G3P-HPPM-R1

User Manual

Release. 2.04

INDEX

1. RELEASE HISTORY

1.1. Release 1.02

- Added internal feature to reduce the radio overload in presence of electrical discharges near the antenna when a metal box is used.
- Bug fixed in macro IF IO…THEN…ELSE that exchanged the status of IO #3 and IO #4.

1.2. Release 1.02B

- Update in the manual chapter #7 with description of the test commands.

1.3. Release 2.03

- Bug fixed in multichannel operation that gave sometimes an AKN error if an HPPX-R1 module receives from an HPPX one.
- Added a filter to prevent a double message received if a noise destroy the AKN.
  In this case the sender not receiving AKN will retransmit.
- Added command **C29** to enable answer "OK" for a successful transmission.
- Added in macro command TX C68 feature that returns the transmission result into variable #0.
  See C68 description.

1.4. Release 2.04

- Added to command C16 the parameter "2" to output CD (Carrier Detect) on pin #7.
- Added parameter "9" to macro command C76 IF RX, see C76 description.
- Added parameter "A" to macro command C76 IF RX, see C76 description.
- Added macro command C71 to select up to 3 AD inputs.
- Added macro command C72 to read the Vcc value.
- Added remote commands, see C36 description.
- Added parameter "2" to AES activation command C50.

2. GENERAL FEATURES

The G3P RF modules are a fully integrated transceiver for radio communications for the low frequency (433, 868 or 915MHz ISM band).
This advanced solution is based on the on the combination of a single chip transceiver Nordic NRF905 and a microcontroller unit.
Gp3 modules can implement different network architectures.
Models available differ by the MCU on board and by the software features.
Those modules provide a competitive solution for cost sensitive or for power critical applications.

Typical wireless applications for these modules are security system, remote control, home automation…

Operating at 3,3 V CMOS power supply, G3P modules have an asynchronous serial interface.

Power Supply	2.2-3.6	V
Supply current active mode @3V	15,35	mA
Supply current sleep mode @3V	3	uA
RF maximum power	10	dBm
RF sensibility	-100	dBm
Temperature range	-40 +75	°C

More information for Nordic nRF905 is available at Nordic webpage http://www.nordicsemi.no

The communication features include:

- 65536 networks.
- 65536 elements per network.
- Automatic AKN
- Automatic retry in case of communication error.
- Single channel or multi channel operating.
- Noise filter allows a proper communication even in very noisy fields.
- Simple serial interface commands.
- 3 different sleep modes.
- Radio wake up a remote unit.
- Mesh functions.
- AES 128 bit encryption available
- Programmable macros to realize simple applications without using an external microcontroller.
- Store the radio set up into the internal flash.
- Define of 8 I/O as second function.
- Double receive mode FSK (G3P mode) and ASK at the same time.
- CE marked and homologated with a wire antenna 17cm long for 433MHz and 8cm long for 868MHz.
- Improved anti noise digital filter.

3. CONTROL SIGNALS

Pin	Function	I/O	If not used	I/O	Second Func.
1	Digital GND				
2	Digital Vcc				
3	Reset	I	Unconnected		
4	Rx	I			
5	Tx	O			
6	Busy	O	Unconnected	I/O 8	Input/Output
7	*Wd/ASK out	O	Unconnected	I/O 7	Input/Output
8	Data Ready	O	Unconnected	I/O 6	Input/Output
9	Active	O	Unconnected	I/O 5	Input/Output
10	Baud 0	I	Vcc or GND	I/O 4	Input/AD 3
11	Baud 1	I	Vcc or GND	I/O 3	Input/AD 2
12	*Data out Enable	I	GND	I/O 2	Input/AD 1
13	Sleep	I	GND	I/O 1	Input/Trigger
14		I	Unconnected		
15	Radio GND				
16	Radio Vcc				
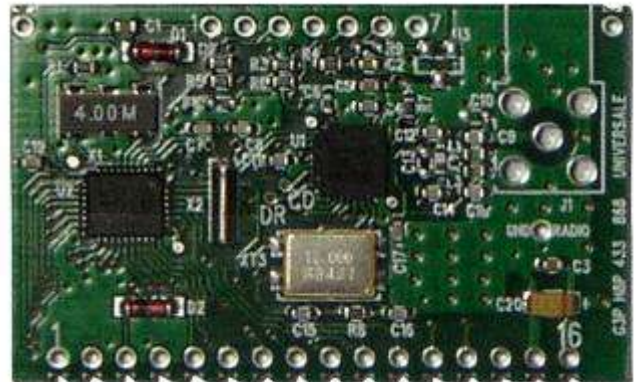
The module can be connected in SMD mode (by the relatives pads) or using a 2.54mm male strip not fitted. See chapter 10.

In the G3P hardware configuration the digital and radio supply are separated, and for best performances must be connected together in the power supply origin point.
The Vcc range is from 2V to 3,6V.
Rx and Tx signal are Cmos at 3,3v level and operating in asynchronous mode 8N1.
Unused input pins must not be unconnected.

*Reset
Input pin, is the active low module reset. The module parameters are set to default

Rx
Asynchronous serial RX input at 3V.

Tx
Asynchronous serial TX output at 3V.

Busy
Output pin. Active high busy signal means that the module is processing the last command. Wait this signal to zero before load a command.
Can be also be used as radio controlled I/O #8.

*Wd/ASK out
Programmable output pin.
As ***WD** is an active low signal meaning that the internal WD has reset the module. Set this pin with the relative command, and then test it. If goes down the module has to be re-initialized.
As **ASK out** gives a signal for a ASK modulation on the working channel. Can be used to connect an ASK receiver and with only one module receive an ASK modulation and communicate in FSK mode in the same time.
Can be also be used as radio controlled I/O #7.
Measuring the medium high time of this signal can be having an idea of the medium traffic in the selected channel.

Data Ready
Active high output, means that the module has received data. The transmission of data on the RX pin depends by the state of "*Data enable Pin".
Can be also be used as radio controlled I/O #6.

Active
Output pin that shows the module status. High the module is active, low the module is sleeping.
Test this pin when the module is running in SLEEP SW mode to understand when is active and can receive a command.
Can be also be used as radio controlled I/O #5.

Baud 0   Baud 1
Input baud rate selection:

Baud 0	Baud 1	Baud Rate
GND	GND	2400
GND	VCC	4800
VCC	GND	9600
VCC	VCC	19200

Can be also be used as radio controlled I/O #4 and #3.
When used as I/O the baud rate will be the stored during the programming.

Data out enable
Active low input pin. Enables the TX pin to transmit the received data.
Used with Data Ready pin, allows to wake up the user micro controller when a message is received. When the microcontroller wakes up and is ready, set low "*Data Out Enable" pin to it receive data on the serial interface.
Can be also be used as radio controlled I/O #2.

Sleep
High active input pin. Put the module in the SLEEP HW mode.
The module wakes up setting this pin low.
Can be also be used as radio controlled I/O #1.

4. ORDER CODES

Code	Band	Network	Antenna	Connection
G3P-HPP-R1-433	433 MHz	PP (Point to Point)	50 Ohm	Strip
G3P-HPP-R1-433-S	433 MHz	PP (Point to Point)	50 Ohm	Smd
G3P-HPP-R1-868	868 MHz / 915 MHz	PP (Point to Point)	50 Ohm	Strip
G3P-HPP-R1-868-S	868 MHz / 915 MHz	PP (Point to Point)	50 Ohm	Smd
G3P-HPPM-R1-433	433 MHz	PPM (Point to Point static Mesh)	50 Ohm	Strip
G3P-HPPM-R1-433-S	433 MHz	PPM (Point to Point static Mesh)	50 Ohm	Smd
G3P-HPPM-R1-868	868 MHz / 915 MHz	PPM (Point to Point static Mesh)	50 Ohm	Strip
G3P-HPPM-R1-868-S	868 MHz / 915 MHz	PPM (Point to Point static Mesh)	50 Ohm	Smd

5. IMPLEMENTED NETWORK ARCHITECTURES

1. *PP*   ....Point to Point
2. *PPM*   ....Point to Point static Mesh

5.1. PP (Point to Point)

Point to point architecture network allows communication between different devices of the same network.
All the network devices must be on radio range.
The header length is only four byte and the user payload can be set from 1 up to 28 bytes.
Command C03 defines the destination address

5.2. PPM (Point to Point static Mesh):

In this network some slaves can be out of the master's radio range.
The master MUST know the network structure, so can send to the BRIDGE-SLAVE the message for the final slave.
There is no limit to the slaves that act as bridge, but only one jump is allowed to reach the destination. For a correct communication must be awake the modules sender, bridge and destination. The other modules of the network can sleep.
In this network six header bytes are reserved for network routing operation. User payload can be defined in the range from 1 up to 26 bytes.
Command C03 defines the physical destination address.
Use command C31 to transmit directly to a device.
Use command C33XXYY to transmit to the XXYY device trough the C03 bridge device.
Example:
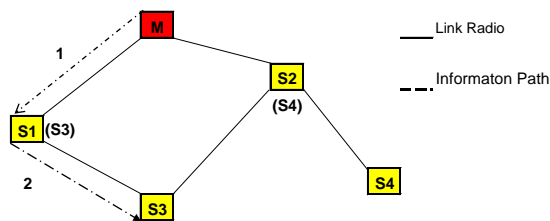
Figure shows a Point to Point mesh network, S1,S2 devices are in the radio range of the master

Example

M (master):

S1 is linked with S3 and is also mapped to routing packets for S3

S2 is linked with S3 and S4

If M sends a message to S3, the message previously pass to bridge slave S1 and after S1 sends the message to S3.

6. TRANSMISSION features

All the devices are described by a four byte address. The first two bytes of the address identify the network and the third and the fourth byte represent the address of the device into the network.
This allows to have different networks separated but in the same radio range.
The user can set the network address and the device address by the CO1 and C02 software commands.
The transmission Baud Rate is configurable via Hardware. Four different baud rate are available setting PIN 10 and PIN 11.
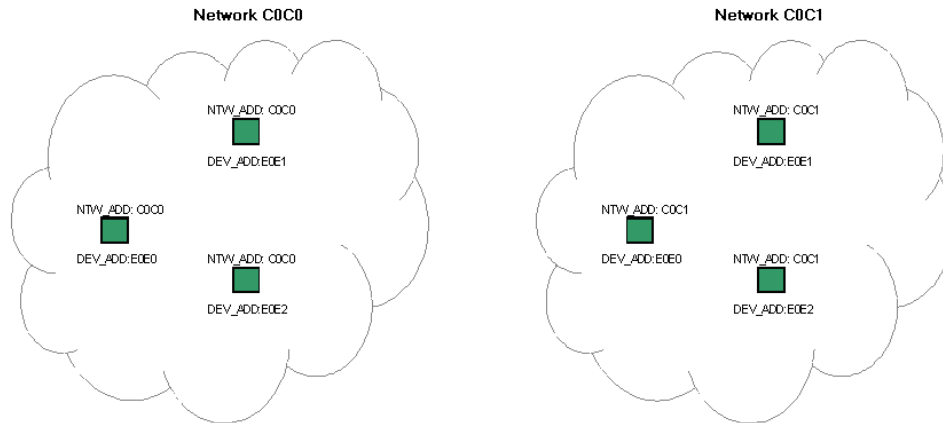
The length of the data packets is variable, and it can be set by command C04. All the devices of the same network MUST use the same packet dimension.

User can also set the transmission power by the C07 command, G3P modules are able to transmit at four different power levels.

Tx Level	Tx Power
0	-10 dBm
1	- 2 dBm
2	+ 6 dBm
3	+10 dBm

G3P modules during the transmission do:
- Controls that the channel isn't busy.
- Transmits the message.
- If AUTO AKN function is activated G3P wait the AKN by the destination device.
- If radio channel is busy or don't receive the AKN on time, the devices repeats the transmission.
- The number of retransmission and the time between two retransmissions can be set by the user.
- In case of transmission error the device send an error message on the serial interface.

6.1.   SINGLE CHANNEL and FREQUENCY HOPPING transmission

The communication can be set in single channel or in frequency hopping mode.
In the single channel mode user chooses the frequency channel of the communication. There are 17 available channels for transmission in 433 MHz ISM band, 5 for transmission in 868 MHz ISM band and 65 channels in 915MHz band.
When the user wants to use the frequency hopping mode, it is necessary to set the number and which channels used for the radio communication.
The channels configuration can be done by the command C05 and C06.
For the frequency hopping can be used from to up to 4 channels.
The receive channel is automatically switched every 500 mS.
Transmission occurs simultaneously on all the channels.

6.1.1.   Frequency hopping restrictions

- The use of frequency hopping is optional in 433MHz and in 868MHz band.
- Frequency hopping is mandatory in 915MHz U.S.A. ISM band.
- Channel #5 in 868MHz band is limited by law to 6dBm.

6.2. TRANSMISSION Functions

6.2.1.   SLEEP Functions

G3P modules can operate in different way for optimize the power consumption especially for battery applications.
There are three different sleep modes: **hardware sleep mode**, **software medium sleep mode** and **software deep sleep mode**. When the devices work in these modes the power consumption decreases.

6.2.2.   Hardware Sleep mode

Setting HIGH the SLEEP input (PIN 13) the device enters in hardware power done mode. The module completes all the pending transmission before entering in this power down mode. The device wakes up only by setting low PIN 13. During the Power down mode radio and serial interface aren't available and the power consumption drop down to 3 µA.
Note: If the pin #7 has been used as ASK OUT function (see command C16) do not use the hardware sleep mode.

6.2.3.   Software Sleep mode

In the software sleep mode the device works in normal mode for a programmed time, then it goes in a sleep status for another time period then the device repeat this cycles. The user can set:
- G3P active time.
- G3P sleep time.
- G3P Extra Active time, this is the extra time of module activity when it receives a message.

The times are set by the commands C24, C25, C26, and C27.
The scale of times can be set by the command C28 in seconds or mS.
There two SW Sleep modes: MEDIUM and DEEP.
They differ by the features of the sleep phase.
In a battery powered system, the pin ACTIVE can be used to wake up the user microcontroller in the correct time to communicate with the module.

6.2.4.   Software MEDIUM sleep mode

In this software sleep mode only the radio components are off.
The sleep phase can be interrupted sending a command to the serial interface of the device.
During the sleep phase the power consumption drops down to 3,25mA.

6.2.5.   Software DEEP sleep mode

In deep sleep mode both radio components and micro controller are turn off.
The sleep phase can't be interrupted.
The device wakes up when receives a command or a radio data in the active phase.
During the sleep phase the power consumption drops down to 11uA
To wake up a remote module, the transmitter can use the commands C40 and C41.

Mode	RX Radio	RS232	Current @3.3V
Active Phase	Available	Available	15,35 mA
Sleep Medium phase		Available	3,25 mA
Sleep Deep phase			11uA
HW Sleep phase			3uA

Example Hardware Sleep Mode:
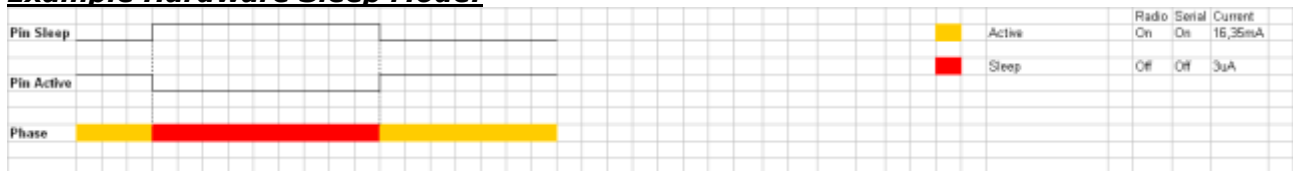
Example Software Medium Sleep Mode:

Example Software Deep Sleep Mode:

6.2.6.   WAKE UP Functions

These functions are useful to communicate with a slave that is running in SOFTWARE DEEP SLEEP MODE with a very low duty cycle.
Command C43 defines the time of the wake up burst.
Command C41 defines the maximum wake up time.
Command C40 or command C42 wake up the slave.

Ex.
The slave runs in Software Deep Sleep Mode with a duty cycle of 20mS active and 1950mS sleep. The duty cycle is 1%, the medium current is 156uA and the cycle period is 2 seconds. The slave can be accessed only if a RF transmission arrives during the 20mS of the active phase.

Set in the master 4 seconds for the wake up timeout (2 cycles minimum) and 1000ms for the burst time (cycle time minimum) and use C40 or C42 to wake up.
The master will send a burst of 1 sec, and then will wait an answer for 100mS. If the slave has been activated stops and return the character 'W'. Otherwise will launch another wake up cycle until reaches the maximum time of 4 second. In case of timeout without success will return the character 'w'.
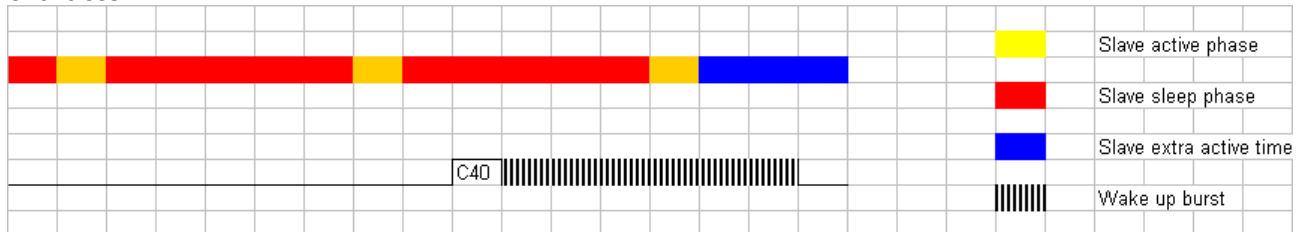
6.2.7.   AUTOAKN Functions

This function allows the G3P the send an AKN message to the sender.
The slave's micro controller isn't involved in this process; AKN is automatically managed by the module.
User can program the maximum waiting time for the AKN, at the end of this time the device retransmits the message following the configuration of AUTO RETRY function.
If after the set number of retransmission the master does not receive the AKN, it sends a serial error message.
If no error AKN arrived at the sender the message was received.

Example:

D1 device sends one packet to D2 device.
D2 sends an ACK message after received the message.
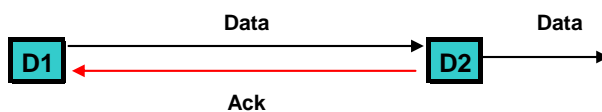
D1 device sends a packet to D2 device. D2 does not send the AKN message.
D1 retransmits like programmed, and then give the error message.
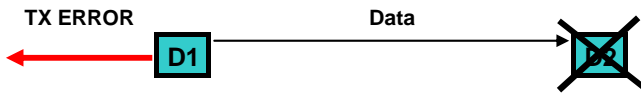
6.2.8.   AUTO RETRY Functions:

User can set the maximum number of retransmissions and the time between two of them.
During the communication the device automatically runs the retransmissions if case on error.
No error message will be send if the transmission has been complete.
If an error occurs the device sends a two bytes error message:

ASCII 128 + T   Transmission error, the channel was always busy.
ASCII 128 + A   AKN error, the receiver didn't send the AKN.

The maximum waiting time of an ACK can be sets by the user. For this reason the user must pay attention to set at the right value of this parameter in the Mesh networks.

The following table shows the transmission time of the payload for different types of transmission.
For mesh networks transmissions times must be multiplied by the number of jumps.

Bytes	Mono Channel	F-Hop 2ch	F-Hop 3ch	F-Hop 4ch
		mS		
1	2,7	15,4	23,1	30,8
2	2,8	15,7	23,6	31,4
3	3,0	16,0	24,0	31,9
4	3,2	16,4	24,6	32,7
5	3,3	16,6	24,9	33,1
6	3,4	17,0	25,4	33,9
7	3,7	17,4	26,0	34,7
8	3,8	17,6	26,4	35,1
9	3,9	18,1	26,9	35,9
10	4,2	18,3	27,3	36,4
11	4,2	18,6	27,8	37,1
12	4,4	19,0	28,4	37,9
13	4,6	19,3	28,8	38,4
14	4,7	19,5	29,3	39,0
15	4,9	19,9	29,9	39,8
16	5,1	20,2	30,3	40,3
17	5,2	20,5	30,7	41,0
18	5,4	20,8	31,2	41,5
19	5,5	21,2	31,7	42,2
20	5,7	21,6	32,2	43,0
21	5,9	21,9	32,7	43,5
22	6,0	22,2	33,2	44,2
23	6,2	22,4	33,5	44,6
24	6,3	22,8	34,1	45,4
25	6,5	23,1	34,7	46,2
26	6,7	23,4	35,0	46,6
27	6,8	23,7	35,6	47,4
28	7,0	24,1	36,0	47,9

G3P-HPPX-R1   User Manual   Release 2.04

6.2.9.   Anti noise filter

The anti noise filter is configurable with the command C17.
The default standard mode allows communicating up to 70% of noise duty cycle.
The Huge mode allows communicating up to 98% of noise duty cycle.
In standard mode the AKN arrives in a shorter time, the result is a quicker communication.
The Huge mode allows a unique anti noise performances but gives an extra delay in the transmission of AKN; the communication will be more sure but slower.

6.2.10.   Transmission Cycle
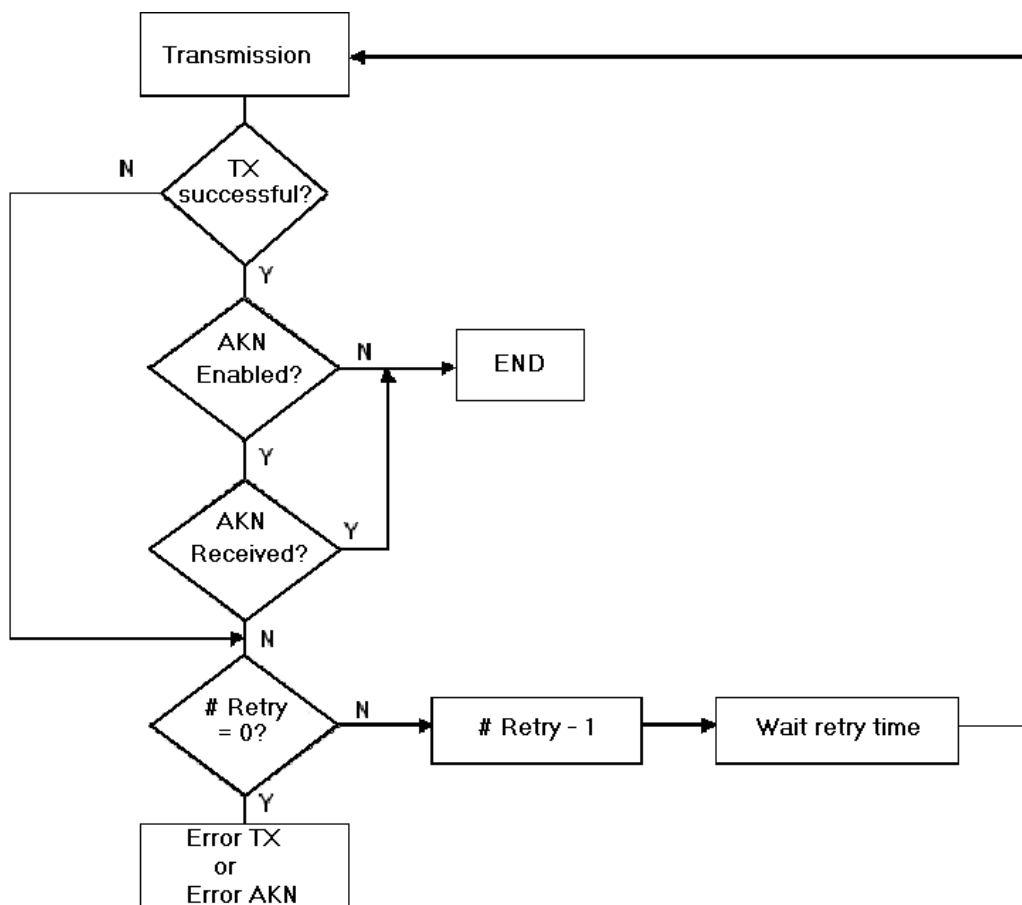
7. MODULE TEST

7.1.   Test commands.

To test the first time a G3P module, are available the following commands:
- C80   Set a fixed carrier (send C801) and reset a carrier (send C800).
            This command is intended for antenna testing.
- C81   Set the pin #7 ***Wd** high for 100mS.
- C82   Set the pin #8 **Data Ready** high for 100mS.
- C83   Set the pin #9 **Active** high for 100mS.
- C84   Set the pin #6 **Busy** high for 100mS.
- C85   The module answers with an asterisk.
            This command is useful to test if the module is alive.

To test the first time the G3P module, connect to a PC or to a microcontroller.
Use the debug ASCII commands to test the serial communication and the control lines if used.
The debug commands allow also generating a fixed carrier for antenna test.

7.2.   Test with a PC.

Use the G3P-DEVKIT-USB adapter to connect to a PC.

Use a terminal emulator like Hyper Terminal set as 19200 8 N 1 no handshake.
Type C85 (uppercase, without spaces and without CR), the module will answer '*'.
The asterisk means that the serial link works properly.
With a PC connection the control pins are not used.
A fixed carrier can be generated for antenna testing.

7.3. Test with a microcontroller.

Connect the G3P module to a **3V** microcontroller at least with the minimum connection diagram:
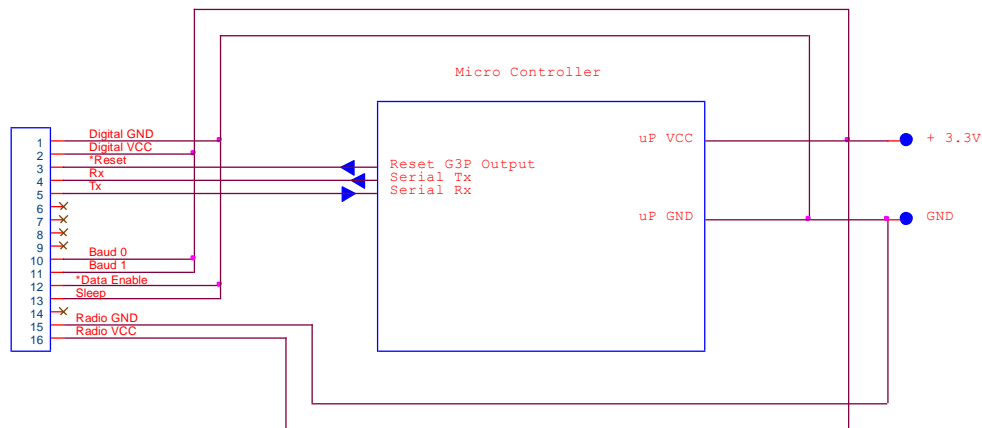
Set the microcontroller serial port as 19200, 8, N, 1.
Send the command C85 and wait an answer from the module.
The module will answer an asterisk, if received the serial link is working properly.

7.4. Generate a fixed carrier.

To generate a fixed carrier must be set the proper channel with the command C00.
Then the carrier can be activated or deactivated with the command C80.
Note: By law is not allowed to generate a fixed carrier for long time.
Use this feature only for antenna testing and switch off the carrier as soon as possible.
The module does not switch off the carrier automatically.

To set the channel type C00xx, where xx is a two digit number.

433Mhz
- C0001   Channel 1   433.1 MHz
- C0002   Channel 2   433.2 MHz
- C0003   Channel 3   433.3 MHz
- C0004   Channel 4   433.4 MHz
- C0005   Channel 5   433.5 MHz
- C0006   Channel 6   433.6 MHz
- C0007   Channel 7   433.7 MHz
- C0008   Channel 8   433.8 MHz
- C0009   Channel 9   433.9 MHz
- C0010   Channel 10   434.0 MHz
- C0011   Channel 11   434.1 MHz
- C0012   Channel 12   434.2 MHz
- C0013   Channel 13   434.3 MHz
- C0014   Channel 14   434.4 MHz
- C0015   Channel 15   434.5 MHz
- C0016   Channel 16   434.6 MHz
- C0017   Channel 17   434.7 MHz

868Mhz
- C0001   Channel 1   868.2 MHz
- C0002   Channel 2   868.4 MHz
- C0003   Channel 3   868.8 MHz
- C0004   Channel 4   869.0 MHz
- C0005   Channel 5   869.8 MHz

Type C801 to switch the carrier ON.
Type C800 to switch the carrier OFF.

Note: Remember to switch off the carrier after the test with the command C800.

8. ASCII commands

8.1. PPM (Point to Point static Mesh) OPERATING commands.

Command	Parameters	Function	433 MHz Range	433 MHz Default	868MHz Range	868MHz Default	915 MHz Range	915 MHz Default
C00	NN	Set operating channel with no F-Hopping	01-17	01	01-05	01	01-65	01
C01	HHLL	Set network address *	0000-FFFF	E7E1	0000-FFFF	E7E1	0000-FFFF	E7E1
C02	HHLL	Set device address *	0000-FFFF	E7E1	0000-FFFF	E7E1	0000-FFFF	E7E1
C03	HHLL	Set transmission address *	0000-FFFF	E7E1	0000-FFFF	E7E1	0000-FFFF	E7E1
C04	NN	Set # bytes data *	01-26	26	01-26	26	01-26	26
C05	AABBCCDD	Set f-hopping channels*	AABBCCDD	01,06,11,16	AABBCCDD	01,02,03,04	AABBCCDD	01,02,03,04
C06	N	Set # used channels in f-hopping *	2-4	4	2-4	4	2-4	4
C07	N	Set TX Power *	0-3	3	0-3	3	0-3	3
C08		Init radio						
C09	N	Set Auto AKN N=0 off N=1 on	0/1	off	0/1	off	0/1	off
C10	N	Set F-Hopping N=0 off N=1 on	0/1	off	0/1	off	0/1	off
C11	N	Set time out AKN N=0 off N=1 on	0/1	on	0/1	on	0/1	on
C12	N	Set 868MHz or 915MHz band. N=0 868MHz, N=1 915MHz *		not available	0/1	868MHz	0/1	868MHz
C13	N	Add CR+LF to received data. N=0 off, N=1 on	0/1	off	0/1	off	0/1	off
C14		Set output *WD						
C15	N	Set * sent after command N=0 off N=1 on	0/1	off	0/1	off	0/1	off
C16	N	Configure Pin #7 as *WD (N=0), ASK OUT (N=1) or CD out (N=2)	0/2	*WD	0/2	*WD	0/2	*WD
C17	N	Set the anti noise filter standard (N=0) or huge (N=1)	0/1	standard	0/1	standard	0/1	standard
C20	NNNN	Set time LBT (0,1-999,9) mS	0001-9999	20 mS	0001-9999	20 mS	0001-9999	20 mS
C21	NNNN	Set time out AKN (0,1-999,9) sec	0001-9999	0,6 sec	0001-9999	0,6 sec	0001-9999	0,6 sec
C22	NNNN	Set time retry in TX (0,1-999,9) mS	0001-9999	500 mS	0001-9999	500 mS	0001-9999	500 mS
C23	NN	Set max retry in TX (1-99)	01-99	05	01-99	05	01-99	05
C24	NNNN	Set auto sleep active time (1-9999) mS/sec	0001-9999	100mS	0001-9999	100mS	0001-9999	100mS
C25	NNNN	Set auto sleep sleep time (1-9999) mS/sec	0001-9999	900mS	0001-9999	900mS	0001-9999	900mS
C26	N	Set auto sleep mode N=0 off, N=1 medium, N=2 high	0-2	off	0-2	off	0-2	off
C27	NNNN	Set auto sleep extra active time after reception (1-9999) mS/sec	0001-9999	100mS	0001-9999	100mS	0001-9999	100mS
C28	N	Set auto sleep time N=0 mS, N=1 sec	0/1	mS	0/1	mS	0/1	mS
C29	N	Send "OK" if a transmission succeed (N=1) or not (N=0)	0/1	Not active	0/1	Not active	0/1	Not active
C30	N0…….Nn	Load TX data N bytes = C04. N0=00 data, N0=xx command						
C31		Transmit loaded data by command C04 to the device C03						
C32	N	Radio power N=0 power down, N=1 Power up	0/1	Power up	0/1	Power up	0/1	Power up
C33	HHLL	Transmit loaded data by to the device HHLL trough the device C03	0000-FFFF		0000-FFFF		0000-FFFF	
C36	N	Set transmission as remote commands (N=1) or remote data (N=0)	0/1	off	0/1	off	0/1	off
C40		Wake up slave define by C41 and C03						
C41	NN	Set wake up timeout in seconds	01-99	5 sec	01-99	5 sec	01-99	5 sec
C42	HHLL	Wake up slave HHLL trough the device C03	0000-FFFF		0000-FFFF		0000-FFFF	
C43	NNNN	Set the wake up burst time (1-5000)mS	0001-5000	1000mS	0001-5000	1000mS	0001-5000	1000mS
C45		Store set up and Baud rate						
C46		Delete setup and user macro program flash						
C47	NKKKK	Set the variable N with the value KKKK of the module defines by the command C03	0-9/0000-9999		0-9/0000-9999		0-9/0000-9999	
C48	N	Set SW Sleep level (N=0/1/2) of the module defined by the command C03	0-2		0-2		0-2	
C50	N	Set AES encryption N=0 off, N=1 on N=2 on compatible	0/2	off	0/2	off	0/2	off
C51	N0…..N15	Set 16 bytes key for AES encryption						
C52	NS	Set IO N with S status of the module defined by the command C03	1-8/0-1		1-8/0-1		1-8/0-1	
C53		Read I/O status						
C54		Send the model type of the module						
		* to active use command C08						

8.2.   PROGRAMMING commands.

Point to Point Programming Commands		
Command	**Parameters**	**Function**
C60		Open programming, delete flash and store the set up
C61		Set I/O configuration, see parameters below
	0	Open I/O definition session
	N 0	Defines I/O # N as input
	N 1 S	Defines I/O #N as output with initial state S .
	N 2	Defines I/O #N as analogic input. (only N=2 allowed)
	N 3	Defines I/O #N as rising edge Trigger. (only N=1 allowed)
	N 4	Defines I/O #N as falling edge Trigger. (only N=1 allowed)
	9	End I/O definition session.
C62	N D0…….Dn	Load messages N=message number (1-4). The message length defined by C04 command
C63		Init load macro session.
C64		Macro Sleep
C65	hhmmss	Macro Sleep time
C66	NK	Macro Reset, Set, Toggle output N (K=0,1,2)
C67		Macro delay
	0NNNN	Delay of NNNN mS (N=1-5000)
	1N	Delay of the variable N value. Variable N value 1-5000.
C68		Transmission to module with address HHLL. If HHLL=0000, transmit to se sender of the last received message.
	0 HHLL N F	Tx to HHLL I/O (N=0) or AD(N=1), format Hex (F=0) or ASCII dec.(F=1)
	1 HHLL N	Tx to HHLL the message N stored with the C62.
	2 HHLL D0…Dn	Tx to HHLL the message D0…Dn
	3 HHLL N F	Tx to HHLL the value of the variable N with format Hex (F=0) or ASCII dec. (F=1).
C69		Timer
	0N	Timer N stop
	1N	Timer N start
	2 N KKKK	Set timer N with the KKKK value in mS.
	3 N M	Set timer N with the value of the variable M
C70		Variables
	0 N KKKK	Set the variable N with the value KKKK
	1 N K	Increment (K=1) or Decrement (K=0) the variable N
	2 N K CCCC	Variable N + CCCC (K=1) or Variable N – CCCC (K=0)
	3 N K M	Variable N + variable M (K=1) or Variable N – variable M (K=0)
	4 N K CCCC	Variable N * CCCC (K=1) or Variable N / CCCC (K=0)
	5 N K M	Variable N * variable M (K=1) or Variable N / variable M (K=0)
	6 N K	Load into variable N the I/O status (K=0) or the AD value (K=1)
	7 N M	Load into variable N the timer M value
	8 N M	Load into variable N the variable M value
C71	N	Set active AD. N=1 Input #2, N=2 Input#3, N=3 Input#4.
C72	N A V CCCC	Vcc value measure. N=I/O number to activate reference, A= AD number, V variable number for the result, CCCC reference value in mV.
C76		If macro
	0	If trigger
	1	If time
	2 C NNNN	If AD value <=> (C=0,1,2) NNNN
	3 C N	If AD value <=> (C=0,1,2) the value of variable N
	4 C N KKKK	If the variable N value <=> (C=0,1,2) KKKK
	5 C N M	If the variable N value <=> (C=0,1,2) the value of variable M
	6 HHLL N	If Rx from HHLL the message #N
	7 HHLL D0…Dn	If Rx from HHLL the message D0…Dn
	8 N K S	If the I/O N status = S (K=0) or I/O N status NON = S (K=1)
	9 HHLL	If Rx any data from HHLL
	A M0…Mn D0…Dn	If Rx data masked by M0…Mn are equal to D0…Dn. Use after C769 macro.
C77		Else macro
C78		End IF macro
C79		End Programming, write the flash and wait for a reset

The programming commands MUST be used only during the programming session.
For details see the programming chapter.

Note: The programming commands write into the internal flash, so MUST be executed only a command per time.
After a command wait the busy pin low or to receive an '*' if has been used the C15 command.
Send a command before the previous one has finished can cause a data lost.

9. COMMANDS DESCRIPTION.

9.1. PPM operating commands.

C00   NN   Set operating channel
Sets the used channel for Single channel communications.
Ex: To use the channel number 12
        C0012

C01   HHLL   Set network address
Sets the two network address bytes (4 ASCII characters).
For a better operation the user should avoid address with many consecutive "0" or "1"
Ex: Network address C3C3
        C01C3C3
C02   HHLL   Set device address
Sets the two address device bytes (4 ASCII characters)
For a better operation the user should avoid address with many consecutive "0" or "1"
Ex: Device address C3C1
        C02C3C1

C03   HHLL   Set transmission address
Sets the two address bytes of the receiver device (4 ASCII characters)
If the current receiver is the same of the previous transmission, it's not necessary to repeat the command.
Ex: Receiver address C3C4
        C03C3C4

C04   NN   Set # bytes data
Sets the length of the payload. (BYTES)
All the devices of the same network must be configured whit the same payload length
The maximum size of payload depends by the type of network architecture.
Note: If AES encryption is enabled by the command C50, the NN value MUST be 16.
        If is used the macro C68 to transmit I/O or AD, the NN value MUST be 04 at least.

        PP   from 1 to 28 bytes
        PPM   from 1 to 26 bytes

Ex: payload length 4 bytes
        C0404

C05   AABBCCDD Set # used channels in f-hopping
Sets the channels used for the frequency hopping communications, 4 values must be set.
To set the number of used channels in the frequency hopping and activate, please see commands C06 and C10.

Ex: At 433MHz use channels 1, 4,7,12 for F-Hopping
        C0501040712
In case of 2 channels frequency hopping transmission only channels 1 and 4 will be used
In case of 3 channels frequency hopping transmission only channels 1, 4 and 7 will be used

C06   N   Set # used channels in f-hopping
Set how many channels will be used in frequency hopping mode

Ex: 2 channels F. Hopping:
        C062

C07   N   Set TX Power
Sets the TX power level.

0	-10	dBm
1	-2	dBm
2	+6	dBm
3	+10	dBm

Ex: power transmission +10 dBm
      C073

C08   Init radio
Initialized radio components.
This command must be used for activate the parameters configured by commands C01, C02, C03, C04, C05, C06, C07 and C12.

C09   N   Set Auto AKN N=0 off N=1 on
Turn on/off the send of ACK messages
Ex: Activate AKN
      C091

C10   N   Set F-Hopping N=0 off N=1 on
Activate/deactivate F. Hopping mode.
Others F-Hopping parameters can be set using C05 and C06 commands
Ex: Enable F-Hopping
      C101

C11   N   Set time out AKN N=0 off N=1 on
Activate/deactivate waiting for the AKN
Ex: Activate the wait of an AKN.
      C111

C12   N   Set 868MHz or 915MHz band.
In 868MHz module, set the band to 868MHz or 915MHz.
Use before the C08 command.
Ex: Set 915MHz Band
      C121

C13   N   Add CR+LF to received data. N=0 off, N=1 on
Activate/deactivate add CR LF to the received data.
Useful for visualization ASCII data with a terminal emulator.
Ex: Add CR LF
      C131

C14   Set output *WD
Sets high *WD output.
This command will be use after the module initialization. If *WD output goes down the device has been reset by the module Watch Dog, so must be re-initialized.

C15   N   Set * sent after command N=0 off N=1 on
Activate/deactivate sending "*" after the execution of a command.
Can be used as an alternatively of the Busy pin when there isn't any I/O for this scope.
Ex: activate sending '*'.
      C151

C16   N   Configure Pin #7 as *WD (N=0), ASK OUT (N=1), CD OUT (N=2)
Configure the pin #7 as **
*WD**, **ASK out** or **CD out**.
If ASK out is selected it's possible to receive an ASK communication and at the same time use the G3P network. It's possible to add the G3P features in a board that just use an ASK receiver, in this case the old ASK receiver is no more necessary.
If CD (Carrier Detect) out is selected the outputs reflects the medium traffic noise on the selected channel.
Ex: Set pin #7 as ASK out.
      C161
      Set pin #7 as CD out.
      C162

C17   N   Set anti noise filter standard (N=0) or huge (N=1)
Configure the anti noise filter as standard (no AKN extra delay) or huge (AKN extra delay).
In standard mode the AKN will be received immediately, the transmission will be quicker and the maximum noise allowed is 70% duty cycle.
In huge mode the AKN will be received with a delay, the transmission will be slower and the maximum noise allowed is 98% duty cycle.
For most part of applications the standard mode is enough, use the huge mode in very hard noise environments.

Ex: Set anti noise filter as huge.
C171

C20   NNNN   Set time LBT (0,1-999,9) mS
Sets the maximum waiting time for finding the channel free.
G3P wait at least this time, after this period will start the AUTO RETRY cycles.
The time is expressed in unit of 100 uS
Ex: max time=500uS.
        C200500

C21   NNNN   Set time out AKN (0,1-999,9) sec
Sets the maximum waiting time for the AKN
After waiting AKN for this time the device begin the AUTO RETRY cycle.
The time is expressed in unit of 100 mS
Ex: wait for 1 S.
        C210010

C22   NNNN   Set time retry in TX (0,1-999,9) mS
Sets the waiting time between two retransmissions if errors occur.
The time is expressed in unit of 100 uS
Ex: sets waiting time at 500 ms
        C225000

C23   NN   Set max retry in TX (1-99)
Sets the maximum number of retry.
When an error (TX or AKN) occurs the device tries to retransmit for the number of retry
Ex: Maximum retry number = 5.
        C2305

C24   NNNN   Set auto sleep active time (1-9999) mS/sec
Sets the "active time" during the sleep cycle. For SW Sleep.
The time is expressed in seconds or mS, according to C28 command.
Ex: Active time=10s
        C240010

C25   NNNN   Set auto sleep sleep time (1-9999) mS/sec
Sets the "sleep time" during the sleep cycle For SW Sleep.
The time is expressed in seconds or mS, according to C28 command.
Ex: sleep time 10 s

        C250010

C26   N   Set auto sleep mode N=0 off, N=1 medium, N=2 high
Activate/Deactivate the SW sleep
The user can set the parameter like:
"0" OFF
"1" Medium mode
"2" Deep Mode
Ex: Set SW sleep mode deep
        C262

C27   NNNN   Set auto sleep extra time after reception (1-9999) mS/sec
Sets the extra active time
After this time if nothing happens, the device continues the normal sleep cycle.
The time is expressed in seconds or mS, according to C28 command.
Ex: Extra active time= 10 seconds
         C270010

C28   N   Set auto sleep time N=0 mS, N=1 sec
Sets power down times unit in seconds/mS.
Ex: unit time seconds
         C281

C29
Sets the module to send "OK" if a transmission is successful.
Ex: Send OK if transmission is successful.
         C291

C30   N0…Nn   Load TX data N bytes.
Loads the data to transmit
After this command might follow how many characters as the number of bytes defined in the C04 command.
Ex: Data length= 4 bytes.
         Loads 4 bytes to transmit
         C0404   Sets data length
         C30FOOD   Loads the 4 bytes "FOOD"

C31   Transmit loaded data by command C04 to the device C03
Transmit to the receiver device the data loaded by C30 command

C32   N   Radio power N=0 power down, N=1 Power up
Turn on/off radio receiver. This reduces the current from 16,35mS to 3,25mA.
If the radio has been turned off, every command send to the module (with exception of command C60) will automatically enable the radio.

Ex: Disable the radio receiver
         C320

C33   HHLL   Transmit loaded data to the device HHLL trough the device C03
Transmits to the receiver device the data loaded by C30 command using a bridge.
With the command C03 has been defined the PHISICAL address of the transmission (the Bridge address).
The final address is defined by the two address bytes (4 ASCII characters) of the parameter.

C36   N   Set remote command (N=1) or data (N=0) transmission
With N=1 the payload will be received as remote command.
Every serial command can be transmitted to a module after setting C361.
With N=0 the module will transmit the payload as data to the remote one.
Note the payload deep (command C04) must be enough to transmit the command.
Ex: Transmit data to the module C0C0, and then change the remote device address to C0C1.
         C0408   Set payload to 8 bytes, both modules need the same payload length.
         C3012345678   Load 8 data bytes.
         C03C0C0   Set transmission destination as C0C0
         C31   Data transmission to C0C0, the received data will flow out the serial port of
                        The remote module C0C0.

         C03C0C0   Set transmission address to C0C0.
         C361   Set remote commands ON.
         C30C02C0C1.   Load data as command C02C0C1, dot is to complete the 8 bytes payload.
         C31   Remote command transmission, the remote module will execute the received
                        Command C02C0C1 and changes it's device address to C0C1.
         C360   Set remote commands OFF.

C40   Wake up slave define by C41 and C03
Wake up the slave module define by C41 and C03 commands
This command is used to wake up a device running in SOFTWARE DEEP SLEEP mode.
The module will try to wake up the slave for the maximum time defined by the command C41.
Will return to the serial link '**W**' if has succeed in waking up the salve, otherwise will return '**w**'.

C41   NN   Set wake up timeout in seconds
Define the maximum time in seconds to wake up a slave module.

Ex: Maximum time 5 sec.
         C4205

C42   HHLL   Wake up slave HHLL trough the device C03
Wake up the slave module define by C41 , C03 commands and parameters using a bridge.
With the command C03 has been defined the PHISICAL address of the transmission (the Bridge address).
The final address is defined by the two address bytes (4 ASCII characters) of the parameter.
This command is used to wake up a device running in SOFTWARE DEEP SLEEP mode.
The module will try to wake up the slave for the maximum time defined by the command C41.
Will return to the serial link '**W**' if has succeed in waking up the salve, otherwise will return '**w**'.

Ex: Wake up the slave C3C2 through the BRIGDE device C3C3.
         C03C3C3   Defines the physical address of the BRIGDE.
         C40   Wakes up the bridge.
         C03C3C3   Defines the physical address of the BRIGDE.
         C42C3C2   Wakes up the FINAL slave C3C2

C43   NNNN   Set the wake up burst time (1-5000)mS
Defines the burst time in mS.
Maximum value is 5000mS.

C45   Store set up
Store the actual Set up and Baud Rate into the internal flash.
Use if needed to PRESET the radio parameters.
Usage:
    1. Send the Setup commands needed.
    2. Send command C45.
On the next power on the module will use the stores Set up and the Baud Rate in the programming moment.
The stored commands by C45 are:
         Baud 0 and Baud 1 status pins.
         C00, C01, C02, C03, C04, C05, C06, C07, C09, C10, C11, C12, C15, C17
         C20, C21, C22, C23, C24, C25, C26, C27.

Note: C45 is not necessary if used the commands from C60 to C79.

C46   Delete setup, program flash and restore the default settings
Delete the entire internal flash program, set up, I/O define and baud rate.
Restore the module in the original state.
On the next power on the baud rate will be set by the pins Baud 0 and Baud 1.

C47   N KKKK   Set the variable N with the value KKKK
Set the variable N of the remote module defined by the command C03 to the value kkkk.
KKKK is an ASCII number in the field 0-9999.
Note: The transmission takes 2 bytes, set the payload length minimum to 2 with the command C04.

Ex: Set the variable #0 of the module C3C2 to 100.
         C03C3C3   Defines the physical address of the remote module.
         C4700100   Set the variable #0 to 100.

22

C48   N   Set remote auto sleep mode N=0 off, N=1 medium, N=2 high
Activate/Deactivate the SW sleep into a remote module defined by the command C03.
The user can set the parameter like:
"0" OFF
"1" Medium mode
"2" Deep Mode
Ex: Set SW sleep mode deep in the module C0C1
        C03C0C1   Address of the remote module
        C482   Set SW sleep mode deep

C50   N   Set AES encryption N=0 off, N=1 on, N=2 on compatible
Turn on/off the AES 128 bit encryption.
To use the AES 128 bit encryption, the payload size defined by the command C04 MUST be 16 bytes
long: **set C0416**.
AES can be activated both with N=1 or N=2. The AES used is the same, but differs for radio bytes
organization.
Set the same N value in all the network devices.
N=1 is the AES encryption used up to release 2.03.
N=2 generate a different radio pattern, this allows to be compatible with external decoders.

Ex: Enable AES encryption compatible.
        C502

C51   N0...N15   Set 16 bytes key for AES encryption
Set the AES 128 bit encryption key.
The key must be 16 bytes long.
Also the payload size define with the command C04 must be 16 bytes long.
The key must be the same for all the network modules.

Ex: Set the AES key like 'abcdefghijklmnop'.
        C51 abcdefghijklmnop

C52   N S   Set IO N with S (0 or 1) status of the module defined by C03
Set a remote I/O defined in the destination module by the Programming Commands C60-C79.
The remote I/O can be set or reset, if in the destination module has not been defined as I/O, nothing will
happen.
Ex: Set the I/O #5 of the module C3C0
        C03C3C0   set the destination module
        C5251   set the I/O #5.

C53   Read I/O status
Remote read user I/O.
Returns a string data (length defined by C04) where the first bytes represents in HEX the user I/O status.

Ex: Read I/O of module C1C0.
        C03C1C0
        C53

        Receive C1C0xx, where xx is one HEX byte.

C54   Send the model type of the module
Send the model type of the module and the software release.

Ex: C54
        Answer: G3P-HPPM-R1-868 R101CR+LF
Means Frequency 868MHz, PPM Network, Software release 1.01

9.2. Flash Programming Commands.

C60   Open programming, delete flash and store the set up
Delete the previous data stored in flash and open e new programming.
Automatically stores the current set up like C45.
The programming sequence is:
- C60   to delete the old data and open a new programming section.
- C61   if is required to configure the I/O
- Other programming commands.
- C79   to close the session, after the module waits for a RESET.

C61   N S K   Set I/O configuration
This command must be used after C60 and defines the pins to be used as custom I/O.
To open the I/O programming use C610 and then define the status pin.
To close the I/O programming use C619
The command **C61** use the parameters **n s k**, the allowed configurations are:

n	s	k	Pin	Function
0				Open the I/O programming session
1	0		Sleep	I/O #1 as Input
1	3		Sleep	I/O #1 as Trigger rising edge
1	4		Sleep	I/O #1 as Trigger falling edge
2	0		Data out Enable	I/O #2 as Input
2	2		Data out Enable	I/O #2 as 10 bit AD 1
3	0		Baud 0	I/O #3 as Input
3	2		Baud 0	I/O #3 as 10 bit AD 2
4	0		Baud 1	I/O #4 as Input
4	2		Baud 1	I/O #4 as 10 bit AD 3
5	0		Active	I/O #5 as Input
5	1	0	Active	I/O #5 as Output, initial state = 0
5	1	1	Active	I/O #5 as Output, initial state = 1
6	0		Data Ready	I/O #6 as Input
6	1	0	Data Ready	I/O #6 as Output, initial state = 0
6	1	1	Data Ready	I/O #6 as Output, initial state = 1
7	0		*Wd	I/O #7 as Input
7	1	0	*Wd	I/O #7 as Output, initial state = 0
7	1	1	*Wd	I/O #7 as Output, initial state = 1
8	0		Busy	I/O #8 as Input
8	1	0	Busy	I/O #8 as Output, initial state = 0
8	1	1	Busy	I/O #8 as Output, initial state = 1
9				Close the I/O programming session

The pins not used as I/O will continue to maintain the original function.
The I/O can be remotely controlled by radio using the command C52 and C53.

Ex: Set ***WD** as output low at reset and **Active** as output High at reset.
       C610   Open the I/O programming.
       C61710Defines I/O 7 (*WD) as output low at reset.
       C61511Defines I/O 5 (Active) as output high at reset.
       C619   Close the I/O programming.

C62   D0...Dn   Load messages N=message number (1-4)
This command must be used after C60 and C61 and stores into the internal flash a message.
The maximum number of messages is 4, the length of the message has been defined by the command C04. The messages will be then used by the operating macros C68 and C76.

Ex: Data length= 4 bytes.
       Loads message #1
       C621abcd

C63   Init load macro
This command must be used after C60, C61, C62 and opens the module to load macros.
The programming session will be close by the command C79.

C64   Macro Sleep
This command must be used after C60, C61, C62, C63.
Set the module in sleep mode. The module will be waked up only by a trigger defined with the command C61.

C65   hhmmss   Macro Sleep time
This command must be used after C60, C61, C62, C63.
Set the module in sleep mode for the specified time. The module will be waked by a trigger if defined with the command C61 or after the specified time.
After use the command C76 with option IF TRIGGER or IF TIME to understand if the module wake up for trigger or timeout.

Ex: Macro sleep 1hour, 10 minutes, 20 seconds.
        C65011020

C66   N K   Macro Reset, Set, Toggle output N (K=0,1,2)
This command must be used after C60, C61, C62, C63.
Reset, set or toggle an output defined by the command C61. Has the parameter N that define the I/O number and the parameter K to define Reset(K=0), Set(K=1), Toggle(K=2) the output.

Ex: C6680   Reset I/O #8
        C6671   Set I/O #7
        C6662   Toggle I/O #6

C67   Macro delay mS (1-9999)
This command must be used after C60, C61, C62, C63.
Gives a delay in mS defined by the 4 digit immediate value or by a variable. Maximum delay is 5000mS.
C67 0 NNNN   Waits NNNN mS.
C67 1 N   Waits the value of variable N

Ex: C670100   Delay of 100mS
        C6712   Delay of (variable #2)mS

C68   Macro Tx
This command must be used after C60, C61, C62, C63.
After transmission into variable #0 will be stored the result:
        0   Transmission OK.
        1   AKN error.
        2   TX error.
The parameter HHLL defines the destination address of the transmission. If HHLL=0000 will transmit to the last sender address.

The action depends by the parameters format:

C68 0 HHLL N F
        Transmits the I/O status or the 10 bit AD value.
        The parameter N defines to transmit I/O status (N=0) or AD value (N=1).
        The parameter F defines the data format, F=0 data in HEX mode, F=1 data in ASCII decimal number.
        If is used the AD, must be enabled by the command C61.
        Note: Remember to set the data payload (C04) at least to 4 bytes.

        Ex: C680C1C000   Transmits to the module C1C0 the I/O status as a hex byte.
                C680C1C001   Transmits to the module C1C0 the I/O status as an ASCII number of 3 digits.
                C680C1C010   Transmits to the module C1C0 the 10 bit AD value as two hex bytes.

C68 1 HHLL N
        Transmits to the module HHLL the stored message N by the command C62.

        Ex: C681C1C03   Transmits to the module C1C0 the message #3 stored by C62.

C68 2 HHLL D0…Dn
Transmits to the module HHLL the specified message by D0…Dn.

Ex: C682C1C0abc   Transmits to the module C1C0 the "abc".

C68 3 HHLL N F
Transmits the value of the specified variable.
The parameter HHLL defines the destination address of the transmission.
The parameter N defines the variable number.
The parameter F defines the data format, F=0 data in HEX mode, F=1 data in ASCII decimal number.
Note: Remember to set the data payload (C04) at least to 4 bytes.

Ex: C683C1C010   Transmits to the module C1C0 the variable #1 in HEX format.
        C683C1C021   Transmits to the module C1C0 the variable #2 in ASCII 3 digits format.

C69   Macro Timer
This command must be used after C60, C61, C62, C63.
There are 2 user timers (timer 0 and timer 1) that count down and stop when reach 0.
The action depends by the parameters format:

C69 0 N
Stop the timer N count down.
The timer must be stopped before load or read it.

Ex: C6900   Stop the timer #0
        C6901   Stop the timer #1

C69 1 N
Start the timer N count down.

Ex: C6910   Start the timer #0
        C6911   Start the timer #1

C69 2 N KKKK
Load the timer N with the value KKKK.
Note: Remember to stop the timer before load it using the command C69 0 N.

Ex: C69200100   Load the timer #0 the value 100
        C69211000   Load the timer #1 the value 1000

C69 3 N M
Load the timer N with the value into the variable M.
Note: Remember to stop the timer before load it using the command C69 0 N.

Ex: C69301   Load the timer #0 the value of the variable #1
        C69312   Load the timer #1 the value of the variable #2

C70   Macro Variables
This command must be used after C60, C61, C62, C63.
There are 10 user variables (variable 0 to variable 9).
The variables are unsigned and an operating field between 0 and 9999.
A module reset will set al variables to 0.
Into the variable #0 will written the transmission result by the macro C68.
The action of command C70 depends by the parameters format:

C70 0 N KKKK
Set the variable N to the value KKKK.
The parameter N is in the field 0-9.
The parameter KKKK is a decimal ASCII number in the field 0-9999.

Ex: C70010100   Set the variable #1 to 0100.

C70 1 N K
Increment (K=1) or decrement (K=0) the variable #N.
The parameter N is in the field 0-9.

Ex: C70121   Increment the variable #2.
        C70150   Decrement the variable #5.

C70 2 N K CCCC

      Variable N + the value CCCC (K=1) or variable N – the value CCCC (K=0).
      The parameter N is in the field 0-9.
      The parameter CCCC is a decimal ASCII number in the field 0-9999.

      Ex: C702101000   Variable #1 - 1000.
             C702210500   Variable #2 + 500.

C70 3 N K M

      Variable N + variable M (K=1) or variable N – variable M (K=0).

      Ex: C703102   Variable #1 – variable #2.
             C703213   Variable #2 + variable #3.

C70 4 N K CCCC

      Variable N * the value CCCC (K=1) or variable N / the value CCCC (K=0).
      The parameter N is in the field 0-9.
      The parameter CCCC is a decimal ASCII number in the field 0-9999.

      Ex: C704101000   Variable #1 / 1000.
             C704210500   Variable #2 * 500.

C70 5 N K M

      Variable N * variable M (K=1) or variable N / variable M (K=0).
      The parameter N and M are in the field 0-9.

      Ex: C705102   Variable #1 / variable #2.
             C705213   Variable #2 * variable #3.

C70 6 N K

      Load the variable N with the I/O status (K=0) or with the AD value (K=1).
      The parameter N is in the field 0-9.
      If is used the AD, must be enabled by the command C61.
      Note: Remember to set the data payload (C04) at least to 4 bytes.

      Ex: C70610   Store into Variable #1 the I/O status.
             C70621   Store into Variable #1 the AD value.

C70 7 N M

      Load in the variable N the timer M value.
      The parameter N is in the field 0-9.
      The parameter M is in the field 0-1.

      Ex: C70710   Store into Variable #1 the Timer #0 value.

C70 8 N M

      Load in the variable N the variable M value.
      The parameters N and M are in the field 0-9.

      Ex: C70810   Store into Variable #1 the Variable #0 value.

C71   N   Input AD set

This command select the active AD.
The AD inputs can be up 3, and must be define into the I/O setting session. (see C61 command).
The parameter N select the active AD input as:
      N=1   AD input #2 (pin #12).
      N=1   AD input #3 (pin #11).
      N=1   AD input #4 (pin #10).

## C72   N A V CCCC   Vcc value measure

This command measures the Vcc value and store into the variable N.
It's useful to know the battery voltage of a remote sensor.
The Vcc value is in unit of 1/100 volt; ex. for 3.30 volt, the value will be 300.
To measure Vcc it's required:
-    Reference voltage applied to one of the 3 AD inputs.
-    An I/O to enable the reference voltage.
Parameters:
-    N   I/O number to enable the reference.
-    A   AD number used to read the reference.
-    CCCC   Decimal value of the reference in mV.

Application example
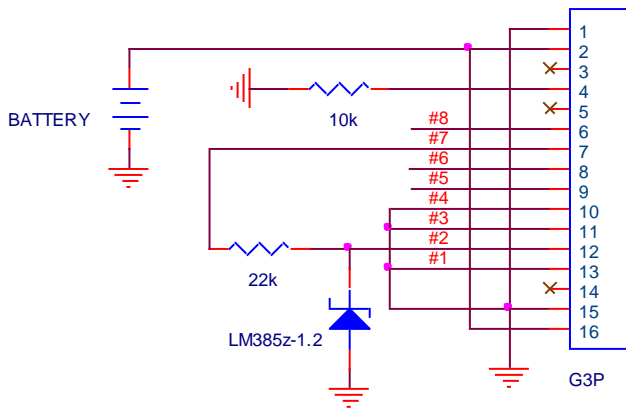
In the example as reference is used an LM385 that gives a reference value of 1.235V.
I/O #7 is used to activate the reference, I/O #5 will be automatically driven by the command C72 for 30mS.
To read the reference value has been used the I/O #2 (AD 1).
The unused I/O #1, #3 and #4 are grounded.

To read the Vcc value into the variable #1, the command syntax is:
C727111235
After the command execution the variable #1 will contain the Vcc value.
Than this value can be transmitted, compared or elaborate using others macros.

The typical maximum error of the measured value is 0.05V.

C76   see table   Macro IF
    Open an IF condition.
C77   Macro ELSE
    Optional in an IF - ENDIF.
C78   Macro ENDIF
    Close an IF condition.

These commands must be used after C60, C61, C62, C63 and open and IF condition closed by the macro ENDIF (C78). In an IF condition can be used also the C77 ELSE statement.
If the condition is satisfied, the macros between IF and ENDIF will be executed.
If the condition is satisfied, the macros between IF and ELSE will be executed, otherwise will be executed the macros between ELSE and ENDIF.

An IF condition can contain other IF up to 7 levels.
The command **C76** use the following parameters:

Parameters	Function	Description
0	If Trigger	If a defined trigger occurs during a Sleep Time macro.
1	If Time	If waked up for a timeout in Sleep Time macro.
2 C NNNN	If AD value	If the AD value is <, =, > (C=0,1,2) of NNNN.
3 C N	If AD variable	If the AD value is <, =, > (C=0,1,2) of variable N.
4 C N KKKK	If Variable value	If the variable N is <, =, > (C=0,1,2) of KKKK.
5 C N M	If Variable	If the variable N is <, =, > (C=0,1,2) of variable M.
6 HHLL N	If RX n	If Rx from HHLL the message #N (stored with C62).
7 HHLL k0…kn	If Rx message	If Rx from HHLL the following message k0…kn.
8 N K S	If I/O	If I/O N equal (K=0) or not equal (K=1) to S.
9 HHLL	If Rx	If Rx from HHLL any message.
A M0…Mn D0…Dn	If Rx Compare	If Rx data masked by M0…Mn are equal to D0…Dn

Ex: **If Trigger, If Time**
    C65000100   Sleep 1 minute.
    C760   If waked up from a trigger.
    …   Other macros.
    C78   End if.

    C761   If waked up by timeout
    …   Other macros.
    C78   End if.

Ex: **If AD value**
    C76201000   If AD value < 1000
    …   Other macros.
    C77   Else.
    …   Other macros.
    C78   End if.

    C76211000   If AD value = 1000
    …   Other macros.
    C78   End if.

    C76221000   If AD value > 1000
    …   Other macros.
    C77   Else.
    C76200500   If AD value < 500
    …   Other macros.
    C78   End if.
    C78   End if.

Ex: **If AD variable**
    C70021000   Set variable 2 to 1000.
    C76302   If AD value < variable 2
    …   Other macros.
    C78   End if.

    C76312   If AD value = variable 2
    …   Other macros.
    C78   End if.

    C76322   If AD value > variable 2
    …   Other macros.
    C77   Else.
    …   Other macros.
    C78   End if.

Ex: **If Variable value**
        C764031000   If the value of Variable #3 < 1000
        …   Other macros.
        C78   End if.

        C764131000   If the value of Variable #3 = 1000
        …   Other macros.
        C78   End if.

        C764231000   If the value of Variable #3 > 1000
        …   Other macros.
        C77   Else.
        …   Other macros.
        C78   End if.

Ex: **If Variable**
        C7121000   Set variable 2 to 1000.
        C765032 If Variable #3 < Variable #2
        …   Other macros.
        C78   End if.

        C765132 If Variable #3 = Variable #2
        …   Other macros.
        C78   End if.

        C765232 If Variable #3 > Variable #2
        …   Other macros.
        C77   Else.
        …   Other macros.
        C78   End if.

Ex: **If Rx N**
        C766E0C02   If received from E0C0 the message #2
        …   Other macros.
        C78   End if

        C76600002   If receiver from someone the message #2
        …   Other macros.
        C78   End if.

Ex: **If Rx message**
        C767E0C0AB   If received from E0C0 the message AB
        …   Other macros.
        C78   End if

        C7670000AB   If receiver from anyone the message AB
        …   Other macros.
        C78   End if.

Ex: **If Rx**
        C769E0C0   If received from E0C0 a message.
        …   Other macros with the message analysis.
        C78   End if

        C7690000AB   If receiver from anyone a message.
        …   Other macros with the message analysis.
        C78   End if.

Ex: **If Rx compare**
        Parameters:
        Mask   string as long as the message bytes defined by the command C04.
                            With the payload of 4 bytes (C0404) the mask will be 4 bytes long.
                            In the mask the characters 'X' are the position of the compared characters.
                            Ex. Mask ..XX means that will be compared only the characters 3 and 4.
        Data   Like mask must be as long as the defined payload by the command C04.
                            The received message will be compared with this data, but only the character corresponding to the 'X'
                            into the mask.
        Use this macro after the macro If Rx (C799) and before its own end if (C78).

        Received the message of 4 bytes "test".
        C76A..XX..st   If the received message is 's' in position 3 and 't' in position 4.
        …   Other macros executed.
        C78   End if

        C76A.XX..st.   If the received message is 's' in position 2 and 't' in position 3.
        …   Other macros NOT executed, the received message in position 2 and 3 is not 'st', is 'es'.
        C78   End if

        C7690000AB   If receiver from anyone a message.
        …   Other macros with the message analysis.
        C78   End if.

Ex: **If I/O**
       C768301   If I/O #3 = 1
       …   Other macros.
       C78   End if.

       C768311   If I/O #3 != 1
       …   Other macros.
       C78   End if.

       C768300   If I/O #3 = 0
       …   Other macros.
       C78   End if.

       C768310   If I/O #3 != 0
       …   Other macros.
       C78   End if.

C79   **End Programming, write the flash and wait for a reset**
Close the programming session, write all data into the internal flash and waits for a reset.

9.3. Flash Macro size.

The total amount for macro programming is 640 bytes.
The following table shows the used flash bytes for every macro command.

Command	Description	Flash bytes used
C64	Sleep	1
C65	Sleep time	4
C66	Reset, Set, Toggle output	3
C67 0	Delay mS immediate value	4
C67 1	Delay mS variable value	3
C68 0	Tx to HHLL I/O or AD	6
C68 1	Tx to HHLL message N	5
C68 2	Tx to HHLL the following message	4 + message
C69 0	Timer N stop	3
C69 1	Timer N start	3
C69 2	Timer N set with the immediate value	5
C69 3	Timer N set with the variable M	4
C70 0	Set Variable N to the value KKKK	5
C70 1	Variable INC/DEC (K=1/0)	4
C70 2	Variable N SUB/SUM value KKKK	6
C70 3	Variable N SUB/SUM variable M	5
C70 4	Variable N DIV/MUL value KKKK	6
C70 5	Variable N DIV/MUL variable M	5
C70 6	Load variable N with I/O or AD	4
C70 7	Load variable N with timer M	4
C70 8	Load variable N with variable M	4
C71	Set active AD	2
C72	Read Vcc	6
C76 0	IF Trigger	2
C76 1	IF Timer	2
C76 2	IF AD Value	5
C76 3	IF AD Variable	4
C76 4	IF Variable value	6
C76 5	IF Variable	5
C76 6	IF RX N	5
C76 7	IF RX message	4 + message
C76 8	IF I/O	5
C769	IF RX	4
C79A	IF RX compare(use after C769)	2 + (2*message)
C77	ELSE IF	1
C78	END IF	1

9.4. Flash Programming Limitations.

To program or reprogram a module, take care of two problems.
   1. Synchronization of the programming commands.
   2. Reprogramming a module with sleep mode activated.

9.4.1.   Synchronization of the commands.

During the programming sometime the internal flash will be rewritten, this will cause to loose the serial commands sent during this phase.
The programming commands must be send one at a time.
Wait for an asterisk if at the beginning has been used the command C151, or wait the busy signal low.
If is used the Busy signal, after goes low wait at least 100mS before send the next command.
No extra time is required after the asterisk if C151 has been used.

9.4.2. Reprogramming a module with sleep mode activated.

When a just programmed module starts with the RX pin connected to a serial interface, will not execute the loaded program.
Otherwise will use the stored set up.
This means that if was previously programmed with deep sleep mode active (C262), will start to sleep and wake up as programmed.
This does not allow to accept serial commands during the sleep phase.
Reset the module then begin to program BEFORE 10 seconds.
When reset the module will stay active for 10 seconds before begin the programmed sleep cycle.
If the programming will start in less then 10 seconds after the reset, the module will stay active until arrive serial commands.
No programming command requires 10 seconds, so the programming can be successfully completed.

9.5. Flash Programming Example.

- Use the needed commands among C00, C01, C02, C03, C04, C05, C06, C07, C08, C09, C10, C11, C12, C15, C17,C20, C21, C22, C23, C24, C25, C26, C27 to initialize the module.
- C60 opens the programming session, will be stored the set up and the current baud rate.
- If is required to configure some I/O use:
   - C610   Opens the I/O programming session.
   - C61nsk   Define the I/O
   - C619   Close the I/O programming session.
- If is required to load some messages use:
   - C62n..data   Load message #n.
   - Others C62, maximum 4 messages (N=1-4).
- If is required to load some macros use:
   - C63   Opens the macro programming session.
   - Macro commands from C64 up to C78.
- C79   to close the entire programming session and waits for a reset.

9.5.1.   Example SET UP only

C01C0C0	Set the Network address
C02E1E0	Set the Device address
C044	Set 4 bytes for payload
C0002	Set channel #2.
……….	Other set up commands
C08	Store commands into the radio.
C79	Close programming.

Reset the module.

9.5.2.   Example SET UP and I/O

C01C0C0	Set the Network address
C02E1E0	Set the Device address
C044	Set 4 bytes for payload
C0002	Set channel #2.
……….	Other set up commands
C08	Store commands into the radio.
C60	Start programming.
C610	Start I/O session.
C61710	Set *WD as output.
C619	Close I/O session.
C79	Close programming.

Reset the module.

9.5.3.   Example SET UP, I/O and MACROS

C01C0C0	Set the Network address
C02E1E0	Set the Device address
C044	Set 4 bytes for payload
C0002	Set channel #2.
……….	Other set up commands
C08	Store commands into the radio.
C60	Start programming.
C610	Start I/O session.
C61710	Set *WD as output.
C619	Close I/O session.
C621AD..	Load message #1 = "AD.."
C622LIVE	Load message #2 = "LIVE"
C623YES.	Load message #3 = "YES."
C63	Init macro session
C766C0C11	IF C0C1 send message #1 "AD.."
C680C0C111	Tx to C0C1 the AD value in ASCII format.
C6671	Set the OUTPUT #7 (a LED)
C6700050	Wait 50mS for the led lamp
C6670	Reset the OUTPUT #7 (a LED)
C78	END IF
C766C0C12	IF C0C1 send message #2 "LIVE"
C681C0C13	Tx to C0C1 the message #3 "YES."
C78	END IF
C79	Close programming.

Reset the module.

9.5.4.   Example SET UP, I/O and RX MACROS

C01C0C0	Set the Network address.
C02E1E0	Set the Device address.
C044	Set 4 bytes for payload.
C0002	Set channel #2.
……….	Other set up commands.
C08	Store commands into the radio.
C60	Start programming.
C610	Start I/O session.
C61810	Set BUSY as output for LED 1.
C61710	Set *WD as output for LED 2.
C619	Close I/O session.
C63	Init macro session.
C767C0C1LIVE	IF C0C1 send message "LIVE".
C681C0C13	Tx to C0C1 the message #3 "YES."
C78	END IF.
C769C0C12	IF C0C1 send a message.
C76AXX.XLD.1	IF the message received is **L,D**,does not care and,**1**.
C6681	Set the OUTPUT #8 (LED 1).
C6700050	Wait 50mS for the led lamp.
C6680	Reset the OUTPUT #8 (LED 1).
C78	END IF for C76A.
C76AXX.XLD.2	IF the message received is **L,D**,does not care and,**2**.
C6671	Set the OUTPUT #7 (LED 2).
C6700050	Wait 50mS for the led lamp.
C6670	Reset the OUTPUT #7 (LED 2).
C78	END IF for C76A.
C78	END IF for C769.
C79	Close programming.
Reset the module.	

10. RADIO CHANNELS

The following table shows the channels band for communication for 433 MHz

Channel #	f min	f0	f max	Duty	dBm
1	433,05	433,1	433,15	10%	10
2	433,15	433,2	433,25	10%	10
3	433,25	433,3	433,35	10%	10
4	433,35	433,4	433,45	10%	10
5	433,45	433,5	433,55	10%	10
6	433,55	433,6	433,65	10%	10
7	433,65	433,7	433,75	10%	10
8	433,75	433,8	433,85	10%	10
9	433,85	433,9	433,95	10%	10
10	433,95	434	434,05	10%	10
11	434,05	434,1	434,15	10%	10
12	434,15	434,2	434,25	10%	10
13	434,25	434,3	434,35	10%	10
14	434,35	434,4	434,45	10%	10
15	434,45	434,5	434,55	10%	10
16	434,55	434,6	434,65	10%	10
17	434,65	434,7	434,75	10%	10

The following table shows the channels band for communication for 868 MHz

Channel #	f min	f0	f max	Duty	dBm
1	868,1	868,2	868,3	1%	10
2	868,3	868,4	868,5	1%	10
3	868,7	868,8	868,9	0,10%	10
4	868,9	869	869,1	0,10%	10
5	869,7	869,8	869,9	100%	6

The following table shows the channels band for communication for 915 MHz

Channel #	f min	f0	f max	Duty	dBm	Channel #	f min	f0	f max	Duty	dBm
1	902,1	902,2	902,3	100%	10	34	915,3	915,4	915,5	100%	10
2	902,5	902,6	902,7	100%	10	35	915,7	915,8	915,9	100%	10
3	902,9	903	903,1	100%	10	36	916,1	916,2	916,3	100%	10
4	903,3	903,4	903,5	100%	10	37	916,5	916,6	916,7	100%	10
5	903,7	903,8	903,9	100%	10	38	916,9	917	917,1	100%	10
6	904,1	904,2	904,3	100%	10	39	917,3	917,4	917,5	100%	10
7	904,5	904,6	904,7	100%	10	40	917,7	917,8	917,9	100%	10
8	904,9	905	905,1	100%	10	41	918,1	918,2	918,3	100%	10
9	905,3	905,4	905,5	100%	10	42	918,5	918,6	918,7	100%	10
10	905,7	905,8	905,9	100%	10	43	918,9	919	919,1	100%	10
11	906,1	906,2	906,3	100%	10	44	919,3	919,4	919,5	100%	10
12	906,5	906,6	906,7	100%	10	45	919,7	919,8	919,9	100%	10
13	906,9	907	907,1	100%	10	46	920,1	920,2	920,3	100%	10
14	907,3	907,4	907,5	100%	10	47	920,5	920,6	920,7	100%	10
15	907,7	907,8	907,9	100%	10	48	920,9	921	921,1	100%	10
16	908,1	908,2	908,3	100%	10	49	921,3	921,4	921,5	100%	10
17	908,5	908,6	908,7	100%	10	50	921,7	921,8	921,9	100%	10
18	908,9	909	909,1	100%	10	51	922,1	922,2	922,3	100%	10
19	909,3	909,4	909,5	100%	10	52	922,5	922,6	922,7	100%	10
20	909,7	909,8	909,9	100%	10	53	922,9	923	923,1	100%	10
21	910,1	910,2	910,3	100%	10	54	923,3	923,4	923,5	100%	10
22	910,5	910,6	910,7	100%	10	55	923,7	923,8	923,9	100%	10
23	910,9	911	911,1	100%	10	56	924,1	924,2	924,3	100%	10
24	911,3	911,4	911,5	100%	10	57	924,5	924,6	924,7	100%	10
25	911,7	911,8	911,9	100%	10	58	924,9	925	925,1	100%	10
26	912,1	912,2	912,3	100%	10	59	925,3	925,4	925,5	100%	10
27	912,5	912,6	912,7	100%	10	60	925,7	925,8	925,9	100%	10
28	912,9	913	913,1	100%	10	61	926,1	926,2	926,3	100%	10
29	913,3	913,4	913,5	100%	10	62	926,5	926,6	926,7	100%	10
30	913,7	913,8	913,9	100%	10	63	926,9	927	927,1	100%	10
31	914,1	914,2	914,3	100%	10	64	927,3	927,4	927,5	100%	10
32	914,5	914,6	914,7	100%	10	65	927,7	927,8	927,9	100%	10
33	914,9	915	915,1	100%	10						

11. HARDWARE CONNECTIONS

G3P modules can be connected in different ways, depending by the availability of I/O from the user microcontroller.

11.1. Complete connection
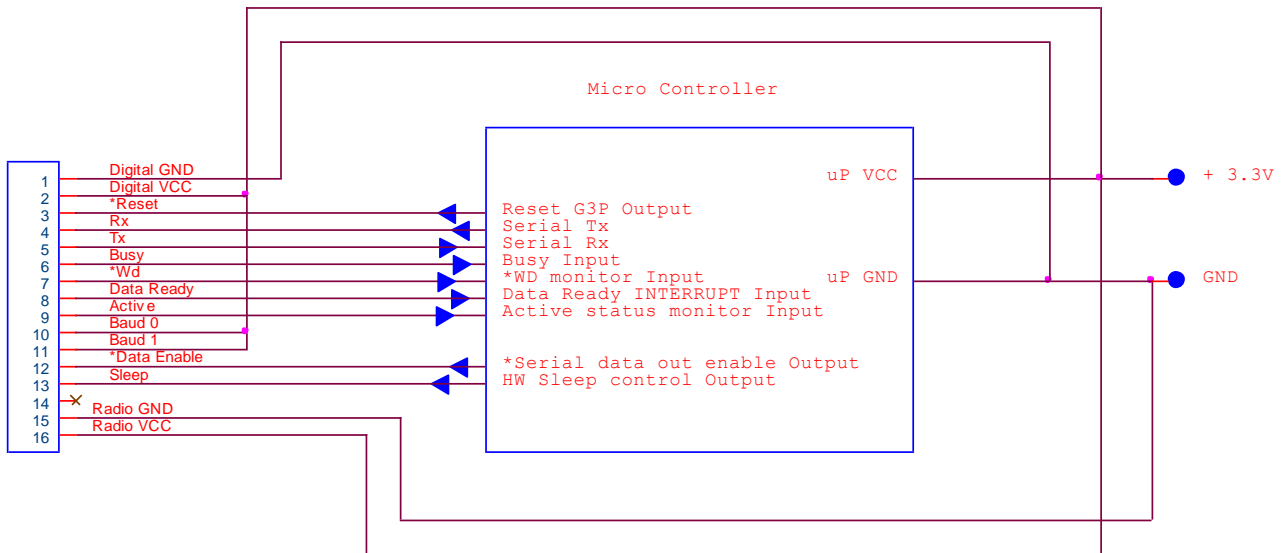
- Baud rate is fixed to 19200.
- All features available.

11.2. Minimum connection
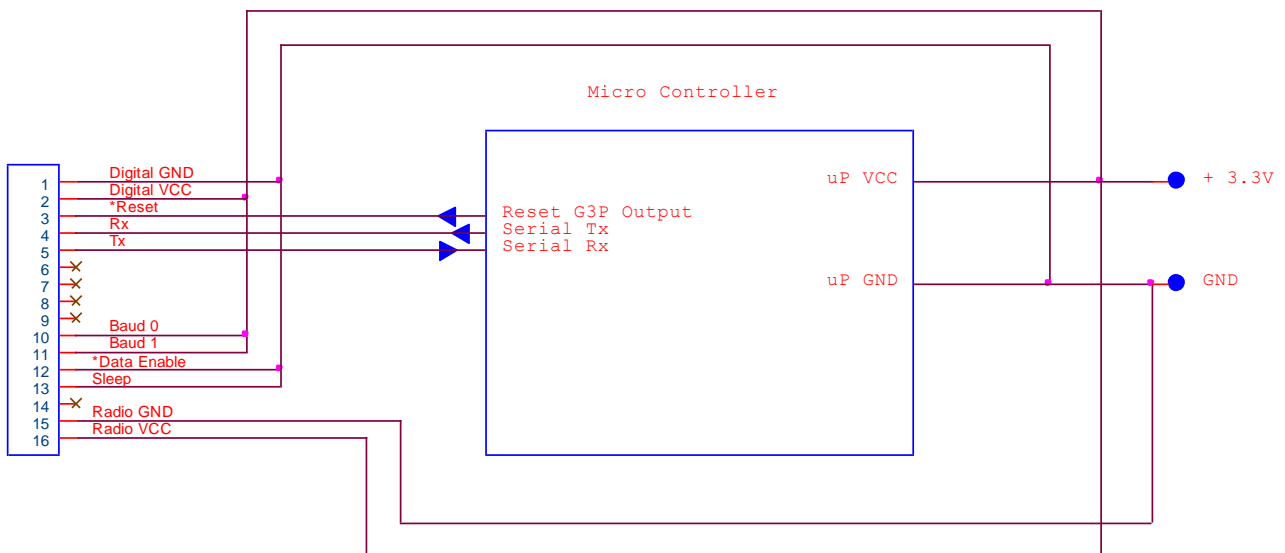
- Baud rate is fixed to 19200.
- Sleep functions not available.
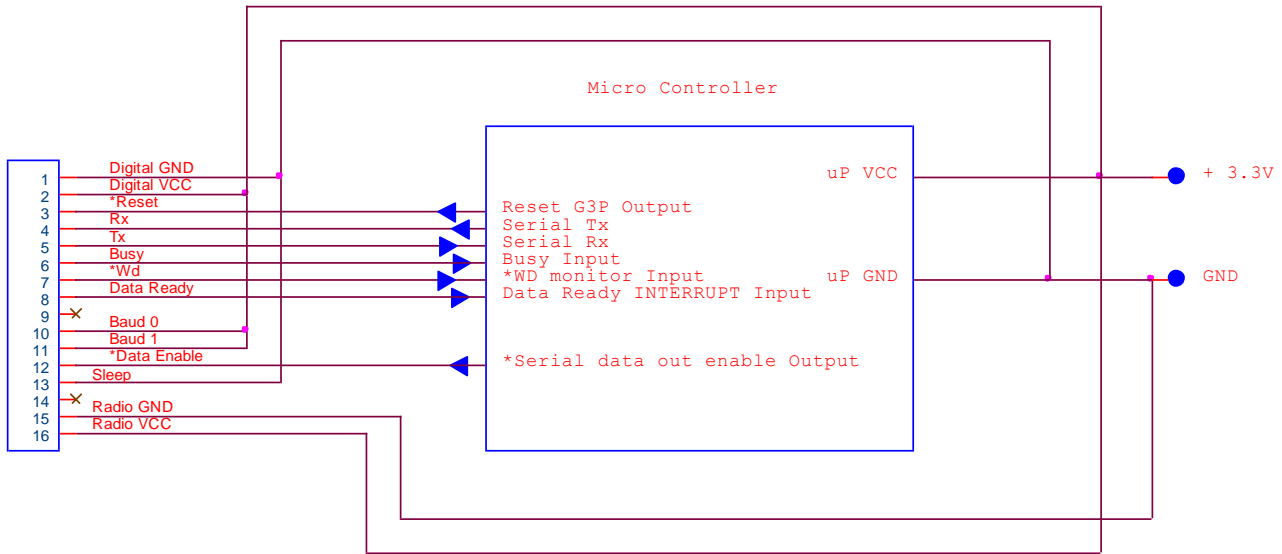- For Busy function use COMMAND C15.

11.3. Sleep HARDWARE connection
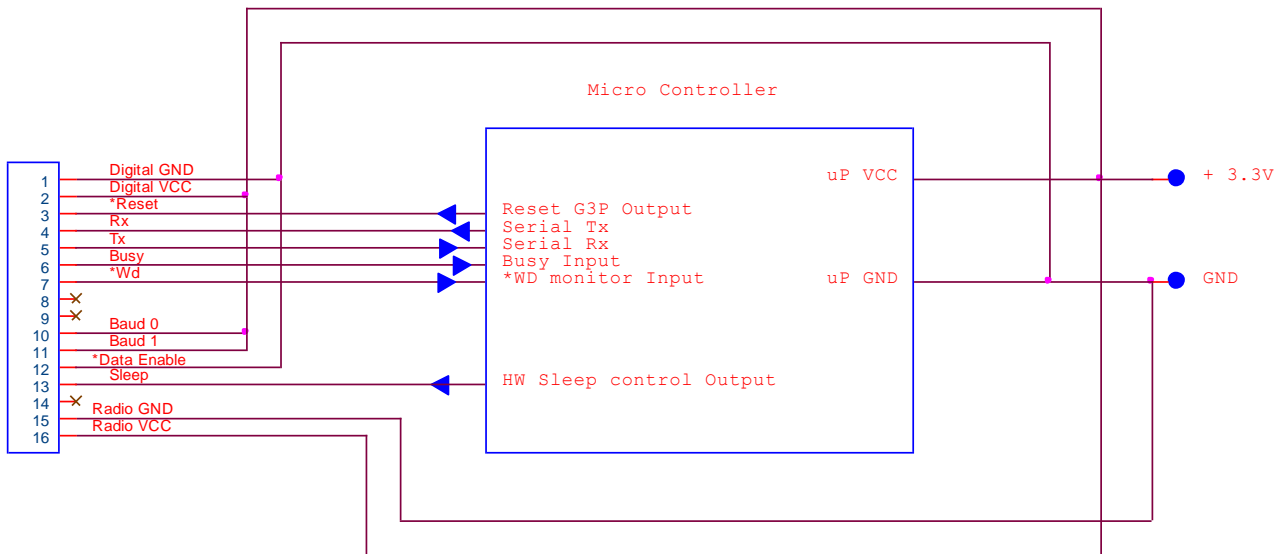
- Baud rate is fixed to 19200.
- Sleep SW functions not available.
- BUSY and *WD are optional.

11.4. Sleep SOFTWARE connection (1)
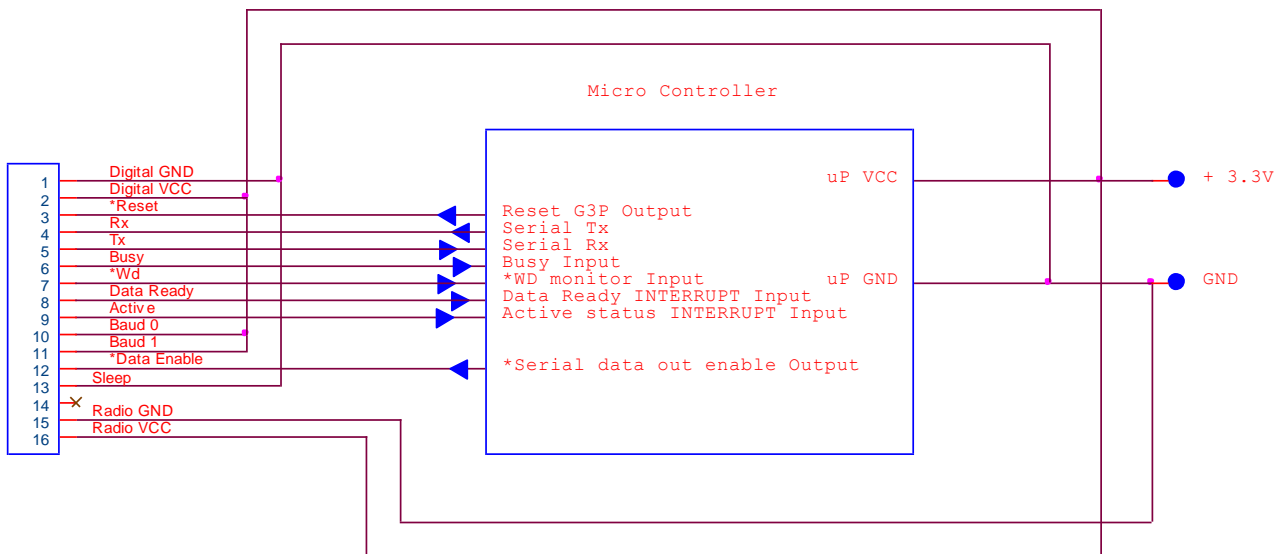
- Baud rate is fixed to 19200.
- Sleep HW function not available.
- BUSY and *WD are optional.
- The uC can be wake up by an incoming data (Data Ready = 1).
- The uC is waked up by active phase (Active =1) to send serial commands.

11.5. Sleep SOFTWARE connection (2)

- Baud rate is fixed to 19200.
- Sleep HW function not available.
- BUSY and *WD are optional.
- The uC can be wake up by an incoming data (Data Ready = 1), set *DATA ENABLE = 0 to receive data and transmit if needed, then set *DATA ENABLE = 1 and sleeps again.

11.6. PC connection
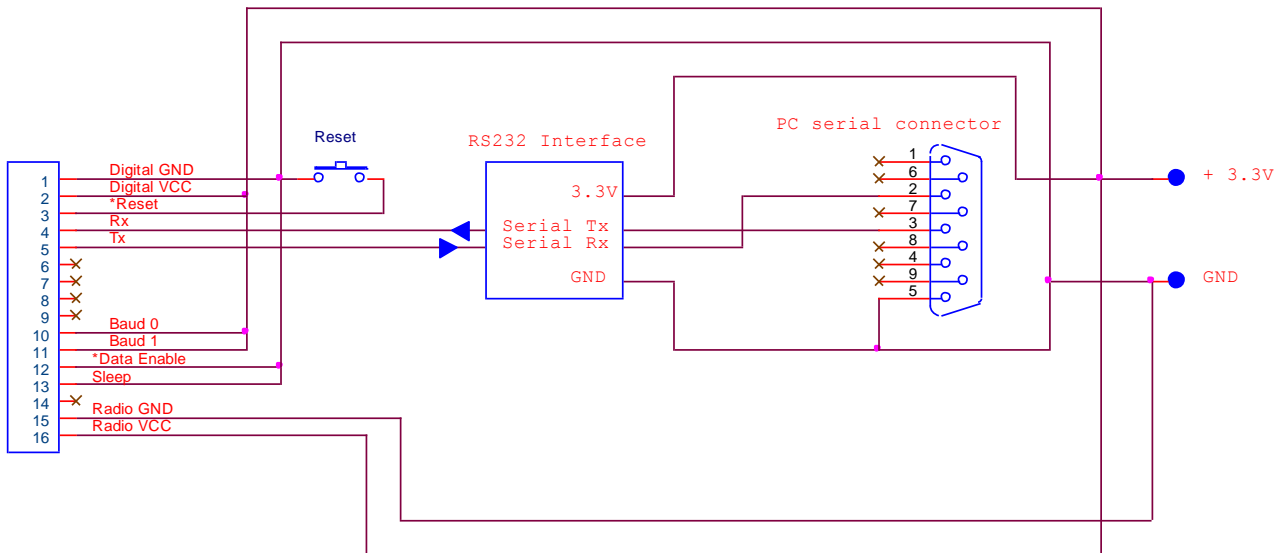
- Baud rate is fixed to 19200.
- Sleep functions not available.
- For Busy function use COMMAND C15.
- RESET push button is optional.

11.7. G3P/ASK double connection
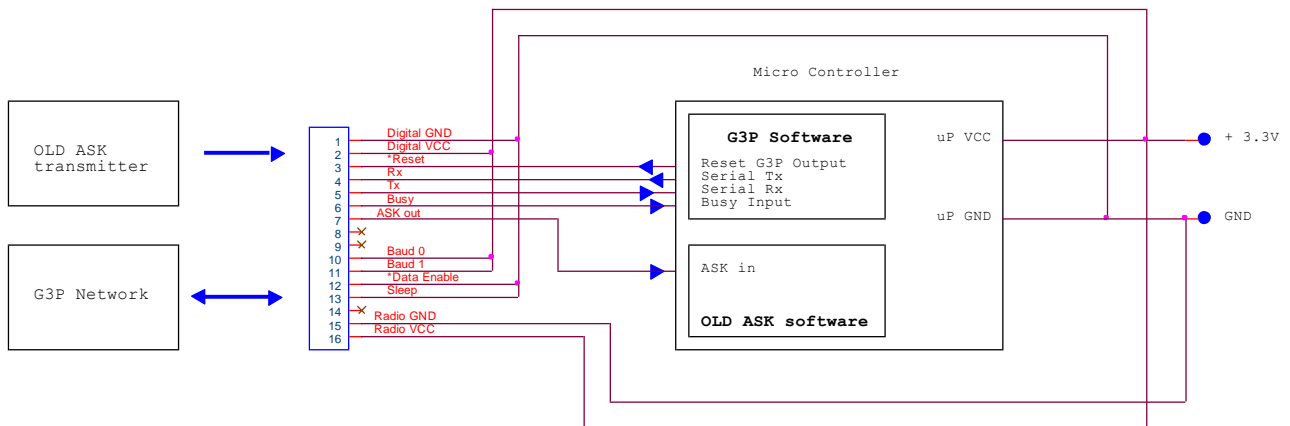
- Baud rate is fixed to 19200.
- Sleep functions not available.
- Both communications G3P and ASK at the same time.

12. ASSEMBLY

The modules allow a connector or smd assembly.
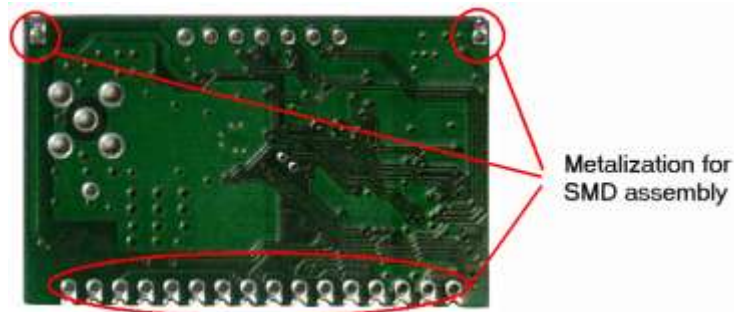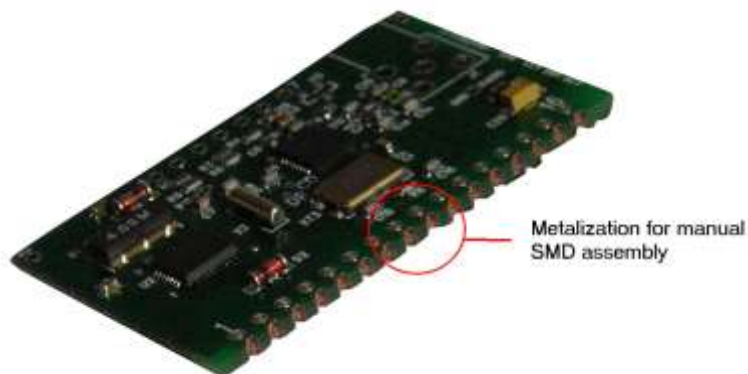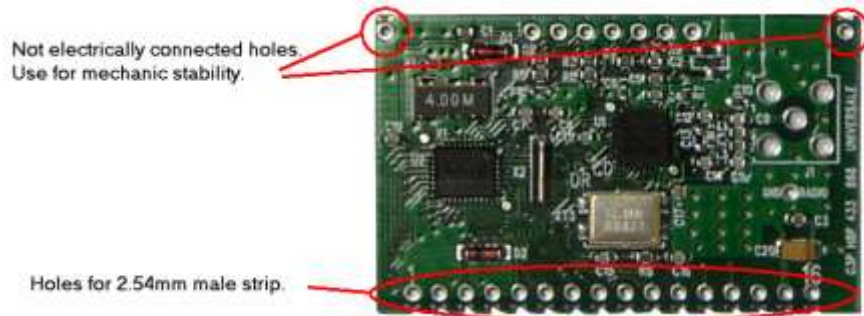
For a proper use some rules must respected:

1. If the module is assembled planar with the board, under the module any CS connection, component , power or ground plane can be placed.
   Under the module the board CS must be wide.
2. Over the module do not place LCDs or other modules that can act as a Faraday shield.
3. Place the module near the card border to allow the RF signal to exit outside with the shortest distance possible.
4. If a wire antenna is used, weld the antenna (17cm @433MHz, 8cm @868MHz) directly on the central point of the SMA holes.
   The wire antenna can be turned if there is not enough space, will only be reduced the maximum distance.
5. If the module is assembled in SMD mode, provide two holes under the module corresponding to the antenna welding point and to the 32kHz oscillator.
   This will guarantee a proper planar contact between the module and the customer PCB.

12.1. Connector assembly

The module is sold WITHOUT connector, if a connector is required can be welded by the customer a male 2.54mm strip.
The module is provided with the holes for the strip and at the same time has the pads for an smd assembly.

12.2. Smd assembly

Provide the two holes described in precaution point #5.
The welding pads are present under the module and also on the border.
This allow to weld both manually (using the border metallization) or automatically.

12.3. Physical dimensions
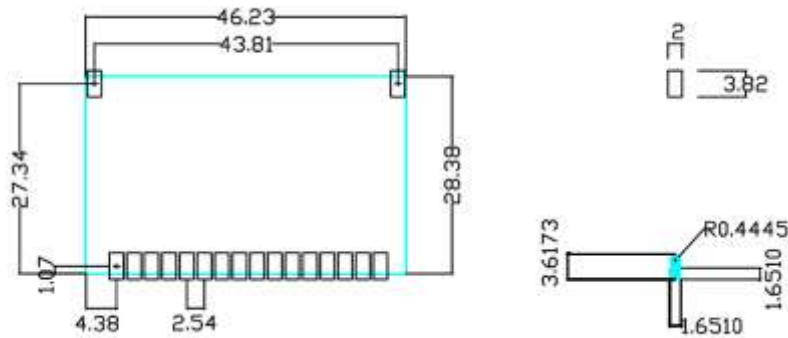
Bottom view with pads dimensions for SMD assembly.
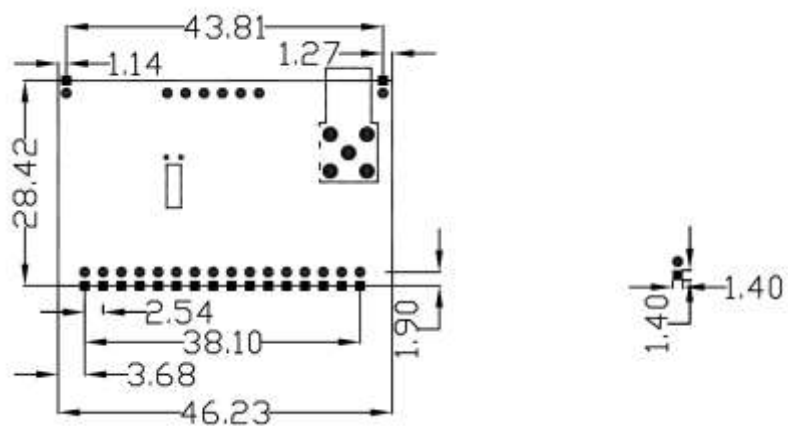
Top view with holes for the 2.54mm male strip, antenna holes (SMA not fitted) and 32KHz oscillator and top pad for manual smd assembly.
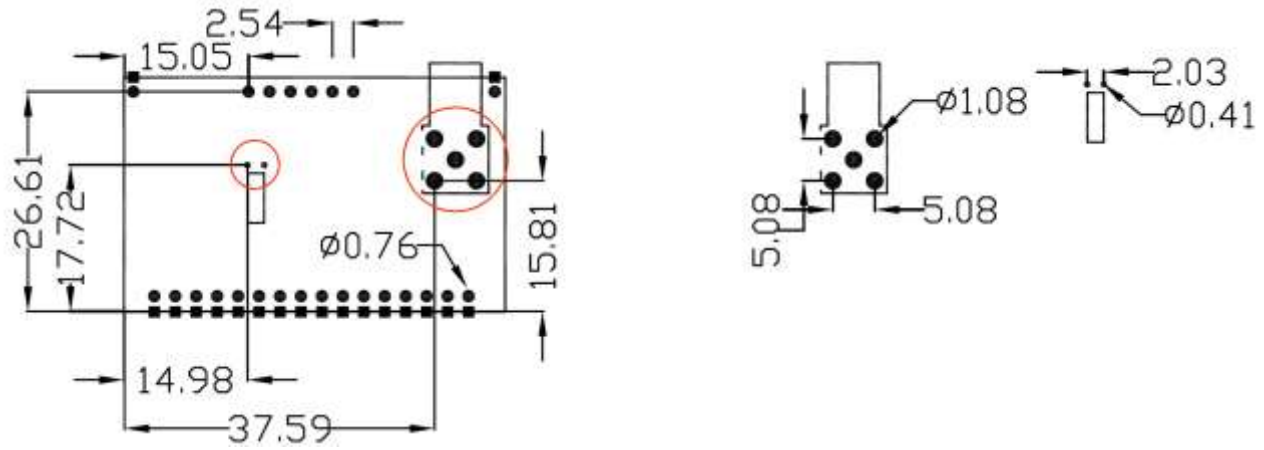
Top view for SMD assembly with the measure to realize two holes under the 32KHz oscillator and under the antenna connection.
In RED the two holes to provide in the PCB.

13.   RF Harmonization

G3P modules respect:

ETSI EN 300 220-03 V. 1.1.1
ETSI EN 300 220-01 V. 2.2.1
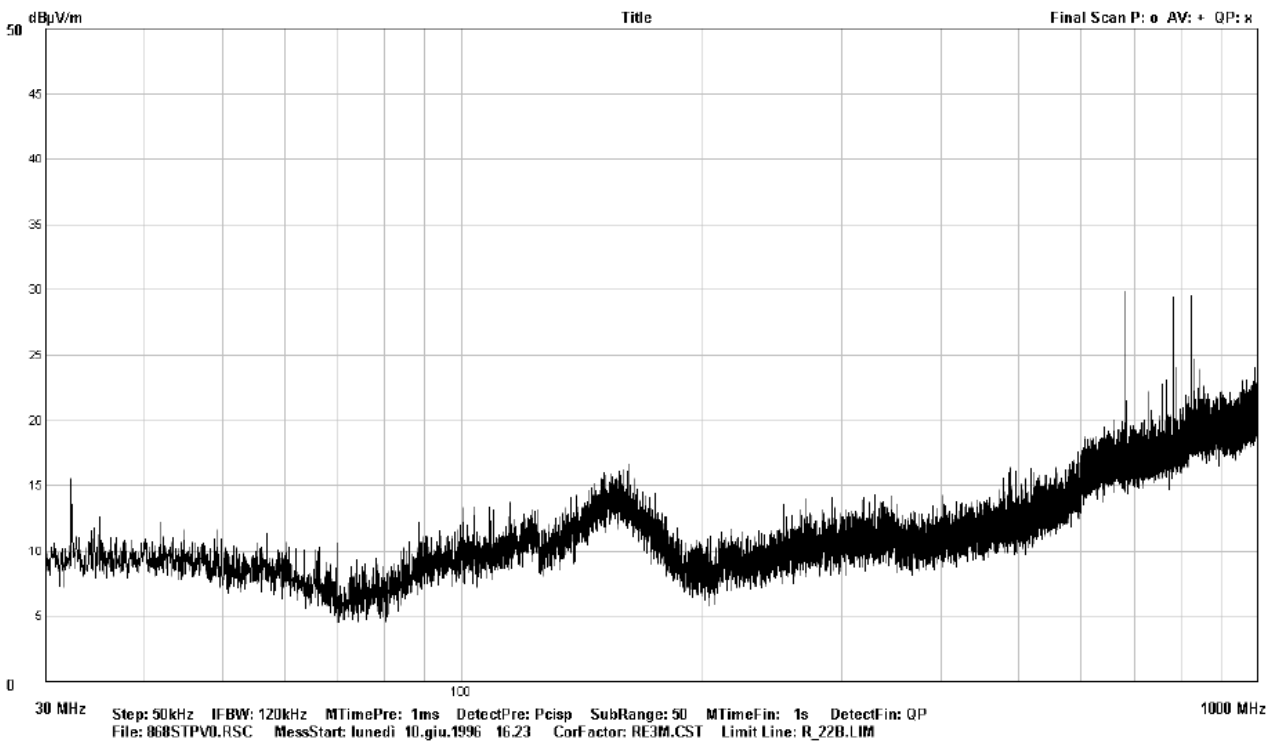
## 13.1. 433MHz Band occupation
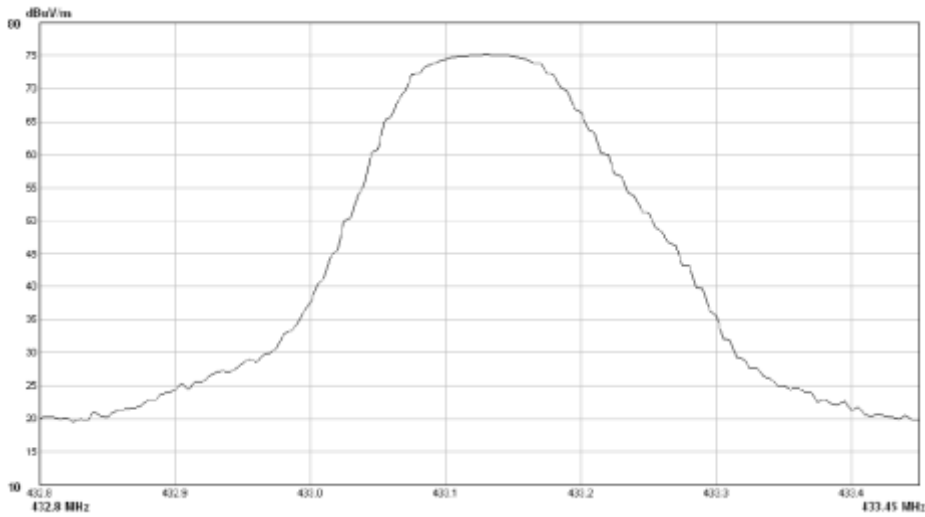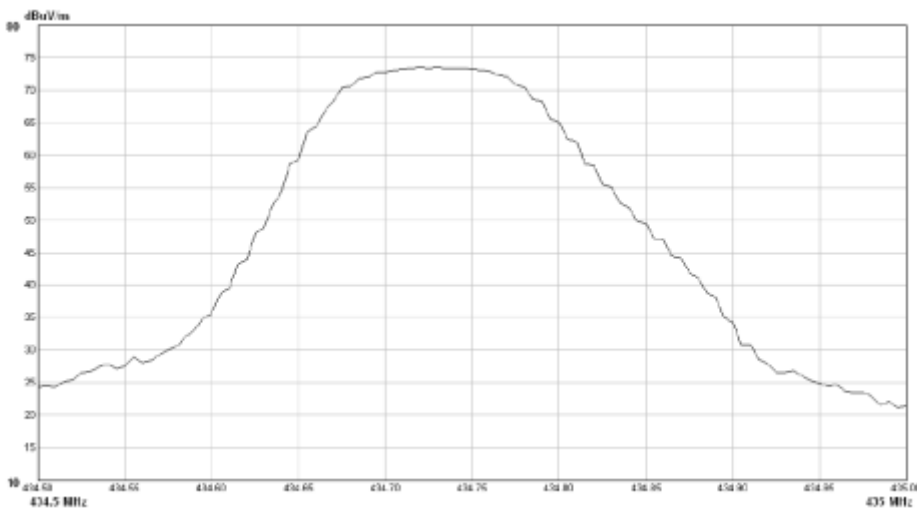
Channel #1

Channel #17

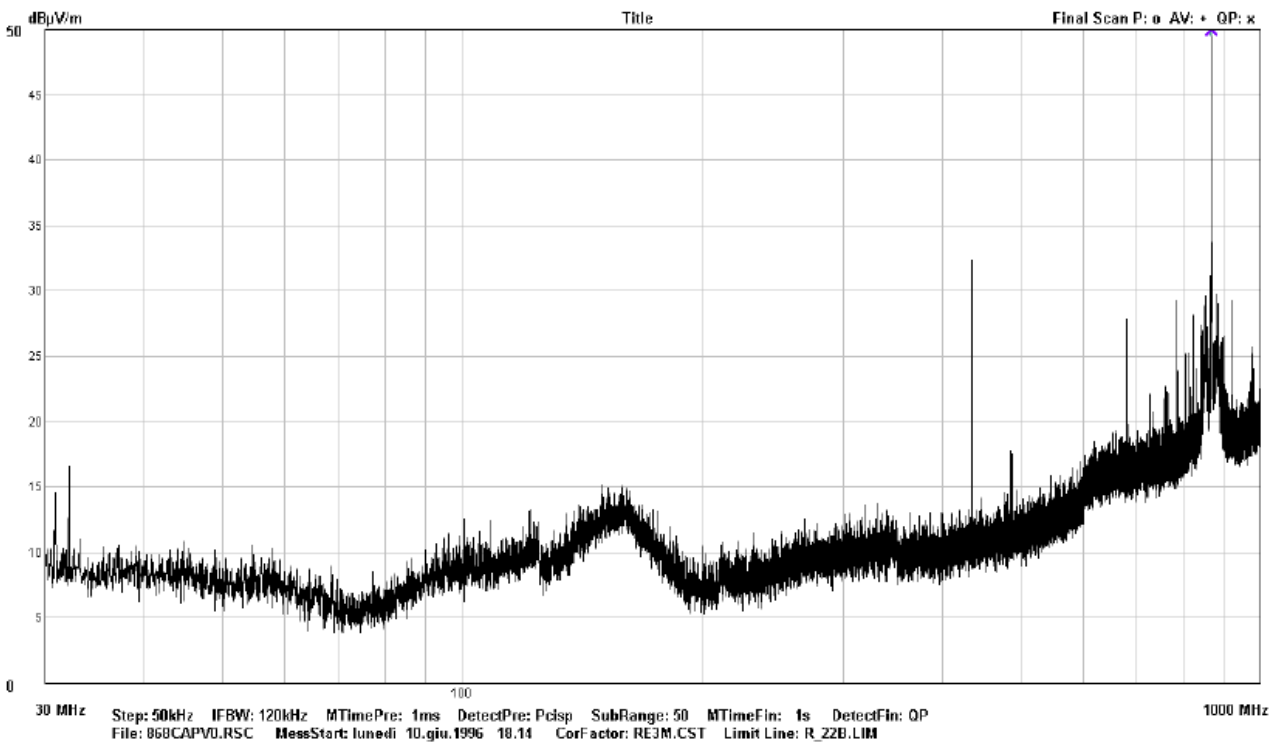## 13.2. 433MHz Transmission spurious emissions
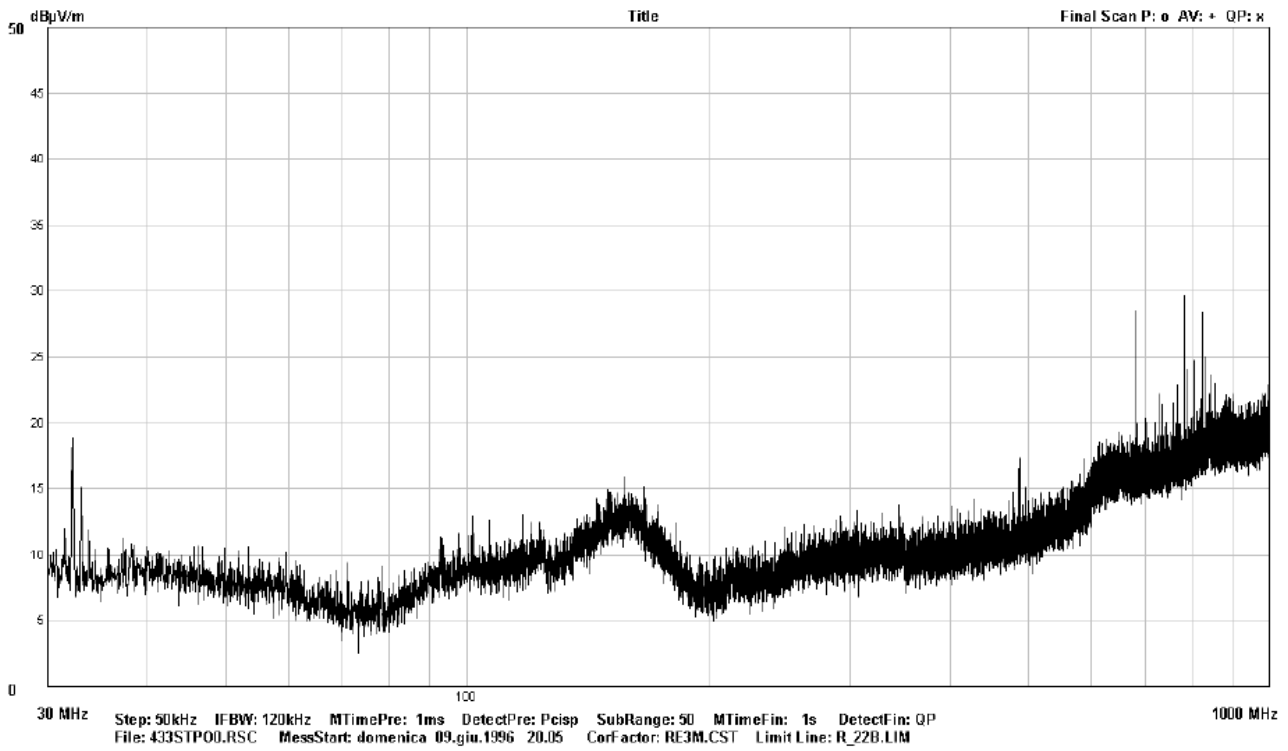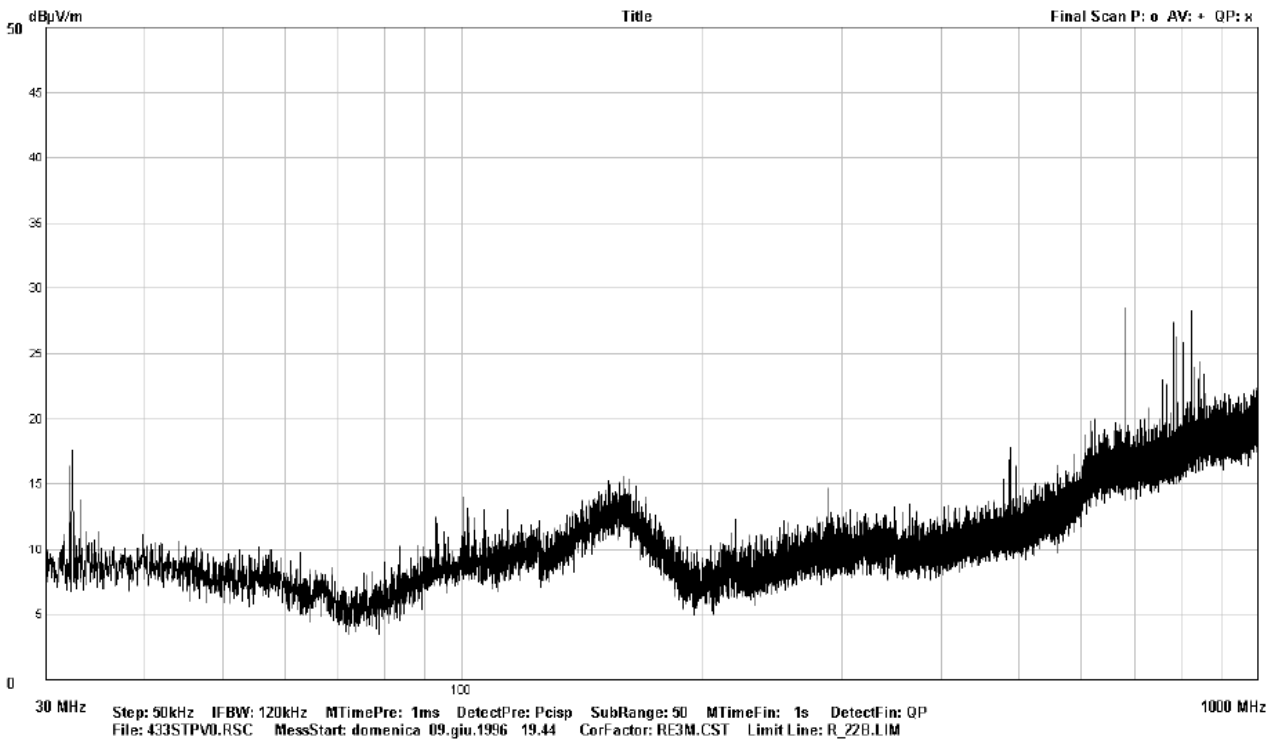
Horizontal polarization 80MHz – 1GHz, standby

Vertical polarization 80MHz – 1GHz, standby
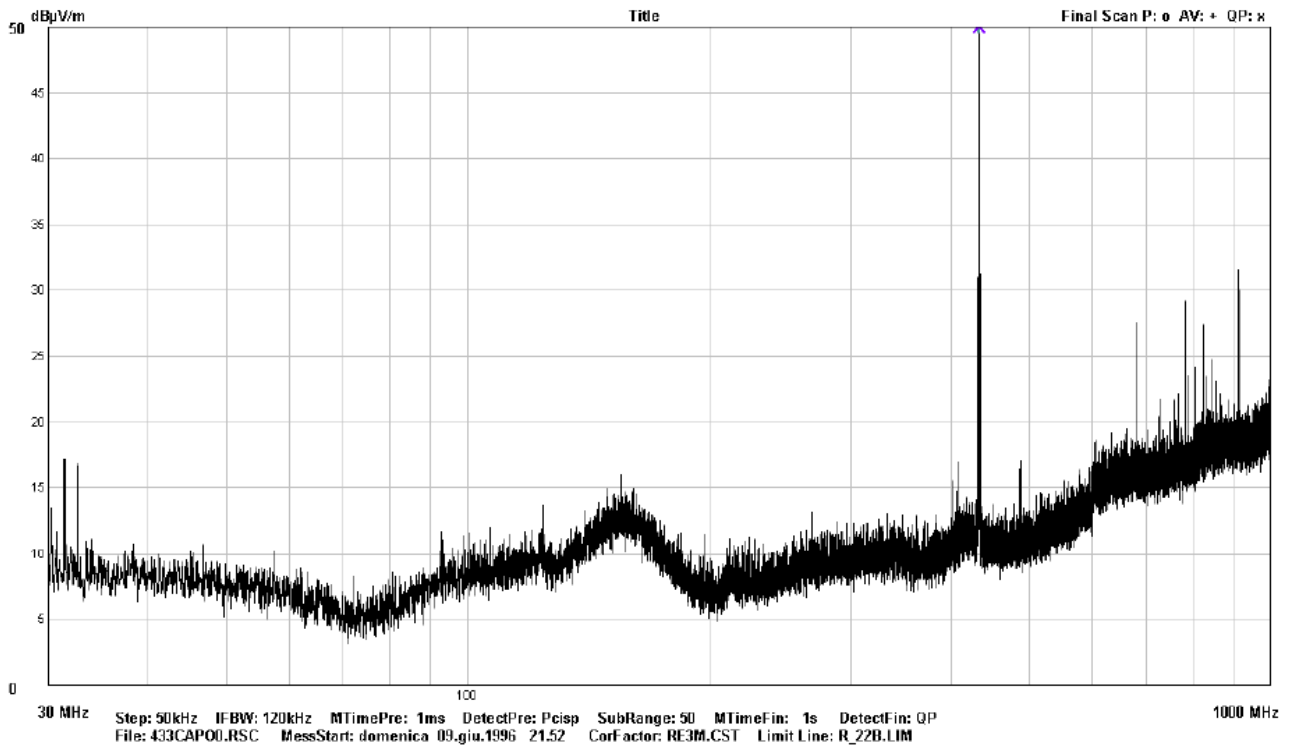
Horizontal polarization 80MHz – 1GHz, in transmission
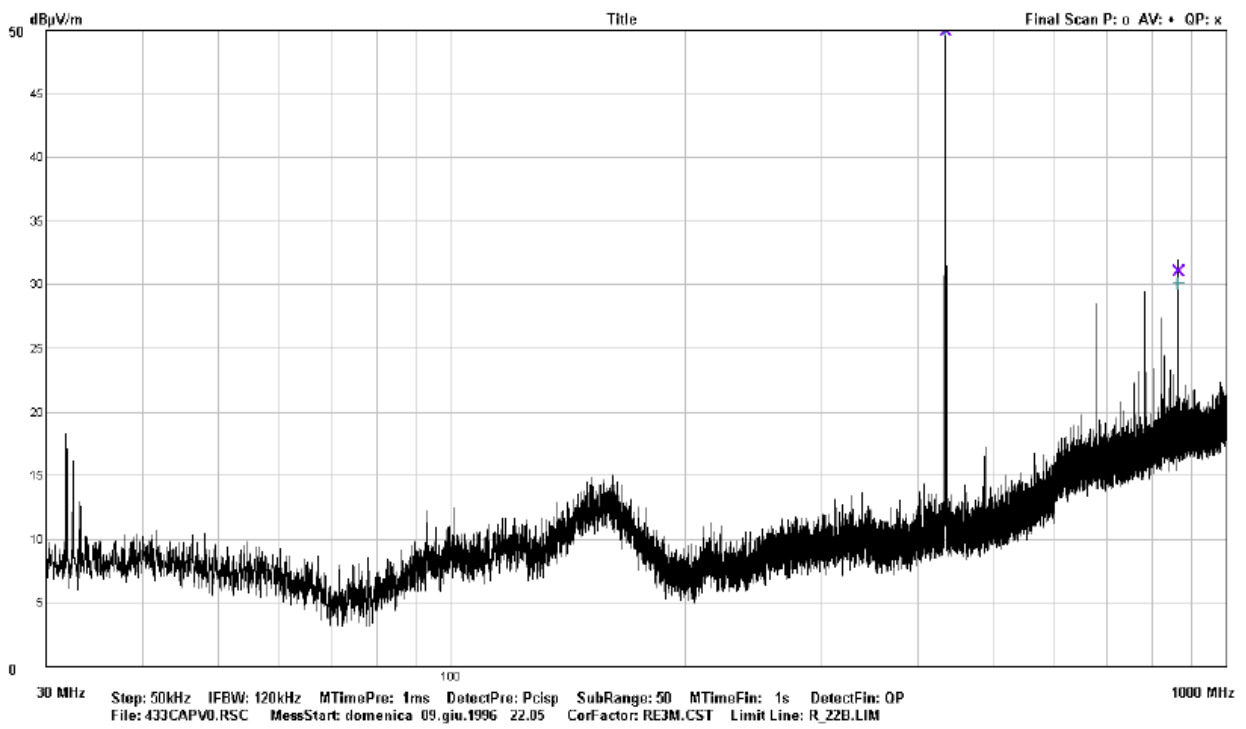
Vertical polarization 80MHz – 1GHz, in transmission

13.3. 433MHz Receiver spurious emissions

Horizontal polarisation 80MHz – 1GHz, Rx mode

Vertical polarisation 80MHz – 1GHz, Rx mode
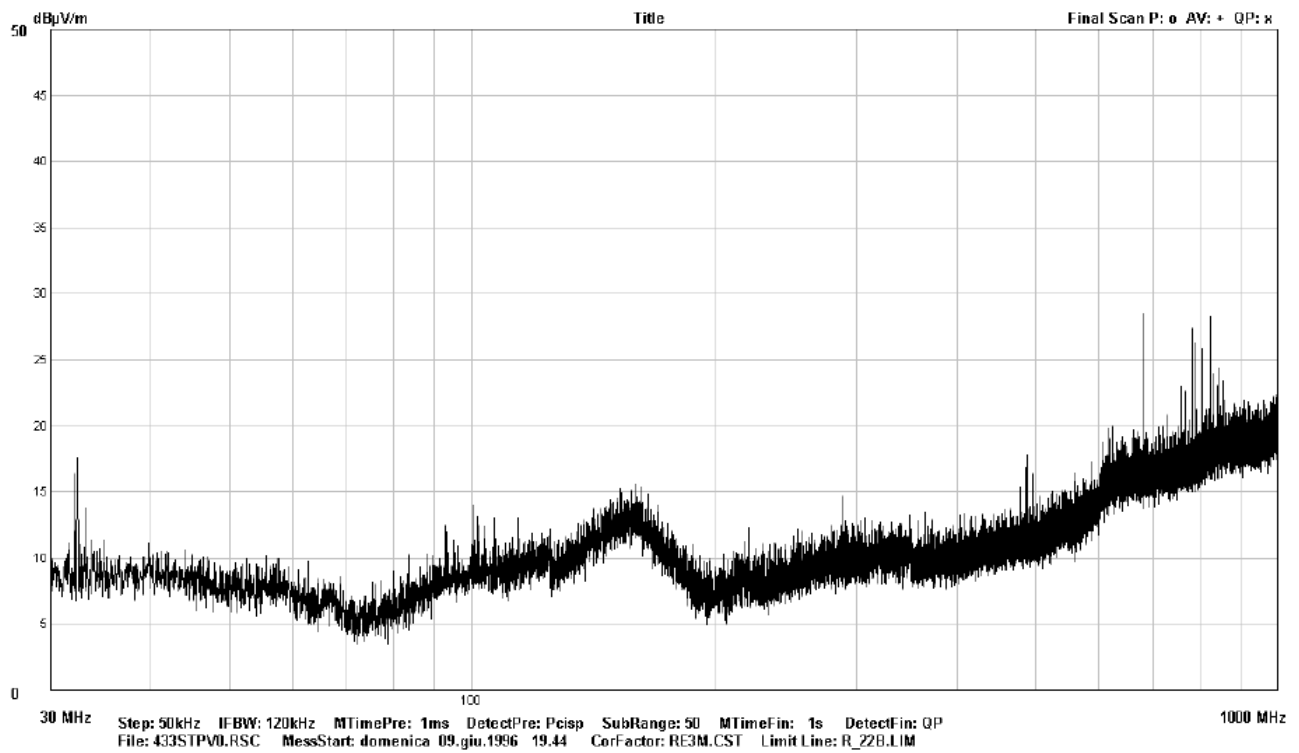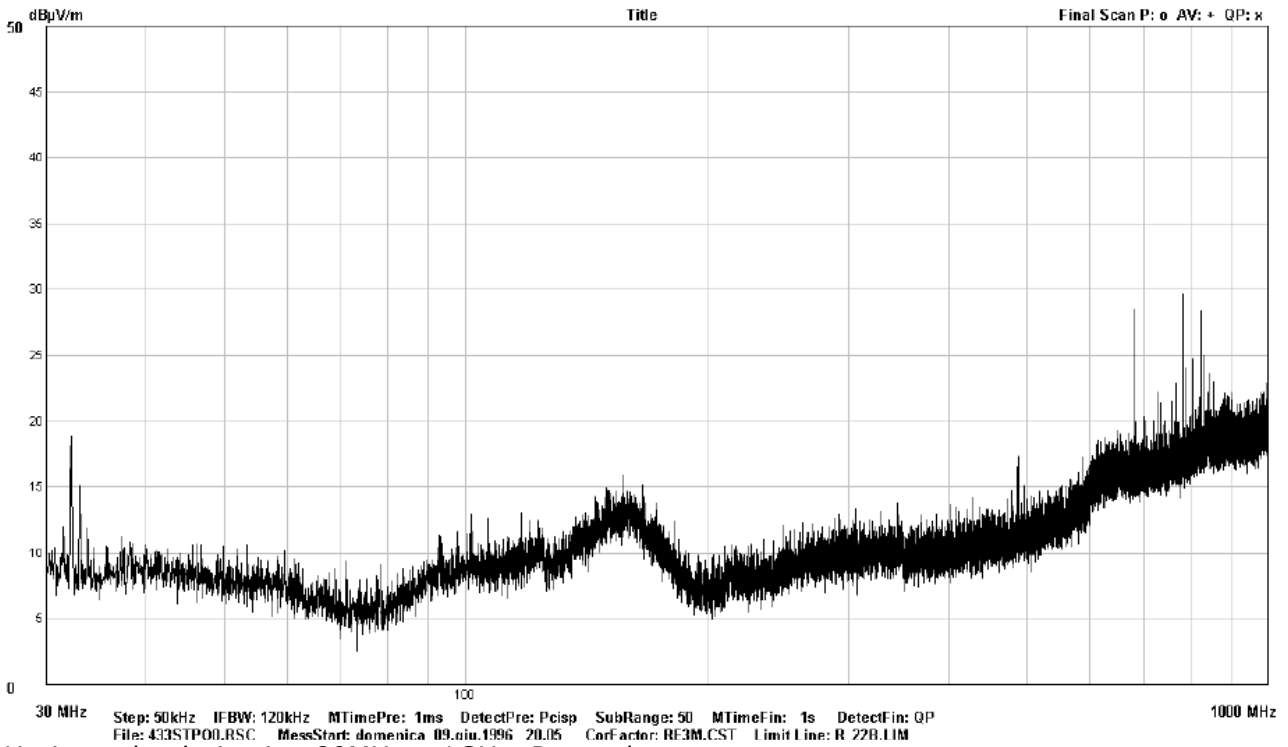
13.4. 868MHz Band occupation
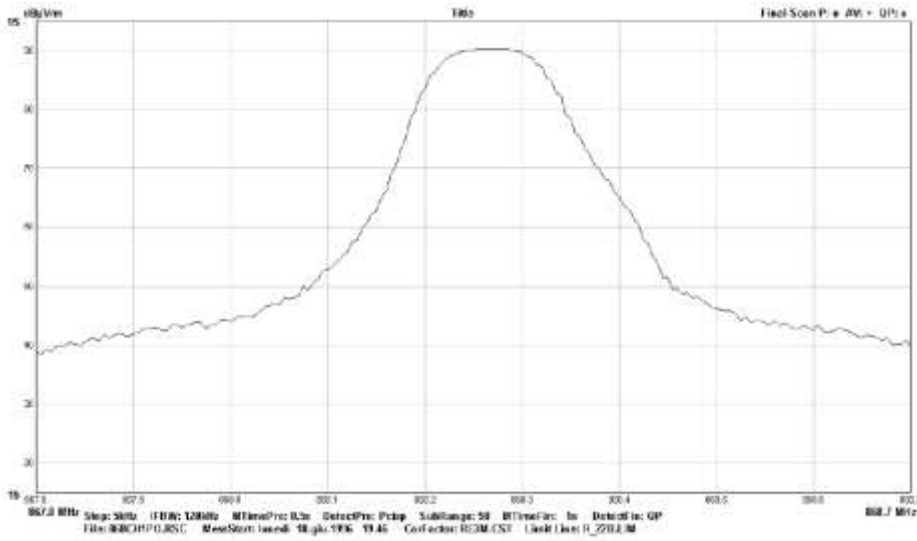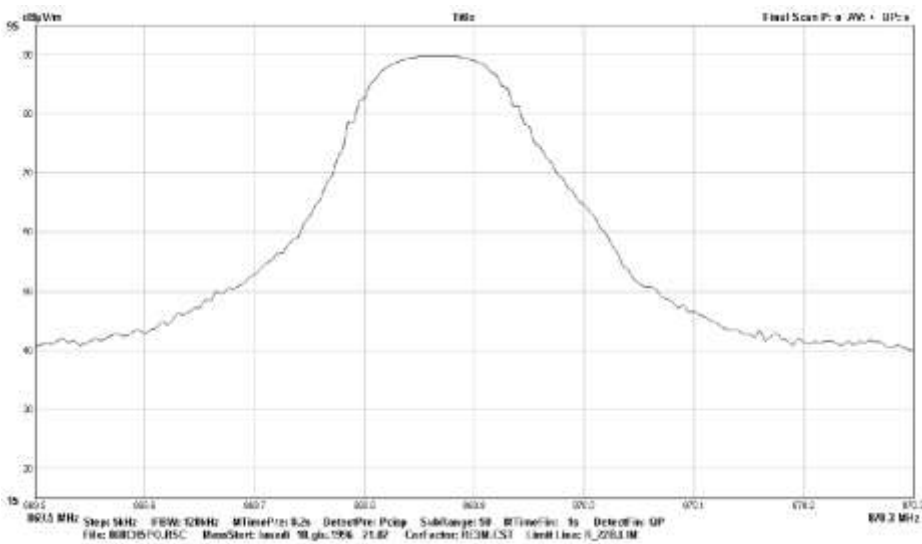
Channel #1

Channel #5

13.5. 868MHz Transmission spurious emissions
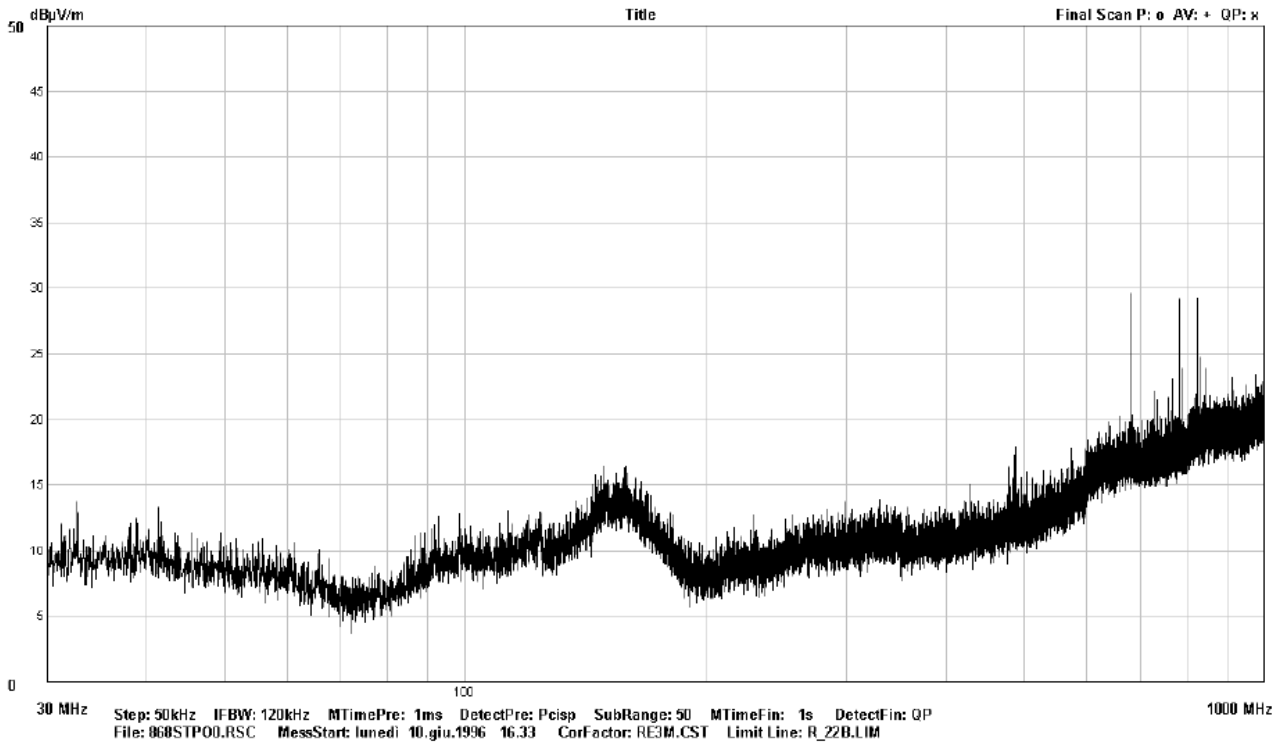
Horizontal polarization 80MHz – 1GHz, standby
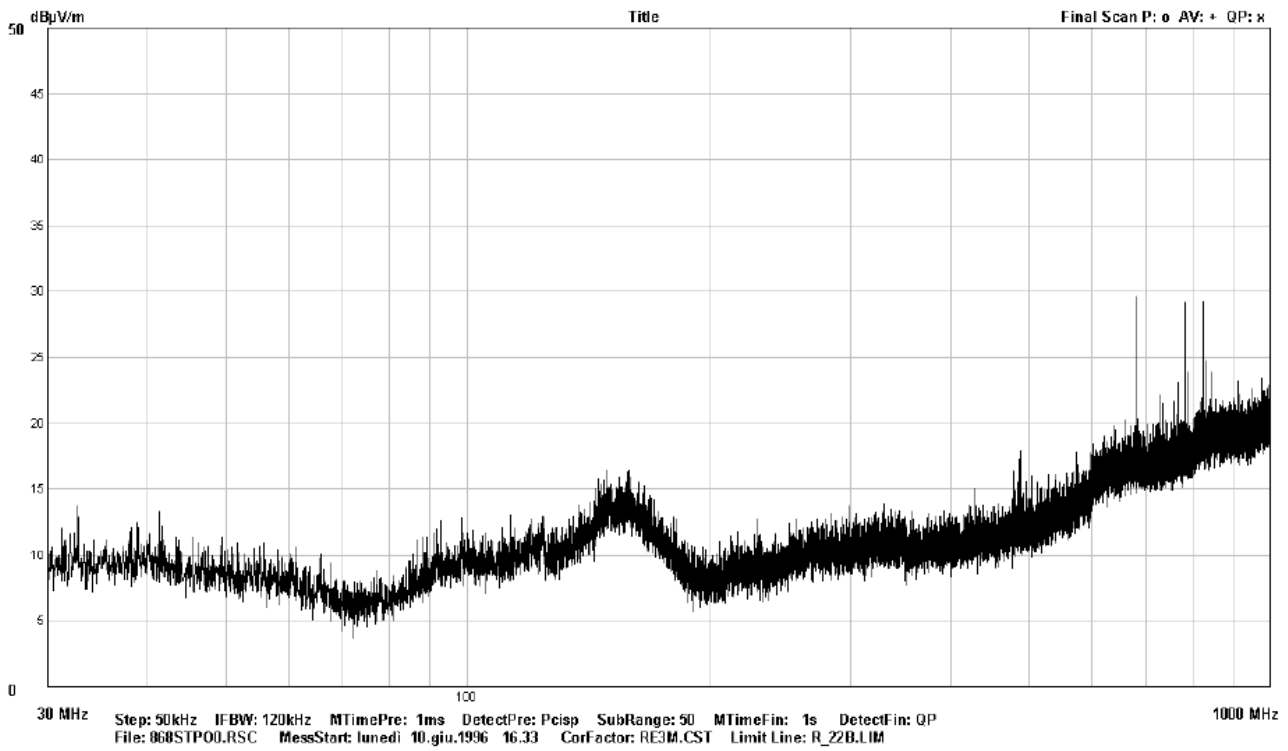

Vertical polarization 80MHz – 1GHz, standby
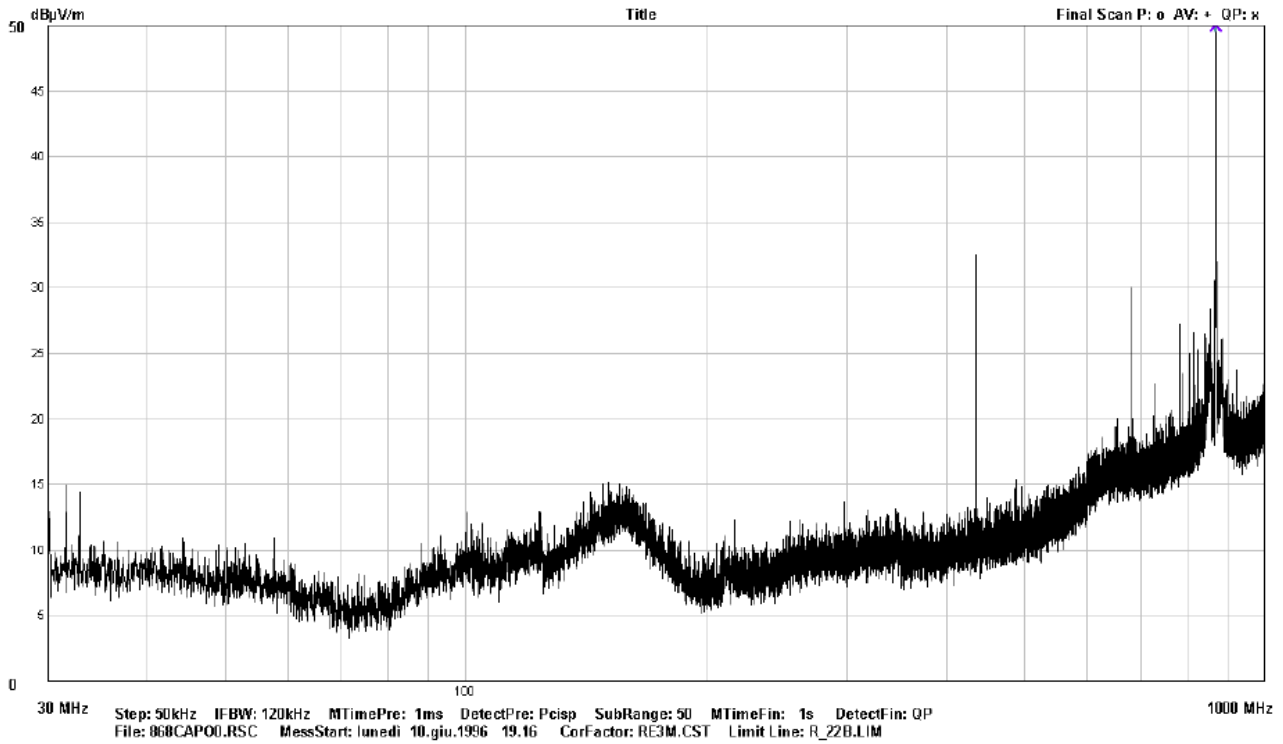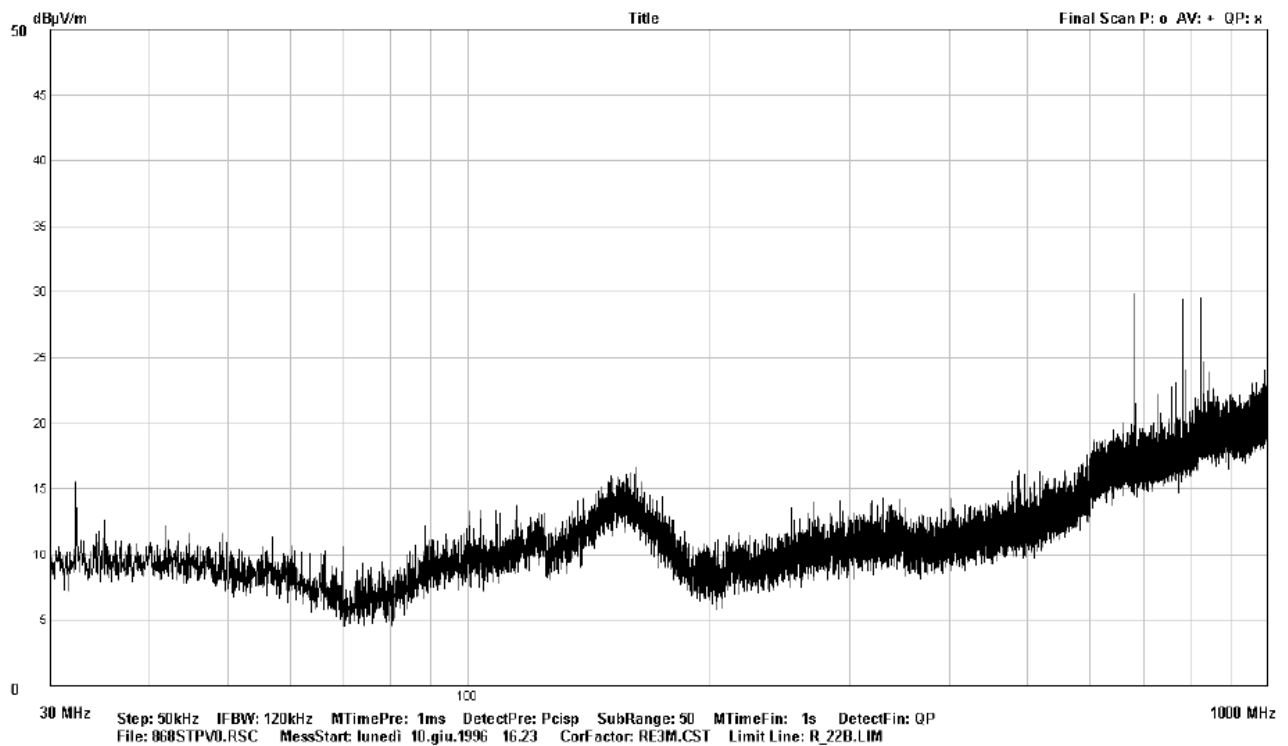
Horizontal polarization 80MHz – 1GHz, in transmission

Vertical polarization 80MHz – 1GHz, in transmission

13.6. 868MHz Receiver spurious emissions

Horizontal polarisation 80MHz – 1GHz, Rx mode

Vertical polarisation 80MHz – 1GHz, Rx mode