 to N except 255 or 65535
ATS255='0X0X00X1' (in binary)	ATS255='000X00X1' (in binary)	ATS255='000X00X1' (in binary)
ATS256=X (up to customer choice)	ATS256=0	ATS256=255 or 65535



## V.6. Configuration and Download Over The Air (DOTA)

TinyLITE module includes the new DOTA functionality. This function is able to change or update the firmware of a remote modem, using a local module. In this application, the new firmware is sent through the radio link to another device without the need of any hardware intervention on the remote device. All steps of the process can be done from a local radio module connected to a computer.



Completing DOTA, the configuration over the air functionality gives access to the Hayes mode of a remote modem. Thanks to it, you can adjust all the settings of a modem without physical access to it.

M868-tinyLITE modules are also re-flashable through the serial link. Both functionalities are available through a specific software tool "TinyTools". Refer to its user manual ([4]) for detailed explanation.



## CHAPTER VI.

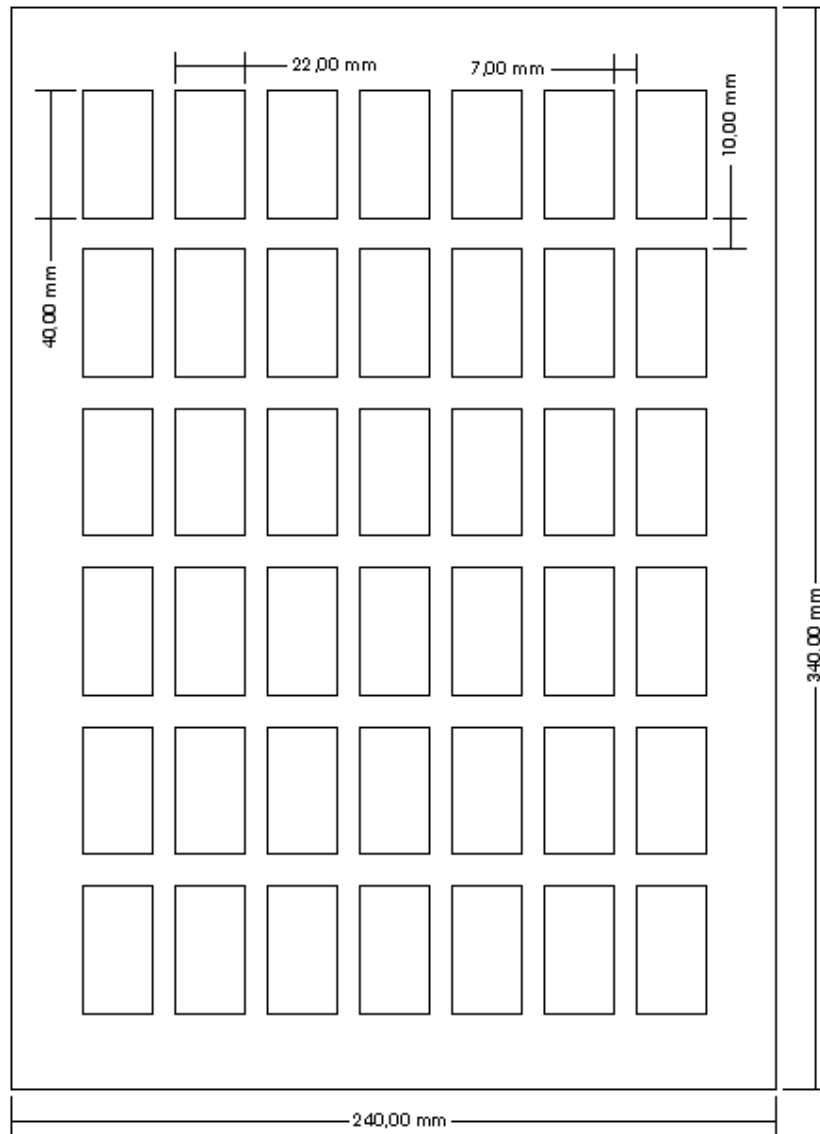
## PROCESS INFORMATION

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### VI.1. Delivery

B868-TinyLite modules are delivered in plastic tray packaging, each tray including 42 units. The dimensions of the tray are the following: 340 mm x 240 mm x 15 mm. Each unit is placed in a 22 mm x 40 mm location. An empty tray weights 76 g and a loaded tray weights around 250 g.





Trays are delivered in carton boxes, each box including 15 trays. The dimensions of the box are the following: 360 mm x 250 mm x 170 mm. An empty box weights around 430 g.



## VI.2. Storage

The optimal storage environment for tiny radio modules should be dust free, dry and the temperature should be included between -40°C and +85°C.

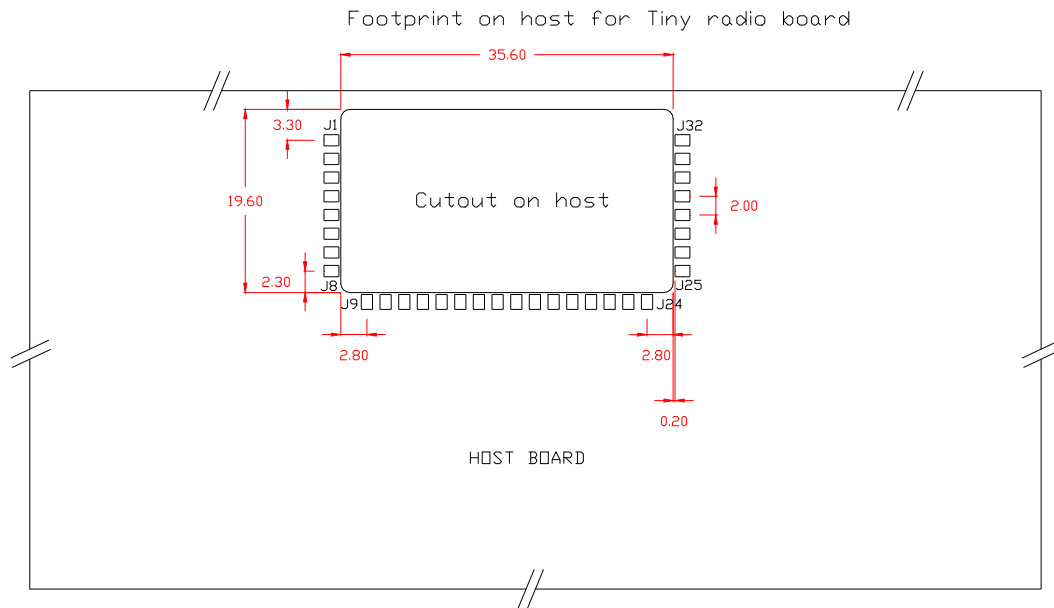
In case of a reflow soldering process, tiny radio modules must be submitted to a drying bake at +60°C during 24 hours. The drying bake must be used prior to the reflow soldering process in order to prevent a popcorn effect. After being submitted to the drying bake, tiny modules must be soldered on host boards within 168 hours.

Also, it must be noted that due to some components, tiny radio modules are ESD sensitive device. Therefore, ESD handling precautions should be carefully observed.

## VI.3. Soldering pad pattern

The surface finished on the printed circuit board pads should be made of Nickel/Gold surface. For optimal performances, the host board needs a maximum ground plane so that the integrated antenna becomes less sensitive to the environment.

The recommended soldering pad layout on the host board, as well as the host board cutout for tiny integration are shown in the diagram below:



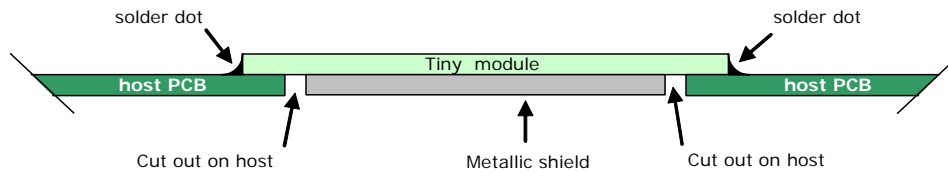
□ Dimension PAD : 1.6mm x 1.2mm



### VI.4. Solder paste (RoHS process)

Tiny radio module is designed for surface mounting using half-moon solder joints (see diagram below). For proper module assembly, solder paste must be printed on the target surface of the host board. The solder paste should be eutectic and made of 95.5% of SN, 4% of Ag and 0.5% of Cu. The recommended solder paste height is 200 to 250 µm (8 – 10 mil).

The following diagram shows mounting characteristics for tiny integration on host PCB:



### VI.5. Placement

The tiny radio module can be automatically placed on host boards by pick-and-place machines like any integrated circuit with the following recommended parameters:

- Placing accuracy: +/- 90 µm minimum
- Nozzle diameter: 5-6 mm
- Vacuum pressure: 9.10 mm
- Application area: Geometrical center of tiny board

### VI.6. Soldering profile (RoHS process)

It must be noted that tiny radio module should not be allowed to be hanging upside down during the reflow operation. This means that the module has to be assembled on the side of the printed circuit board that is soldered last.

The reflow process should be a regular surface mount profile. The ramp up speed should not exceed 3°C/s, reaching a peak temperature of 220 to 250°C during 45 to 60 seconds. The maximum sloping rate should not be higher than 5°C/s.

The barcode label located on the module shield is able to withstand the reflow temperature.

**CAUTION**

*It must also be noted that if the host board is submitted to a wave soldering after the reflow operation, a solder mask must be used in order to protect the tiny radio module's metal shield from being in contact with the solder wave.*



## CHAPTER VII. BOARD MOUNTING RECOMMENDATION

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### VII.1. Electrical environment

The best performance of the B868-TinyLite module are obtained in a “clean noise” environment. Some basic recommendations must be followed :

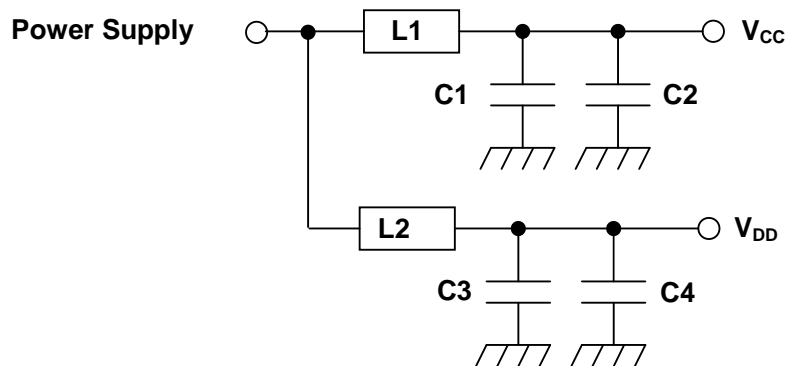
- Noisy electronic components (serial RS232, DC-DC Converter, Display, Ram, bus ,...) must be placed as far as possible from the B868-TinyLite module.
- Switching components circuits (especially RS-232/TTL interface circuit power supply) must be decoupled with a 100  $\mu$ F tantalum capacitor. And the decoupling capacitor must be as close as possible to the noisy chip.





## VII.2. Power supply decoupling on B868-TinyLite module

The power supply of B868-TinyLite module must be nearby decoupled. A LC filter must be placed as close as possible to the radio module power supplies,  $V_{CC}$  (RF power supply) and  $V_{DD}$  (digital power supply).



In order to limit voltage drop-out on  $V_{CC}$  at transmission, it is important to choose L1 with a very low series resistance (< 0.1Ohm).

<b>Symbols</b>	<b>Reference</b>	<b>Value</b>	<b>Manufacturer</b>
L1, L2	LQH31MN1R0K03	1 $\mu$ H	Murata
C1, C3	GRM31CF51A226ZE01	22 $\mu$ F	Murata
C2, C4	Ceramic CMS 25V	100nF	Multiple

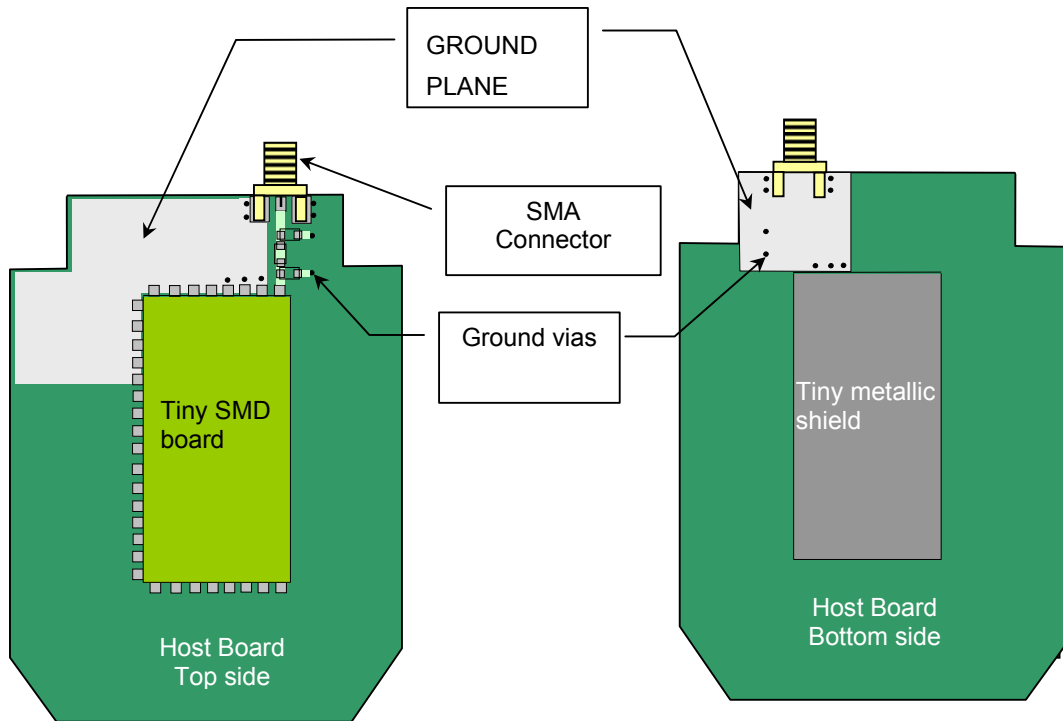


### VII.3. RF layout considerations

Basic recommendations must be followed to achieve a good RF layout :

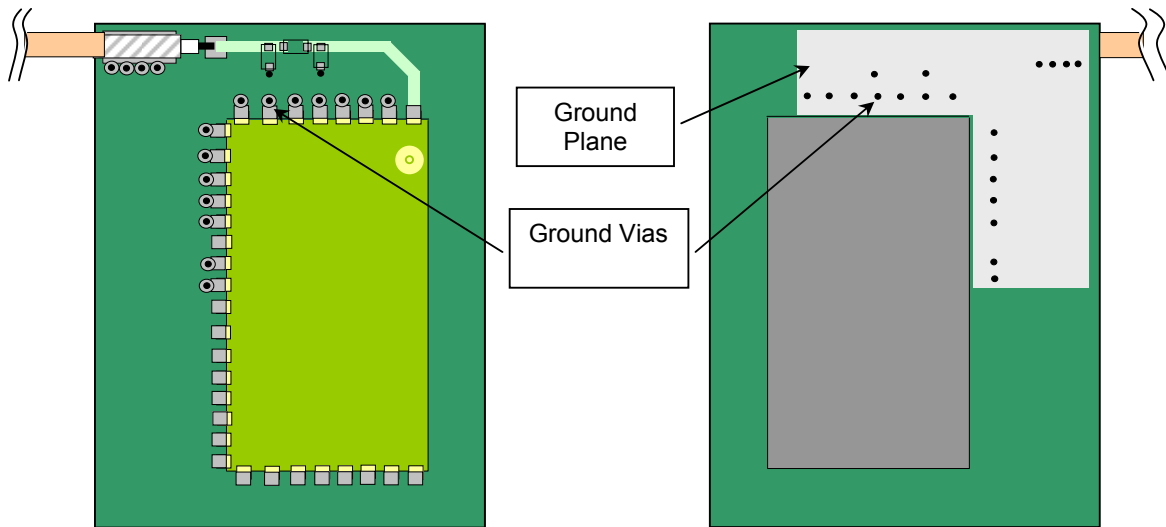
- It is recommended to fill all unused PCB area around the module with ground plane.
- The radio module ground boundaries must be connected to a ground plane.

*Layout VII.3.a : Example of GND layout implantation (top and bottom side)*

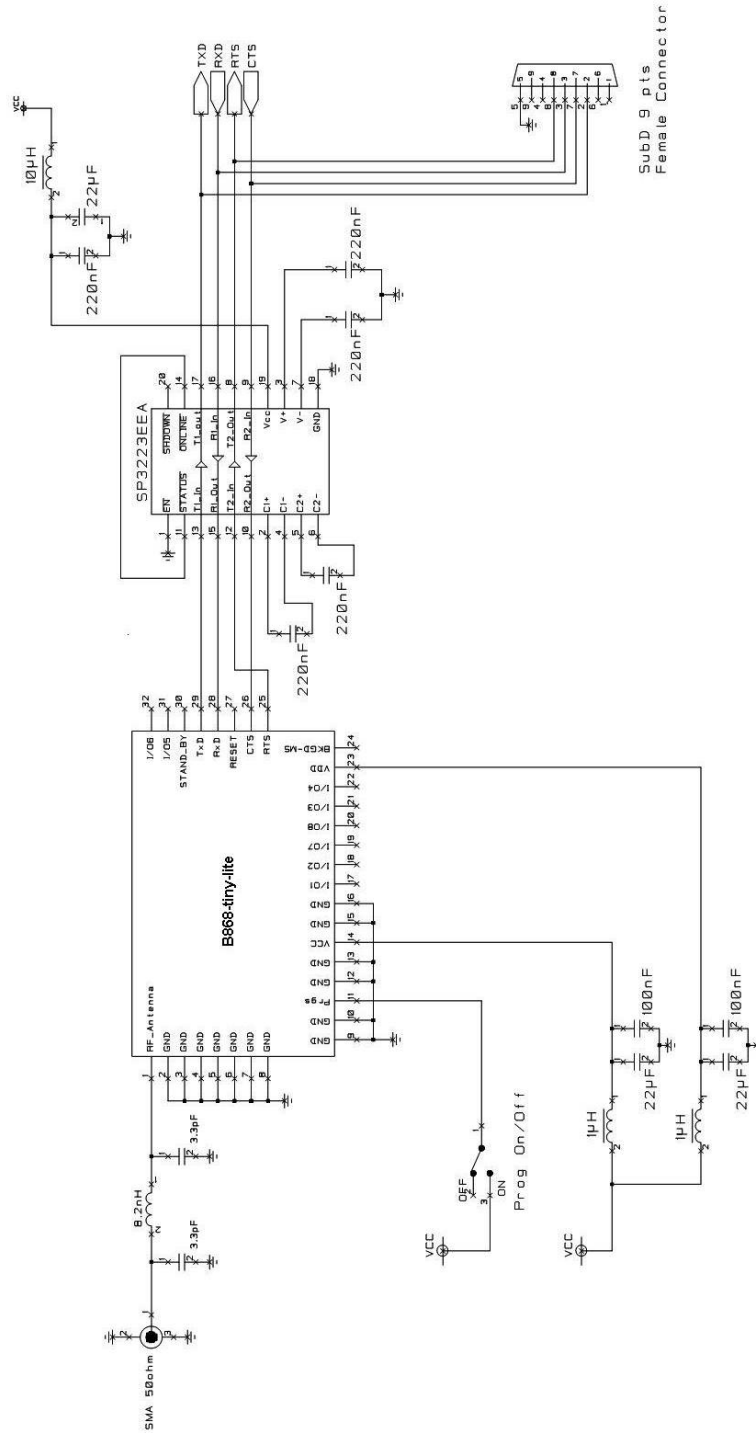


- If the ground plane is on the opposite side, a via must be used in front of each ground boundary.

*Layout VII.3.b : Example of GND layout implantation(top and bottom side)*



### VII.4. B868-TinyLite interfacing : full RS-232 connection



## CHAPTER VIII.

## ANTENNA CONSIDERATIONS

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### VIII.1. Antenna recommendations

B868-TinyLite performances when used in a product are strongly dependent on the antenna type and its location. Particular cautions are required on the following points:

- Use a good and efficient antenna designed for the 868 MHz band.
- Antenna must be fixed in such a location that electronic noise cannot affect the performances. (outside location is ideal if available).
- Antenna directivity must be low (omni directional antenna is usually the best choice).

Recommended antenna specifications :

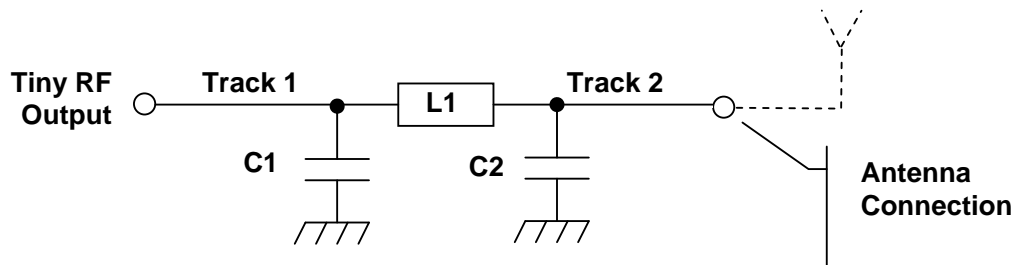
- Frequency Band : 868MHz +/- 25MHz
- Radiation Pattern : Omni directional
- Nominal Impedance: 50  $\Omega$
- VSWR: 1.5:1 max.
- Gain: 0dBi
- Polarization: Vertical



## VIII.2. Antenna matching

Impedance matching can be required to deliver the maximum possible power from the module to the antenna and vice versa. This is typically accomplished by inserting a matching network into a circuit between the source and the load.

This matching network must be established as close as possible to the tiny module. Here after an example of matching network between a B868-TinyLite module and an antenna.



Symbols	Reference	Package	Value	Comments
L1	Coil	0603	-	These values must be measured and optimized with a Network Analyzer.
C1, C2	Capacitor	0603	-	
Track 1, Track 2	50Ohms Stripline	<ul style="list-style-type: none"> <li>Width = 1,2mm (for a 1,6mm PCB thickness and FR4 Epoxy material)</li> <li>Track 1 length ≤ 10mm (as short as possible)</li> <li>Track 2 length ≤ 30mm (as short as possible)</li> <li>The opposite side requires a ground plane</li> </ul>		
Antenna connection	Coaxial cable Pad: Hot point: 2*2mm Ground pad:2*4mm Or a specific SMA connector can be used.			

If no impedance matching is required, this network can be replaced by the following default values:

Symbols	Reference	Package	Value
L1	Resistance	0603	0 Ohm
C1, C2	-	-	not mounted

See the layouts §VII.3 to have an idea of the antenna matching implantation :

- Layout VII.3.a: antenna connection via a coaxial solder pad (Top and bottom side)
- Layout VII.3.b: antenna connection via a SMA connector (Top and bottom side)



### VIII.3. Antenna types

The following are the antenna examples that may be suitable for tiny applications. We distinguish two types of antenna :

- External antenna (antenna is mounted outside of the device)
- Embeddable antenna (antenna is integrated inside the device)

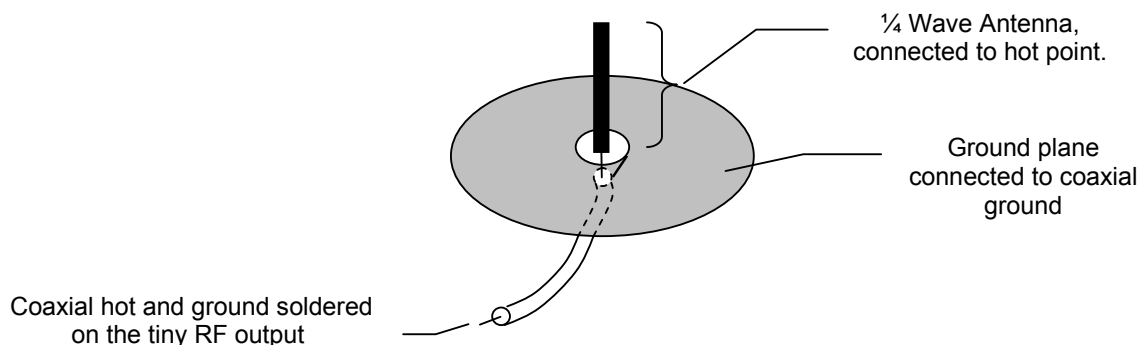
### VIII.4. External antenna

External antenna is recommended when the range performance is primordial. For example, for base stations and access points , where a better antenna gain may be required.

#### ▪ ¼ Wave Monopole antenna:

The ¼ Wave antenna is 8 cm long. Shorter compensated antennas could be used as long as they are adapted to 868 MHz frequency.

Best range may be achieved if the ¼ Wave antenna is placed perpendicular in the middle of a solid ground plane measuring at least 10 cm radius. In this case, the antenna should be connected to the module via some 50 ohm characteristic impedance coaxial cable.



**WARNING**  
*The metallic plane must be ideally under the antenna (balanced radiation). Never short-circuit the hot and cold pins!*

The installation directives are the following:

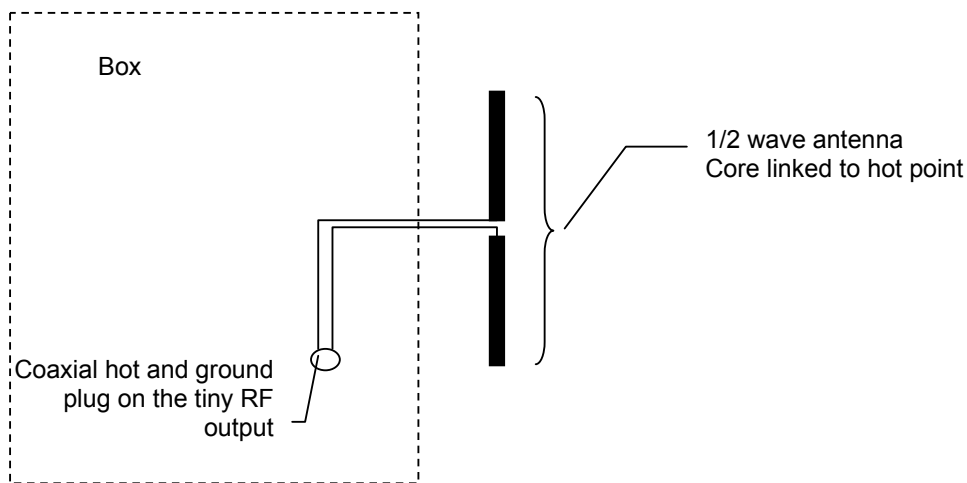
- Solder the coaxial cable on the hot and ground pad antenna (of the B868-TinyLite module.)
- Fix the antenna on a metallic plane, or on a metallic box with the metallic screw provided with the antenna.
- If the tiny module is integrated in a plastic box, use a metal tape (copper) glued on the plastic side under the antenna.



▪ **Half Wave Dipole antenna:**

The ½ Wave Dipole antenna is around 16 cm long. Shorter compensated antennas could be used as long as they are adapted to 868 MHz frequency. In a ½ Wave Dipole antenna the metallic plane is replaced by a second ¼ Wave antenna balancing the radiation.

Half wave monopole antenna typically offers a ground-independent design with favorable gain, excellent radiation pattern. It has a high impedance and requires an impedance-matching circuit (See paragraph IX.3)



**WARNING**

***It is recommended to place the ½ wave dipole antenna away from all metallic object, which will detuned it.***

***Particularity it is not recommended to place this type of antenna directly on a metallic box, but the antenna can be deported away through a 50 Ohm coaxial cable.***





### VIII.5. Embeddable antennas

In this section you will find antennas designed to be directly attached to B868-TinyLite module, inside the product casing. These antennas are only used in application where security, cosmetics, size or environmental issues make an external antenna impractical. This type of antenna is used when the integration factor becomes primordial (for mobile and handheld devices) to the range performances.

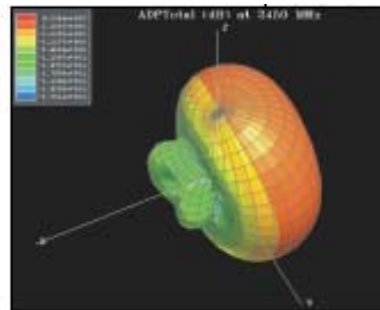
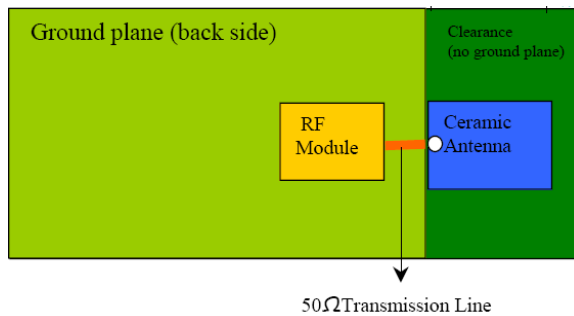
The basic recommendation are :

- The radio module must not be placed in a metallic casing or close to metallic devices.
- The internal antenna must be far from noisy electronic.

#### ▪ **Ceramic antenna:**

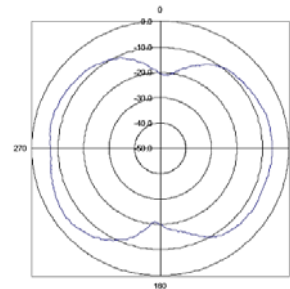
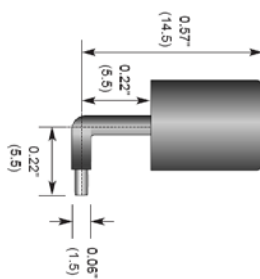
Ceramic antenna is a SMD component to be mounted directly on the PCB. It is designed so that it resonates and be 50 Ohms at the desired frequency. But we recommended to place an impedance-matching circuit (See paragraph IX.3).

The place under and around the ceramic antenna must be free of any track or ground plane. (refer to the antenna constructor requirements). It usually has a hemispherical radiation pattern has described below.



#### ▪ **Miniaturized antenna:**

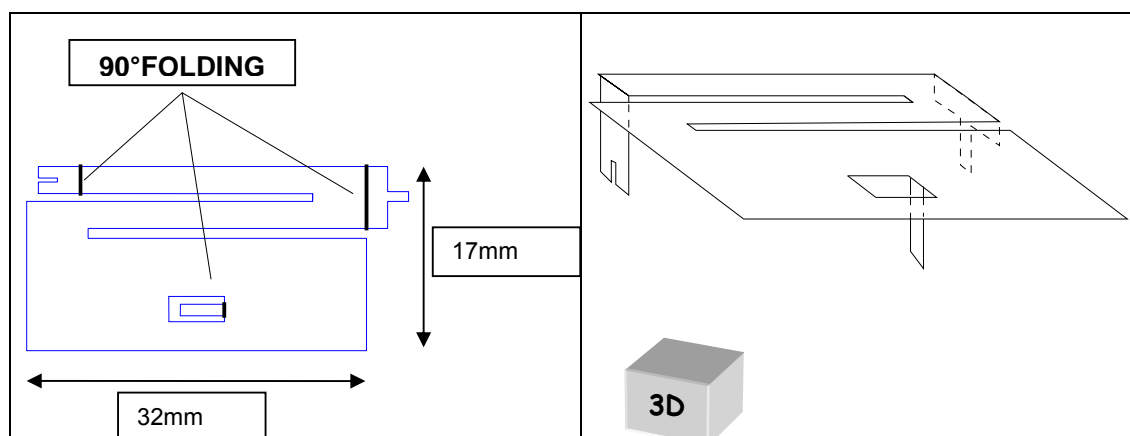
This type of antenna features a through-hole feedline to directly attach it to the PCB. This antenna acts like a ¼ wave antenna so that a minimum ground plane is required.



▪ ***Telit integrated antenna***

Integrated Antenna Characteristics :

- Resonating frequency: 869.000 MHz.
- Bandwidth: 0.5 %.
- Impedance: 50 Ohms.
- Gain: > -6 dB
- Dimensions: 32 x 17 x 4 mm



This antenna required a solid ground plane to give the best performances.

Because the ground plane is not a part of the tiny board itself but must be provided by the host PCB, and because the ground plane has influence on the antenna polarization, thus on the antenna performances, special care is needed during the design of the host PCB.

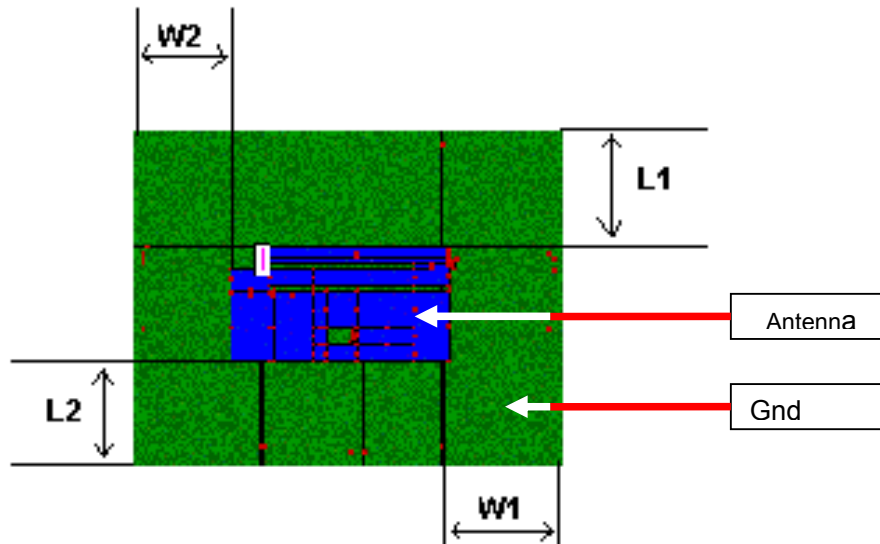
Best performance is reached when the polarization of both transmitting and receiving units are identical. The best polarization for an application depends on the placement of the B868-tiny modules. In general, two alternative situations can be distinguished:

- If both tiny modules operate at the same height, optimal range should be realized when the antennas of both modules are horizontally polarized.
- If one tiny module is located above a second one, optimal range should be realized when both modules are vertically polarized.



To reach optimal performances, experiments with different ground plane dimensions have been performed.

Radiation setting parameters (i.e. gain, radiation diagram and polarization) can be defined regarding the antenna's ground plane's dimensions. 4 parameters, W1, W2, L1, and L2, are therefore defined as shown below:

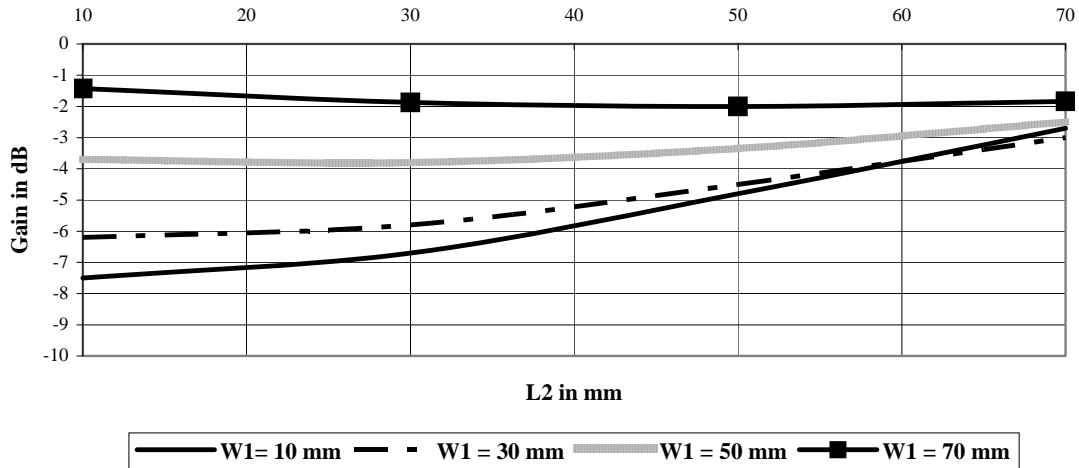


A parametric study can show the important parameters to optimize the antenna's polarization (vertical or horizontal) and gain:

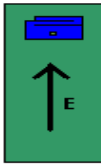
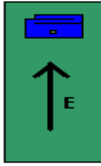
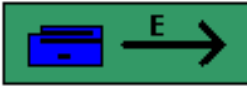

- The ground plane can be located indifferently on the top side or the bottom side
- W2 and L1 can be small as their influence on the antenna's electrical performances is weak. They are therefore fixed to a short dimension of 10 mm.
- W1 and L2 are important and strongly influence the antenna's electrical performances.
- To get a horizontal polarization, W1 has to be maximized.
- To get a vertical polarization, L2 has to be maximized.
- To increase the antenna's gain, W1 or L2, or W1 and L2 have to be maximized.



The following diagram shows the gain's evolution when W1 and L2 are increased (10 to 70 mm):



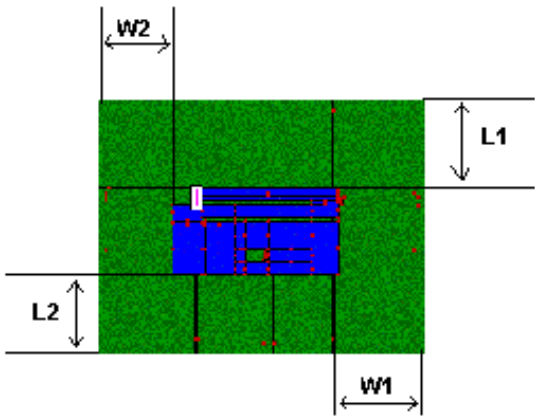


- The diagram clearly shows that the gain increases with W1 and L2. Therefore, the longer W1 and L2, the better the antenna's electrical performances will be.
- Actually, the polarization also needs to be considered, i.e. a proper W1-L2 combination needs to be chosen to get the desired polarization (vertical or horizontal).
- The table shown below details the different combination to get a pure polarization for an optimal radiation:

W1 (mm)	L2	Polarisation	
10	≥ 50 mm	Vertical	
30	≥ 70 mm	Vertical	
50	≤ 30 mm	Horizontal	
70	≤ 50 mm	Horizontal	



- Therefore, W1 must be much smaller than L2 to get a good vertical polarization and much greater than L2 to get a good horizontal polarization.

The following table shows the two optimal uses of the B868-tiny antenna:

		
<b>VERTICAL POLARISATION</b>		
<b>W1 = 10 mm</b> <b>W2 = 10 mm</b> <b>L1 = 10 mm</b>	<b>L2 &gt; 50 mm</b> <b>G &gt; -5 dB</b>	
	<b>L2 &gt; 70 mm</b> <b>G &gt; -4 dB</b>	
<b>HORIZONTAL POLARISATION</b>		
<b>W2 = 10 mm</b> <b>L1 = 10 mm</b> <b>L2 = 10 mm</b>	<b>W1 &gt; 50 mm</b> <b>G &gt; -4 dB</b>	
	<b>W1 &gt; 70 mm</b> <b>G &gt; -2 dB</b>	

Finally, when the integrated antenna is used, the tiny radio module should not be placed in a metallic casing or close to metallic devices.



## CHAPTER IX.

## ANNEXES

### IX.1. ETSI 300-220 standards (summary)

#### ETSI EN 300 220

The ETSI EN 300 220 specifies in detail the requirements and test methods to be used for type approvals of licence free operated radio equipment. The following is a summary of the most important requirements. The complete document can be downloaded from [www.etsi.fr](http://www.etsi.fr).

#### Frequency error (section 8.1)

The maximum frequency error depends on type of use; base/mobile or portable, and of the channel separation. The requirement applies only when a channel spacing is specified.

Frequency band	10/12.5kHz channel spacing	20/25 kHz channel spacing	Comment
300-500 MHz	1 / 1.5 / 2.5	2 / 2 / 2.5	Figures is in kHz for base/mobile/portable
500-1000MHz	N.A.	2.5 / 2.5 / 3	

#### Carrier power, conducted (section 8.2)

This requirement applies for equipment with external antenna connector. The maximum power depends on equipment class. The class is found in the table on page 4

Class	Maximum power mW / dBm
7a	5 / 7
8	10 / 10
9	25 / 14
11	100 / 20
12	500 / 27

#### Effective radiated power (section 8.3)

This requirement applies for equipment with dedicated or integral antenna. The test method is different from equipment with external antenna connector, but the test limits are the same as above.

#### TX modulation (section 8.4)

This test apply to analogue speech systems only (FM and AM).

#### Adjacent channel power (section 8.5)

This test is applicable for equipment operating in bands with specified channel separation and bandwidths.

For 25kHz channel spacing, which is the narrowest channel spacing used in the 868MHz band, the test receiver bandwidth and filter shape for the adjacent channel is specified as follows:

Offset kHz	Attenuation dB
6	-2
8	-6
9.25	-26
13.25	-90

(There is special test instruments made for this kind of measurements, for example the Rhode & Swartz test receiver CMTA 84)

The test should be used using test modulation patterns D-M3 (package) or D-M2 (data stream).



TinyOne Lite 868MHz User Guide  
**1v0300825 Rev.3 – 29/06/2010**

The requirement for 25kHz channel spacing is 200nW = -37dBm for normal test conditions, and 640nW = -32dBm for extreme test conditions.

**Modulation bandwidth for wideband equipment (>25kHz) (section 8.6)**

This test is applicable when no channel spacing is specified, or channel spacing is larger than 25kHz.

The power envelope shall be measured with a spectrum analyser, RBW=100 Hz, VBW=10kHz, using the maximum hold display function. The bandwidth is defined as the bandwidth of the power envelope where the power is above the required spurious level. The spurious level limit is 250nW = -36dBm.

**Spurious emission (section 8.7)**

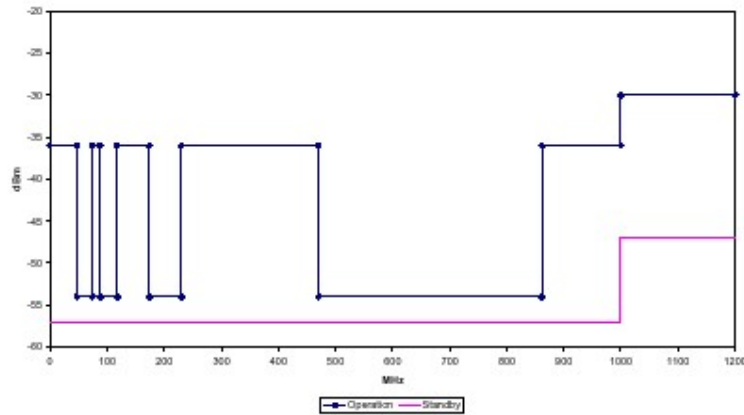
The spurious emission is a measurement of unwanted emitted signals. The device shall be measured without modulation applied.

If the carrier frequency is < 470 MHz the equipment shall be measured for unwanted emissions from 9kHz to 4 GHz. If the carrier frequency is >470 MHz, the upper limit is 12.75 GHz.

All spurs except emission at the intended channel and the adjacent channels shall be measured. The requirement is given in the table, and illustrated in the figure below.

State	47-74 MHz 87.5-118 MHz 174-230 MHz 470-862MHz	Other frequencies below 1000 MHz	Above 1000 MHz
Operating	4nW = -54 dBm	250nW = -36dBm	1µW = -30dBm
Standby	2nW = -57dBm	2nW = -57dBm	20nW = -47dBm

Spurious emission requirement



**Frequency stability for low voltage, battery operation (section 8.8)**



This requirement applies for battery operated equipment only.

The requirement is that when reducing the operating voltage to zero, the equipment should stay on the desired frequency, or cease to function altogether.

**Duty cycle (section 8.9)**

This requirement states the transmitter on/off ratio measured during 1 hr period. The duty cycle ratio is found in the table on page 4.

**Receiver spurious radiation (section 9.1)**

For equipment with integral antenna the radiated emission from the receiver shall be measured. Equipment with external antenna connector shall be measured for both conducted spurious emission and cabinet radiation.

If the carrier frequency is < 470 MHz the equipment shall be measured for unwanted emissions from 9kHz to 4 GHz. If the carrier frequency is >470 MHz, the upper limit is 12.75 GHz.

The radiation limit is given in the table below.

State	Below 1000 MHz	Above 1000 MHz
Receive	20W = -57dBm	20W = -47dBm

**Receiver spurious response or blocking (section 9.2)**

The ETSI standard does not give any mandatory requirements to receiver spurious response or blocking.





## IX.2. Examples of propagation attenuation

Factor	433 MHz		868 MHz		2.4 GHz	
	Loss	Attenuation	Loss	Attenuation	Loss	Attenuation
Open office	0 %	0 dB	0 %	0 dB	0 %	0 dB
Window	< 5 %	< 1 dB	15 %	1 – 2 dB	30 %	3 dB
Thin wall (plaster)	25 %	3 dB	35 %	3 – 4 dB	50 %	5 – 8 dB
Medium wall (wood)	40 %	4 – 6 dB	50 %	5 – 8 dB	70 %	10 – 12 dB
Thick wall (concrete)	50 %	5 – 8 dB	60 %	9 – 11 dB	85 %	15 – 20 dB
Armoured wall (reinforced concrete)	70 %	10 – 12 dB	80 %	12 – 15 dB	90 %	20 – 25 dB
Floor or ceiling	50 %	5 – 8 dB	60 %	9 – 11 dB	85 %	15 – 20 dB
Armoured floor or ceiling	70 %	10 – 12 dB	80 %	12 – 15 dB	90 %	20 – 25 dB
Rain and/or Fog	90 %	20 – 25 dB	95 %	25 – 30 dB	?? *	?? *

\* = *Attenuations increase along with the frequency. In some cases, it is therefore difficult to determine loss and attenuation value.*

Note = *The table above is only indicative. The real values will depend on the installation environment itself.*



### IX.3. Declaration of Conformity



## DECLARATION OF CONFORMITY

We, **Telit RF Technologies**

Of: **Rue Evarist Galois  
 06410 BIOT  
 FRANCE**

declare under our sole responsibility that the product:

### ***TinyOne Lite 868MHz module***

Radio module for wireless data transmission in 868MHz ISM band

to which this declaration relates is in conformity with all the essential requirements of the European Directive 1999/05/EC (R&TTE).

The conformity with the essential requirements of the European Directive 1999/05/EC has been verified against the following harmonized standards:

RF spectrum efficiency (R&TTE art. 3.2)	EN 300220 -2 Version 2.1.2
EMC (R&TTE art. 3.1b)	EN 301489 -3 Version 1.4.1
Electrical Safety and Health protection (R&TTE art. 3.1a)	EN 60950 -1/A11 and EN 50371

Restrictions :

- Only antenna with maximum gain of 0dBi are allowed to use.
- CE marking applies only to End Products. Because this equipment is only a subassembly, compliance tests have been realized with Telit terminal. Manufacturer of End Products, based on such a solution, has to insure full conformity to be able to CE label marking.

The technical documentation relevant to the above equipment will be held at:

**Rue Evarist Galois  
 06410 BIOT  
 FRANCE**



Biot, **23th April 2009**

<Xavier TATOPOULOS – R&D Manager>

