

**<GSUB-0002>**

# **UWB+BLE Combo SiP Module**

Pb-free, halogen-free and RoHS compliant

# Restricted

## 1. Security warning

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## 2. Publication history

Version	Date	Description	Author	Approved
V0.1	2021/10/18	First release		
V0.2	2021/12/18	Update DC/RF Characteristics		

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# 1. Introduction

## 1.1 Functional Description

GSUB-0002 module is based on System-in-Package (SiP) technology which consists of a NORDIC nRF52840 Bluetooth SoC, a QORVO DW3120 UWB transceiver, a ST LIS2DW12TR 3-axis accelerometer, a 1.6V step-down switching voltage regulator and the matched passive components. All these components are integrated in a tiny 97-pins 10.5x8.3x1.2 mm<sup>3</sup> LGA package with sputter technology to achieve EMI shielding. GSUB-0002 can be used to scheme location application for IOT devices.

The DW3120 is an Ultra Wide Band(UWB) low-power and low-cost transceiver IC compliant to IEEE802.15.4-2015 and IEEE802.15.4z (BPRF mode). It can be used in 2-way ranging, TDoA and PDoA systems to locate assets to an accuracy of 10 cm; meanwhile, it supports 850 kbps, 6.8 Mbps and 27 Mbps data rates.

The nRF52840 is a Bluetooth 5, IEEE 802.15.4-2006, 2.4 GHz transceiver and contains a 32-bit ARM Cortex-M4 processor with FPU running at 64MHz, 1 MB internal flash and 256 kB RAM; It has numerous digital peripherals and interfaces such as high speed SPI and QSPI for interfacing to external flash and displays, and a full speed USB device for data transfer and power supply for battery recharging.

The LIS2DW12TR is a high-performance ultra-low-power 3-axis accelerometer, connected to Bluetooth nRF52840 through I2C and could be used as motion detection to save power consumption.

## 1.2 Hardware Features

- BLE:
  - -95 dBm sensitivity in 1 Mbps Bluetooth low energy mode
  - -103 dBm sensitivity in 125 kbps Bluetooth low energy mode (long range)
  - -20 to +8 dBm TX power, configurable in 4 dB steps
  - Supported data rates:
    - Bluetooth 5 – 2 Mbps, 1 Mbps, 500 kbps, and 125 kbps
    - IEEE 802.15.4-2006 – 250 kbps
    - Proprietary 2.4 GHz – 2 Mbps, 1 Mbps

- Fast wake-up using 64 MHz internal oscillator
- USB 2.0 full speed (12 Mbps) controller
- QSPI 32 MHz interface
- High-speed 32 MHz SPI
- UWB:
  - IEEE802.15.4-2015 UWB
  - IEEE802.15.4Z (BPRF mode)
  - Supports channels 5 & 9 (6489.6MHz & 7987.2 MHz)
  - Supports 2-way ranging, TDOA and PDOA location schemes
  - Worldwide UWB Radio Regulatory compliance
  - Low power consumption
  - Data rates of 850 kbps, 6.8 Mbps and 27Mbps
  - Integrated HW AES 256

## 1.3 Applications

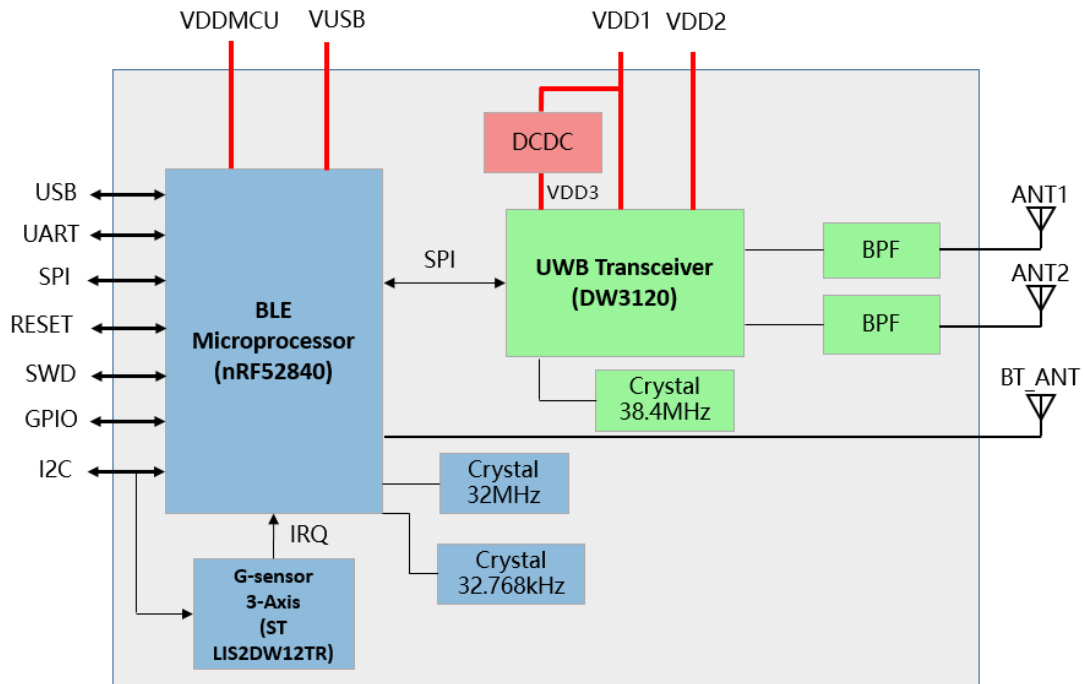
Precision real time location systems (RTLS) using two-way ranging, TDoA or PDoA schemes in a variety of markets:

- Healthcare
- Consumer
- Industrial
- Automotive

## 2.Part Number

Part Number	GSUB-0002
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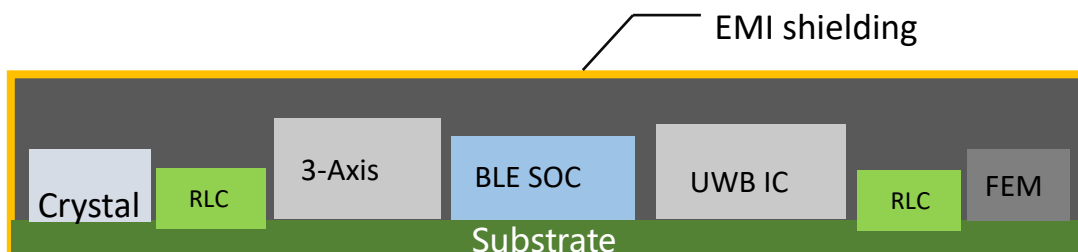
### 3. Block Diagram



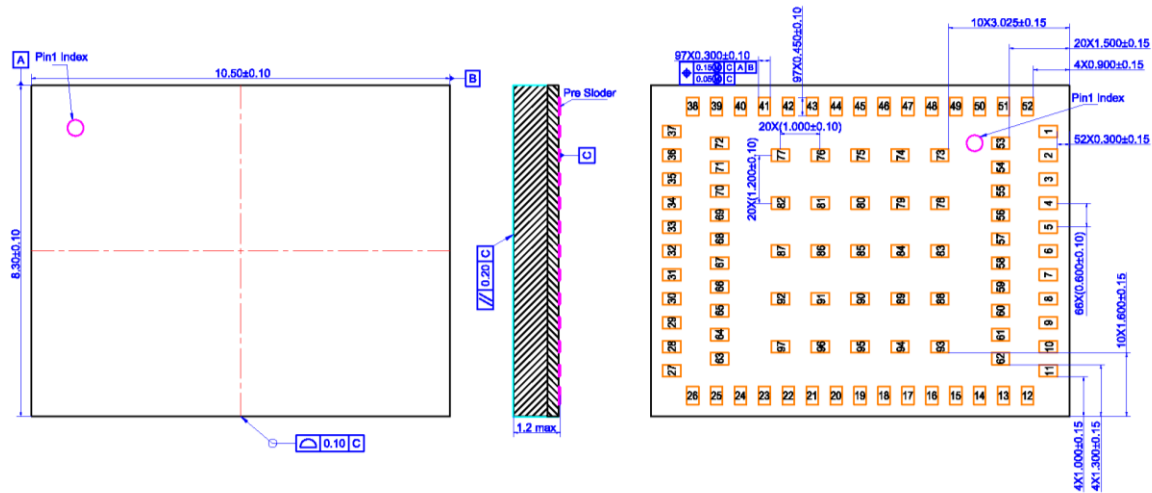
### 4. Certification Information (TBD)

## 5. Structure, Dimensions, Marking and Terminal Configurations

### 5.1 Structure



## 5.2 Dimensions



## 5.3 Terminal Configurations

Pin NO.	Name of pin NO.	Connection to IC terminal	Function	Recommended usage
1	GND_1	GND	Ground	
2	P0.05/AIN3	P0.05/AIN3	GPIO/Analog input	
3	P0.04/AIN2	P0.04/AIN2	GPIO/Analog input	
4	P0.27	P0.27	GPIO	
5	P0.26	P0.26	GPIO	
6	P0.30/AIN6	P0.30/AIN6	GPIO/Analog input	Standard drive, low frequency I/O only
7	P0.28/AIN4	P0.28/AIN4	GPIO/Analog input	Standard drive, low frequency I/O only
8	P0.02/AIN0	P0.02/AIN0	GPIO/Analog input	Standard drive, low frequency I/O only
9	P0.03/AIN1	P0.03/AIN1	GPIO/Analog input	Standard drive, low frequency I/O only
10	P1.13	P1.13	GPIO	Standard drive, low frequency I/O only
11	P1.12	P1.12	GPIO	Standard drive, low frequency I/O only
12	P1.11	P1.11	GPIO	Standard drive, low frequency I/O only
13	P1.10	P1.10	GPIO	Standard drive, low frequency I/O only
14	P0.10/NFC2	P0.10/NFC2	GPIO/ NFC antenna connection	Standard drive, low frequency I/O only
15	P0.09/NFC1	P0.09/NFC1	GPIO/ NFC antenna connection	Standard drive, low frequency I/O only
16	GND_2	GND	Ground	
17	BT_ANT	BT_ANT	RF port for BT antenna	

18	GND_3	GND	Ground	
19	GND_4	GND	Ground	
20	P1.07	P1.07	GPIO	Standard drive, low frequency I/O only
21	P1.06	P1.06	GPIO	Standard drive, low frequency I/O only
22	P1.05	P1.05	GPIO	Standard drive, low frequency I/O only
23	GND_5	GND	Ground	
24	SWDCLK	SWDCLK	Serial wire debug clock input for debug and programming	
25	SWDIO	SWDIO	Serial wire debug I/O for debug and programming	
26	GND_6	GND	Ground	
27	ANT2	ANT2	RF port for UWB antenna 2	PDoA option, in non PDoA application, it should be grounded with 50 $\Omega$
28	GND_7	GND	Ground	
29	P0.22	P0.22	GPIO	
30	P0.19	P0.19	GPIO	
31	GND_8	GND	Ground	
32	DW_GPIO7	DW3120 GPIO7	GPIO of DW3120	
33	P0.24	P0.24	GPIO	
34	P0.21	P0.21	GPIO	
35	P0.18/nRESET	P0.18/nRESET	GPIO/Configurable as pin reset	
36	GND_9	GND	Ground	
37	ANT1	ANT1	RF port for UWB antenna 1	
38	GND_10	GND	Ground	
39	USB_D+	D+	USB_D+	USB
40	USB_D-	D-	USB_D-	USB
41	GND_11	GND	Ground	
42	Reserved 1_vdd3	/	NC	Must be open
43	VDD2	DW3120 VDD2	Power Supply (2.5~3.6V) for DW3120	
44	VDD1	DW3120 VDD1	Main Power Supply (2.5~3.6V) for DW3120, should be always ON	
45	VUSB	VBUS	Power Supply (4.4~5.5V) for BLE USB 3.3 V regulator	Left open if USB interface is not used.

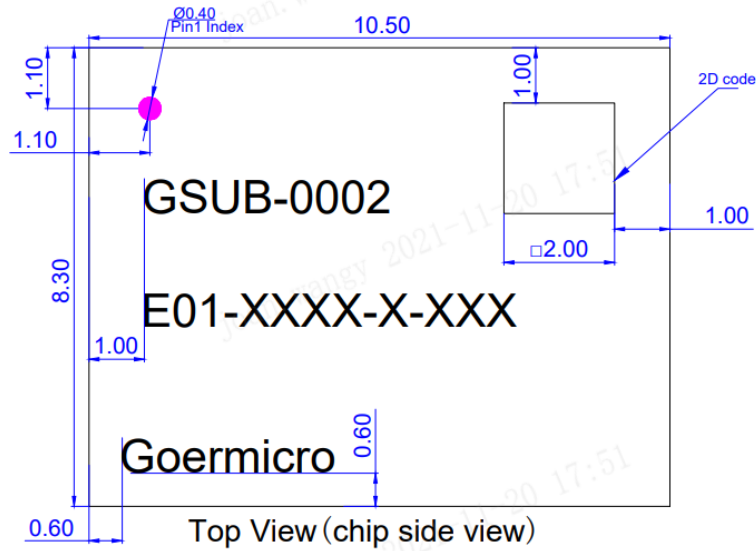


46	VDDMCU	VDD and VDDH	Main Power Supply(2.5~3.6V) for BLE	
47	GND_12	GND	Ground	
48	P1.08	P1.08	GPIO	
49	P1.09	P1.09/TRACEDAT A3	GPIO/Trace buffer TRACEDATA[3]	
50	P0.08	P0.08	GPIO	UART_RX
51	P0.07	P0.07/TRACECLK	GPIO/Trace buffer clock	UART_TX
52	P0.06	P0.06	GPIO	
53	GND_13	GND	GND	
54	P0.12	P0.12/TRACEDAT A1	GPIO/Trace buffer TRACEDATA[1]	
55	P0.11	P0.11/TRACEDAT A2	GPIO/Trace buffer TRACEDATA[2]	
56	P0.13	P0.13	GPIO	
57	P0.14	P0.14	GPIO	
58	P0.31/AIN7	P0.31/AIN7	GPIO/Analog input	
59	P0.29/AIN5	P0.29/AIN5	GPIO/Analog input	
60	P1.15	P1.15	GPIO	Standard drive, low frequency I/O only
61	P1.14	P1.14	GPIO	Standard drive, low frequency I/O only
62	GND_14	GND	Ground	
63	DW_GPIO0	DW3120 GPIO0	GPIO of DW3120	
64	DW_GPIO1	DW3120 GPIO1	GPIO of DW3120	
65	DW_GPIO2	DW3120 GPIO2	GPIO of DW3120	
66	DW_GPIO3	DW3120 GPIO3	GPIO of DW3120	
67	DW_GPIO4	DW3120 GPIO4	GPIO of DW3120	
68	DW_GPIO5	DW3120 GPIO5	GPIO of DW3120	
69	DW_GPIO6	DW3120 GPIO6	GPIO of DW3120	
70	Reserved	/	/	Left open
71	Reserved	/	/	Left open
72~97	GND_15~40	GND	Ground	

\*Note:

1. For more information on standard drive, see GPIO — General purpose input/output in nRF52840 datasheet. Low frequency I/O is signals with a frequency up to 10 kHz.
2. GPIO pins should be left OPEN if not used.

## 5.4 Marking



Marking	Content	Height	Font	Type
Logo	Goermicro	0.6	Arial	Laser
Projcet Name	GSUB-0002	0.6		
Version	E01	0.6		
Config Name	XXXX	0.6		
Strip No.	X (X=1,2,..9,A,Z)	0.6		
Unit No.	XXX(XXX=001,...., 147)	0.6		

## 6. Absolute Maximum Ratings

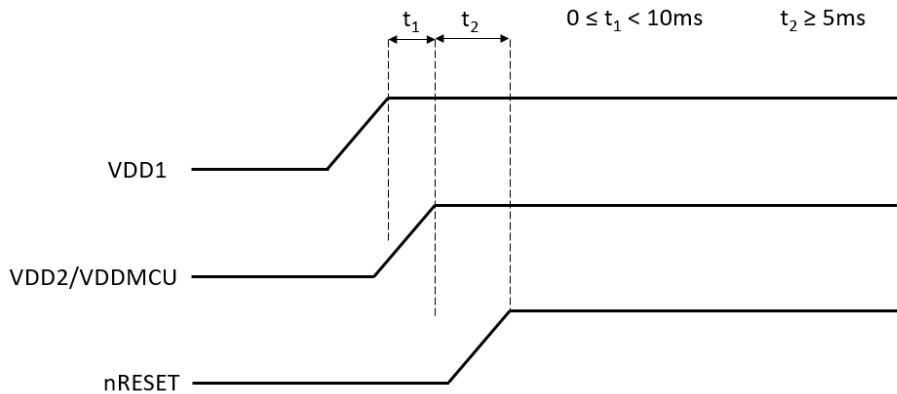
Parameter		Min	Max	Unit
Storage Temperature		-40	85	°C
Supply Voltage	VDD1	-0.3	4.0	V
	VDD2	-0.3	4.0	V
	VUSB	-0.3	5.8	V
	VDDMCU	-0.3	3.9	V

\*Stresses in excess of the absolute ratings may cause permanent damage. Functional operation is not implied under these conditions. Exposure to absolute ratings for extended periods of time may adversely affect reliability. No damage assuming only one parameter is set at limit at a time with all other parameters are set within operating condition.

# 7. Operating Condition

Parameter	Min.	Typ.	Max.	Unit	
Operating Temperature	-20	25	85	°C	
Supply Voltage	VDD1	2.5	3.0	3.6	V
	VDD2	2.5	3.0	3.6	V
	VUSB	4.35	5.0	5.5	V
	VDDMCU	2.5	3.0	3.6	V

# 8. Power Up Sequence



# 9. DC / RF Characteristics

Conditions : 25°C, VDD1, VDD2 and VDDMCU = 3.0V.

## 9.1 Current Consumption

Items	Status	Min.	Typ.	Max.	Unit
DEEP Sleep mode	DW3120: Deep sleep nRF52840 :System OFF			1.1	uA
	DW3120: Deep sleep nRF52840: System ON, RTC and Sensor are disabled		TBD		uA
IDLE-RC mode	DW3120: IDLE-RC mode nRF52840: a wake		7.1		mA
INIT mode	DW3120: INIT-RC mode nRF52840: a wake		5.7		mA
Current consumption@	TX CH5(nominal power@ -41.3dBm/MHz)		41.2		mA

<b>continuous TX/RX</b>	TX CH5(maximum power@ -33dBm/MHz)		54.2		mA
	TX CH9(nominal power@ -41.3dBm/MHz)		48.3		mA
	TX CH9(maximum power@ -35dBm/MHz)		59.8		mA
	RX CH5		48.7		mA
	RX CH9		59.0		mA

## 9.2 Receiver Characteristics (UWB)

Items	Min.	Typ.	Max.	Unit
Frequency range	6000		8500	MHz
Center Frequency Channel 5		6489.6		MHz
Channel bandwidths		499.2		MHz
Minimum Input Level Sensitivity				
Data Rate 850 kbps (PER < 1%)		-100		dBm/500MHz
Data Rate 6.8 Mbps (PER < 1%)		-92		dBm/500MHz
Data Rate 27 Mbps (PER < 1%)		TBD		dBm/500MHz

Items	Min.	Typ.	Max.	Unit
Frequency range	6000		8500	MHz
Center Frequency Channel 9		6489.6		MHz
Channel bandwidths		499.2		MHz
Minimum Input Level Sensitivity				
Data Rate 850 kbps (PER < 1%)		-99		dBm/500MHz
Data Rate 6.8 Mbps (PER < 1%)		-91		dBm/500MHz
Data Rate 27 Mbps (PER < 1%)		TBD		dBm/500MHz

## 9.3 Transmitter Characteristics (UWB)

Items	Min.	Typ.	Max.	Unit
Frequency range	6250		8250	MHz
Center Frequency Channel 5		6489.6		
Center Frequency Channel 9		7987.2		
Channel bandwidths		499.2		MHz
Output Power spectral density (programmable)*1			-41.3	dBm/MHz
Output Chanel Power		-18.5		dBm

\*Using the pre-loaded embedded firmware of the module, otherwise see the DW3000 datasheet.

## 9.4 DC/RF Characteristics for Bluetooth (LE)

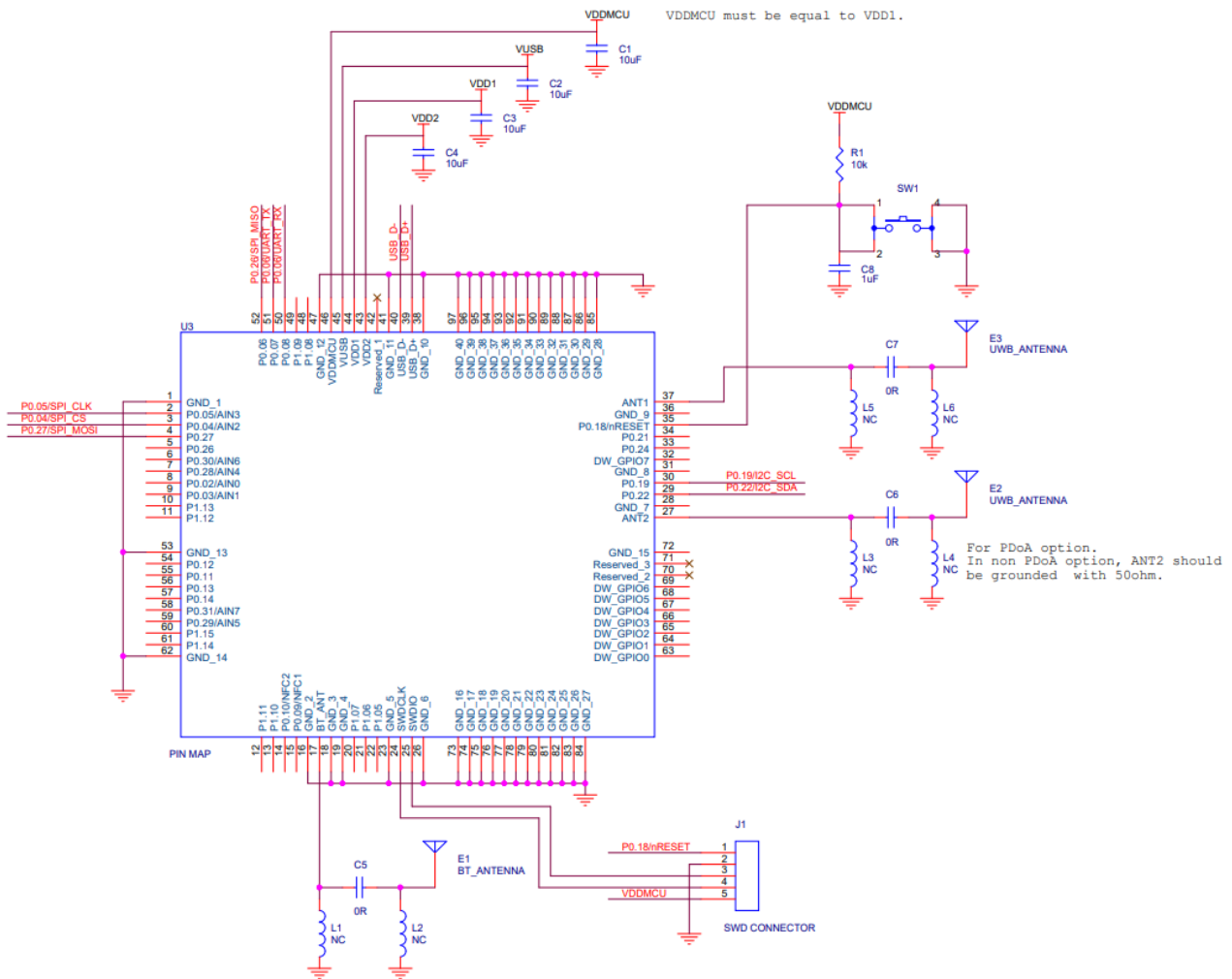
Items	Contents			
Bluetooth specification (power class)	Version 5.0(LE)			
Channel frequency (spacing)	2402 to 2480 MHz (2MHz)			
Number of RF Channel	40			
Data Rate	2Mbps			
Item / Condition	Min.	Typ.	Max.	Unit
Center Frequency	2402	-	2480	MHz
Channel Spacing	-	2	-	MHz
Number of RF channel	-	40	-	-
Output power	-20	-	8	dBm
Modulation Characteristics				
1) $\Delta f_{1_{avg}}$	450	-	550	kHz
2) $\Delta f_{2_{max}}$ (at 99.9%)	370	-	-	kHz
3) $\Delta f_{2_{avg}} / \Delta f_{1_{avg}}$	0.8	-	-	-
Carrier frequency offset and drift				
1) Frequency offset	-	-	150	kHz
2) Frequency drift	-	-	50	kHz
3) Drift rate	-	-	20	kHz
Receiver sensitivity (PER < 30.8%)	-	-92	-	dBm
Maximum received signal strength (PER < 0.1%)	0	-	-	dBm
PER Report Integrity (-30dBm input)	TBD	-	TBD	%

Items	Contents			
Bluetooth specification (power class)	Version 5.0(LE)			
Channel frequency (spacing)	2402 to 2480 MHz (2MHz)			
Number of RF Channel	40			
Data Rate	1Mbps			
Item / Condition	Min.	Typ.	Max.	Unit
Center Frequency	2402	-	2480	MHz
Channel Spacing	-	2	-	MHz
Number of RF channel	-	40	-	-
Output power	-20	-	8	dBm
Modulation Characteristics				
1) $\Delta f_{1_{avg}}$	225	-	275	kHz
2) $\Delta f_{2_{max}}$ (at 99.9%)	185	-	-	kHz
3) $\Delta f_{2_{avg}} / \Delta f_{1_{avg}}$	0.8	-	-	-
Carrier frequency offset and drift				
1) Frequency offset	-	-	150	kHz
2) Frequency drift	-	-	50	kHz
3) Drift rate	-	-	20	kHz
Receiver sensitivity (PER < 30.8%)	-	-95	-	dBm
Maximum received signal strength (PER < 0.1%)	0	-	-	dBm
PER Report Integrity (-30dBm input)	TBD	-	TBD	%

Items	Contents			
Bluetooth specification (power class)	Version 5.0(LE)			
Channel frequency (spacing)	2402 to 2480 MHz (2MHz)			
Number of RF Channel	40			
Data Rate	500Kbps			
Item / Condition	Min	Typ	Max	Unit
Center Frequency	2402	-	2480	MHz
Channel Spacing	-	2	-	MHz
Number of RF channel	-	40	-	-
Output power	-20	-	8	dBm
Modulation Characteristics				
1) $\Delta f_{1_{avg}}$	-	-	-	kHz
2) $\Delta f_{2_{max}}$ (at 99.9%)	-	-	-	kHz
3) $\Delta f_{2_{avg}} / \Delta f_{1_{avg}}$	-	-	-	-
Carrier frequency offset and drift				
1) Frequency offset	-	-	-	kHz
2) Frequency drift	-	-	-	kHz
3) Drift rate	-	-	-	kHz
Receiver sensitivity (PER < 30.8%)	-	-98	-	dBm
Maximum received signal strength (PER < 0.1%)	0	-	-	dBm
PER Report Integrity (-30dBm input)	TBD	-	TBD	%

Items	Contents			
Bluetooth specification (power class)	Version 5.0(LE)			
Channel frequency (spacing)	2402 to 2480 MHz (2MHz)			
Number of RF Channel	40			
Data Rate	125Kbps			
Item / Condition	Min	Typ	Max	Unit
Center Frequency	2402	-	2480	MHz
Channel Spacing	-	2	-	MHz
Number of RF channel	-	40	-	-
Output power	-20	-	8	dBm
Modulation Characteristics				
1) $\Delta f_{1_{avg}}$	225	-	275	kHz
2) $\Delta f_{2_{max}}$ (at 99.9%)	185	-	-	kHz
3) $\Delta f_{2_{avg}} / \Delta f_{1_{avg}}$	-	-	-	-
Carrier frequency offset and drift				
1) Frequency offset	-	-	150	kHz
2) Frequency drift	-	-	50	kHz
3) Drift rate	-	-	19.2	kHz
Receiver sensitivity (PER < 30.8%)	-	-103	-	dBm
Maximum received signal strength (PER < 0.1%)	0	-	-	dBm
PER Report Integrity (-30dBm input)	TBD	-	TBD	%

# 10. Reference Circuit



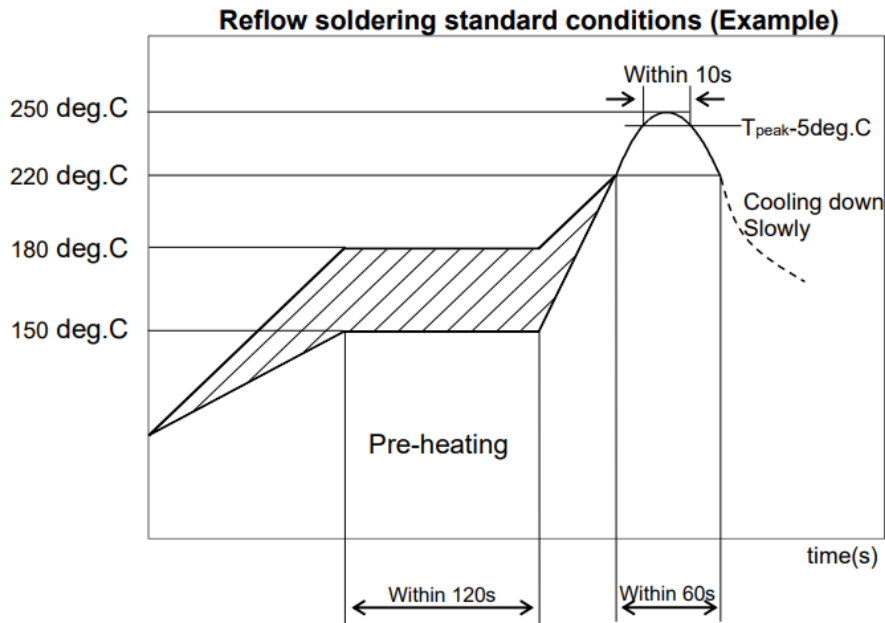
**Notes:**

- 1) The UART, SPI and I2C interface definition in circuit above is based on GSUB-0002 test FW configuration. These interfaces can be mapped to other physical pins according to customer FW configuration.
- 2) Left VUSB, USB\_D+ and USB\_D- open if USB interface is not used.

# 11. Other Specification and Methods

## 11.1 Soldering Conditions

The recommendation conditions of soldering are as in the following figure. Soldering must be carried out by the mentioned conditions to prevent products from damage. Set up the highest temperature of reflow within 260 °C. Contact Goertek Microelectronics before use if concerning other soldering conditions.



Please use the reflow within 2 times.

Use rosin type flux or weakly active flux with a chlorine content of 0.2 wt % or less.

## 12. Tape and Reel Packing

TBD