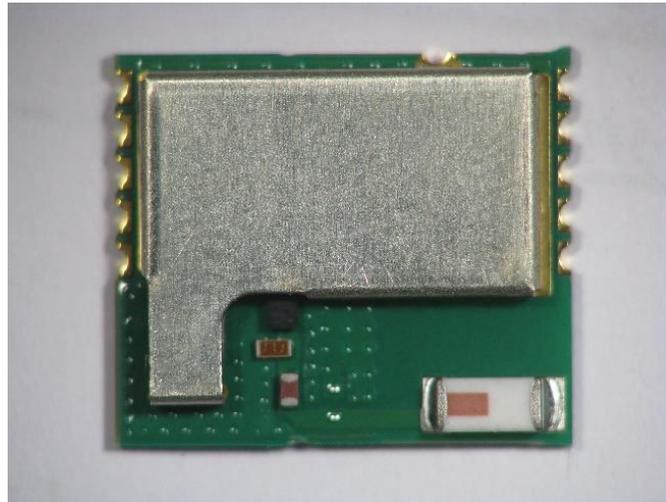


Technical Description Document

BLUENRG-M2SP

FCC ID S9NBNRGM2SP and IC-ISED ID 8976C-BNRGM2SP

The BLUENRG-M2SP is represented by the following photographs:



Photograph showing a generic BLUENRG-M2SP, covered by metallic shield.



Photograph showing a BLUENRG-M2SP, with shield removed.

What exactly is the BLUENRG-M2SP?

The BlueNRG-M2SP is a Bluetooth® low Energy System-on-Chip application processor certified module, compliant with BT specifications v5.0 and BQE qualified.

The BlueNRG-M2SP module supports multiple roles simultaneously and can act at the same time as Bluetooth Smart master and slave device.

The BlueNRG-M2SP is based on BlueNRG-2 System-on-Chip and entire Bluetooth Low Energy stack and protocols are embedded into module.

The BlueNRG-M2SP 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-M2SP can be powered directly with a pair of AAA batteries or any power source from 1.7 to 3.6 V.

List of possible 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

Some detailed features

- Bluetooth v5.0 compliant
 - Supports master and slave modes
 - Multiple roles supported simultaneously
 - LE data packet length extension
- Embedded ST 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
 - Up to +8 dBm available output power
 - Down to -88 dBm Rx sensitivity
 - Up to 96 dB link budget with excellent link reliability
- Embedded BALF-NRG-02D3 integrated matched balun with harmonic filter
- 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

- PCB antenna (BlueNRG-M2SP)
- Small form factor: 11.5 mm x 13.5 mm
- 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

- Certification
 - CE qualified
 - FCC, IC modular approval certified
 - ARIB qualified
 - BQE qualified

- Pre-programmed UART bootloader
- Operating supply voltage: from 1.7 to 3.6 V
- Operating temperature range: -40 °C to 85 °C

A general overview about the BLUENRG-M2SP

The BLUENRG-M2SP is a Bluetooth Smart application processor module compliant with Bluetooth® specifications v5.0.

The BLUENRG-M2SP module has been designed around the ST BlueNRG-2 SoC where its Cortex-M0 core can execute both Bluetooth protocols and customer application. Optimized memory architecture includes 256 KB of Flash memory and 24 KB of ultra-low-leakage RAM (with full data retention). A complete power-optimized Bluetooth stack library provides:

Master, slave, multiple roles support

GAP: central, peripheral, observer or broadcaster roles

simultaneous advertising and scanning

capability of being slave of up to two masters simultaneously

ATT/GATT: client and server

SM: privacy, authentication and authorization

L2CAP

Link Layer: AES-128 encryption and decryption

Being based on the BlueNRG-2 SoC, the BLUENRG-M2SP module leverages all the tools and documentation of its ecosystem: Development Kit, Application Notes, User Manuals, Design Notes & Tips. A wide set of sample programs are also available in C source code.

The BLUENRG-M2SP module has a wide set of peripherals available for customer application (1 x UART interface, 1 x SPI interface, 1 x I2C interface, 14 GPIO, 2 x multifunction timer, 10-bit ADC, Watchdog & RTC, DMA controller, PDM stream processor).

The BLUENRG-M2SP module enables wireless connectivity into electronic devices, not requiring any RF experience or expertise for integration into the final product. The BLUENRG-M2SP module provides a complete RF application platform in a tiny form factor (11.5 x 13.5 x 2.0 mm) and being a certified solution optimizes the time to market of the final applications.

The BLUENRG-M2SP module allows applications to meet the tight advisable peak current requirements imposed with the use of standard coin cell batteries. For the BLUENRG-M2SP the best performances in terms of power consumption are achieved using a 1.8V DC power supply.

BLUENRG-M2SP can be powered directly with a standard 3 V coin cell battery as with a pair of AAA batteries or any power source from 1.7 to 3.6 V.

Software architecture (BLUENRG-M2SP)

Software development Kit

The BLUENRG-M2SP module embeds the BlueNRG-2 application processor. Refer to the BlueNRG-2 web page (<http://www.st.com/en/wireless-connectivity/BlueNRG-2.html>) to get access to:

- BlueNRG-2 datasheet
- development kit
- application notes
- user manuals
- tools & software
- design note and tips

Software and firmware should be configured taking into account the BLUENRG-M2Sx specific configuration as described in the block diagram chapter.

The BLUENRG-M2SP module has:

- 32 MHz crystal oscillator
- LDO converter

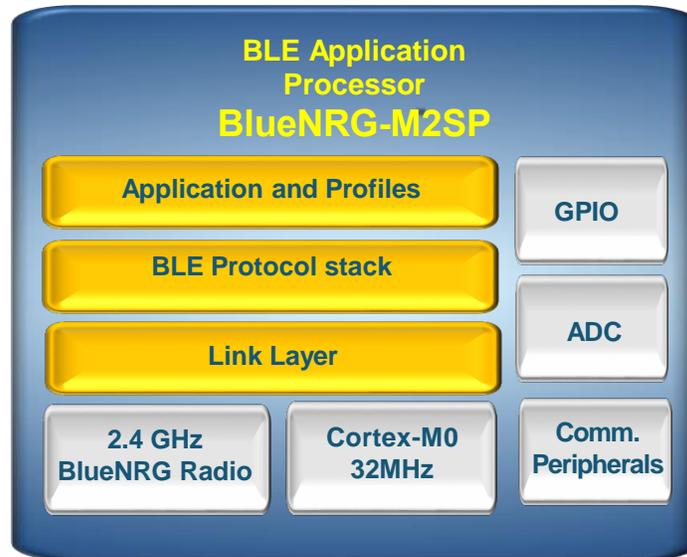
The projects provided with the development kit should be customized defining as following:

- HS_SPEED_XTAL=HS_SPEED_XTAL_32MHZ
- SMPS_INDUCTOR=SMPS_INDUCTOR_NONE

Software Architecture

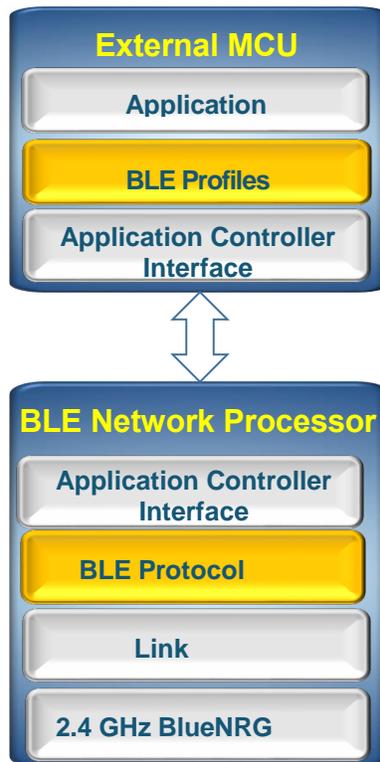
There are two possible software architectures:

1. Host-less mode (application processor): customer application runs on the BLUENRG-M2SP module. Many sample projects are available in the Development Kit.



BLUENRG-M2SP - BLE Application Processor

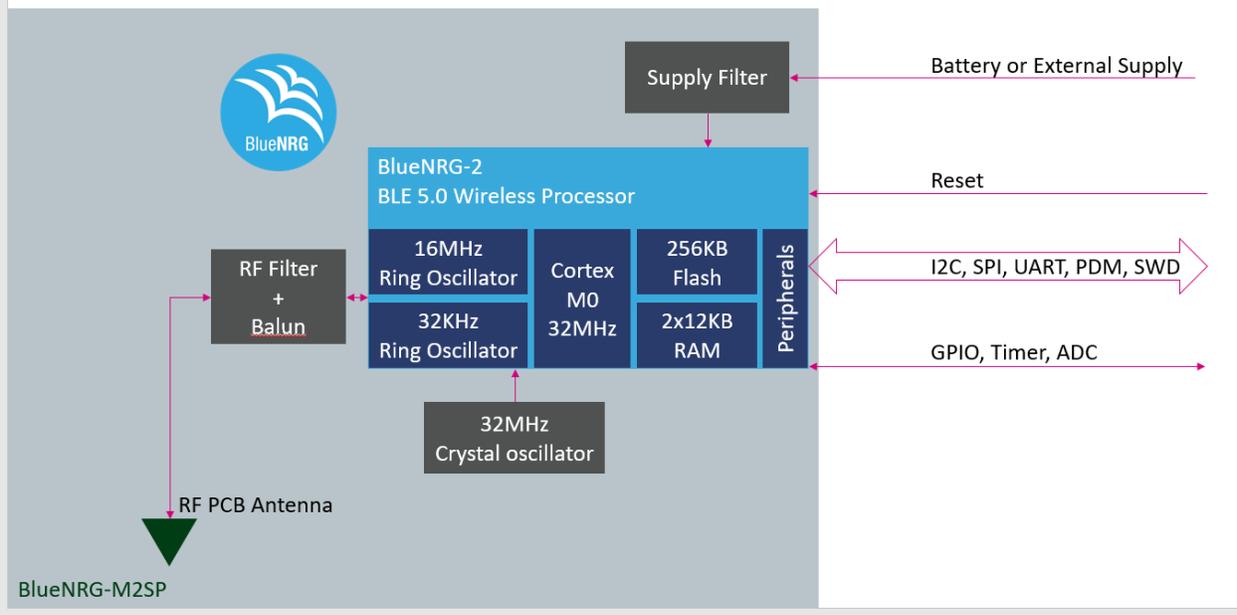
2. Hosted mode (Network processor): the module is configured as network module controlled by an external host connected via SPI or UART. A project named DTM is available in the Development Kit that configures the BLUENRG-M2SP module as a network module.



BLUENRG-M2SP as BLE Network Processor

Block diagrams for the BLUENRG-M2SP

HW block diagram for BLUENRG-M2SP



General characteristics of the BLUENRG-M2SP

In the following two Tables are summarized the minima fundamental parameters for the BLUENRG-M2SP module.

Absolute maximum ratings

Table related to the 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

Table related to the 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 of the BLUENRG-M2SP

In the following Tables are summarized the fundamental electrical specification parameters for the BLUENRG-M2SP module.

Electrical characteristics

Characteristic measured over recommended operating condition unless otherwise specified.
Typical values are referred to $V_{IN}= 3.3\text{ V}$, $25\text{ }^{\circ}\text{C}$, SMPS off, RO 32KHz and 32MHz.

Electrical characteristics for the BLUENRG-M2SP

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{DD}	Supply current	Reset		5		nA
		Standby		0.5		uA
		Sleep mode: 32 kHz RO ON (24 kB retention RAM)		2.1		μA
		Active mode		2.75		mA
		RX		15		mA
		TX +8 dBm		33.9		mA
		TX +4 dBm		22.6		mA
		TX +2 dBm		19.1		mA
		TX -2 dBm		16.9		mA
		TX -5 dBm		15.6		mA
		TX -8 dBm		14.7		mA
		TX -11 dBm		14.1		mA
		TX -14 dBm		13.7		mA

Digital I/O specifications of the BLUENRG-M2SP

IO pins are directly connected to the embedded state of the art BlueNRG-2 chipset. For more details about the digital I/O specification, please refer directly to the BlueNRG-2 datasheet available on www.st.com/BlueNRG-2.html.

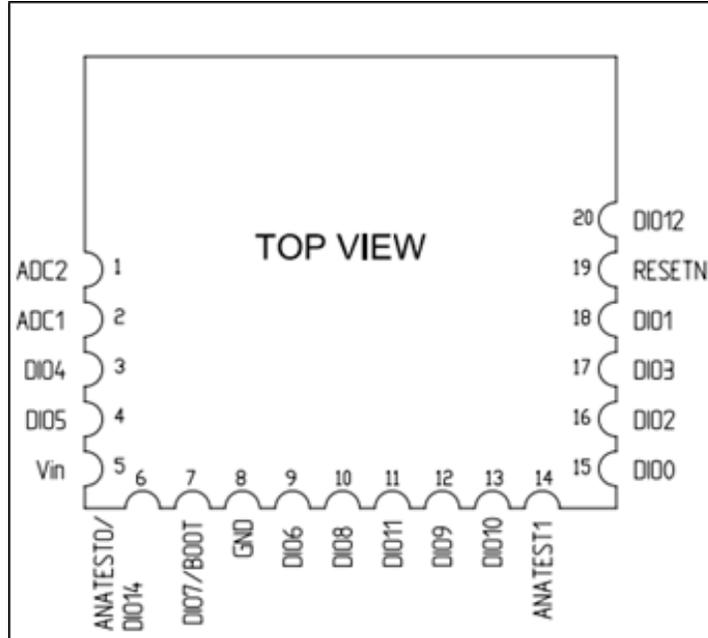
RF General characteristics of the BLUENRG-M2SP

Characteristic measured over recommended operating condition unless otherwise specified. Typical value are referred to VIN= 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 of the BLUENRG-M2SP



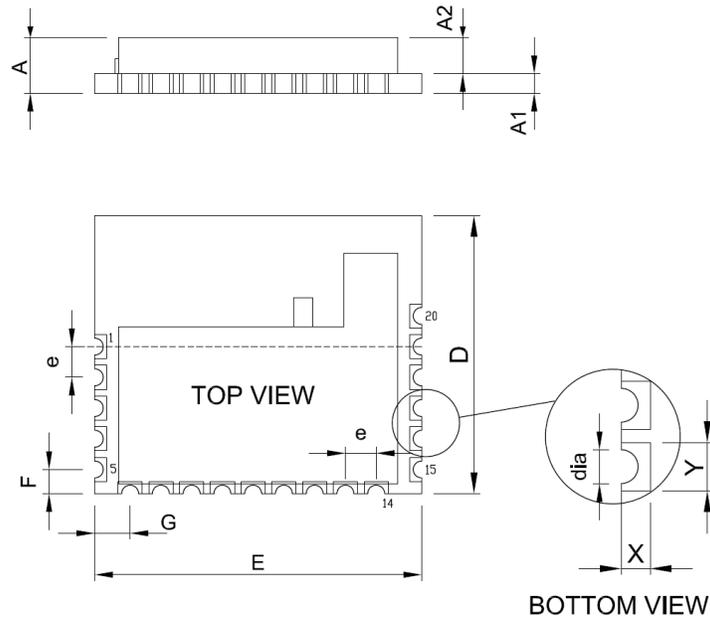
Pin connection of the BLUENRG-M2SP

Pin assignment of the BLUENRG-M2SP

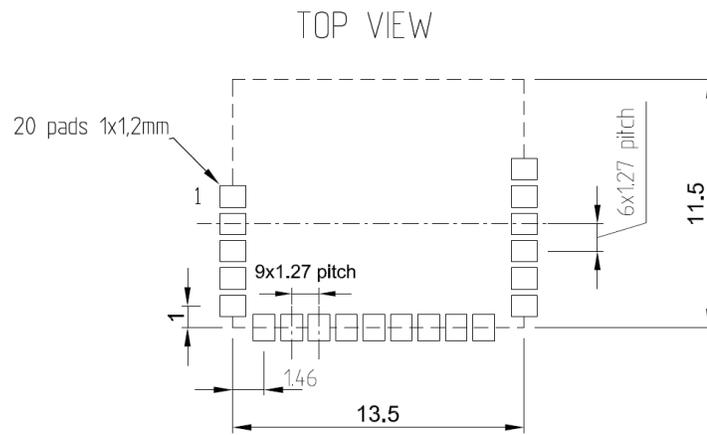
Pin #	Name	Function			
		Mode "000"	Mode "001"	Mode "100"	Mode "010"
1	ADC2	ADC input 2			
2	ADC1	ADC input 1			
3	DIO4	GPIO4	UART_RXD	I2C2_CLK	PWM0
4	DIO5	GPIO5	UART_TXD	I2C2_DAT	PWM1
5	VIN	Power Supply			
6	ANATEST0/DIO14	GPIO14	I2C1_CLK	SPI_CLK	ADC_DAT
7	DIO7/BOOT (a)	GPIO7	UART_CTS	I2C2_DAT	PDM_CLK
8	GND	Ground			
9	DIO6	GPIO6	UART_RTS	I2C2_CLK	PDM_DAT
10	DIO8	GPIO8	UART_TXD	SPI_CLK	PDM_DAT
11	DIO11	GPIO11	UART-RXD	SPI_CS1	
12	DIO9	GPIO9	SWCLK	SPI_IN (b)	
13	DIO10	GPIO10	SWDIO	SPI_out (c)	
14	ANATEST1	Anatest1			
15	DIO0	GPIO0	UART_CTS	SPI_CLK	
16	DIO2	GPIO2	PWM0	SPI_OUT	PDM_CLK
17	DIO3	GPIO3	PWM1	SPI_IN	ADC_CLK
18	DIO1	GPIO1	UART_RTS	SPI_CS1	PDM_DAT
19	RESETN	Reset			
20	DIO12	GPIO12 (d)		I2C1_CLK	
21 (e)	NC	Leave unconnected			
22 (e)	NC	Leave unconnected			
23 (e)	NC	Leave unconnected			

- (a) The pin DIO7/BOOT is monitored by bootloader after power up or hardware Reset and it should be low to prevent unwanted bootloader activation
- (b) The function SPI_IN indicates that the pin is always an input when configured for SPI. Thus in case of SPI master role, it acts as MISO pin. In case of SPI slave role, this pin act as MOSI. See Table 6.
- (c) The function SPI_OUT indicates that the pin is always an output when configured for SPI. Thus in case of SPI master role, it acts as MOSI pin. In case of SPI slave role, this pin act as MISO. See Table 6.
- (d) DI012 can only be General Purpose Input pins (not output), or I2C1 clock pin.
- (e) BlueNRG-M2SA only

Mechanical dimensions of the BLUENRG-M2SP



Recommend land pattern top view



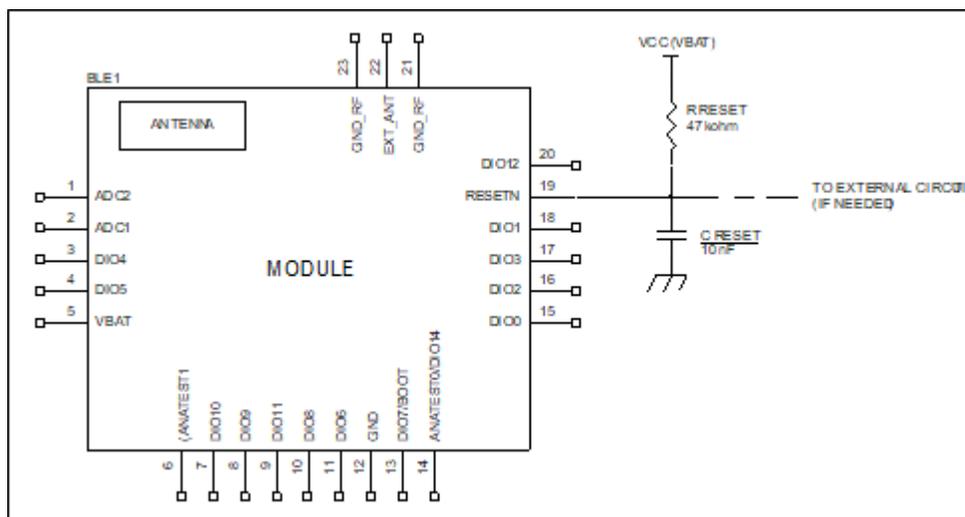
RECOMMENDED LAND PATTERN
All Dimensions are in millimeters

Hardware design of the BLUENRG-M2SP

- 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.

Reset circuitry

The BLUENRG-M2SP module requires an external pull-up reset circuitry to ensure proper operation at power on. Refer to the "Reset management" chapter of the BlueNRG-2 datasheet for details.



If reset pin is controlled by an external host, there is no need to have RC circuit on the RESETn line.

Reflow soldering of the BLUENRG-M2SP

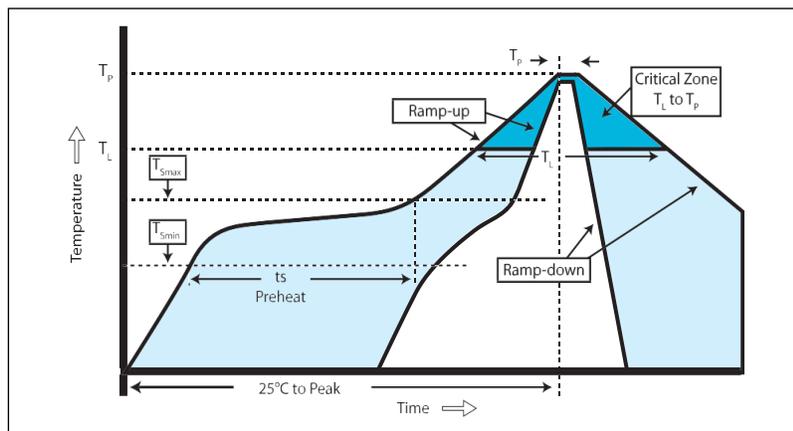
The BLUENRG-M2SP is a high temperature strength surface mount Bluetooth[®] module supplied on 20 pin (BLUENRG-M2SP) 4-layer PCB. The final assembly recommended reflow profiles are indicated here below.

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 ($T_{S\text{MAX}}$ to T_p)	3°C/ sec max
Preheat	
Temperature min (T_S mn)	150 °C
Temperature max (T_S max)	200 °C
Time (t_S min to t_S max) (t_S)	60-100 sec
Time maintained above:	
Temperature T_L	217 °C
Time t_L	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



For a complete and detailed overview of additional technical info please consult the Data Sheet of the referenced BLUENRG-M2SP module.

Revision History

Revision	Date	Author	Comment
1.0	05/03/2019	Enrico Massoni	First version