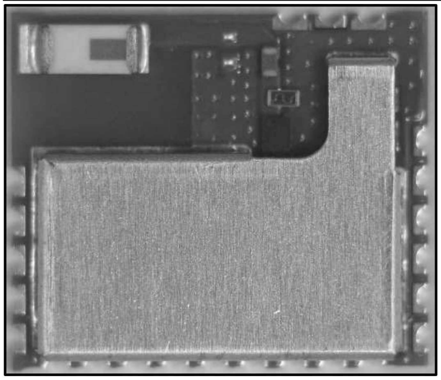
BLUENRG-M2SA – Operational Description technical notes

Very low power BlueNRG module for Bluetooth® Low Energy v5.0



Features

- Bluetooth v5.0 compliant
  - Supports master and slave modes
  - Multiple roles supported simultaneously
- Based on BlueNRG-2, BLE SoC:
  - High performance, ultra-low power Cortex-M0 32-bit based core
  - Programmable embedded 256 KB Flash
  - 24 KB embedded RAM with data retention
- Interfaces:
  1 x UART, 1 x I2C, 1xSPI, 14 x GPIO, 2 x multifunction timer, 10-bit ADC, Watchdog & RTC, DMA controller, PDM stream processor, SWD debug Interface
- Bluetooth radio performance:
  - Max Tx power: + 8 dBm
  - Excellent link reliability
  - Embedding BALF-NRG-02D3 integrated matched balun with harmonic filter
- On-board chip antenna
- Small form factor: 11.5mmx13.5mm
- Complemented with Bluetooth low energy protocol stack library (GAP, GATT, SM, L2CAP, LL)
- AES security co-processor
- Bluetooth low energy SDK with wide range of profile available
- Certifications:
  - EU (RED) Type certificate
  - FCC, IC modular approval certification
  - BT SIG End Product QDID
- Pre-programmed UART bootloader
- Operating supply voltage: from 1.7 to 3.6 V
- Operating temperature range: -40 °C to 85 °C

Applications

- Internet of Things
- Smart Home
- Building and Industrial Automation
- Smart Lighting
- Remote and access control
- Fitness, wellness and sports
- Consumer medical
- Security and proximity
- Assisted living
- PC and smart phone peripherals

Module Description

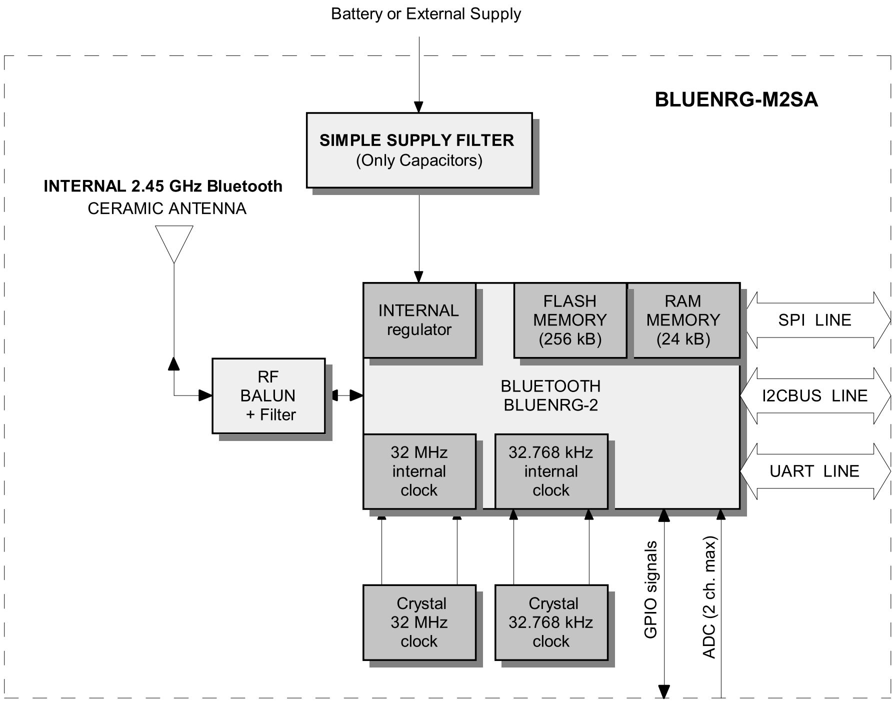
The BLUENRG-M2SA is a Bluetooth® low Energy System-on-Chip application processor certified module, compliant with BT specifications v5.0 and BQE qualified. The BLUENRG-M2SA module supports multiple roles simultaneously and can act at the same time as Bluetooth Smart master and slave device.

The BLUENRG-M2SA is based on BlueNRG-2 system-on-chip and entire Bluetooth Low Energy stack and protocols are embedded into module.

The BLUENRG-M2SA module provides a complete RF platform in a tiny form factor. Radio, embedded antenna and high frequency oscillators are integrated to offer a certified solution to optimize the time to market of the final applications.

The BLUENRG-M2SA can be powered directly with a pair of AAA batteries or any power source from 1.7 to 3.6 V.

1 BLUENRG- M2SA Module Block diagram



A more complete information and technical notes related to the BLUETOOTH BLUENRG-2 device, which is present in the block diagram above, are available from the "STMicroelectronics" document:

https://www.st.com/resource/en/datasheet/DM00399302.pdf

1.1 Module Pin assignment

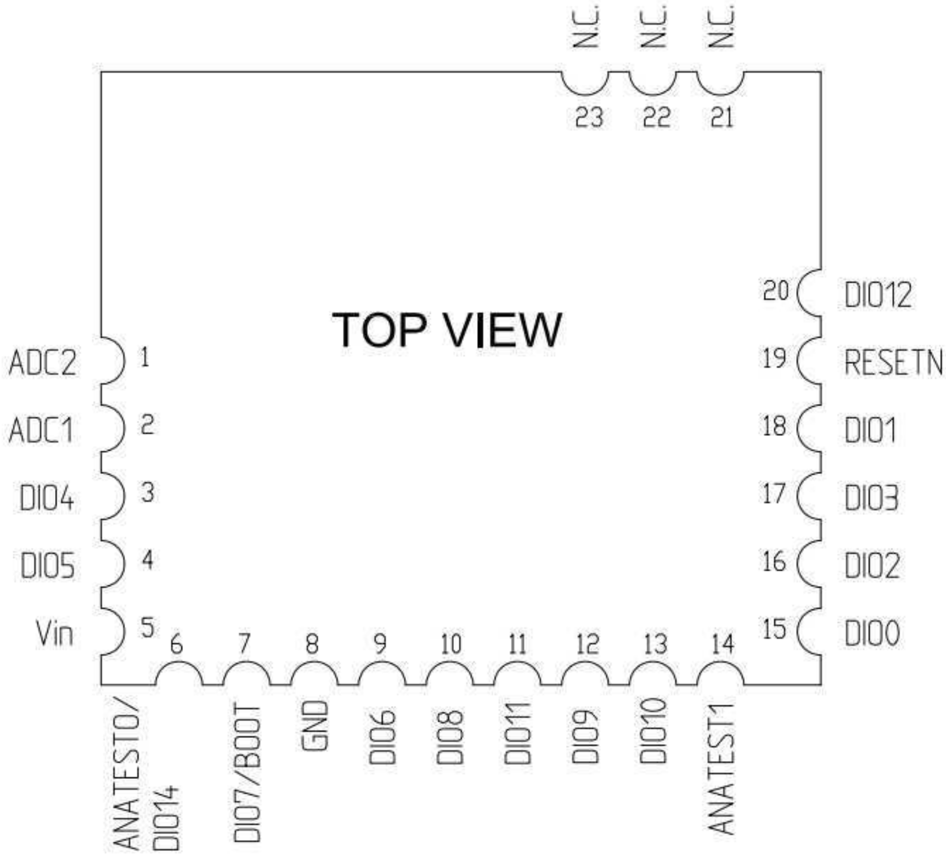


Figure 1: Pin assignment

A more complete information and technical notes related to the BLUETOOTH LOW ENERGY – BLUENRG-M2SA module, which is present in the pin assignment diagram above, will be available from the "STMicroelectronics" document:

BLUENRG-M2SA Datasheet

BLUENRG-M2SA module: some technical note about the Radio device embedded in the module, displayed in the Module Block Diagram as “BLUETOOTH BLUENRG-2”.

The BlueNRG-2 is a very low power Bluetooth low energy (BLE) single-mode system-on-chip, compliant with Bluetooth specifications.

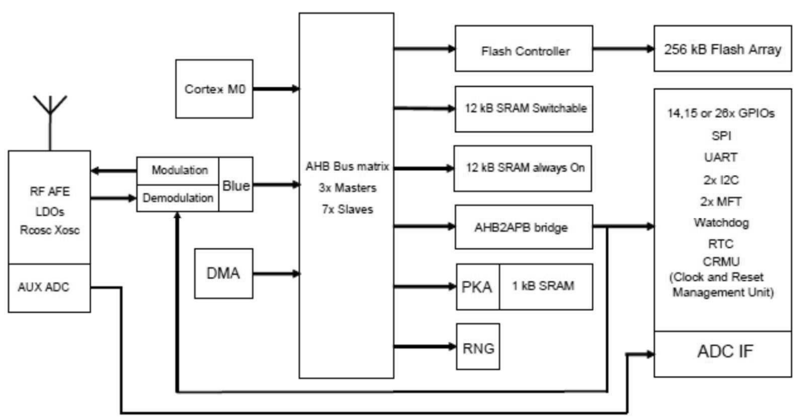
The BlueNRG-2 extends the features of award-winning BlueNRG network processor, enabling the usage of the embedded Cortex M0 to run the user application code.

The BlueNRG-2 includes 256 kB of programming Flash memory, 24 kB of static RAM memory with retention (tw 12 kB banks) and SPI, UART, I²C standard communication interface peripherals. It also features multifunction timers, watchdog, RTC and DMA controller.

An ADC is available to interface with analog sensors, and to read the measurement of the integrated battery voltage sensor. A digital filter is available to process a PDM stream.

The BlueNRG-2 offers the same excellent RF performance of the BlueNRG radio, and the integrated high efficiency DC-DC converter keeps the same ultra-low power characteristics, but the BlueNRG-2 improves the BlueNRG sleep mode current consumption allowing a further increase in the battery lifetime of the applications.

BLUENRG-2 Architecture



life.augmented

BlueNRG-2 Bluetooth low energy stack

The BlueNRG-2 is complemented with a Bluetooth low energy stack C library that provides:

- 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

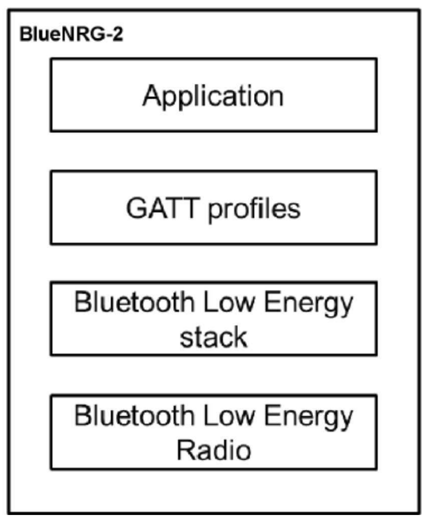
The BlueNRG-2 can be configured to support single chip or network processor applications.

The BlueNRG-2 supports LE data packet length extension, in compliance with Bluetooth smart v5.0.

In the first configuration, the BlueNRG-2 operates as single device in the application for managing both the application code and the Bluetooth low energy stack. The whole Bluetooth low energy stack is provided as object code in a single library file whereas the GATT low energy profiles are provided as object codes in separate libraries.

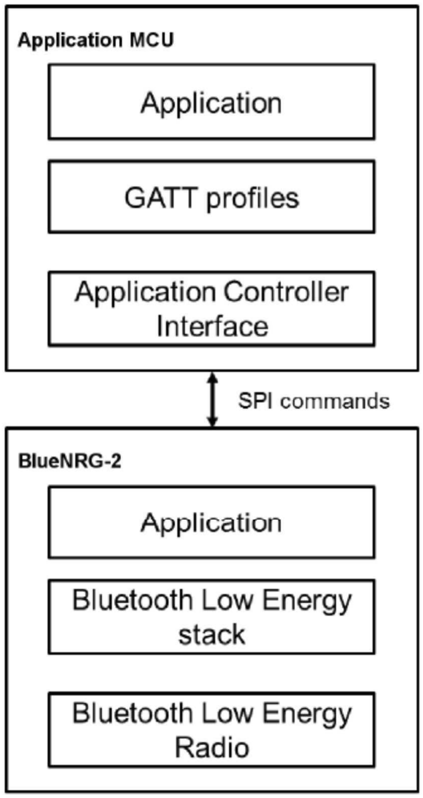
The figure below shows the single chip RF software layers.

Figure 3. **BlueNRG-2 single-chip RF software layers**



The BlueNRG-2 can be configured to operate as a network coprocessor. In this case, dedicated firmware is provided to support the interface with an external application processor. The whole Bluetooth low energy stack runs in the BlueNRG-2; the GATT profiles are provided to run in the application processor together with the application code. The figure below shows the network processor RF software layers.

Figure 4. **BlueNRG-2 network processor RF software layers**



Bluetooth low energy radio

The BlueNRG-2 integrates an RF transceiver compliant to the Bluetooth specification and to the standard national regulations in the unlicensed 2.4 GHz ISM band.

The RF transceiver requires very few external discrete components. It provides 96 dB link budgets with excellent link reliability, keeping the maximum peak current below 15 mA.

In transmit mode, the power amplifier (PA) drives the signal generated by the frequency synthesizer out to the antenna terminal through a very simple external network. The power delivered as well as the harmonic content depends on the external impedance seen by the PA.

Radio operating modes

Several operating modes are defined for the BlueNRG-2 radio:

- Reset mode
- Sleep mode
- Active mode
- Radio mode
  - RX mode
  - TX mode

In Reset mode, the BlueNRG-2 is in ultra-low power consumption: all voltage regulators, clocks and the RF interface are not powered. The BlueNRG-2 enters Reset mode by asserting the external Reset signal. As soon as it is de-asserted, the device follows the normal activation sequence to transit to active mode.

In sleep mode either the low speed crystal oscillator or the low speed ring oscillator are running, whereas the high speed oscillators are powered down as well as the RF interface. The state of the BlueNRG-2 is retained and the content of the RAM is preserved.

While in sleep mode, the BlueNRG-2 waits until an internal timer expires and then it goes into active mode.

In active mode the BlueNRG-2 is fully operational: all interfaces, including RF, are active as well as all internal power supplies together with the high speed frequency oscillator. The MCU core is also running.

Radio mode differs from active mode as also the RF transceiver is active and it is capable of either transmitting or receiving.

Electrical characteristics

Characteristics measured over recommended operating conditions unless otherwise specified. Typical value are referred to T_A = 25 °C, V_{BAT} = 3.0 V. All performance data are referred to a 50 Ω antenna connector, via reference design, QFN32 package version.

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
Power consumption when DC-DC converter active						
I_{BAT}	Supply current	Reset	–	5	–	nA
		Standby	–	500	–	nA
		Sleep mode: 32 kHz XO ON (24 KB retention RAM)	–	0.9	–	µA
		Sleep mode: 32 kHZ RO ON (24 KB retention RAM)		2.1		
		Active mode: CPU, Flash and RAM on	–	1.9	–	mA
		RX	–	7.7	–	mA
		TX +8 dBm	–	15.1	–	mA
		TX +4 dBm		10.9		
		TX +2 dBm		9		
		TX -2 dBm		8.3		
		TX -5 dBm		7.7		
		TX -8 dBm		7.1		
		TX -11 dBm		6.8		
		TX -14 dBm		6.6		
Power consumption when DC-DC converter not active						
I_{BAT}	Supply current	Reset	–	5	–	nA
		Standby	–	500	–	nA
		Sleep mode: 32 kHz XO ON (24 KB retention RAM)	–	0.9	–	µA
		Sleep mode: 32 kHZ RO ON (24 KB retention RAM)	–	2.1	–	
		Active mode: CPU, Flash and RAM on	–	3.3	–	mA
I_{BAT}	Supply current	RX	–	14.5	–	mA
		TX +8 dBm	–	28.8		mA
		TX +4 dBm		20.5		
		TX +2 dBm		17.2		
		TX -2 dBm		15.3		
		TX -5 dBm		14		
		TX -8 dBm		13		
		TX -11 dBm		12.3		
		TX -14 dBm		12		

Table 213. **Digital I/O specifications**

Symbol	Test conditions	Min.	Typ.	Max.	Unit
T(RST)L			1.5		ms
TC			3.3		V
TC1			2.5		V
TC2			1.8		V
VIL				0.3*VDD	V
VIH		0.65*VDD			V
VOL	IOL = 3 mA			0.4	V
VOH	IOH = 3 mA	0.7*VDD			V
IOL (low drive strength)	TC (VOL = 0.4 V)		5.6		mA
	TC1 (VOL= 0.42 V)		6.6		mA
	TC2 (VOL =0.45 V)		3		mA
IOL (high drive strength)	TC (VOL = 0.4 V)		11.2		mA
	TC1 (VOL= 0.42 V)		13.2		mA
	TC2 (VOL =0.45 V)		6		mA
IOL (Very high drive strength)	TC (VOL = 0.4 V)		16.9		mA
	TC1 (VOL= 0.42 V)		19.9		mA
	TC2 (VOL =0.45 V)		9.2		mA
IOH (low drive strength)	TC (VOH =2.4 V)		10.6		mA
	TC1 (VOH = 1.72 V)		7.2		mA
	TC2 (VOH = 1.35 V)		3		mA
IOH (high drive strength)	TC (VOH = 2.4 V)		19.2		mA
	TC1 (VOH = 1.72 V)		12.9		mA
	TC2 (VOH = 1.35 V)		5.5		mA
IOH (very high drive strength)	TC (VOH = 2.4 V)		29.4		mA
	TC1 (VOH = 1.72 V)		19.8		mA
	TC2 (VOH = 1.35 V)		8.4		mA

Table 214. **Peripheral current consumption**

Peripheral	Typical consumption V_{DD} = 3.0 V, T_A = 25 °C	Unit
GPIO	11.0	µA
Flash controller	6.0	
System controller	0.75	
UART	77.0	
SPI	41.0	
Watchdog	4.0	
ADC	5.0	
I2C1	92.0	
I2C2	92.0	
MFT1	7.5	
MFT2	7.5	
RTC	7.5	
DMA	16.5	
RTC	25.0	
PKA	26.0	

Note: The values are calculated as the increment to the current consumption when the peripheral is activated. The peripheral is activated if the related clock is provided.

RF general characteristics

Characteristics measured over recommended operating conditions unless otherwise specified. Typical value are referred to T_A= 25 °C, V_{BAT} =3.0 V. All performance data are referred to a 50 Ω antenna connector, via reference design, QFN32 package version.

Table 215. **RF general 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

RF transmitter characteristics

Characteristics measured over recommended operating conditions unless otherwise specified. Typical value are referred to T_A = 25 °C, V_{BAT} = 3.0 V. All performance data are referred to a 50 Ω antenna connector, via reference design, QFN32 package version.

Table 216. **RF transmitter characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
MOD	Modulation scheme		GFSK			
BT	Bandwidth-bit period product		–	0.5	–	
Mindex	Modulation index		–	0.5	–	
DR	Air data rate		–	1	–	Mbps
PMAX	Maximum output power	At antenna connector	–	+8	+10	dBm
PRFC	Minimum output power		–	-16.5	–	dBm
PBW1M	6 dB bandwidth for modulated carrier (1 Mbps)	Using resolution bandwidth of 100 kHz	500	–	–	kHz
PRF1	1st adjacent channel transmit power 2 MHz	Using resolution bandwidth of 100 kHz and average detector	–	-35	–	dBm
PRF2	2nd Adjacent channel transmit power >3 MHz	Using resolution bandwidth of 100 kHz and average detector	–	-40	–	dBm
ZLOAD	Optimum differential load	@ 2440 MHz	–	25.4 + j20.8 (1)	–	Ω

1. *Simulated value.*

RF receiver characteristics

Characteristics measured over recommended operating conditions unless otherwise specified. Typical value are referred to T_A = 25 °C, V_{BAT} =3.0 V. All performance data are referred to a 50 Ω antenna connector, via reference design, QFN32 package version.

Table 217. **RF receiver characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
RXSENS	Sensitivity	BER <0.1%		-88		dBm
PSAT	Saturation	BER <0.1%		11		dBm
zIN	Input differential impedance	@ 2440 MHz		25.5-j14.2		Ω
RF selectivity with BLE equal modulation on interfering signal						
C/ICO-channel	Co-channel interference	Wanted signal = -67 dBm, BER ≤ 0.1%		6		dBc
C/I1 MHz	Adjacent (+1 MHz) interference	Wanted signal = -67 dBm, BER≤0.1%		0		dBc
C/I2 MHz	Adjacent (+2 MHz) interference	Wanted signal = -67 dBm, BER ≤ 0.1%		-40		dBc
C/I3 MHz	Adjacent (+3 MHz) interference	Wanted signal = -67 dBm, BER ≤ 0.1%		-47		dBc
C/I≥4 MHz	Adjacent (≥ ± 4 MHz) interference	Wanted signal = -67 dBm, BER ≤ 0.1%		-46		dBc
C/I≥6 MHz	Adjacent (≥ ± 6 MHz) interference	Wanted signal= -67 dBm BER ≤ 0.1%		-48		dBc
C/I≥25 MHz	Adjacent (≥ ±25 MHz) interference	Wanted signal= -67 dBm, BER ≤ 0.1%		-70		dBc
C/IImage	Image frequency interference -2 MHz	Wanted signal = -67 dBm, BER ≤ 0.1%		-16		dBc

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C/IImage±1 MHz	Adjacent (±1 MHz) interference to in-band image frequency -1 MHz -3 MHz	Wanted signal = -67 dBm, BER ≤ 0.1%		0 -23		dBc
Intermodulation characteristics (CW signal at f_1, BLE interfering signal at f_2)						
P_IM(3)	Input power of IM interferes at 3 and 6 MHz distance from wanted signal	Wanted signal = -64dBm, BER ≤ 0.1%		-34		dBm
P_IM(-3)	Input power of IM interferes at -3 and -6 MHz distance from wanted signal	Wanted signal = -64 dBm, BER ≤ 0.1%		-48		dBm
P_IM(4)	Input power of IM interferes at ±4 and ±8 MHz distance from wanted signal	Wanted signal = -64 dBm, BER ≤ 0.1%		-34		dBm
P_IM(5)	Input power of IM interferes at ±5 and ±10 MHz distance from wanted signal	Wanted signal = -64 dBm, BER ≤ 0.1%		-34		dBm

High speed crystal oscillator characteristics

Characteristics measured over recommended operating conditions unless otherwise specified. Typical value are referred to T_A = 25 °C, V_{BAT} = 3.0 V.

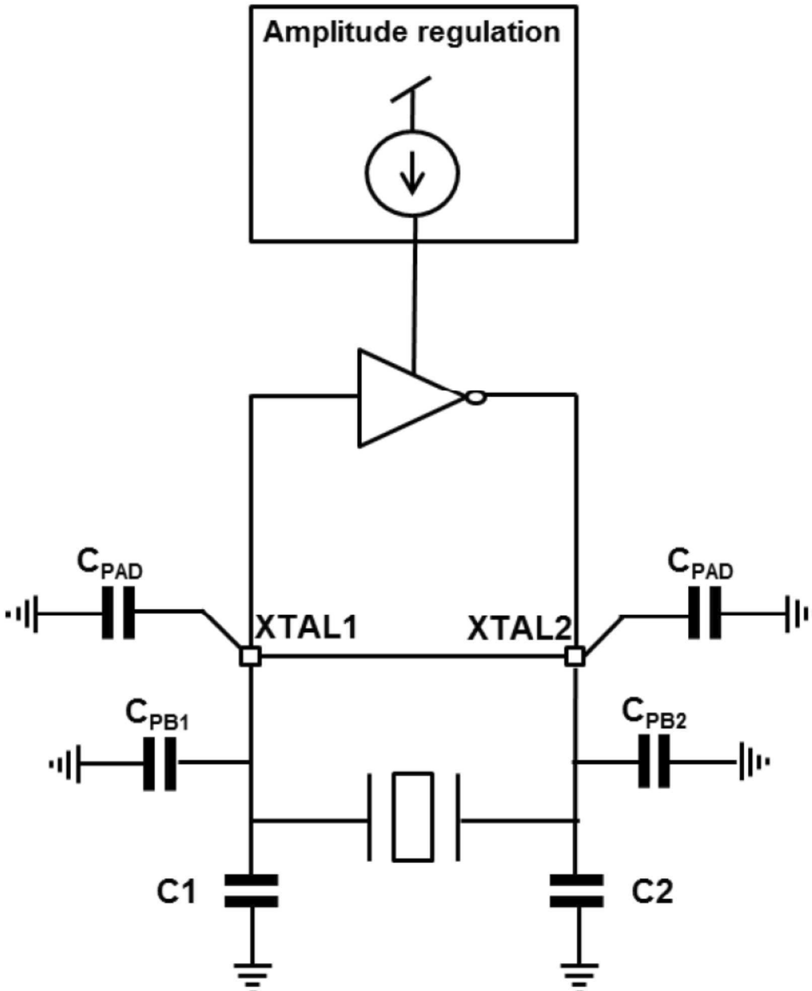
Table 218. **High speed crystal oscillator characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
fNOM	Nominal frequency		–	16/32	–	MHz
fTOL	Frequency tolerance	Includes initial accuracy, stability over temperature, aging and frequency pulling due to incorrect load capacitance	–	–	±50	ppm
ESR	Equivalent series resistance		–	–	100	Ω
PD	Drive level		–	–	100	μW

High speed crystal oscillator

The BlueNRG-2 includes a fully integrated low power 16/32 MHz Xtal oscillator with an embedded amplitude regulation loop. In order to achieve low power operation and good frequency stability of the XTAL oscillator, certain considerations with respect to the quartz load capacitance C0 need to be taken into account. Figure 31. High speed oscillator block diagram shows a simplified block diagram of the amplitude regulated oscillator used on the BlueNRG-2.

Figure 31. **High speed oscillator block diagram**



Low power consumption and fast startup time is achieved by choosing a quartz crystal with a low load capacitance C0. A reasonable choice for capacitor C0 is 12 pF. To achieve good frequency stability, the following equation needs to be satisfied:

$$C_0 = \frac{C_1' * C_2'}{C_1 + C_2} \tag{6}$$

Where $C_1' = C_1 + C_{PCB1} + C_{PAD}$, $C_2' = C_2 + C_{PCB2} + C_{PAD}$, where C_1 and C_2 are external (SMD) components, C_{PCB1} and C_{PCB2} are PCB routing parasites and C_{PAD} is the equivalent small-signal pad-capacitance. The value of C_{PAD} is around 0.5 pF for each pad. The routing parasites should be minimized by placing quartz and C_1/C_2 capacitors close to the chip, not only for an easier matching of the load capacitance C_0, but also to ensure robustness against noise injection. Connect each capacitor of the Xtal oscillator to ground by a separate vias.

Low speed crystal oscillator characteristics

Characteristics measured over recommended operating conditions unless otherwise specified. Typical value are referred to T_A = 25 °C, V_{BAT} =3.0 V.

Table 219. **Low speed crystal oscillator characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
fNOM	Nominal frequency		–	32.768	–	kHz
fTOL	Frequency tolerance	Includes initial accuracy, stability over temperature, aging and frequency pulling due to incorrect load capacitance.	–	–	±50	ppm
ESR	Equivalent series resistance		–	–	90	kΩ
PD	Drive level		–	–	0.1	µW

These values are the correct ones for NX3215SA-32.768 kHz-EXS00A-MU00003.

High speed ring oscillator characteristics

Characteristics measured over recommended operating conditions unless otherwise specified. Typical value are referred to T_A= 25 °C, V_{BAT} =3.0 V.

Table 220. **High speed ring oscillator characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
f_{NOM}	Nominal frequency		–	14	–	MHz

Low speed ring oscillator characteristics

Characteristics measured over recommended operating conditions unless otherwise specified. Typical value are referred to T_A = 25 °C, V_{BAT} =3.0 V, QFN32 package version.

Table 221. **Low speed ring oscillator characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
32 kHz ring oscillator (LSROSC)						
f_{NOM}	Nominal frequency		–	32	–	kHz

N-fractional frequency synthesizer characteristics

Characteristics measured over recommended operating conditions unless otherwise specified. Typical value are referred to T_A = 25 °C, V_{BAT} =3.0 V, f_c = 2440 MHz.

Table 222. **N-Fractional frequency synthesizer characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
PNSYNTH	RF carrier phase noise	At ±1 MHz offset from carrier	–	-113	–	dBc/Hz
		At ±3 MHz offset from carrier	–	-119	–	dBc/Hz

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
LOCKTIME	PLL lock time		–	–	40	μs
TOTIME	PLL turn-on / hop time	Including calibration	–	–	150	μs

Auxiliary block characteristics

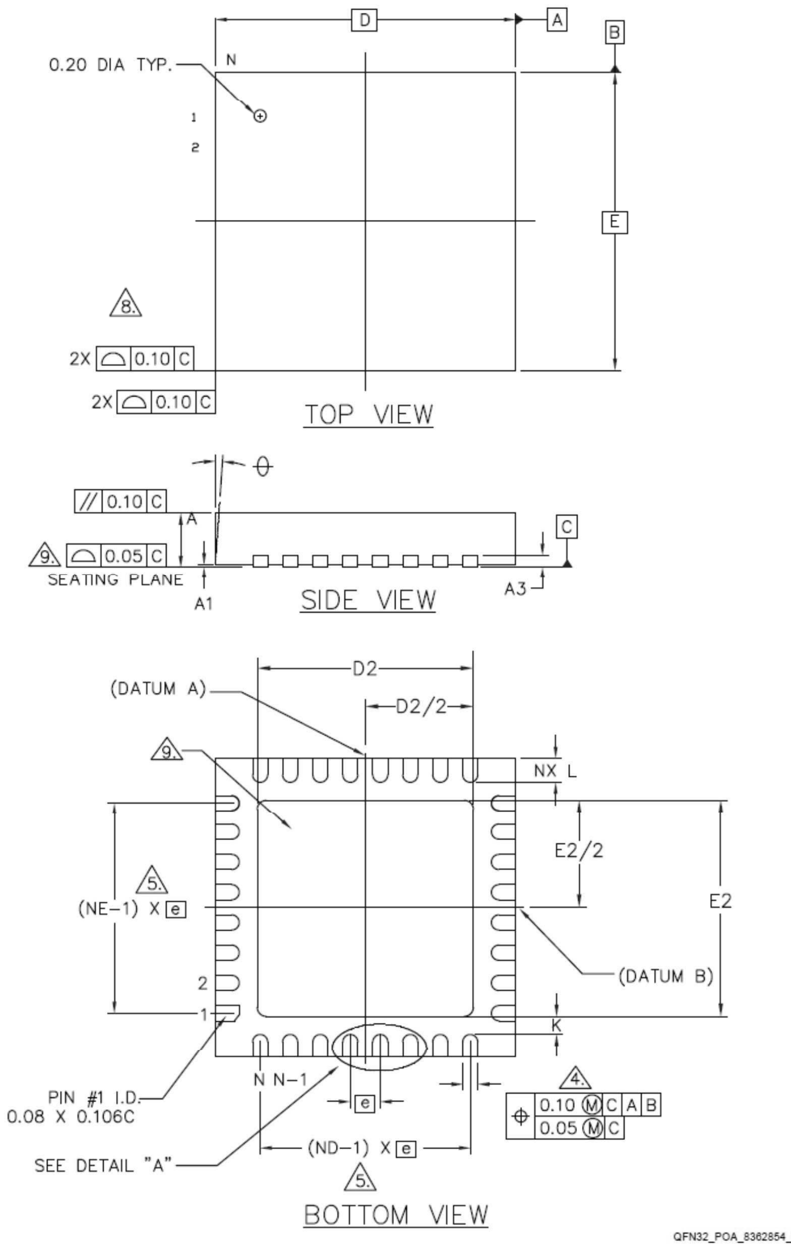
Characteristics measured over recommended operating conditions unless otherwise specified. Typical values are referenced to T_A = 25 °C, V_{BAT} =3.0 V, f_{ADCclk} =1 MHz. QFN32 package version.

Table 223. **Auxiliary blocks characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
Analog-to-digital converter (ADC)						
V_{DDA}	Analog supply voltage		1.7	3.0	3.6	V
$I_{DDA, AVG}$	Analog supply current	Average current during conversion	–	–	0.55	mA
$V_{INP, INN}$	Input pin voltage	With input attenuator	-50 mV	–	(V_{BAT}+50 mV) / input attenuation	V
SNR Diff	Signal-to-noise ratio	Differential input, with OSR = 200, PGA=0 dB. Sinewave with VinDC=0.6 V, Vpeak diff = 0.85 V, Fin = 1 kHz	–	74	–	dB
SNR SE 1	Signal-to-noise ratio	Single-ended input, with Vbias = 0.6 V, OSR = 200, PGA=0 dB. Sinewave with VinDC=0.6 V, Vpeak = 0.425 V, Fin = 1 kHz	–	70	–	dB
SNR SE 2	Signal-to-noise ratio	Single-ended input, with Vbias = 1.2 V, OSR = 200, PGA=0 dB. Sinewave with VinDC=1.2 V, Vpeak = 0.85 V, Fin = 1 kHz	–	74	–	dB
ENOB Diff	Effective number of bits	Differential input, OSR = 200, PGA=0 dB. Sinewave with VinDC=0.6 V, Vpeak diff = 0.85 V, Fin = 1 kHz	–	12	–	bit
ENOB SE 1a	Effective number of bits	Single-ended input, with Vbias = 0.6 V, with OSR = 200, PGA=0 dB. Sinewave with VinDC=0.6 V, Vpeak = 0.425 V, Fin = 1 kHz	–	8.5	–	bit
ENOB SE 1b	Effective number of bits	Single-ended input, with Vbias = 0.6 V, OSR = 200, PGA=0 dB. Sinewave with VinDC=0.6 V, Vpeak = 0.15 V, Fin = 1 kHz	–	9.5	–	bit
ENOB SE 2a	Effective number of bits	Single ended input, with Vbias = 1.2 V, OSR = 200, PGA=0 dB. Sinewave with VinDC=1.2 V, Vpeak = 0.85 V, Fin = 1 kHz	–	8.5	–	bit
ENOB SE 2b	Effective number of bits	Single ended input, with Vbias = 1.2 V, OSR = 200, PGA=0 dB. Sinewave with VinDC=1.2 V, Vpeak = 0.3 V, Fin = 1 kHz	–	9.5	–	bit
Analog temperature sensor						
TRANGE	Temperature range		-40	–	+105	°C
TERR	Error in temperature		-4	0	+4	°C
Brown-out reset (BOR)						
VABOR	Ascending brown-out threshold		–	1.68	1.7	V
VDBOR	Descending brown-out threshold		1.62	1.645	–	V

QFN32 package information

Figure 32. **QFN32 (5 x 5 x 1 pitch 0.5 mm) package outline**



BLUENRG-M2SA module: some technical note about the BALUN-FILTER device embedded in the module, displayed in the Module Block Diagram as "RF BALUN + Filter".

BALUN + Filter DESCRIPTION

Chip Scale package on glass
4 bumps - 1.4 x 0.85 mm²

Features

- 50 Ω nominal input / conjugate match to BlueNRG device
- Low insertion loss
- Low amplitude imbalance
- Low phase imbalance

Benefits

- Small footprint
- RF BOM reduction
- High RF performance

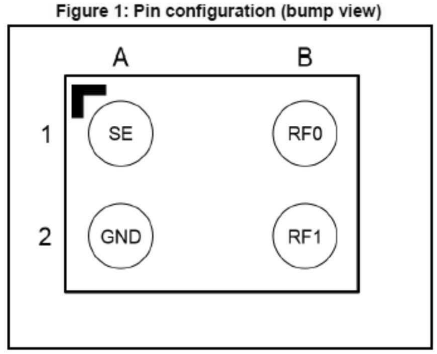
Applications

- Bluetooth low energy impedance matched balun filter
- Optimized for ST BlueNRG RFIC

Description

This device is an ultra-miniature balun which integrates matching network and harmonics filter. Matching impedance has been customized for the BlueNRG ST transceiver.
The BALF-NRG-02D3 uses STMicroelectronics IPD technology on non-conductive glass substrate which optimizes RF performance.

Figure 1: Pin configuration (bump view)



Characteristics

Table 1: Absolute maximum ratings (limiting values)

Symbol	Parameter	Value			Unit
		Min.	Typ.	Max.	
P_{IN}	Input power RFIN		-	10	dBm
V_{ESD}	ESD ratings human body model, all I/O one at a time while others connected to GND	2000	-		V
	ESD ratings machine model (MM: C = 200 pF, R = 25 Ω, L = 500 nH)	200	-		
T_{OP}	Operating temperature	-40	-	+105	°C

Table 2: Electrical characteristics (T_{amb} = 25 °C)

Symbol	Definition	Value			Unit
		Min.	Typ.	Max.	
Z_{diff}	Nominal differential impedance	Match to BlueNRG			Ω
Z_{ANT}	Nominal antenna impedance		50		Ω
f	Frequency range (bandwidth)	2400		2500	MHz
I_L	Insertion loss in bandwidth		1.33	1.85	dB
RL_{SE}	Single ended return loss in bandwidth	21	30		
RL_{DIFF}	Differential return loss in bandwidth	17	19		
H2	Second harmonic attenuation (differential mode)	40	49		
H3	Third harmonic attenuation (differential mode)	46	55		
H4	Fourth harmonic attenuation (differential mode)	42	50		
H5	Fifth harmonic attenuation (differential mode)	31	56		
H6	Fifth harmonic attenuation (differential mode)	29	45		
H7	Fifth harmonic attenuation (differential mode)	30	42		
Φ_{imb}	Output phase imbalance	-3.5	0	3.5	°
A_{imb}	Output amplitude imbalance	-1	0	1	dB

RF measurement

Figure 3: Differential transmission (dB)

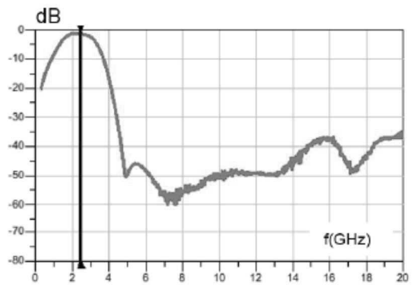


Figure 4: Insertion loss (dB)

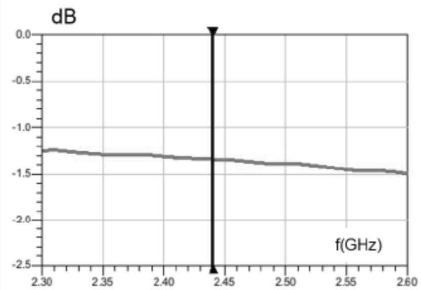


Figure 5: Return loss single ended (dB)

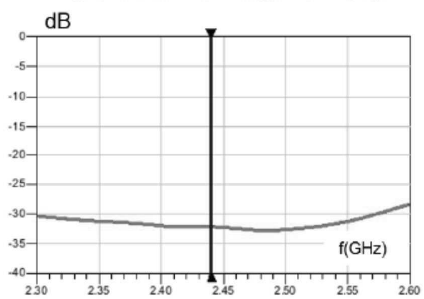


Figure 6: Return loss differential (dB)

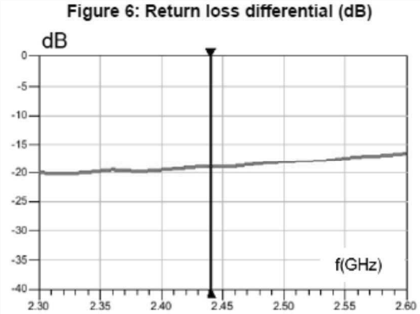


Figure 7: H2 harmonic attenuation (dB)

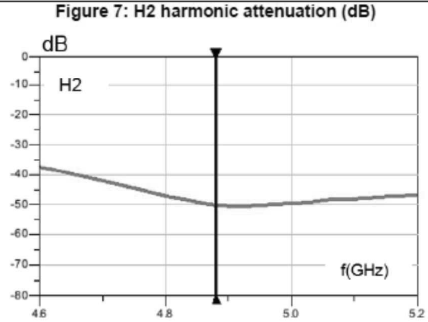


Figure 8: H3 harmonic attenuation (dB)

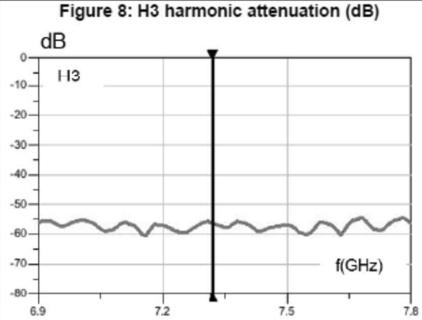


Figure 9: H4 harmonic attenuation (dB)

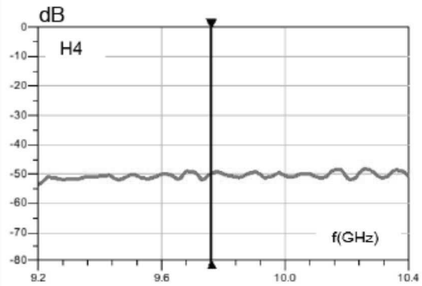


Figure 10: H5 harmonic attenuation (dB)

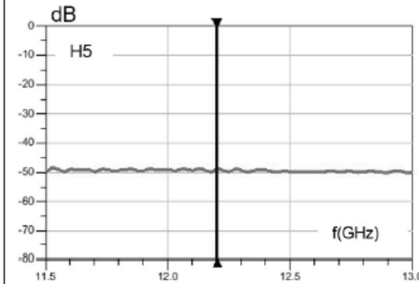


Figure 11: H6 harmonic attenuation (dB)

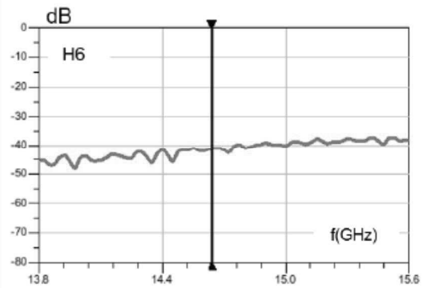


Figure 12: H7 harmonic attenuation (dB)

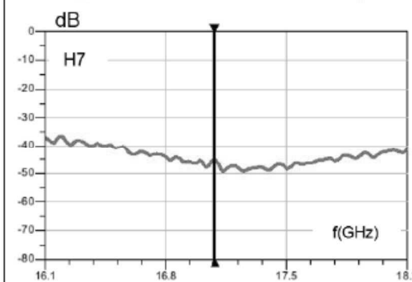


Figure 13: Amplitude imbalance in dB

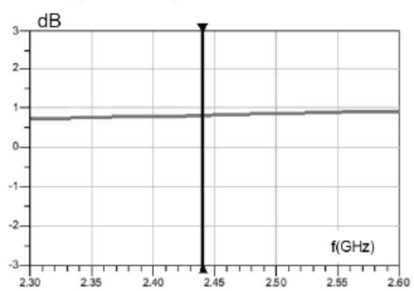
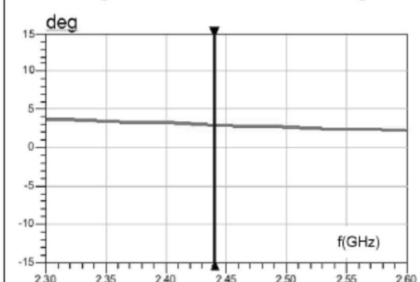


Figure 14: Phase imbalance in deg



life.augmented

BLUENRG-M2SA module: some technical note about the Antenna device embedded in the module, displayed in the Module Block Diagram as “internal RF antenna”.

ANTENNA DESCRIPTION

The supplier of the module internal antenna is:

JOHANSON TECHNOLOGY

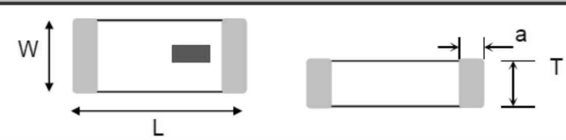
www.johansontechnology.com
001 Calle Tecate • Camarillo, CA 93012 • TEL 805.389.1166 FAX 805.389.1821

Ver 1.3

General Specifications	
Part Number	2450AT18A100
Frequency Range	2400 - 2500 Mhz
Peak Gain	0.5 dBi typ. (XZ-V)
Average Gain	-0.5 dBi typ. (XZ-V)
Return Loss	9.5 dB min.
Input Power	2W max. (CW)
Impedance	50 Ω
Operating Temperature	-40 to +125°C
Reel Quanity	3,000

Mechanical Dimensions

	In	mm
L	0.126 ± 0.008	3.20 ± 0.20
W	0.063 ± 0.008	1.60 ± 0.20
T	0.051 +.004/-.008	1.30 +0.1/-0.2
a	0.020 ± 0.012	0.50 ± 0.30



Antenna electrical characteristic

Return Loss with matching circuit @ +25C VSWR with matching circuit @ +25C and +125C