

PowerOne 868MHz Module User Guide

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This document is related to the following product :



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CHAPTER I.

INTRODUCTION

I.1. Aim of Document

The objective of this document is to present the features and the application of the B868MC-power radio module.

The characteristics of the B868MC-power radio module will be described within four distinct chapters:

- "Requirements" describes the general specifications of the module,
- "General characteristics" details the mechanical, functional and power supply characteristics of the module.
- "Description of the module" describes the block diagram and interface of the module.
- "Functionalities" lists the registers used on this modem and their use.



I.2. Reference Documents

- | | |
|-------------------------|--|
| [1] EN 300 220-1 v1.3.1 | ETSI Standards for SRD , Sept 2000 |
| [2] ERC Rec 70-03 | ERC Recommendation for SRD, March 2001 |
| [3] 2002/95/EC | Directive of the European Parliament and of the Council, 27 January 2003 |

I.3. Glossary

ACP	Adjacent Channel Power
BER	Bit Error Rate
CER	Character Error Rate
dBm	Power level in decibel milliwatt ($10 \log (P/1mW)$)
EMC	Electro Magnetic Compatibility
EPROM	Electrical Programmable Read Only Memory
ETR	ETSI Technical Report
ETSI	European Telecommunication Standard Institute
FM	Frequency Modulation
FSK	Audio Frequency Shift Keying
GMSK	Gaussian Minimum Shift Keying
IF	Intermediary Frequency
ISM	Industrial, Scientific and Medical
LNA	Low Noise Amplifier
PLL	Phase Lock Loop
PROM	Programmable Read Only Memory
NRZ	Non return to Zero
RF	Radio Frequency
RoHS	Restrictive Use of Hazardous Substances
RSSI	Receive Strength Signal 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

I.4. Software & Manuals

The standard configuration and test software MTC is fully described in its own manual. It gives an user friendly interface for the modems and boards configuration, and offers an easy test environment for the different communication modes.



II.2. Functional Requirements

The B868MC-POWER module has a digital part and a RF part.

The digital part has the following functionalities:

- Power supply
- Protocol interface
- Micro controller with embedded software
- Data coding and shaping

The RF part has the following functionalities:

- Frequency synthesis
- Front-end
- Low noise reception

The radio link is a Half Duplex bi-directional link.

II.3. Temperature Requirements

Operation:

- Temperatures : -20°C to + 55°C
- Relative humidity : 20 % to 75 %

Storage:

- Temperatures : -40°C to + 85 °C
- Relative humidity : 0 % to 95 %

II.4. Ordering information

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

B 868 MC – power / 10 – XXX

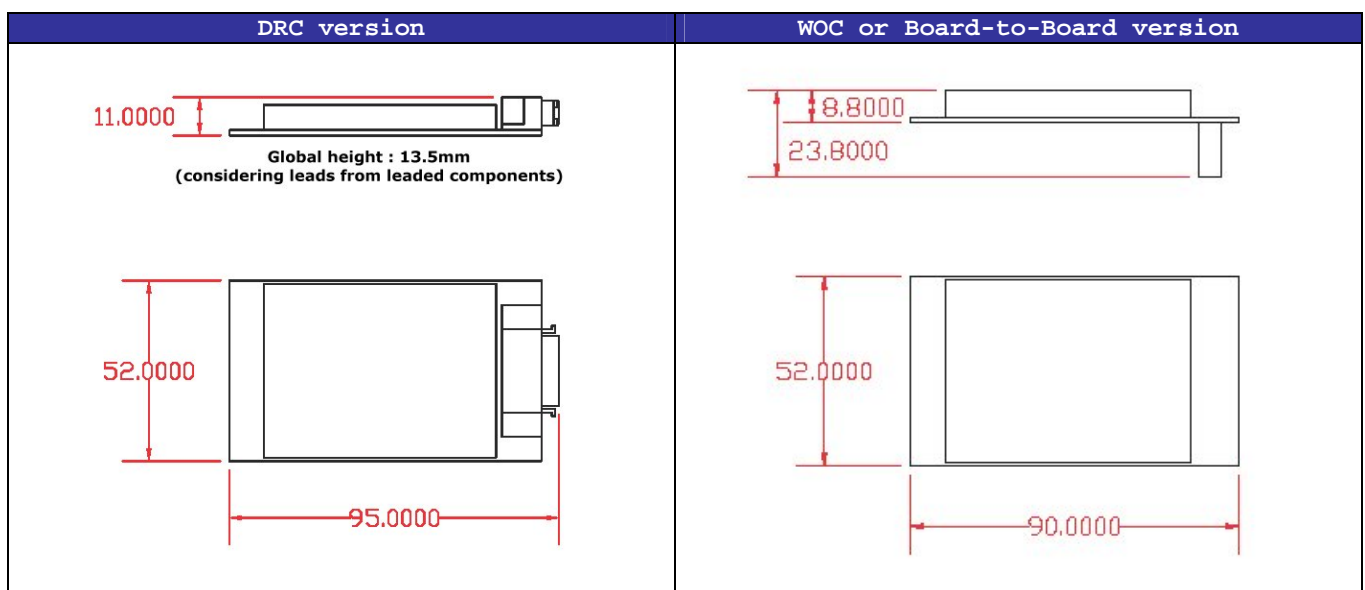
Connector option
DRC: Delta-Ribbon Connector
WOC: Without Connector



CHAPTER III.

GENERAL CHARACTERISTICS

III.1. Mechanical Characteristics



Note: Dimensions are in millimeters.



Format :	Rectangular 95x52 mm (included right angled connector).
Height :	13.5 mm (included right angled connector).
PCB :	The circuit is a 6 layers circuit in epoxy FR4 / 1,6mm width. The PCB has 4 fixing holes.
Cover :	Due to high radiated power, it is important to limit coupling and EMC problems : <ul style="list-style-type: none"> - The VCO is protected by its own metallic cover. - Furthermore, a global metallic cover is present on the “top” face of the board.
Components :	All SMD components except discriminator and IF filter. All the components are on the “top” face of the PCB and under the cover.
Connectors :	<p><u>For serial link :</u></p> <ul style="list-style-type: none"> - 1 connector « Delta Ribbon » male 26 points right angled from 3M. See connector drawing in Annex 2. This is the connector used for integration in IP41 casing. <p style="text-align: center;"><u>or</u></p> <ul style="list-style-type: none"> - 1 connector « Delta Ribbon » male 26 points straight for board-to-board connection. This is the connector used for integration in IP65 & IP67 casing. It is not populated by default. <p><u>For RF link :</u></p> <p>1 SMA connector which is not populated by default.</p>
Status LEDs :	2 external LEDs are available (out of the global cover) : <ul style="list-style-type: none"> - 1 red LED, lightening during data transmission, - 1 green LED, lightening during data reception.



Reception	Min.	Typ.	Max.
Sensitivity for CER <math>10^{-3}</math> :	-110 dBm	-112 dBm under 50 Ohms	-
Saturation for CER <math>10^{-3}</math> :	up to 0 dBm under 50 Ohms		
Remaining CER :	1.10^{-6} at -50 dBm		
Selectivity :	-	70 dB protection between channels	-
Immunity :			
<i>Protection against adjacent channels jammer at -20 dBm :</i>	40 dB	-	-
<i>Protection against other channels jammer at -20 dBm :</i>	45 dB	60 dB	-
Spurious responses :			
<i>Protection against out of the band spurious :</i>	40 dB	60 dB	-
<i>Protection against image frequency :</i>	20 dB	30 dB	-
Spurious leakage :			
<i>Below 1 GHz :</i>	-	-	-57 dBm
<i>Over 1 GHz :</i>	-	-	-47 dBm

III.3. Antenna Characteristics

A possible antenna is a $\lambda/2$ antenna from BONDALE Electronic.

Loss :	Approximately 2 dB
Connection :	6.5 cm coaxial cable to solder, screw fixing

WARNING

As the B868MC-power module delivers 500mW, it is very sensitive to the quality of the antenna used. Only choose antennas validated by Telit RF Technology.



III.4. DC Characteristics

Characteristics	Min.	Typ.	Max.
Power Supply V_{DD} :	+3.45V	+3.6V	+3.75V
Consumption :			
<i>Transmission :</i>	-	500mA	600mA
<i>Reception :</i>	-	50mA	60mA
<i>Stand-by :</i>	-	5 μ A	15 μ A
“TTL” I/O low level :	GND	-	GND+0.4V
“TTL” I/O high level :	V_{DD} -0.4V	-	V_{DD}

III.5. Digital Characteristics

Processor :	Micro-controller RISC 16 bits with Flash memory (> 48KB)
Serial link :	Full Duplex, from 1200 to 38400 Bauds Protocol Type : RS232, RS485, RS422 or TTL
Flux control :	Software (Xon/Xoff) & Hardware (RTS/CTS)
Specific signals :	<i>Outputs :</i> Ack_Tx, Tx/Rx et RSSI (analog) <i>Inputs :</i> Stand-By, RSSI <i>I/O :</i> IO1 to IO6, analog or digital I/O <i>Flashing :</i> TxD_Flash, RxD_Flash et TCK_Flash

III.6. Absolute Maximum Ratings

Voltage applied to V_{DD} :	-0.3 to +6V
Voltage applied to “TTL” Input :	-0.3V to V_{DD} +0.3V
Voltage applied to “Serial” Input :	\pm 25V



IV.2. Board Interface

The B868MC-power module communicates with its host via a connector which carries all the signals from the serial link and control (see description below).

The connector chosen is a « Delta-Ribbon » from 3M, 26-point in right angled version or straight board-to-board version. Drawings of the right angled connector are available in Appendix.



○ Pin out of the connector

Bus Pin	Interface Function	Signal direction ⁽²⁾	Signal level ⁽¹⁾	Function Description
1 & 2	V _{DD}	-	3.6V	3.6 volts power – Not used on Modem
3	RxD	I	TTL	RxD UART : Serial Data Reception
4	TxD	O	TTL	TxD UART : Serial Data Emission
5	RTS	O	TTL	RTS: Request To Send.
6	CTS	I	TTL	CTS : Clear To Send (INACTIVE) .
7	Ack_Tx	O	TTL	Radio Transmission Ok.
8	RS232/422	I	TTL	Serial link type selection: RS232 or RS485/422. (Must be set at startup)
9	Stand-By	I	TTL	Stand-By (Active high).
10	Lock	O	TTL	Network Synchronization Ok.
11	Tck_Flash	I	TTL	Clock using when flashing firmware.
12	RESET	I	TTL	External Reset. Also used during the programming of the Flash Program.
13	RxD_Flash	I	TTL	Data Reception using when flashing firmware.
14	TxD_Flash	O	TTL	Data Emission using when flashing firmware.
15	I/O-1	I/O	TTL/Analog	Analog Input or Logic Input/Output.
16	RSSI	S	Analog	Analog level of the received radio signal
17	I/O3	I/O	TTL/Analog	Analog Input or Logic Input/Output.
18	I/O2	I/O	TTL/Analog	Analog Input or Logic Input/Output.
19	I/O5	I/O	TTL/Analog	Analog Input or Logic Input/Output.
20	I/O4	I/O	TTL/Analog	Analog Input or Logic Input/Output.
21	RxD / A / -	I/I+/NC	Serial	Serial link signals for RS232 / RS422 / RS485
22	TxD / Z / B	O/O/-	Serial	
23	RTS / Y / A	O/O+ / +	Serial	
24	CTS / B / -	I/I-/NC	Serial	
25 & 26	GND	-	0V	Ground

⁽¹⁾: TTL signal levels are 0 and V_{DD}.
⁽²⁾: I = Input / O = Output



o **Description of the signals**

- RESET :** Reset hardware of the modem card. Maximum Duration: 200 ms. Active on low.
- ACK_TX :** Indicates that the buffer transmission has been executed correctly. This signal is valid at the end of the transmission of a radio message (Active RTS Signal) and is kept until RTS returns to inactive. Active (buffer transmitted) on low.
- xx_Flash :** Signals for the Flash programming of the Modem from the host. There are three signals : RxD, TxD and Clock.

When the host wants to read and/or modify the Flash, the modem must absolutely be in reset by activating the RESET Signal.
- RS232/RS485 :** Allows choice of the serial link : RS232 (active on open) or RS485/422 (active on low). High by default (internal pull up).
- CTS :** Clear To Send: signal coming into the Modem. Indicates if the modem can send serial data to the User (Active on low) or not (Inactive on high).
- RTS :** Request To Send: signal going out of the Modem. Indicates that the user can transmit serial data (Active on low) or not (Inactive on high). This signal switches when the serial reception buffer's filling rate reaches a programmable threshold (S218) or when the user finished transmitting serial data (out on Time-Out).
- TxD, RxD :** Serial link signals in NRZ format. TxD is for the data going out of the Modem while RxD is for the data coming into the Modem. Logical '1' is represented by high.
- Tx/Rx :** Indicates that the serial link is on reception or emission mode. This signal can be used with a half-duplex interface (typical a RS-485). Signal Active (serial on reception mode) on low.
- Stand-By :** Stand-by signal for the modem. Active on high.
- I/Ox :** Analog Input (12 bits) or Logic Input/Output. Not used in Standard firmware, these E/S can be used in a specific firmware or in the future Standard Firmware. Used as Logic Input for the moment.



CHAPTER V.

FUNCTIONALITIES

V.1. General concept

Telit RF Technologies modems and boards are provided with embedded software which allows to choose between different communication protocols and to play on numerous parameters. The configuration of the module is set through the use of Hayes type commands sent on the serial link.

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

<i>A</i>	<i>T</i>	<i>Command</i>	<i>Additional data</i>	<i><CR></i>
----------	----------	----------------	------------------------	-------------------

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.

These three + characters must be sent as one frame. The use of the keyboard to type them will not work. If you use a terminal, you will have to copy/paste them.

Despite its similarity to standard telecommunication modem, TELIT RF modems and boards remain radio link modems and are consequently fitted with some particular and specific 'AT' commands proper to radio transmission (I.e. Communication channel, radio rate ...).



V.2. Commands

Command	Description
Operating mode	
+++	<p>Hayes Mode Activation</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. '+++ ' command should be entered as one string, i.e. it should not be preceded by 'AT' and followed by <CR> 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. Hayes mode inactivates radio functions.</p>
ATO	<p>Communication mode activation</p> <p>'ATO' ' command gives an instant access to the modem's operating mode, configured in S220 register. 'ATO' ' command is used to get out of Hayes mode. Answer : OK or ERROR if the configuration is not complete</p>
AT/V	<p>Modem's firmware version</p> <p>'AT/V' ' command displays the modem's firmware version number as follows: Version <Product>: vX.YZn (refer to the firmware version history appendix).</p>
AT/S	<p>Modem's registers status</p> <p>'AT/S' ' command displays a dynamic and clear status of all relevant registers of the modem with the following categories:</p> <ul style="list-style-type: none"> • Radio • Serial link • Operation <p>Depending on the operating mode configured via S220, the following categories will be dynamically displayed:</p> <ul style="list-style-type: none"> • Network • Telemetry
ATSn?	<p>Register interrogation</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 RF modems while others are specific to some products. Answer : Sn=x<CR></p>
ATSn=m	<p>Register modification</p> <p>'ATSn=m' ' command configures Hayes register number n with the value m, e.g. AT200=4<CR> enters the value '4' in the register S200. The value is automatically stored in the EEPROM memory. Answer : OK or ERRORxx (Refer to the Error codes table)</p>
ATR	<p>Parameters reset</p> <p>'ATR' ' command resets all modem's parameters to their default values. Answer : OK</p>



Command	Description
Test functions	
ATNx	RSSI value indication (Received Signal Strength Indication) 'ATNx;y' : RSSI on channels 'x' to 'y' in dB -aa, -bb, -cc, ... <CR><LF> 'ATNx' : RSSI on channels 'x' to 'maxi channel' in dB -aa, -bb, -cc, ... <CR><LF> 'ATNRx;y': Repeat RSSI on channels 'x' to 'y' in dB until new character arrive on serial link : -aa, -bb, -cc, ... <CR><LF> -aa, -bb, -cc, ... <CR><LF>
ATT0	Pure carrier transmission representing '0'
ATT1	Pure carrier transmission representing '1'
ATT2	Max modulated carrier transmission
ATT6	Min modulated carrier transmission

The modem's response to any AT command is as follows:

- If the command is correct, the modem answers 'OK<CR>'
- If the command is not applicable, the modem answers 'ERROR xx<CR>'. See §IV.4 for error codes



V.3. Registers Detailed Use

The parameters to be configured via Hayes mode are stored in the modem's permanent memory, called S registers.

Those registers are always listed as follows:

- S20x registers correspond to the radio parameters
- S21x registers correspond to the serial parameters
- S22x registers correspond to the general operation parameters
- S25x registers correspond to the network operation parameters
- S26x to S28x registers correspond to the I/O operation parameters (only for modem M868MC-power in IP67 box).

○ Radio Configuration

The Radio configuration is set via the S20x registers.

Through them, you can:

- Change Radio Channel : S200,
- Change the radio baud rate : S201,
- Modify the output power : S202,
- Modify the carrier length : S204,
- Set the 2nd radio channel used for the Repeater mode : S207,
- Temporarily change the radio channel: S208.

The radio parameters are preferably set in the following order :

1. Change the radio baud rate: S201

This register allows changing the radio baud rate. The **default setting is '1'** for normal B868MC-power functioning at 9.6kb/s.

S201 value	Radio baud rate
0	4.8 kb/s
1	9.6 kb/s

When compatibility with the B868MC-tiny is chosen (see register S222), this register is automatically set to '0' .



2. Radio channel assignment : S200

This register sets the radio channel used for the communication. The B868MC-power can use any of 10 channels (0 to 9), spaced by 25 KHz and starting at 869.4125 MHz.

Channel	Frequency
0	869.4125 MHz
1	869.4375 MHz
2	869.4625 MHz
3	869.4875 MHz
4	869.5125 MHz
5	869.5375 MHz
6	869.5625 MHz
7	869.5875 MHz
8	869.6125 MHz
9	869.6375 MHz

The B868MC-power modems must be on the same channel to communicate.
 The default value for this register is **S200=0**

If more than one group of B868MC-power have to be present in the same area, each must be set to a different radio channel to be able to communicate without interference from the other groups. Each channel must be chosen as far as possible from the others to avoid inter channel interferences.

For example, if two B868MC-power groups are set in the same room, one will be on channel 0, and the other on one of the last channels (7 to 9).

3. Radio output power : S202

This register allows to choose the output power of the module, between 25, 100 and 500mW. This parameter allows to optimize power consumption in function of the desired range.

The default value for this register is **500mW (S202=3)**.

4. Radio carrier length : S204

This register sets the duration (in milliseconds) of the radio carrier sent before the data. It serves as synchronization frame for the receiver(s). The default value is 10 milliseconds (S204=10).

Usually, this register is not modified. However, in some hostile environment (metallic parts, vibrations...), it can be raised to 20ms in order to have a more reliable synchronization thus a more reliable communication.

This will lower the over air throughput as it increases the non-data use of the radio.

5. 2nd radio channel use for the Repeater mode: S207

This register defines a second channel for use in Repeater mode. The default value is 5.



2. Serial timeout setting : S214

The B868MC-power 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 baud rate: it must at least be equal to the length of 2 characters. See the table in the baud rate (S210) part of this chapter.
For example, for a 19200 bit per second baud rate, the time to send 1 character (1 start bit + 8 data bits + 1 stop bit) is 521 μ 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 registers : S211, S212 and S213

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

- S211 : Number of data bits. It can take two values, 7 or 8 bits. The default value is 8.
- 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 :

Format type		Data Bits S211	Parity S212	Stop Bits S213
8/N/1	8 data bits, no parity, 1 stop bit	8	1	1
8/E/1	8 data bits, even parity, 1 stop bit	8	2	1
8/O/1	8 data bits, odd parity, 1 stop bit	8	3	1
8/N/2	8 data bits, no parity, 2 stop bits	8	1	2
8/E/2	8 data bits, even parity, 2 stop bits	8	2	2
8/O/2	8 data bits, odd parity, 2 stop bits	8	3	2
7/N/1	7 data bits, no parity, 1 stop bit	7	1	1
7/E/1	7 data bits, even parity, 1 stop bit	7	2	1
7/O/1	7 data bits, odd parity, 1 stop bit	7	3	1
7/N/2	7 data bits, no parity, 2 stop bits	7	1	2
7/E/2	7 data bits, even parity, 2 stop bits	7	2	2
7/O/2	7 data bits, odd parity, 2 stop bits	7	3	2



4. Serial type management : S215

The B868MC-power serial link can be configured to work in any of the 4 following modes:

- RS232 (S215=0, default value) : This is the standard full duplex serial link. It works on up to 5 signals (3 without flow control): RxD, TxD, RTS, CTS and GND, and uses +/-12V levels. It is the only serial link type allowing flow control.
- RS422 (S215=1) : Full duplex link on 4 wires(A,B,Y,Z) using voltage difference.
- RS485 (S215=2) : Half duplex link on 2 wires(A,B) using voltage difference.
- RS485-Full (S215=3) : Full duplex link on 4 wires(A,B,Y,Z) using voltage difference. Unlike the point-to-point RS422 protocol, it can be used for multipoint operations.

5. Flow control management : S216

In transparent mode, the data are sent through the radio link as soon as they arrive. In all the other modes, the data are stored in a buffer, formatted and then sent. Thus, it is necessary to have a control on the serial flow to avoid a buffer overflow and a loss of data.

This register works with the Buffer Size register S218, which sets the limit to activate the flow control.

The B868MC-power manages the 3 following control types:

- Hardware or CTS/RTS (S216=0) : The RTS signal from the B868MC-power will authorise 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 B868MC-power 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 B868MC-power 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 only for RS232 serial link type. The RS485 and RS422 serial link protocols do not include control signals, and the RS485 cannot send Xon/Xoff characters as it is a half-duplex communication.

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

6. Serial buffer size: S218

The serial management includes two serial buffers for reception and transmission. The memory size of these buffers is 260 bytes.

It works with the flow control, and sets the filling limit when the flow control is activated.

There is always a delay between the flow control activation and the actual stop of the flow. Then, the host must adjust the buffer size to be able to store the few bytes sent after the flow control activation. A value of 240 bytes is enough in most of the configurations.



o **Operating Mode configuration**

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

- Set the operating mode : S220,
- Set the Auto repeat : S221,
- Set the functioning mode : S222,
- Set the number of retries: S223,
- Set the number of repeaters : S225.

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

1. Functioning mode : S222

This register allows the compatibility with the B868MC-tiny :

<i>S222 value</i>	<i>Functioning mode</i>
0 (default)	Normal functioning between B868MC-power boards
1	Compatible functioning with B868MC-tiny boards

When compatible functioning with the B868MC-tiny is chosen, the radio baud rate is automatically set to 4.8kb/s (S201=0).

2. Operation Mode : S220

This is the most significant register : It tells the B868MC-power how it must run.

Warning:

Each time the Operation mode register S220 is modified, the Network registers S25x are reset to default values depending on the new Operation mode selected to reflect its way of working.

The available operation modes are :

<i>Value</i>	<i>Mode</i>	<i>S25x Registers Value</i>
1	Transparent Mode (default)	
3	Secured Transparent Mode	S25x=0.
4	Network Server Mode	S25x=0, S252=255 & S255=1.
5	Network Client Mode	S25x=0, S255=17.
6	Telemetry Server Mode	S25x=0, S255=1.
7	Telemetry Client Mode	S25x=0, S255=1.
8	Repeater Mode	Not used. S207 active.
9	Addressed Secured Mode	S25x=0, S255=1.
10	Demo Mode Master	Not used
11	Demo Mode Slave	Not used



3. Auto repeat activation : S221

This register is used in transparent mode only, and for test purpose.
When activated, the modem sends back on the radio each received frame without echoing them on the serial link.

This mode gives the possibility to install a B868MC-power in one place without serial link and to test the range limit by sending frames from another modem connected to a computer.
The frames sent must be smaller than the buffer's physical size (260 bytes).

4. Number of repetitions : S223

This register is used in all the modes, except transparent, relay and demo-modes.
When the B868MC-power sends a frame in a secured mode (Transparent secured, Addressed secured or Network), it waits for an Acknowledge frame from the remote modem. If it doesn't receive this acknowledge, it will send the message again up to S223 times until it receives it.
This register is set to 2 as default. It is enough in most of the configurations.

5. Number of Repeaters : S225

This register can be used in all modes except Network, as its protocol is not compatible with the use of repeaters.
When one or more repeaters are used between two (or more) B868MC-power, the number of repeaters between them **must** be specified in order to compute the transmission time and set the timeout for acknowledge reception.
The default value is 0 repeater.



o **Network mode Configuration**

The configuration to use the B868MC-power in Network, Addressed or Telemetry modes is done with the S25x registers.

Through them, you can:

- Set the Network address : S250,
- Set the Client Address : S252,
- Set the number of clients : S254,
- Set the operation options : S255,
- Set a default address for transmission : S256.

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

1. Network Address : S250

When in a Network or Addressed Secured operation, the B868MC-power can communicate only if they are parts of the same 'network'.

There can be up to 65535 network defined, but only one can work in a given area in each radio channel, i.e. in order to place more than one network in the same area, different radio channels must be used instead of different network numbers.

The default value is 0.

In Network mode, a network consists of 1 server and up to 32 clients, and the communication can go only to or from the server (Star network), with no risk of collision.

In Addressed Secured mode, a network consists of up to 65535 modems, each able to communicate with any other. There is no collision avoidance protocol.

This register has a special usage :

- If this register is set to 0, it can be configured with any network number.
- If this register is different from 0, it must be reset first to 0 before being set to another number.
This procedure resets also the registers 252, 254, 255 and 256 to their default values.



2. Network/Addressed Options : S255

When running in Network or Addressed modes, this register contains the option flags used to configure the operation.

This register is a group of 6 flag bits (0 to 5) :

Bits	7	6	5	4	3	2	1	0
Name	-	-	2 bits	Ret	Acq	NHd	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 n° 2:
"1=data" if the header is ASCII
"<0x01>data" if the header is numeric.
If set to 0, the receiver will not know the origin of the frame.
- ↪ 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>). Example "1=Data<CR>"
- ↪ Numeric header (Bit 2, **default 0**) : Used with bit 0 (Header), it sets the type of header for transmission or reception to ASCII(0) or numeric(1).
- ↪ Automatic Acquisition (Bit 3, **default 0**) : Used in Network mode only.
Defines if the server will automatically acquire and configure a free client in its range (bit3=0), or if the user has to set himself the network registers S250, S252 (on the client) and S254 (on the server).
If this bit is set to 0 (Automatic Acquisition), the registers 252 and 254 will be read only.
- ↪ Status answer (Bit 4, **default 0**) : Defines if the B868MC-power 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 1 (Answer), it returns OK if the acknowledge has been received, ERROR45 otherwise, and ERROR41 whether the frame is invalid (no header, or wrong format).
- ↪ 2 bits numeric header (Bit 5, **default 0**) : Used with bits 0 and 2, in Addressed Secured mode. Defines if the numeric header is on 1 byte (0) for less than 256 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 if the bit 5 is set to 1: "<0x00><0x01>Data" instead of "<0x01>Data" if this bit is 0.

3. Client Address: S252

If the modem operates in Network Server or in Network Client with Auto Acquisition active, this register is read only and is automatically set by the B868MC-power.

Otherwise, the user can set a Client number between 1 and 32 in Network mode, or between 1 and 65535 in Addressed mode. The client numbers must all be different in a network.
The default value is 0.



4. Number of Clients : S254

This register is used only if the modem operates as Network Server. If the Automatic Acquisition is activated (S255, bit3 to 0), this register is read only and is automatically set by the B868MC-power.

This register indicates the highest client number in the network. To get the better speed for the network management, the client numbers must be as small as possible.
The default value is 0.

5. Default transmission Address: S256

This register is used only in Addressed Secured mode.

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 Tables

Numbers in **bold** indicate the default value

Access	Register	Name	Description
Radio			
R/W	S200	Channel	Number of the radio channel in use. Between 0 and 9 Default : 0
R/W	S201	Radio BaudRate	Indicates the radio link rate Default : 1 : 9.6 Kbps
R/W	S202	Output Power	Radio power output 0 : 25 mW 1 : 100 mW 2 : 500 mW
R/W	S204	Radio Carrier Length	Indicates the radio carrier length in milliseconds. This carrier is sent before each data frame and is used to synchronize the receiver Default : 10
R/W	S207	2 nd channel	Used for the repeater mode only : working channel of the second modem Default : 5
W	S208	Temporary channel	Number of the radio channel in use, but not stored in EEPROM : if the modem is switched on – off, the channel will come back to the S200 value. Used to change channel often without burning the EEPROM



Access	Register	Name	Description
--------	----------	------	-------------

Serial Link																	
R/W	S210	Serial Speed.	<p>Indicates the speed on the Serial Connection</p> <p>'1': 1200 Bits/s '5': 19200 Bits/s '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"> <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> <tr> <td>1 ms</td> <td>≥ 38400 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	1 ms	≥ 38400 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																
1 ms	≥ 38400 bits/s																
R/W	S211	Data Bits	Serial Link Data Bits : 7 or 8 bits														
R/W	S212	Parity	Serial Link Parity Type: '1': None '2': Even '3': Odd														
R/W	S213	Number of Stop bits	Serial Link Stop Bits. : 1 or 2 bits														
R/W	S214	Serial Link Time Out	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) and between 1 and 100 milliseconds Default : 5														
R/W	S215	Serial type	<p>Selects the type of serial link used:</p> <p>'0' : RS232 '1' : RS422 '2' : RS485 '3' : RS485 full duplex</p> <p>The selection between RS232 and the other modes is done with the RS232/RS485 hardware signal (pin 8)</p>														
R/W	S216	Flow Control	Indicates flow control type: '0': Hardware: CTS/RTS '1': Software: Xon/Xoff '2': None														
R/W	S218	Buffer Size	Indicates the maximum frames size that will be given to the Modem. When this size is reached, the modem resets the RTS signal. Between 30 and 260 Default : 260														



Access	Register	Name	Description
Operation			
R/W	S220	Function Mode	Operation mode of the Modem. '1' : Transparent '7' : Telemetry Client '3' : Transparent Secured '8' : Repeater '4' : Network Server '9' : Addressed Secured '5' : Network Client '10' : Demo Master '6' : Telemetry Server '11' : Demo Slave
R/W	S221	Auto-Repeat Mode	Indicates auto repeat status : '0' : Auto-Repetition Off (Default) , '1' : Auto-Repetition On.
R/W	S223	Number of Retries	Maximum recoveries count in case of problems in non Transparent (Non-Ack response to a message) mode. If this Register is at 0, the frames are not checked and considered as still good (used for the tests). Included between 0 and 255 Default value: 2
R/W	S225	Number of Repeaters	Indicates the number of repeaters between two modems. Not available in network mode. Included between 0 and 10. Default value: 0
Low Power			
R/W	S240	Type of Low-power	Indicates whether the low power control pin is used or not '0' : No Low Power (default) , '1' : Stand-By activated by Hardware pin, '2' : Stand-By activated by Serial, '3' : Stand-By with Auto-Scan Radio.
R/W	S241	Inactivity time before standby mode	Inactivity time before Standby mode in seconds from 1 to 200 seconds. Default: 10
R/W	S243	Inter-Scanning time	Time between 2 radio scanning in milliseconds. From 1 to 60000 ms. Default: 1000
R/W	S245	Radio Scanning time	Time during radio scanning, in milliseconds. From 1 to 200 ms. Default: 50



Access	Register	Name	Description																								
Inputs/ Outputs (only for modem M868MC-power in IP67 box)																											
R/W	S260	I/O ports configuration	<p>Allows configuring the digital I/O as input or as output. Each I/O is independent of each other and is represented by two bits of that register.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>-</td><td>-</td><td>-</td><td>I/</td><td>I/</td><td>I/</td><td>I/</td><td>I/</td> </tr> <tr> <td></td><td></td><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td> </tr> <tr> <td></td><td></td><td></td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td> </tr> </table> <p>Bits to 00 ⇒ Port equivalent to Logic input Bits to 01 ⇒ Port equivalent to Logic output Bits to 10 ⇒ Port equivalent to analog input Bits to 11 ⇒ Not used Default : 0 (All ports as logic inputs)</p> <p>IP67 casing Warning: See §III.2 for hardware switches settings.</p>	-	-	-	I/	I/	I/	I/	I/				0	0	0	0	0				5	4	3	2	1
-	-	-	I/	I/	I/	I/	I/																				
			0	0	0	0	0																				
			5	4	3	2	1																				
R/W	S263	I/O configuration (Telemetry server only)	<p>Indicates whether the server operates in self-contained mode , i.e. I/O copy mode (S263=1) or not (S263=0) Default : 0 (No I/O copy)</p>																								
R/W	S264	Telemetry server stand-by time (Telemetry server only)	<p>Used in I/O copy. Indicates the time in seconds between an answer reception and a command transmission, (in seconds). Included between 0 (immediate answer) and 255. Default : 0</p>																								
R/W	S265	Telemetry client Stand-by time (Telemetry server only)	<p>Used in I/O copy. Indicates the time in seconds between a command reception and an answer transmission, (in seconds). Included between 0 (immediate answer) and 255. Default : 0</p>																								
R/W	S270	Digital I/O ports values	<p>1-byte register indicating the values of each digital I/O port on 1 bit.</p>																								
R	S28x	I/Ox analog ports values (1<x<5)	<p>2-byte registers indicating the values of each analog input port on 12 bits in mV. Therefore included between 0 and 3600.</p>																								



V.5. Error codes

Code	Error
Hayes commands	
01	AT characters are missing in the command
02	Command unknown or unauthorized in the current configuration
03	Register unknown
04	Register content not correct. Refer to the registers description for various limitations
07	Serial speed modification impossible because of low time-out. Time-out should be modified before serial speed.
08	Time-out modification impossible because of high serial speed. Serial speed should be modified before time-out
09	The addressing is missing in the command (Client ID =)
10	Channels to be scanned not correct
11	Command not correct. The client must have a network ID different from 0
12	Command not correct. The server must have a network ID different from 0
13	Client activation impossible. The network ID must be different from 0
14	Server activation impossible. The network ID must be different from 0
15	Radio speed modification impossible because of high serial speed. Serial speed should be modified before radio speed
16	Serial speed modification impossible because of low radio speed. Radio speed should be modified before serial speed
17	Radio speed modification impossible because of high number of channels. Number of channels should be modified before radio speed
18	Repeater mode only. Radio speed modification impossible because channel N°2 is above the number of channels limit. Channel N°2 should be modified before radio speed
19	Repeater not allowed in network
Telemetry mode	
31	Transmission to client impossible: No client response or radio noise
32	Telemetry client not responding to command
33	Telemetry client's answer format not valid
Network / Addressed secured mode	
40	Command not valid
41	Client ID not valid on server
44	Client ID not found on server
45	Transmission to client impossible: No client response or radio noise



V.6. Board reflashing

The B868MC-power module is reflashable when populated with its right angled connector.

To reflash the module, a special cable is necessary. Ask your sales contact or our support team for more information.



CHAPTER VI.

APPENDIX

VI.1. Modems' Installation: Principles and cautions

- You must use the power supply and serial cable provided by Telit RF with the modem.
- The radio environment should be closely studied prior to any installation with a spectrum analyzer in order to determine whether and where the installation will be optimal.
- In case of outdoor installations, IP casings are recommended.
- In case of a ceiling installation, the modem should be mounted upside down for a better radiation
- A 1 m distance between two modems should be respected under 25 mW power output, at least 2 m at 100 mW and 3 m at 500 mW.
- The modems should be located as high and as free as possible so that a line of sight propagation is established between modems.
- The modem should not be surrounded by metallic masses because of the disturbances caused by reflection phenomena.
- The electrical disturbances can come from various sources and should be avoided
 - ✓ Engines
 - ✓ High current devices
 - ✓ Power relays
 - ✓ Transformers
 - ✓ Etc...
- The radio disturbances should also be avoided:
 - ✓ System in the same frequency band such as cars remote control systems.
 - ✓ Systems in a nearby frequency band such as high power (2 W) talkie-walkie systems.
- Vibrations and/or shocks can also be source of disturbances. It is therefore advised to mount the modems in silent-blocks in order to stabilize it whenever necessary.
- Distances, obstacles and weather conditions can strongly affect radio communications and cause disturbances as well as communication breakdowns.



VI.2. 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.

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).



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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)

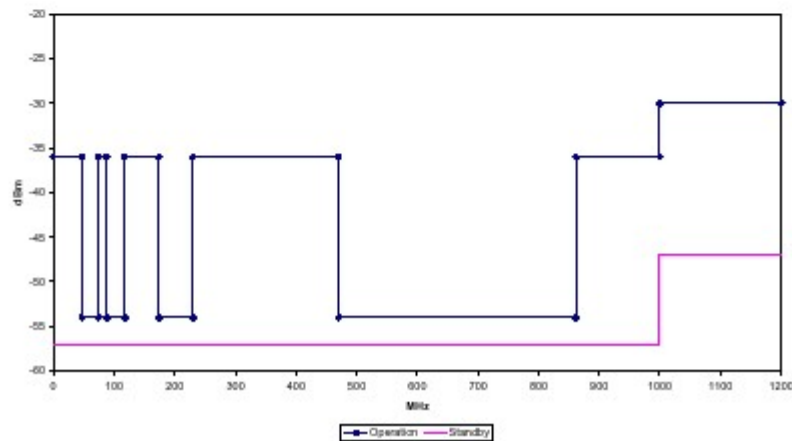
The spurious emission is a measurement of unwanted emitted signals. The device shall be measured without modulation applied.

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	2nW = -57dBm	20nW = -47dBm

Receiver spurious response or blocking (section 9.2)

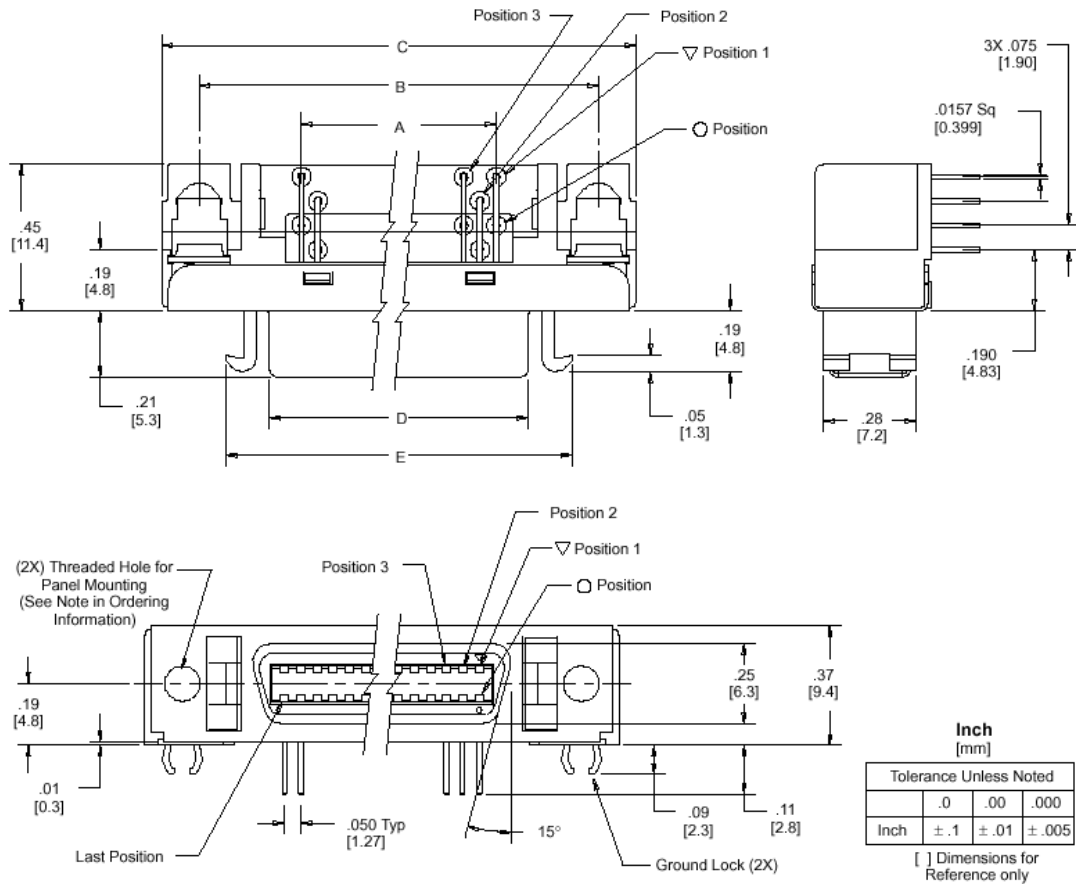
The ETSI standard does not give any mandatory requirements to receiver spurious response or blocking.



VI.3. Connector « Delta Ribbon »

Drawings of the 26 points male right angled connector from 3M :

Contact Quantity	Dimensions				
	A	B	C	D	E
14	.300 [7.62]	.93 [23.6]	1.16 [29.6]	.50 [12.6]	.77 [19.6]
20	.450 [11.43]	1.08 [27.5]	1.31 [33.4]	.65 [16.4]	.92 [23.4]
26	.600 [15.24]	1.23 [31.3]	1.46 [37.2]	.80 [20.2]	1.07 [27.2]
36	.850 [21.59]	1.48 [37.6]	1.71 [43.5]	1.05 [26.6]	1.32 [33.6]
40	.950 [24.13]	1.58 [40.2]	1.81 [46.1]	1.15 [29.1]	1.42 [36.1]
50	1.200 [30.48]	1.831 [46.50]	2.06 [52.5]	1.40 [35.5]	1.67 [42.5]
68	1.650 [41.91]	2.281 [57.93]	2.51 [63.9]	1.85 [46.9]	2.12 [53.9]



VI.4. Connection to a RS422 or RS485 interface

All the B868MC-power boards are configured in RS232 mode by default: it allows to directly connecting them on a PC serial port.

To configure the modem in RS422 or RS485 mode:

- ↗ Go to Hayes Mode and configure S215 Register: set to '1' for RS485 and to '2' for RS422.
- ↗ Power Off Modem.
- ↗ Connect RS485 or RS422 serial link to Modem (see Connector PinOut page 11).
- ↗ Connect RS232/422 pin to GND (see Connector PinOut page 11).
- ↗ Power On Board.

N.B.: if you Power off Board and set RS232/422 pin open, RS485/RS422 is inactivate and RS232 is activate.

VI.5. Examples of attenuation factors

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	?? *	?? *

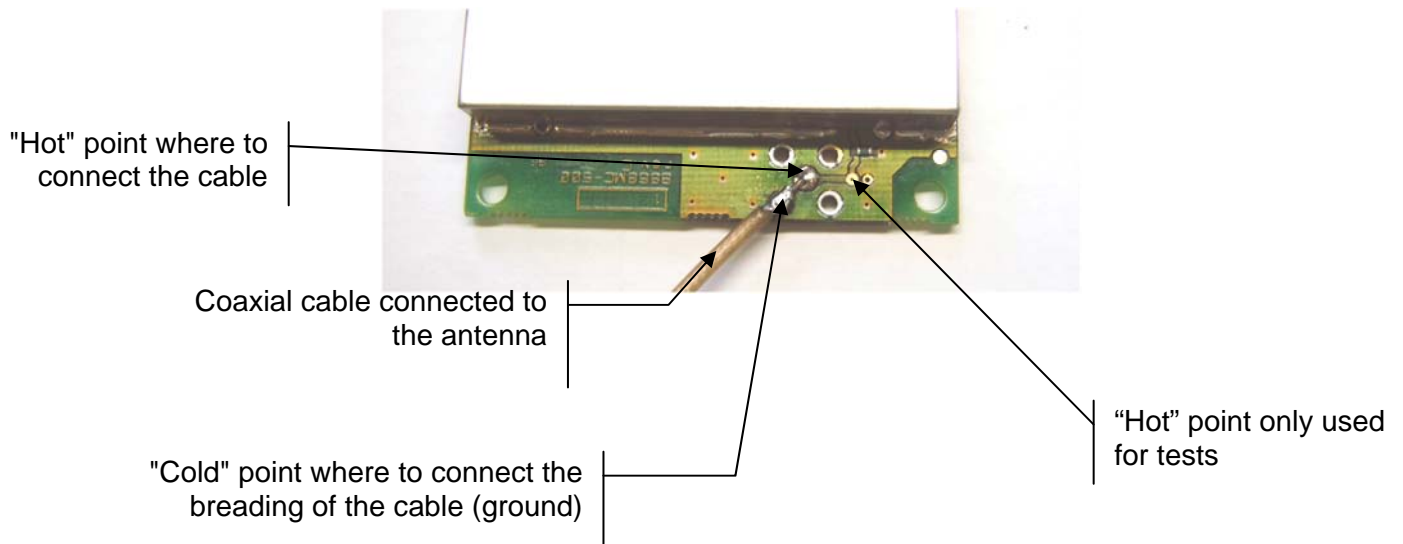
* = Attenuations increase along with the frequency. In some cases, it is therefore difficult to determine loss and attenuation value.

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



VI.6. Antenna Connection

Here is an example of the coaxial cable connection of the 868MHz antenna provided with the B868MC-power. The hot and cold point can easily be seen before and after the soldering process.



VI.7. 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:

PowerOne 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 2.1.1
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, *26th June 2009*

<Xavier TATOPOULOS – R&D Manager>

