TinyOne Plus 868MHz Terminal User Guide

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CHAPTER I. INTRODUCTION

I.1. Aim of the Document

The aim of this document is to present the features and the application of M868-TinyPlus radio terminal. The characteristics will be described within three distinct chapters:

- "General characteristics" describes the electrical and mechanical characteristics.
- "Mechanics and connections" details the casing, connector, cabling and power supply.
- "Functionalities" lists the operating modes, registers and their use.

I.2. Reference documents

[1] EN 300 220-2 v2.1.2	ETSI Standards for SRD , June 2007
[2] ERC Rec 70-03	ERC Recommendation for SRD, June 2009
[3] 2002/95/EC	Directive of the European Parliament and of the Council, 27 January 2003
[4] TinyTools : User Manual	1vv0300824_Tiny Tools User Guide
[5] Mesh Lite : User Manual	1vv0300819_M_ONE Protocol Stack User Guide

I.3. Document change log

Revision	Date	Changes
ISSUE # 0	29/04/09	First Release
ISSUE # 1	21/06/10	Updated: reference documents table, ERC 70-30 recommendation table Added description of the behavior for internal LEDs

I.4. Glossary

ACP	Adjacent Channel Power
BER	Bit Error Rate
Bits/s	Bits per second (1000 bits/s = 1Kbps)
CER	Character Error Rate
dBm	Power level in decibel milliwatt (10 log (P/1mW))
EMC	Electro Magnetic Compatibility
EPROM	Electrical Programmable Read Only Memory
ETR	ETSI Technical Report
ETSI	European Telecommunication Standard Institute
FM	Frequency Modulation
FSK	Audio Frequency Shift Keying
GFSK	Gaussian Frequency Shift Keying
GMSK	Gaussian Minimum Shift Keying
IF	Intermediary Frequency
ISM	Industrial, Scientific and Medical
kbps	kilobits/s
LBT	Listen Before Talk
LNA	Low Noise Amplifier
MHz	Mega Hertz (1 MHz = 1000 kHz)
PLL	Phase Lock Loop
PROM	Programmable Read Only Memory
NRZ	Non return to Zero
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RSSI	Receive 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

CHAPTER II. GENERAL CHARACTERISTICS

II.1. General Requirements

The M868-TinyPlus terminal is a multi channel radio modem, delivering up to 25 mW in the 868 MHz ISM band (unlicensed frequency band).

It allows 'point-to-point', `multipoint' or 'mesh' 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 :

ERC recommendation 70-03				
Band	***Frequency band (MHz)***	***Maximum radiated power (mW)***	***Channel spacing (kHz)***	***Duty cycle (%)***
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

This band is free to use but the terminal and the user must respect some limitations. Most of these restrictions are integrated in the conception of the terminal, 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 terminal 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 terminal complies with the ETSI 300-220 (specific for SRD). The main requirements are described in Appendix 1.

Finally, the terminal 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**
Band G1		
Russian	No info	

Federation		
Band G3		
Russian Federation	No info	
Band G4		
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
Band A		
France	Duty cycle limited to 0.1%	
Russian Federation	Limited implementation	868-868.2 MHz
Band B		
Russian Federation	No info	
Band C		
Russian Federation	No info	
Band D		
Russian Federation	No info	
Band E		
France	Not implemented	
Greece	Not implemented	
Macedonia	Not implemented	Planned
Russian Federation	No info	
Sweden	Not implemented	

11.2. Temperature Characteristics

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

11.3. Mechanical Characteristics

Mechanical characteristics			
Characteristics	***IP67 casing***	***USB Dongle***	***Unit***
Material	Aluminium	polypropylene	
Connectors	Terminal blocks inside the casing. Exit through cable gland	USB socket type A	-
Dimensions	117 x 64 x 40 (without antenna)	78 x 30 x 7.5 (without USB socket)	mm^3
Weight	300	25	g
Antenna length : • Fixed antenna • Remote antenna	 83 93	internal antenna	mm
LEDs	No LEDs are available	No LEDs are available	

11.4. DC Characteristics

DC characteristics			
Characteristics	***IP67 casing***	***USB Dongle***	***Unit***
Power Supply	+6 to +40	+5 (through USB port)	V
Transmission consumption (@25mW)	*@6V :* 60 *@12V :* 35 *@40V :* 15	85mA	mA
Reception consumption	*@6V :* 30 *@12V :* 25 *@40V :* 10	30mA	mA
Stand-by consumption	70	-	µA

11.5. Timing Characteristics

Characteristics	***Min.***	***Typ.***	***Max.***
Power Up Sequence :	-	135 ms	150 ms
Stand by :			
Enter in Hard Stand-by :	-	700 µs	900 µs
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	-

11.6. Functional characteristics

The M868-tinyPlus functional characteristics depend on the RF data rate. 4 data rates are available : 4.8, 9.6, 19.2 or 38.4 kbps.

Frequency Sub-Band (MHz)	*Band g1 868-868.6*	*Band 7a 868.6-868.7*	*Band g2 868.7-869.2*	*Band 7d, 7b & 7e 869.2-869.4*	*Band g3 869.4-869.65*	*Band 7c 869.65-869.7*	*Band g4 869.7-870*
Global							
RF data rate : 4.8 kbps							
Channel number	12	4	10	2, 2 & 4	10	2	6
Channel width (kHz)	50	25	50	25	25	25	50
Frequency Channel 0	868.025	868.6125	868.725	869.2125	869.4125	869.6625	869.725
Transmission							
Output Power (under 50 Ω)	4 levels selectable by software (see Hayes command ATS202)						
Max output power (mW)	25	10	25	10	25	25	5
Modulation	GFSK with ±5 kHz deviation						
Reception							
Sensitivity for CER<10^{-3}	**-105 dBm** (± 1dB) under 50Ω						
Remaining CER	< 1.10^{-6}						
Saturation for CER<10^{-3}	**Up to -5 dBm** under 50Ω						
RF data rate : 9.6 kbps							
Channel number	12	4	10	2, 2 & 4	10	2	6
Channel width (kHz)	50	25	50	25	25	25	50
Frequency Channel 0	868.025	868.6125	868.725	869.2125	869.4125	869.6625	869.725
Transmission							
Output Power (under 50 Ω)	4 levels selectable by software (see Hayes command ATS202)						
Max output power (mW)	25	10	25	10	10	10	5
Modulation	GFSK with ±10 kHz deviation						
Reception							
Sensitivity for CER<10^{-3}	**-103 dBm** (± 1dB) under 50 Ω						
Remaining CER	< 1.10^{-6}						
Saturation for CER<10^{-3}	**Up to -5 dBm** under 50 Ω						

Frequency Sub-Band (MHz)	*Band 1f 868-868.6*	*Band 7a 868.6-868.7*	*Band 1g 868.7-869.2*	*Band 7d, 7b & 1h 869.2-869.4*	*Band 1i 869.4-869.65*	*Band 7c 869.65-869.7*	*Band 1k 869.7-870*
Global							
RF data rate : 19.2 kbps							
Channel number	6	None	5	None	1	None	3
Channel width (kHz)	100	-	100	-	100	-	100
Frequency Channel 0	868.05	-	868,75	-	869,525	-	869,75
Transmission							
Output Power (under 50 Ω)	4 levels selectable by software (see Hayes command ATS202)						
Max output power (mW)	25		25		25		5
Modulation	GFSK with ±20 kHz deviation						
Reception							
Sensitivity for CER<10^{-3}	**-102 dBm** (± 1dB) under 50 Ω						
Remaining CER	< 1.10^{-6}						
Saturation for CER<10^{-3}	**Up to -5 dBm** under 50 Ω						
Radio Bit Rate : 38.4 kbps							
Channel number	3	None	2	None	1	None	2
Channel width (kHz)	200	-	200	-	200	-	200
Frequency Channel 0	868,1	-	868,85	-	869,525	-	869,775
Transmission							
Output Power (under 50 Ω)	4 levels selectable by software (see Hayes command ATS202)						
Max output power (mW)	25		25		25		5
Modulation	GFSK with ±40 kHz deviation						
Reception							
Sensitivity for CER<10^{-3}	**-100 dBm** (± 1dB) under 50 Ω						
Remaining CER	< 1.10^{-6}						
Saturation for CER<10^{-3}	**Up to -5 dBm** under 50 Ω						

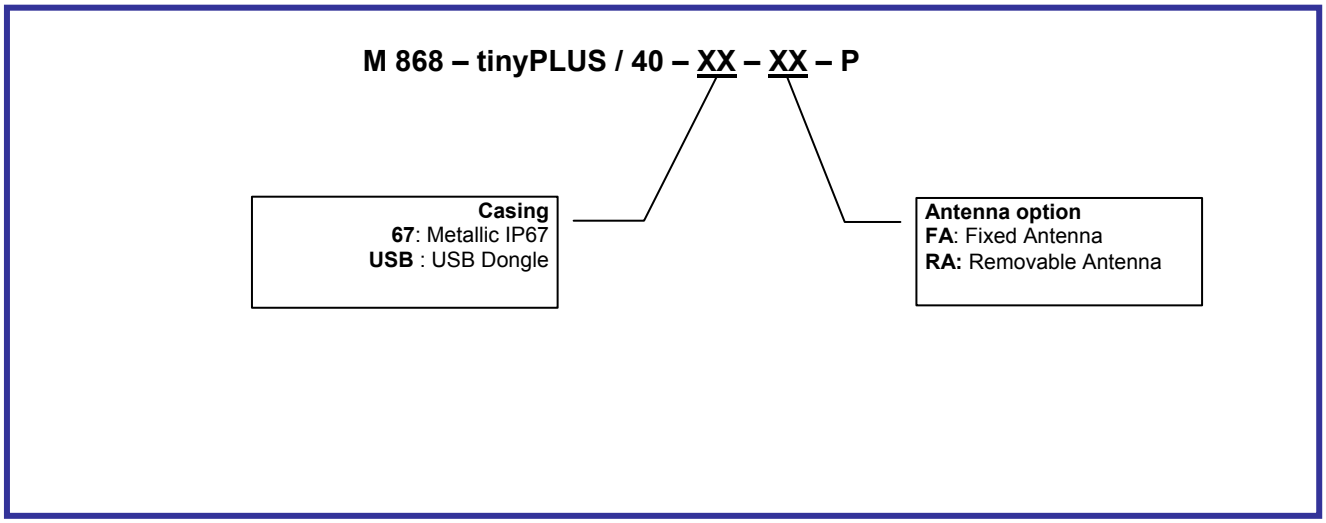
11.7. Digital Characteristics

Digital characteristics	
Micro-controller	Micro-controller RISC 8 bits with Flash memory
Programming	• Through serial link • Through the air (Download Over The Air)
RAM memory	2 Kbytes
Flash memory	16 Kbytes

Serial link characteristics		
Characteristics	***IP67 casing***	***USB Dongle***
Serial link type	RS232 / 485 / 422	Virtual COM port through the USB link (compatible USB v1.1 and v2.0)
Serial speed	1200 to 115200 bits/s	
Data bits	8	
Stop bits	1 or 2	
Parity	None, Even, Odd	
Flow control type	None, Hardware (RTS/CTS), Software (Xon/Xoff)	

11.8. Ordering information

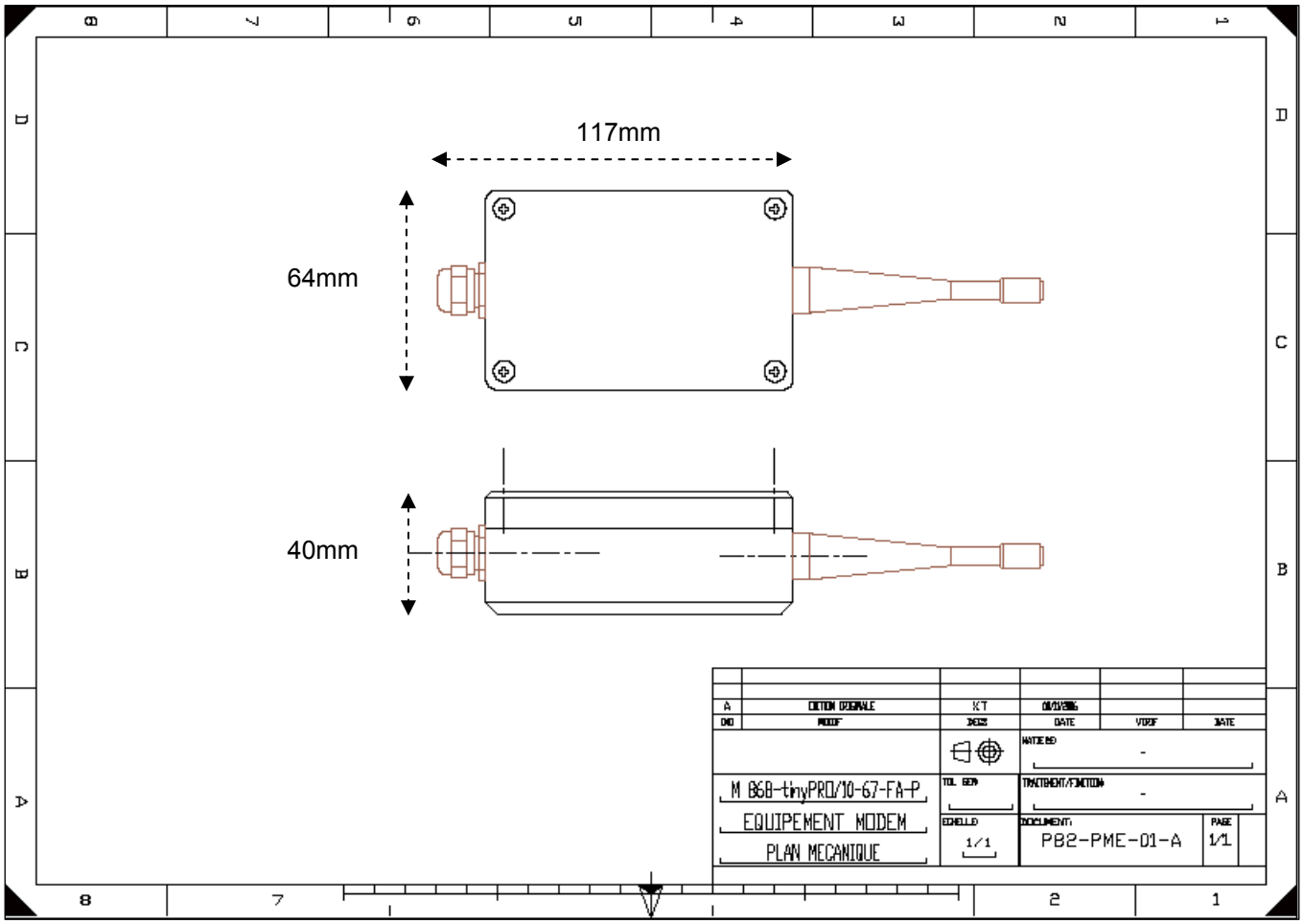
Select the desired options from the list below to identify the appropriate Telit part number you need.



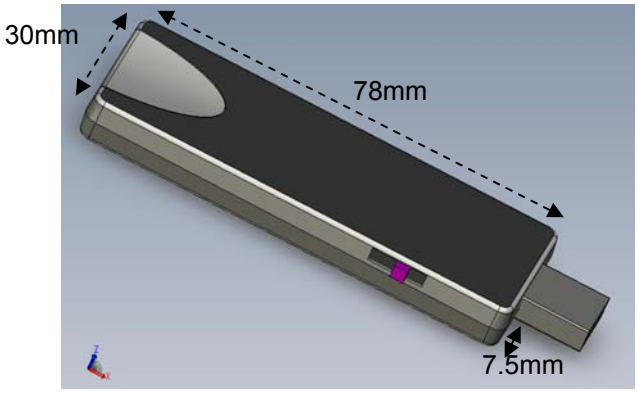
CHAPTER III. MECHANICS AND CONNECTION

III.1. Mechanical Characteristics

- ***Mechanical Drawings for IP67 casing***



- ***Mechanical Drawings for USB Dongle***



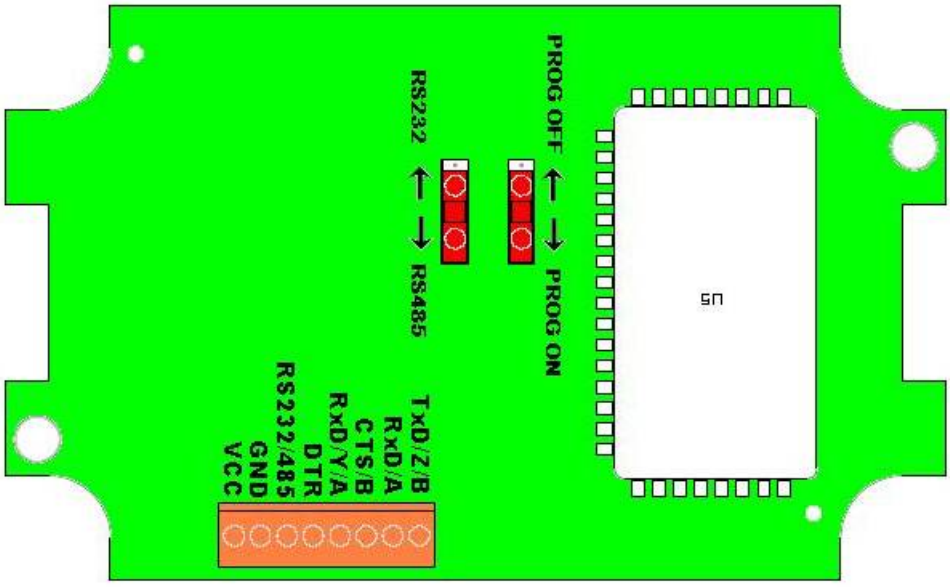
- ***Accessories for IP67 casing***

Ask directly Telit to get external mounting brackets on IP67 casing.

III.2. Connections

- ***IP67 casing***

The terminal will communicate with the host through a cable connected to terminal blocks on the mother board inside the casing (orange part on the following drawing) :



- TxD, RxD: Serial link signals in RS232 format. TxD is for the data going out of the Modem while RxD is for the data coming into the Modem. The logic '1' is represented by signal between –3 and –15V.
- DTR: Stand-By signal into the Modem. Switches the Modem in Low-Power Mode ('1', -15V to -3V) or in Normal Mode ('0', +3V to +15V).
- RS232/485: Used with the S215 Register, selects the type of serial link : open for RS232 (default, internal pull up 100 Kohms), GND for RS422 or RS485. Can be also made by RS232/485 switch.
- A, B, Y, Z : RS422/RS485 signals.
  For RS422 use A (or Rx+), B (or Rx-), Y (or Tx+) and Z (or Tx-).
  For RS485, use only A (or D+) and B (or D-).
- CTS: Clear To Send: signal into the Modem. Indicates if the Modem can send serial data to the User (Active on '0', +3V to +15V) or not (Inactive on '1', -15V to -3V).

- RTS: Request To Send: signal going out of the Modem. Indicates that the user can transmit serial data (Active on '0', +3V to +15V) or not (Inactive on '1', -15V to -3V). 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).
- 6-40V : 6 to 40 VDC power supply. There is no internal ON/OFF switch for the power supply. The switch off capability should be external.

Internal LED:
- Green: informs about association (blinks when searching for association, stays ON when associated)
- Red: indicates data reception (blinks each 5 seconds when receiving beacon)

Note: In case of the S-One stack green LED indicated transmission.

- ***USB Dongle***

The Modem will communicate with the host through a USB socket type A (sky blue part on the following drawing) :

USB Socket Pin	Name	Description
1	+5V	Power supply from the host
2	D-	Differential Data to and from the modem
3	D+	Differential Data to and from the modem
4	GND	Ground Signal

III.3. Cables Description for IP67 Casing

The associated cable is connected to the terminal blocks of the mother board and goes out of the modem through a cable gland. The cable must be shielded and have an external diameter between 3.5 and 7mm. The conductors must have a cross section of 0.22mm² (24AWG).

Possible cable references:

Supplier	Reference	Description
NEXANS	***SMBL07x0.22***	7 conductors
ALPHA WIRE	***5118C***	8 conductors
TELIT	***205.000.094***	1 meter serial cable with subD-9 connector for RS232 and 2 points connector for power supply

- ***Case of RS-232***

Connector (8 points)	Name Modem Side	Color	Name PC/Automate Side	Connector Sub-D (9 points)
1	TxD (Transmit Data)	Blue	RxD (Receive Data)	2
2	RxD (Receive Data)	White	TxD (Transmit Data)	3
3	CTS (Clear To Send)	Brown	RTS (Request To Send)	7
4	RTS (Request To Send)	Yellow	CTS (Clear To Send)	8
5	DTR	Green	DTR	4
6	RS232/422-485	Orange	**Open**	
7	Gnd (ground)	Black	Gnd (ground)	5
8	Vcc (6 to 40v)	Red	Vcc (6to 40v)	

- ***Case of RS-422:***

Connector (8 points)	Name Modem Side	Color	Name Automate Side
1	Z or Tx- (Transmit Data)	Blue	B or Rx- (Receive Data)
2	A or Rx+ (Receive Data)	White	Z or Tx+ (Transmit Data)
3	B or Rx- (Receive Data)	Brown	Y or Tx- (Transmit Data)
4	Y or Tx+ (Transmit Data)	Yellow	A or Rx+ (Receive Data)
5	DTR	Green	Open
6	RS232/422-485	Orange	**GND (and S215=1)**
7	Gnd (ground)	Black	Gnd (ground)
8	Vcc (6 to 40v)	Red	Vcc (6 to 40v)

- ***Case of the RS-485***

Connector (8 points)	Name Modem Side	Color	Name Automate Side
1	B (Data-)	Blue	B (Data-)
2	open	White	Open
3	open	Brown	Open
4	A (Data+)	Yellow	A (Data+)
5	DTR	Green	Open
6	RS232/422-485	Orange	**GND (and S215=2)**
7	Gnd (ground)	Black	Gnd (ground)
8	Vcc (6 to 40v)	Red	Vcc (6 to 40v)

CHAPTER IV.
STANDARD FIRMWARE : DESCRIPTION OF THE FUNCTIONALITY

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

M868-TinyPlus terminal is available with the following firmwares :

- ***S-ONE protocol stack:***
  - ***Standard firmware.;*** working in transparent or address secured mode..

- ***M-ONE protocol stack:***
  - ***Mesh Lite firmware,*** allowing mesh networking : refer to dedicated manual (**[5]**) for detailed explanation.

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

NOTE: The available memory space on the terminal is limited and for this reason Standard and Telemetry firmware are available in the separate installation packages.

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 terminal. 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

IV.1. Configuration Mode

Hayes or 'AT' commands complies with Hayes protocol used in PSTN terminal standards. This ‘AT’ protocol or Hayes mode is used to configure the terminal 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 M868-TinyPlus terminal.

Command	*Description*
+++	***Hayes Mode Activation*** ‘+++’ command gives an instant access to the terminal’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.
ATO	***Communication mode activation*** ‘ATO’ command gives an instant access to the terminal’s operating mode, configured in S220 register. ‘ATO’ command is used to get out of Hayes mode. Answer : OK or ERROR if the configuration is not complete
AT/V	***Terminal’s firmware version*** ‘AT/V’ command displays the terminal’s firmware version number as follows: *Version <Product>: vX.YZn*
AT/S	***Terminal’s registers status*** ‘AT/S’ command displays status of all relevant registers of the terminal

ATSn?	***Register interrogation*** 'ATSn?' command displays the content of Hayes register number n (Refer to the register description table). Some registers are standard for every Telit terminals while others are specific to some products. Answer : Sn=x<CR>
ATSn=m	***Register modification*** 'ATSn=m' command configures Hayes register number n with the value m, e.g. ATS200=4<CR> enters the value '4' in the register S200. The value is automatically stored in the EEPROM memory. Answer : OK or ERROR
ATN	***RSSI interrogation*** '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 : - '0' : received level < -87dBm - '1' : received level between -87 and -82dBm - '2' : received level between -82 and -77dBm - '3' : received level > -77dBm
ATR	***Parameters reset*** 'ATR' command resets all terminal's parameters to their default values. Answer : OK
ATP	***Stand By Activation*** When serial stand by is set, the 'ATP' command put the terminal in stand by mode. To wake up the terminal, send a NULL (0x00) character.
ATBL	***Switch to Bootloader*** '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.

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	***Pure carrier transmission*** at center frequency
ATT1	***Pure carrier transmission*** representing '0'
ATT2	***Pure carrier transmission*** representing '1'
ATT3	***Max modulated carrier transmission***
ATT6	***Min modulated carrier transmission***

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.

IV.2. Operating Mode

There are 4 communication protocols available on the M868-TinyPlus terminal :

- Transparent mode : this is the default communication protocol of the terminal. The terminal 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 terminal can communicate with every terminal 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 terminal.
- Auto-repeat mode : this is a specific communication protocol in which the terminal sends back the frames it has received (radio or serial) without echoing. It allows the user to easily test the terminal remotely.

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

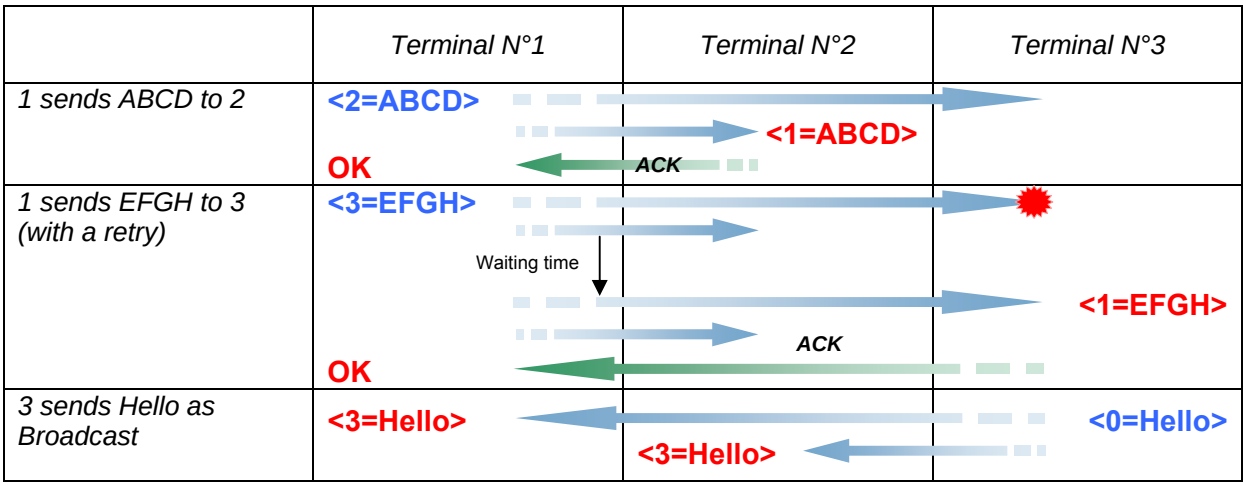
- ***Basic Illustration of Transparent mode***

	Terminal N°1	*Terminal N°2*	*Terminal N°3*
1 sends ABCD	**<ABCD>**	**<ABCD>**	**<ABCD>**
2 sends Hello	**<Hello>**	**<Hello>**	**<Hello>**

<in blue> : data sent

<in red> : data received

- ***Basic Illustration of Addressed Secured mode***

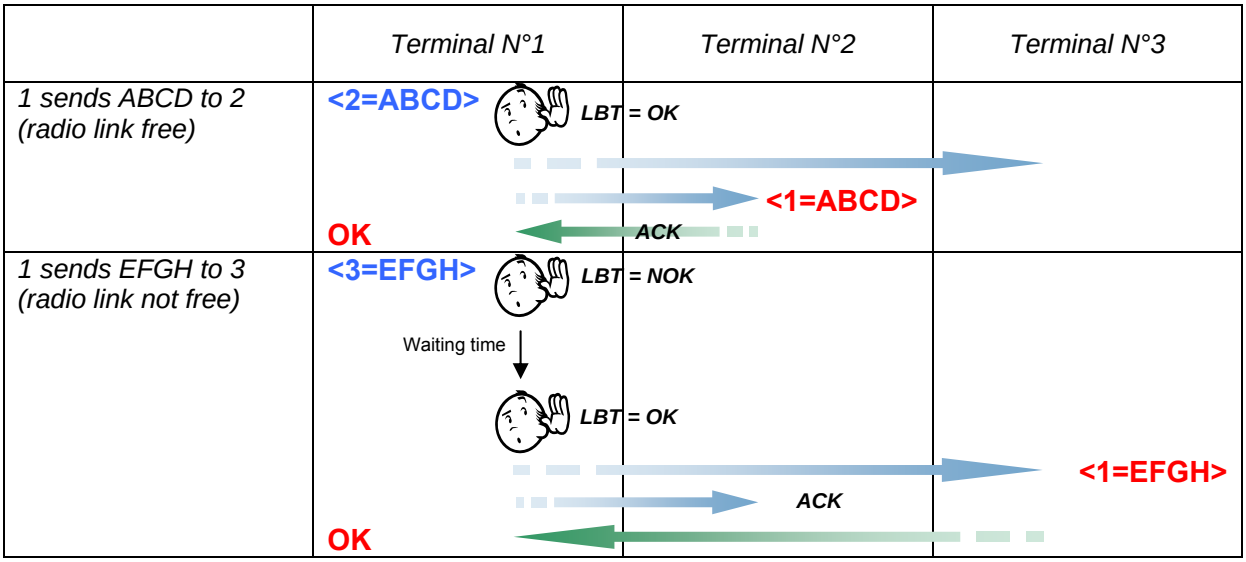


Collision or error

<in blue> : data sent

<in red> : data received

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



IV.3. Registers Detailed Use

The parameters to be configured via Hayes mode are stored in the terminal 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 radio channel : S200,
- 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. Radio baud rate : S201

This register allows changing the radio baud rate.

S201 value	*Radio baud rate*
0	4.8 kbps
1	9.6 kbps
2	19.2 kbps
3 (default)	**38.4 kbps**

2. Frequency Sub-band assignment : S206

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

- At 4.8 and 9.6 kbps, the terminal can use any of 9 Sub-Bands (0 to 8), starting at 868 MHz and ending at 870 MHz.

S206 value	Band	Frequency Sub-Band
0	1f	868-868.6 MHz
1	7a	868.6-868.7 MHz
2	1g	868.7-869.2 MHz
3	7d	869.2-869.25 MHz
4	7b	869.25-869.3 MHz
5	1h	869.3-869.4 MHz
6	1i	869.4-869.65 MHz
7	7c	869.65-869.7 MHz
8	1k	869.7-870 MHz

- At 19.2 and 38.4 kbps, the terminal is limited with 4 Sub-Bands.

S206 value	Band	Frequency Sub-Band
0	1f	868-868.6 MHz
2	1g	868.7-869.2 MHz
6	1i	869.4-869.65 MHz
8	1k	869.7-870 MHz

Terminals must be on the same Sub-Band to communicate. The default value for this register is **S206=0**

3. Radio channel : S200

This register sets the radio channel used for the communication. For example, at 38.4 kbps on Sub-Band 0, the terminal can use any of 3 channels (0 to 2), spaced by 200 kHz.

Channel	Frequency
0	868.100 MHz
1	868.300 MHz
2	868.500 MHz

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

If more than one group of M868-TinyPlus 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.

4. Radio Output power : S202

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

Frequency Sub-Band	*Band g1* *868-868.6*	*Band 7a* *868.6-868.7*	*Band g2* *868.7-869.2*	*Band 7d, 7b & 7e* *869.2-869.4*	*Band g3* *869.4-869.65*	*Band 7c* *869.65-869.7*	*Band g4* *869.7-870*
Radio Bit Rate : 4.8 Kbps							
S202 Value	0: 1mW 1: 3mW 2: 8mW **3: 25mW**	0: 1mW 1: 3mW **2: 8mW**	0: 1mW 1: 3mW 2: 8mW **3: 25mW**	0: 1mW 1: 3mW **2: 8mW**	0: 1mW 1: 3mW 2: 8mW **3: 25mW**	0: 1mW 1: 3mW 2: 8mW **3: 25mW**	0: 1mW **1: 3mW**
Radio Bit Rate : 9.6 Kbps							
S202 Value	0: 1mW 1: 3mW 2: 8mW **3: 25mW**	0: 1mW 1: 3mW **2: 8mW**	0: 1mW 1: 3mW 2: 8mW **3: 25mW**	0: 1mW 1: 3mW **2: 8mW**	0: 1mW 1: 3mW **2: 8mW**	0: 1mW 1: 3mW **2: 8mW**	0: 1mW **1: 3mW**
Radio Bit Rate : 19.2 Kbps & 38.4 Kbps							
S202 Value	0: 1mW 1: 3mW 2: 8mW **3: 25mW**		0: 1mW 1: 3mW 2: 8mW **3: 25mW**		0: 1mW 1: 3mW 2: 8mW **3: 25mW**		0: 1mW **1: 3mW**

5. 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 8 milliseconds (S204=8).

Usually, this register isn't modified. However, in some hostile environment (metallic parts, vibrations…) it can be raised to 20ms to have a more reliable synchronization. This will lower the over air throughput as it increase the non-data use of the radio.

6. Radio Whitening Character : S209

This register sets the value XOR with each character of the radio frame in order to avoid long sequences of 0s or 1s. If the user application sends frames containing series of 0x00 or 0xFF, the receiver can unsynchronized itself, thus the need for this whitening.

To mix a frame of these types, use a value of 170 (Hex : 0xAA , Bin : 10101010)

▪ *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 serial link type : S215,
- Set the flow control type : S216,

After each modification in the serial settings, the M868-TinyPlus 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 :

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

2. Serial timeout : S214

The M868-TinyPlus 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 terminal 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 µs, 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 :

Format type		*Parity S212*	*Stop Bits S213*
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. Serial type management (for IP67 terminal only) : S215

The M868-TinyPlus 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 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 M868-TinyPlus manages three types of flow control :

- Hardware or CTS/RTS (S216=0) : the RTS signal from the M868-TinyPlus will authorize the host to transmit data. The other way will be controlled by the CTS signal entering the terminal.

- Software or Xon/Xoff (S216=1) : the M868-TinyPlus 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 M868-TinyPlus 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 .

Note 1 : in Hayes mode, the flow control is not active so as to be able to modify these registers without locking the serial link.

Note 2 : in Addressed Secured mode, the flow control works only by activating the default transmission address (S256 ≠ 0).

▪ *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 M868-TinyPlus must run. The available operating modes are :

Value	*Mode*
1	**Transparent Mode (default)**
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.

Value	*LBT*	*Comment*
0	**OFF (default)**	**no LBT**
1	ON with high sensitivity	LBT with detection for RF >-87dBm
2	ON with medium sensitivity	LBT with detection for RF >-82dBm
3	ON with low sensitivity	LBT with detection for RF >-77dBm

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 terminal 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). When LBT functionality is ON, it is automatically activated. The random waiting time is comprised between 0 and 64mS.

S227 value	*Random Waiting Time*
0 (default)	**OFF**
1	ON

▪ *Network Configuration*

The configuration to use the M868-TinyPlus in Addressed Secured mode is done with the S25x registers. Through them, you can:

- Set the Network ID : 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, M868-TinyPlus terminals 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	-	$\overline{\text{ACK}}$	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 M868-TinyPlus returns a transmission status after sending a frame. If set to 1 (no answer), the terminal 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, 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 terminals, or 2 bytes (1) for up to 65535 terminals. 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

- $\overline{ACK}$ (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.

IV.4. Registers List

Numbers in **bold** indicate the default value

Access	Register	Name	Description
		General	
R	S192	Serial Number	Serial number of the terminal, the one present on the sticker. Read-only register.
		Radio	
R/W	S200	Channel	Number of the radio channel in use, depend of the Frequency Sub-Band used (Refer to § III.4) **Default : 0.**
R/W	S201	Radio Baud-Rate	Indicates the radio link rate. • 0 : 4.8 Kbits/s, • 1 : 9.6 Kbits/s, • 2 : 19.2 Kbits/s, • **3 : 38.4 Kbits/s.**
R/W	S202	Output Power	Radio power output in milliwatts, depend of the Frequency Sub-Band used (Refer to § III.4). • 0 : 1 mW, • 1 : 3 mW, • 2 : 8 mW, • **3 : 25 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. Between 5 and 60mS. **Default : 8 ms.**
R/W	S206	Frequency Sub-Band	Indicates the frequency Sub-Band in use (Refer to § III.4). Between **0** and 8.
R/W	S209	Radio Whitening Character	Indicates the XOR value for radio data. Between **0** and 255.

Access	Register	Name	Description
		Serial Link	
R/W	S210	Serial Speed.	Indicates the speed on the Serial Connection '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 The time out value must be compatible with the serial speed: *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	Serial Link Parity Type: • **'1': None (default) ,** • '2': Even, • '3': Odd.
R/W	S213	Number of Stop bits	Serial Link Stop Bits : • **1 bit (default),** • 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). Between 2 and 100 milliseconds **Default : 5.**
R/W	S215	Serial type	Selects the type of serial link used: **'0' : RS232** '1' : RS422 '2' : RS485 '3' : RS485 full duplex This functionality is for IP67 terminal only. The selection between RS232 and the other modes is done with the RS232/RS485 hardware signal (pin 6 on the terminal blocks) or through the switch
R/W	S216	Flow Control	Indicates flow control type: • '0': Hardware: CTS/RTS • '1': Software: Xon/Xoff • **'2': None (default)**

Access	Register	Name	Description
		Operation	
R/W	S220	Function Mode	Operating mode of the Terminal : • **'1' : Transparent** • '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). **Default value: 2**
R/W	S226	LBT	LBT ON / OFF, and sensitivity • **'0' : OFF** • '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 • **'0' : OFF** • '1' : ON
		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

<table>
<tr><th>Access</th><th>Register</th><th>Name</th><th>Description</th></tr>
<tr><td colspan="4"><u>Network Control</u></td></tr>
<tr><td>R/W</td><td>S250</td><td>Network ID</td><td>Network Number on 2 Bytes.
Default : 0</td></tr>
<tr><td>R/W</td><td>S252</td><td>Client Number</td><td>Client Number on 2 Bytes.
Between 0 and 65535.
Default : 0</td></tr>
<tr><td>R/W</td><td>S255</td><td>Network Options</td><td>Indicates the Network options. 4 bits are used :

<table>
<tr><td>Bits</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<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>
</table>

Default value : 01.

➢ Bit 'N°': indicates whether the received frame begins with the Client ID (1) or not (0).
➢ Bit 'CR': indicates whether the received frame ends with the ‘Carriage Return’ character (0x0D) (1) or not (0).
➢ Bit 'NH': indicates whether the format in Transmission (and in reception, if the Bit 'N°' is activated) is ASCII (1=Data) (0) or Numeric (<0x01>Data) (1).
➢ Bit 'Ret': Indicates if the ‘OK’ should be returned after each radio transmission (0) or not (1).
➢ Bit '2B': 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 terminals in your system.
➢ Bit ‘/ACK’ : Disable the radio acknowledgement (1) or enable (0).</td></tr>
<tr><td>R/W</td><td>S256</td><td>Default Address</td><td>Indicates the default address to which every radio frame will be sent.
Default : 0 (inactive)</td></tr>
</table>

IV.5. Configuration Example

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

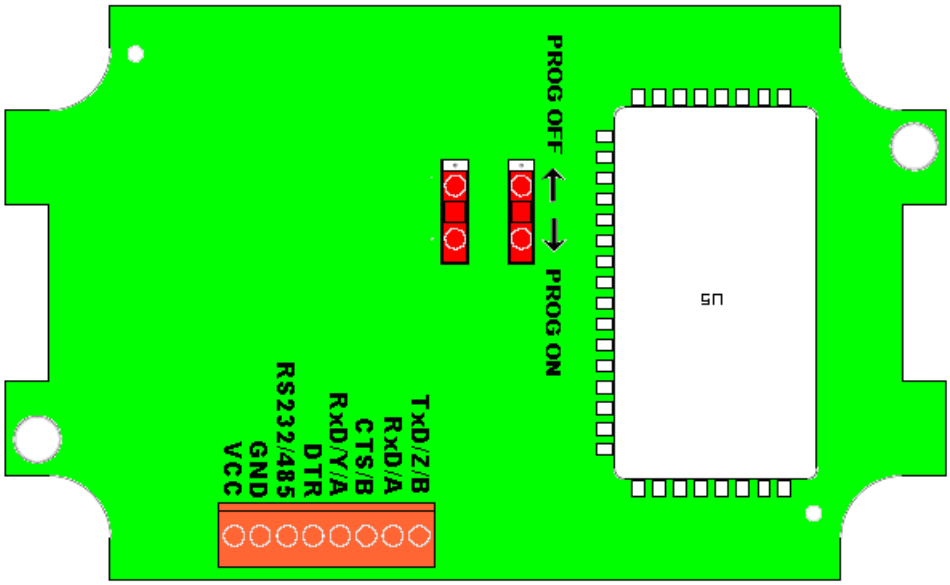
- One classical configuration where all the terminals in the network can communicate to each others.
- One specific configuration equivalent to a Client/Server configuration, also called “Star” network, where communications are able only between the Server and the Clients.

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

IV.6. Modems reflashing

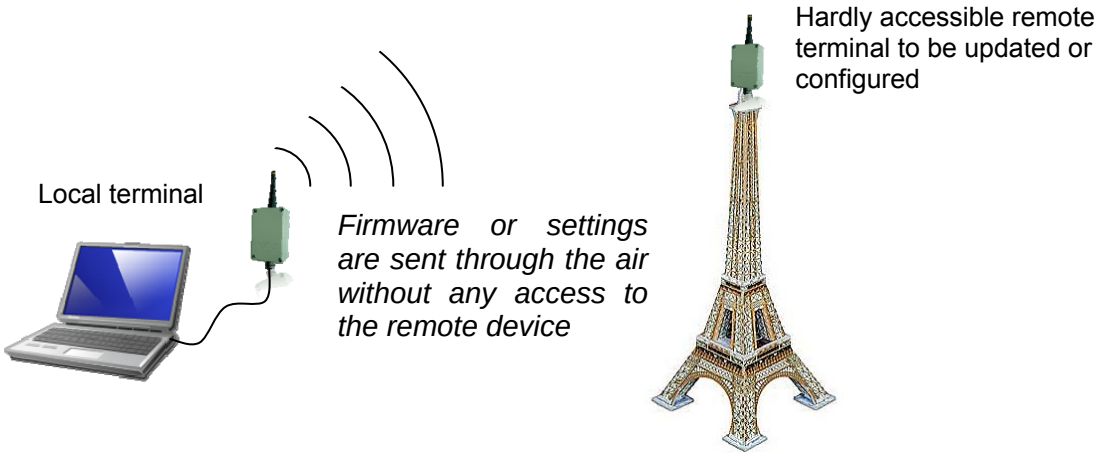
M868-TinyPlus terminals are re-flashable through the serial link.

To reflash the modem, switch off the power supply, open the casing, put the “PROG” switch on “ON” position, and switch on the power supply. Then, a specific software tool “TinyTools” is necessary. Refer to its user manual (**[4]**) for detailed explanation.



IV.7. Configuration and Download Over The Air (DOTA)

TinyPlus terminal includes the new DOTA functionality. This function is able to change or update the firmware of a remote terminal, using a local terminal. 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 terminal connected to a computer.



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

Both functionalities are available through a specific software tool “TinyTools”. Refer to its user manual (**[4]**) for detailed explanation.

CHAPTER V. ANNEXES

V.1. Modems' Installation: Principles and cautions

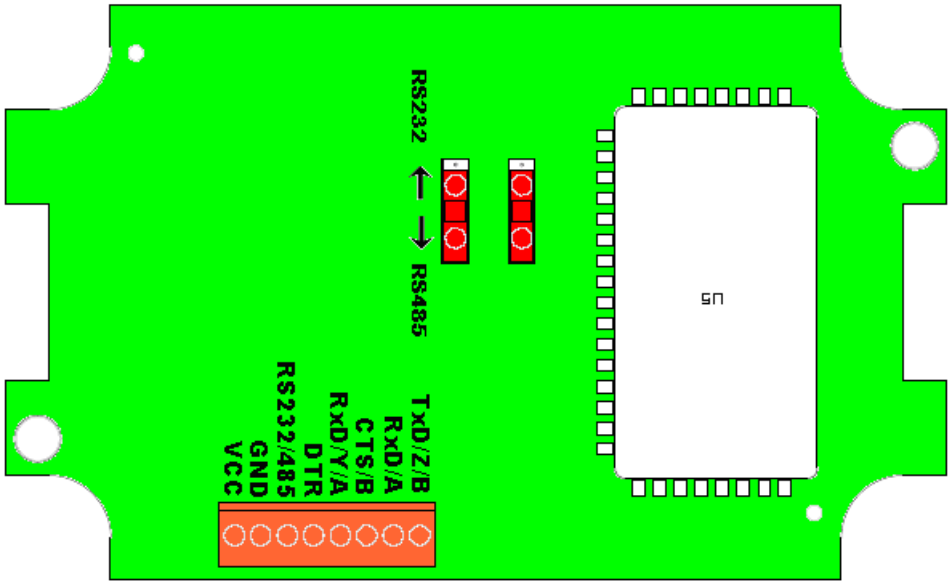
- You must use the power supply and serial cable provided by Telit with the modem. Take care of the polarity for the power supply connection (red wire +Vcc, black wire GND).
- The ON/OFF switching capability of the power supply is external to the modem.
- The radio environment should be closely studied 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 a 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.

V.2. Connection to a RS422 or RS485 interface

M868-TinyPlus terminal is configured in RS232 mode by default : it allows to directly connect it on a PC serial port.

To configure the terminal in RS422 or RS485 mode :

- Go to Hayes Mode and configure S215 Register : set to '2' for RS485 and to '1' for RS422.
- Power Off the terminal.
- Connect RS485 or RS422 serial link to the terminal.
- Connect RS232/422 pin to GND or set RS232/485 switch to RS485 side.



- Power On the terminal.

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

V.3. ETSI 300 220-3 Version 1.3.1 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 steam).

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.

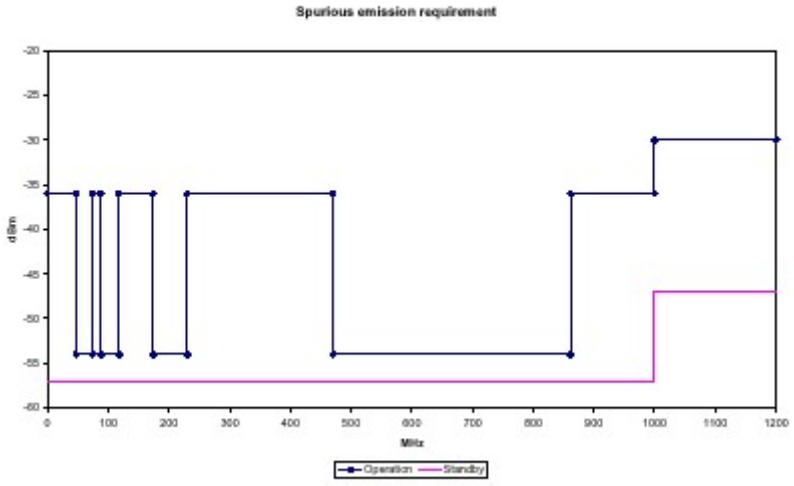
The power envelope shall be measured with a spectrum analyser, RBW=100 Hz, VBW=10kHz, using the maximum hold display function. The bandwidth is defined as the bandwidth of the power envelope where the power is above the required spurious level. The spurious level limit is 250nW = -36dBm.

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



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.

V.4. 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.*

V.5. Declarations of Compliance

Telit RF TECHNOLOGIES

DECLARATION OF CONFORMITY

We,
Telit RF Technologies

Of:
Rue Evarist Galois
06410 BIOT
FRANCE

declare under our sole responsibility that the product:

TinyOne Plus 868MHz Terminal

Radio terminal 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

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

Rue Evarist Galois
06410 BIOT
FRANCE

Biot, *14th April 2009*

<Xavier TATOPOULOS – R&D Manager>