Cover Letter highlighting the differences between the BLUENRG-M0A and BLUENRG-M0L

FCC ID S9NBNRGM0AL

ISED IC ID 8976C-BNRGM0AL

General description of the BLUENRG-M0x family

The BLUENRG-M0x is a single-mode Bluetooth low energy master/slave network processor module compliant with Bluetooth® v4.2.

The BLUENRG-M0x module integrates a 2.4 GHz RF radio the ST BlueNRG-MS on which a complete power-optimized stack for Bluetooth single mode protocol runs, providing

- Master, slave role support
- GAP: central, peripheral, observer or broadcaster roles
- ATT/GATT: client and server
- SM: privacy, authentication and authorization
- L2CAP
- Link Layer: AES-128 encryption and decryption

The BlueNRG-MS radio embeds nonvolatile Flash memory allows on-field stack upgrading. In

addition, according the Bluetooth specification v4.2 the BLUENRG-M0x module provides:

- Multiple roles simultaneously support
- Support simultaneous advertising and scanning
- Support being slave of up to two masters simultaneously
- Privacy V1.1
- Low duty cycle directed advertising
- Connection parameters request procedure
- LE Ping
- 32 bits UUIDs
- L2CAP connection oriented channels

The BLUENRG-M0x module is equipped with Bluetooth low energy profiles in C source code, available for the ST radio BlueNRG-MS.

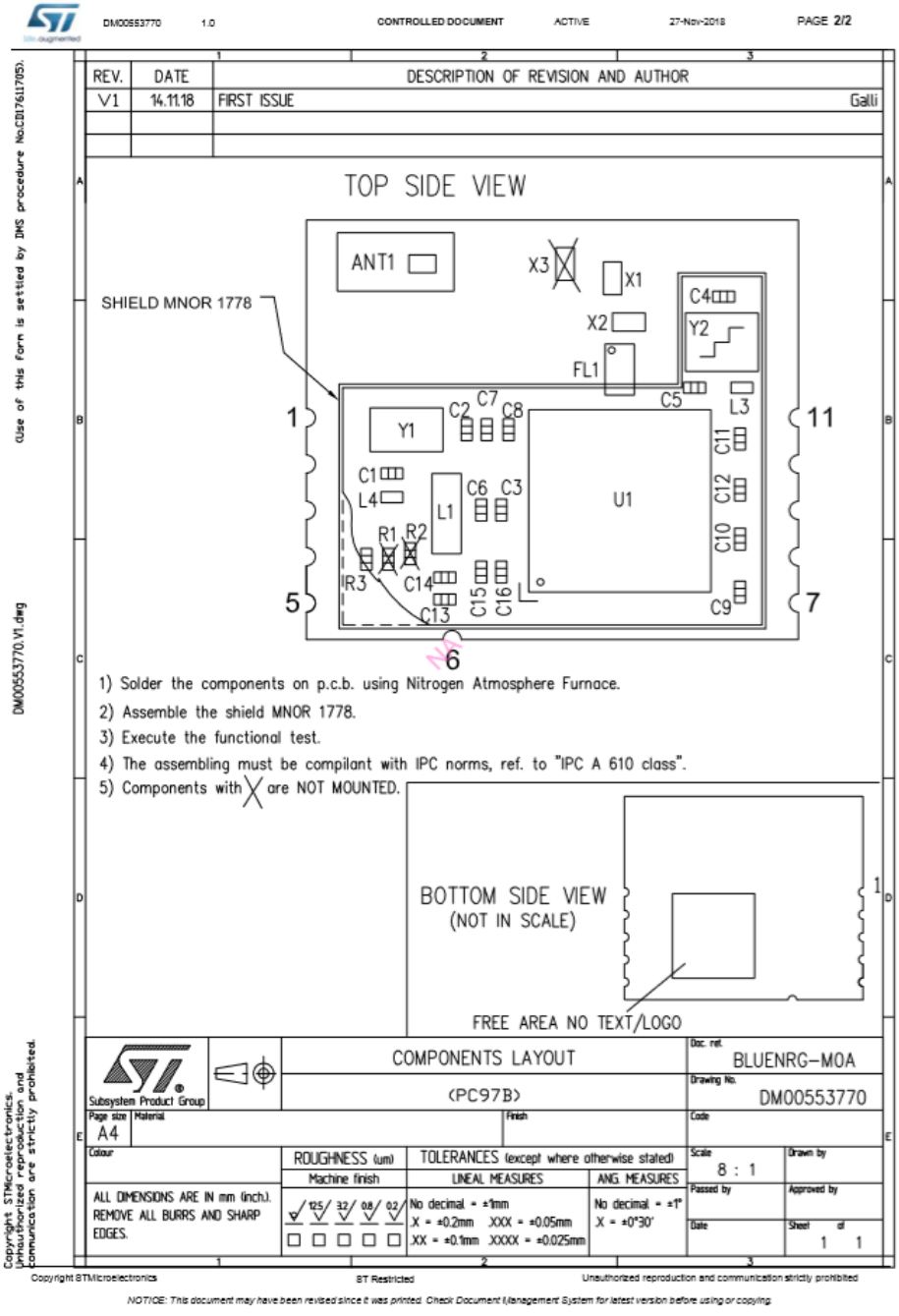
The external host application processor, where the application resides, is interfaced with the BLUENRG-M0x module through an application controller interface protocol, which is based on a standard SPI interface.

The BLUENRG-M0x module enables wireless connectivity into electronic devices, not requiring any RF experience or expertise for integration into the final product. The BLUENRG-M0x module provides a complete RF platform in a tiny form factor and being a certified solution optimizes the time to market of the final applications.

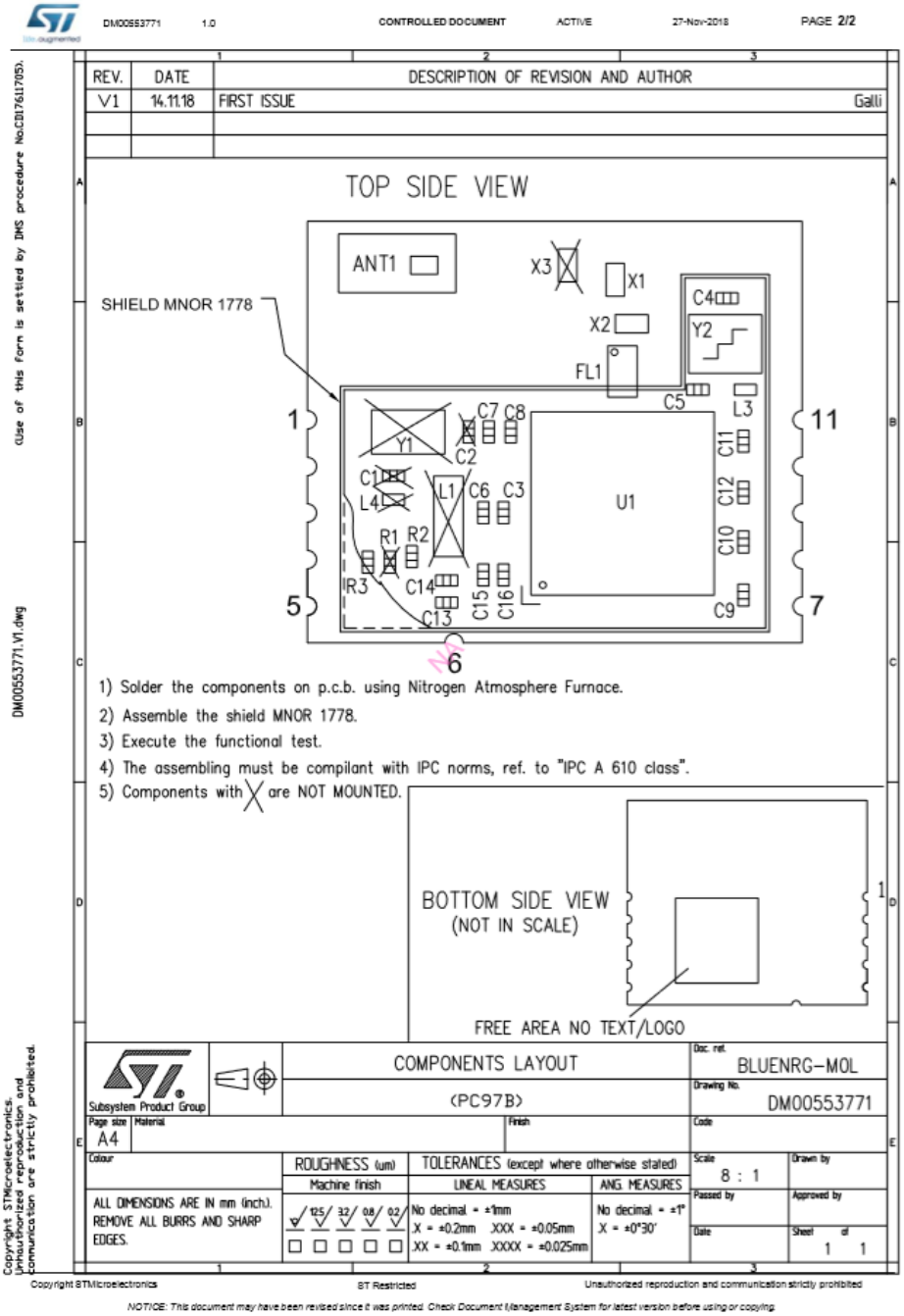
The BLUENRG-M0x module allows applications to meet of the tight advisable peak current requirements imposed with the use of standard coin cell batteries. Optimized results are obtained when the embedded high-efficiency DC-DC step-down converter is used (BLUENRG-M0A). Instead, for the BLUENRG-M0L the best performances in terms of power consumption are achieved using a 1.8V DC power supply.
BLUENRG-M0x can be powered directly with a standard 3 V coin cell battery, a pair of AAA batteries or any power source from 1.7 to 3.6 V.

ST may update the FW provided with the modules at any time. ST recommends that users regularly check for documentation and the current FW version available at www.st.com/bluemodules.

The components layout of the BLUENRG-M0A is represented by the following image:



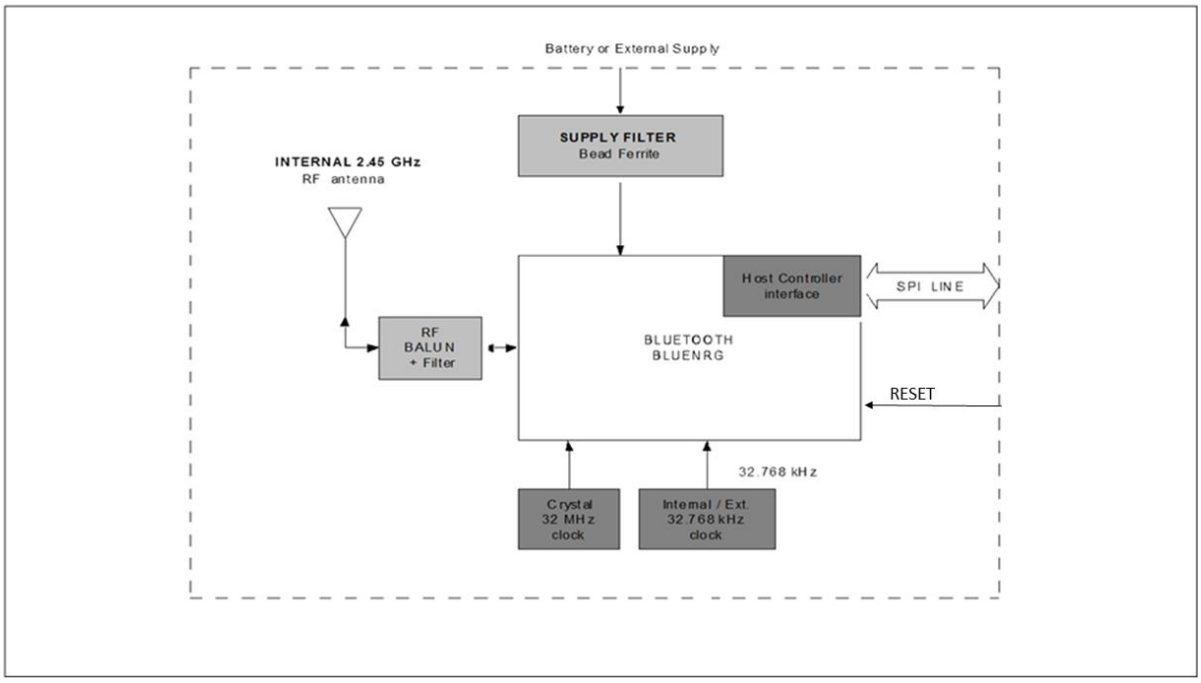
While the components layout of the BLUENRG-M0L (simply de-populated version of the BLUENRG-M0A) is represented by the following image:



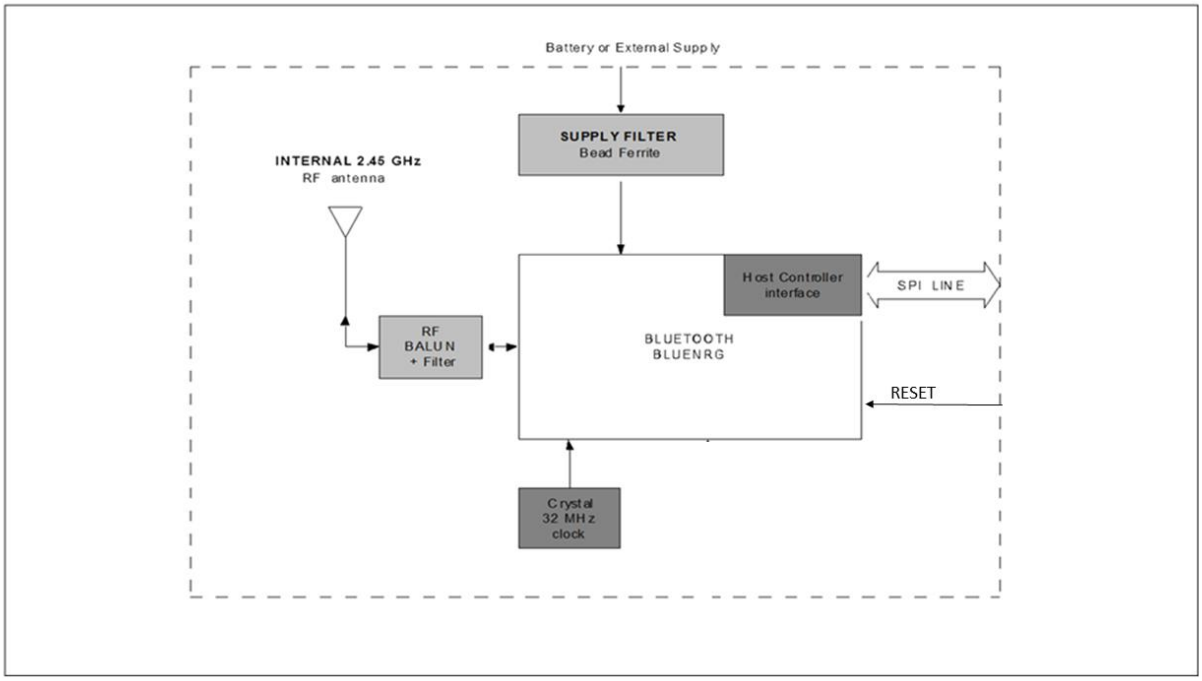
In particular, Y1 represents the external oscillator XO operating at 32.768 kHz, that is present in the “BLUENRG-M0A” and it has been removed in the “BLUENRG-M0L”. Its function is to provide precise 32.768kHz use for the time-base of the BLE communication. In the depopulated version, namely BLUENRG-M0L, Y1 it has been removed, but the time-base is provided by the Internal Ring Oscillator. This depopulated cheaper version is not affecting the performances of the overall system.

Block diagrams

HW block diagram for BLUENRG-M0A



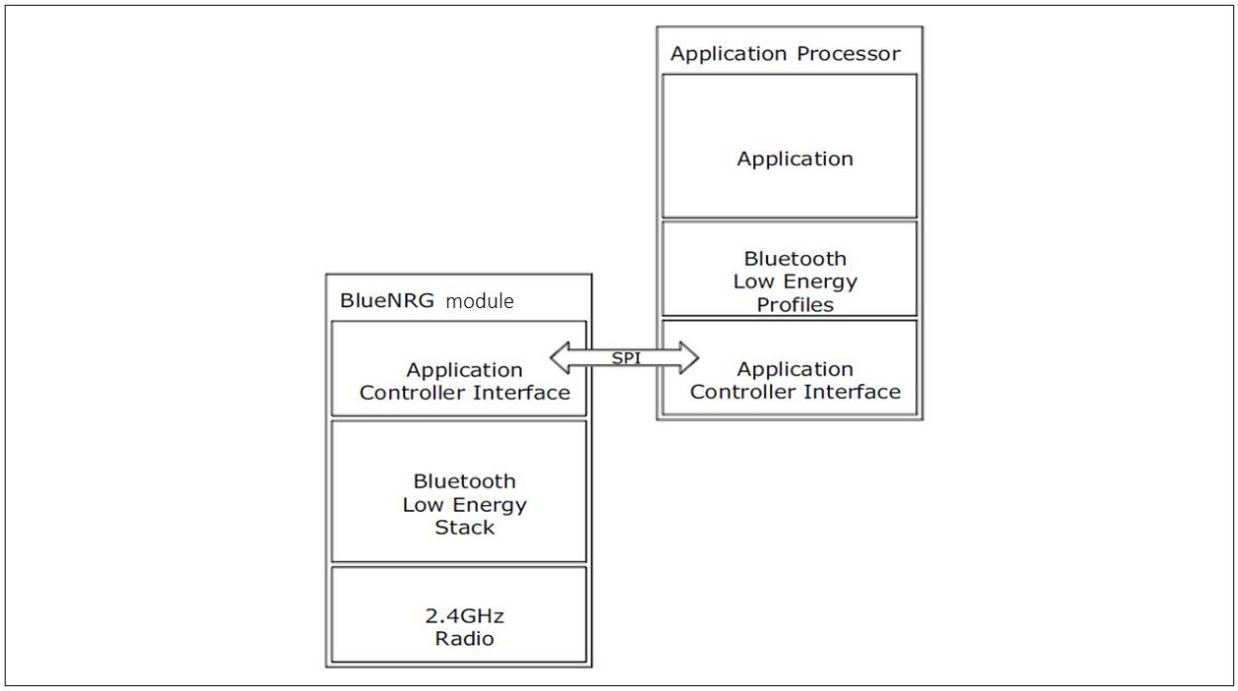
HW block diagram for BLUENRG-M0L



Software architecture

Bluetooth firmware implementation

BLUENRG-M0A and BLUENRG-M0L application block diagram



General characteristics

Absolute maximum ratings

Absolute maximum ratings

Rating	Min	Typ.	Max	Unit
Storage temperature range	-40	-	+85	°C
Supply voltage, V_{IN}	-0.3	-	3.9	V
I/O pin Voltage (V_{IO} five-volt tolerant pin)	-0.3	-	3.9	V
RF saturation input power	-	8	-	dBm
VESD-HBM Electrostatic discharge voltage		±2.0 kV		kV

Operating conditions

Operating conditions

Rating	Min	Typ.	Max	Unit
Storage temperature range	-40	-	+85	°C
Operating ambient temperature range	-40	-	+85	°C
Supply voltage, V_{IN}	1.7	3.3	3.6	V
Signals & I/O pin voltage (according supply voltage)	1.7	-	3.6	V
Frequency range	2402	-	2480	MHz

Electrical specification

Electrical characteristics

Characteristic measured over recommended operating condition unless otherwise specified. Typical value are referred to V_{IN}= 3.3 V, 25 °C, SMPS on, XO 32KHz and 32MHz.

Electrical characteristics for the BLUENRG-M0A

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{DD}	Supply current	Reset		5		nA
		Standby		1.8		uA
		Sleep mode: 32 kHz XO ON (12 KB retention RAM) Mode 1		1.7		µA
		Sleep mode: 32 kHZ XO ON (24 KB retention RAM) Mode 2		2.2		
		Active mode		2.12		mA
		RX		9.36		mA
		TX +8 dBm		16.50		mA
		TX +4 dBm		12.04		mA
		TX +2 dBm		10.40		mA
		TX -2 dBm		9.44		mA
		TX -5 dBm		8.79		mA
		TX -8 dBm		8.29		mA
		TX -11 dBm		8.01		mA
		TX -14 dBm		7.82		mA

Characteristic measured over recommended operating condition unless otherwise specified. Typical value are referred to V_{IN}= 3.3 V, 25 °C, SMPS off, RO 32KHz and 32MHz.

Electrical characteristics for the BLUENRG-M0L

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{DD}	Supply current	Reset		N/A		nA
		Standby		1.7		uA
		Sleep mode: 32 kHz RO ON (12 KB retention RAM) Mode 1		2.8		µA
		Sleep mode: 32 kHZ RO ON (24 KB retention RAM) Mode 2		3.2		
		Active mode		2.54		mA
		RX		16.36		mA
		TX +8 dBm		29.16		mA
		TX +4 dBm		21.3		mA
		TX +2 dBm		18.29		mA
		TX -2 dBm		16.44		mA
		TX -5 dBm		15.18		mA
		TX -8 dBm		14.19		mA
		TX -11 dBm		13.61		mA
		TX -14 dBm		13.25		mA

Digital I/O specifications

IO pins are directly connected to the embedded state of the art BlueNRG-MS chipset. For more details about the digital I/I specification, please refer directly to the BlueNRG-MS datasheet available on www.st.com.

RF General characteristics

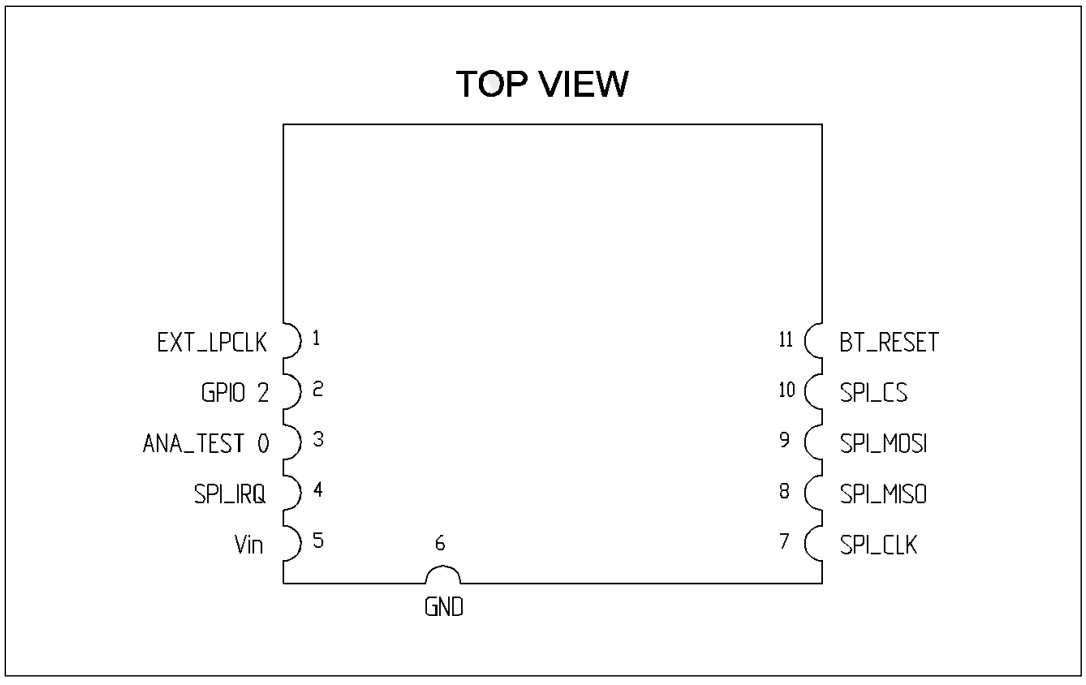
Characteristic measured over recommended operating condition unless otherwise specified. Typical value are referred to V_{IN}= 3.3 V, 25 °C, DC/DC on, XO 32KHz and XO 32MHz.

Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
FREQ	Frequency range		2400	-	2483.5	MHz
FCH	Channel spacing		-	2	-	MHz
RFch	RF Channel center frequency		2402	-	2480	MHz

Pin assignment

Pin connection

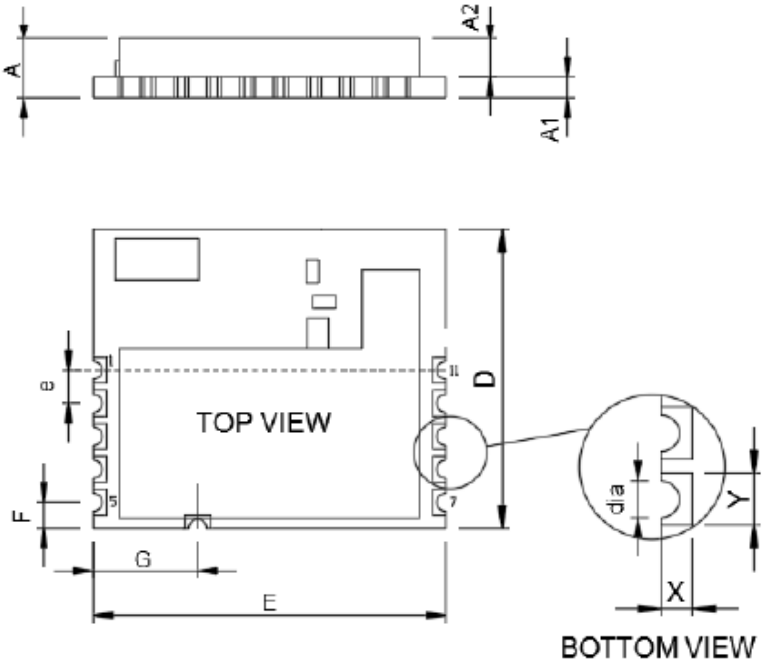


Pin assignment

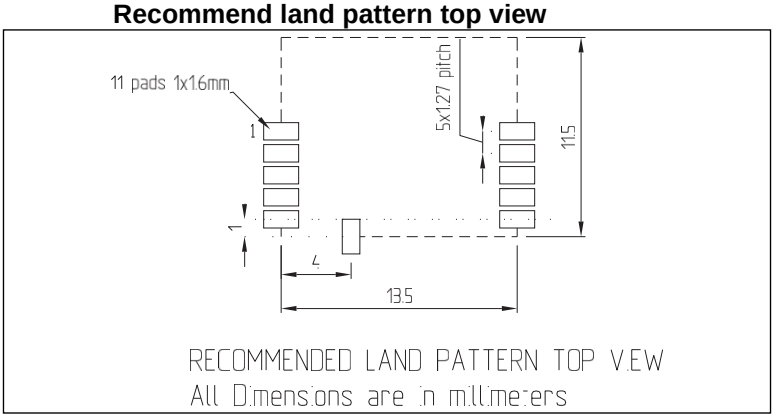
Name	Type	Pin #	Description	V max. Tolerant
SPI Interface				
SPI_IRQ	O	4	SPI IRQ (SLAVE has data for MASTER)	V_{in}
SPI_CLK	I	7	SPI CLOCK (Max. 8 MHz)	V_{in}
SPI_MISO	O	8	SPI MISO (MASTER in / SLAVE out)	V_{in}
SPI_MOSI	I	9	SPI MOSI (MASTER out SLAVE in)	V_{in}
SPI_CS	I	10	SPI “Chip select” (SPI slave select)	V_{in}
Power and ground				
V_{in}		5	V_{in}	(1.7V - 3.6V max.)
GND		6	GND	
Reset				
BT_RESET	I	11	Reset input (active low < 0.35 V_{in})	(1.7V - 3.6V max.)
LPO				
EXT_LPCLK	I	1	Not connected	
GPIO2	I/O	2	Not connected	
ANA TEST 0	I	3	Not connected	

Mechanical dimensions

Mechanical dimensions



Recommend land pattern top view



Hardware design

BLUENRG-M0x module supports SPI hardware interfaces.

Note: *- All unused pins should be left floating; do not ground.*

- All GND pins must be well grounded.

- The area around the module should be free of any ground planes, power planes, trace routings, or metal for 6 mm from the module antenna position, in all directions.

- Traces should not be routed underneath the module.

Reflow soldering

The BLUENRG-M0x is a high temperature strength surface mount Bluetooth® module supplied on a 11 pin, 4-layer PCB. The final assembly recommended reflow profiles are indicated here below.

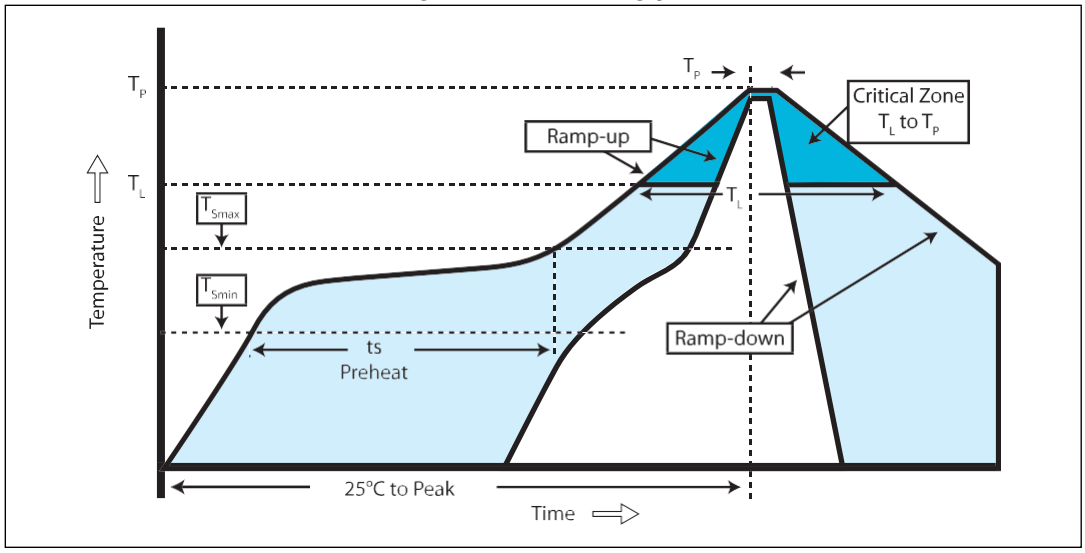
Soldering phase has to be executed with care: in order to avoid undesired melting phenomenon, particular attention has to be taken on the set up of the peak temperature.

Here following some suggestions for the temperature profile based on following recommendations.

Soldering profile

Profile feature	PB-free assembly
Average ramp up rate (T_{SMAX} to T_p)	3°C/ sec max
Preheat Temperature min (T_S mn) Temperature max (T_S max) Time (t_S min to t_S max) (t_S)	 150 °C 200 °C 60-100 sec
Time maintained above: Temperature T_L Time t_L	 217 °C 60-70 sec
Peak temperature (T_P)	240 + 0 °C
Time within 5 °C of actual peak temperature (T_P)	10-20 sec
Ramp down rate	6 °C/sec
Time from 25 °C to peak temperature	8 minutes max

Figure 11. Soldering profiles



For a more detailed and complete overview about the BLUENRG-M0x family please do consult the User Manual of those modules.

For this evidence, a unique family named BLUENRG-M0AL has been created including both BLUENRG-M0A and BLUENRG-M0L.