

K-Solution Consulting Company Ltd.

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# PRBMD02 tiny BT5 ready module

Data sheet version 1.10

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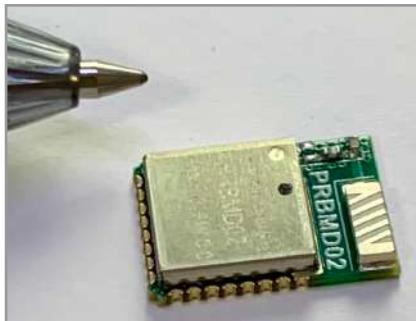
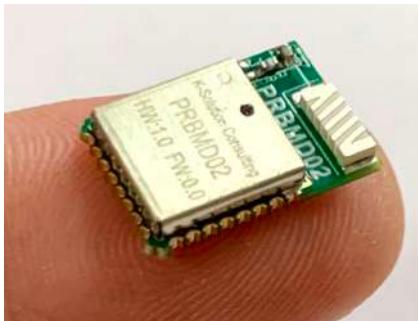
# Introduction

Base on PHY+ Microelectronics' PHY6222 Bluetooth 5 ready core chip, PRBMD02 BT 5 ready module provides a reliable and easy BT5 solution, allowing user, even without any RF design experience, brings their product or system, embedded with BT5 feature, to market in time.

Integrated with almost all peripheral components, such as RF matching network, Antenna, 16MHz Crystal, 32768Hz RC, and DC/DC inductor, which saves engineer resource from hardware design for BLE.

PRBMD02 provides a small form factors which is suitable for different applications, with GPIO count, provides high flexibility to user.

PRBMD02 is FCC, CE and Telec \* certified module, which reduces customer's resource for qualification and allows product to be time to market.



# Applications

- Phone accessories
- Computer peripherals
- CE remote controls for TV, STB and media systems
- Beacons
- Proximity and security alert tags
- Sports and fitness sensors
- Healthcare and lifestyle sensors
- Game controllers
- Home Automation
- Smart RF tags for tracking and social interaction

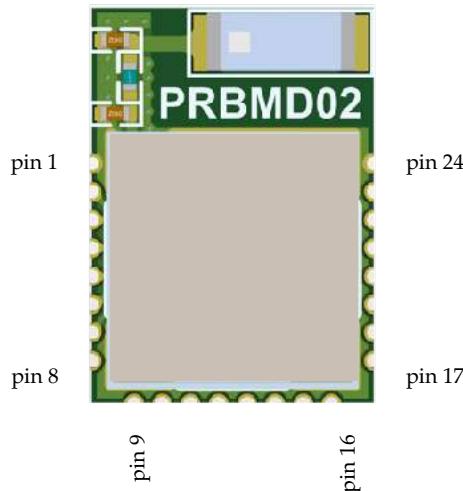
\*In progress

# Hardware information

## Features

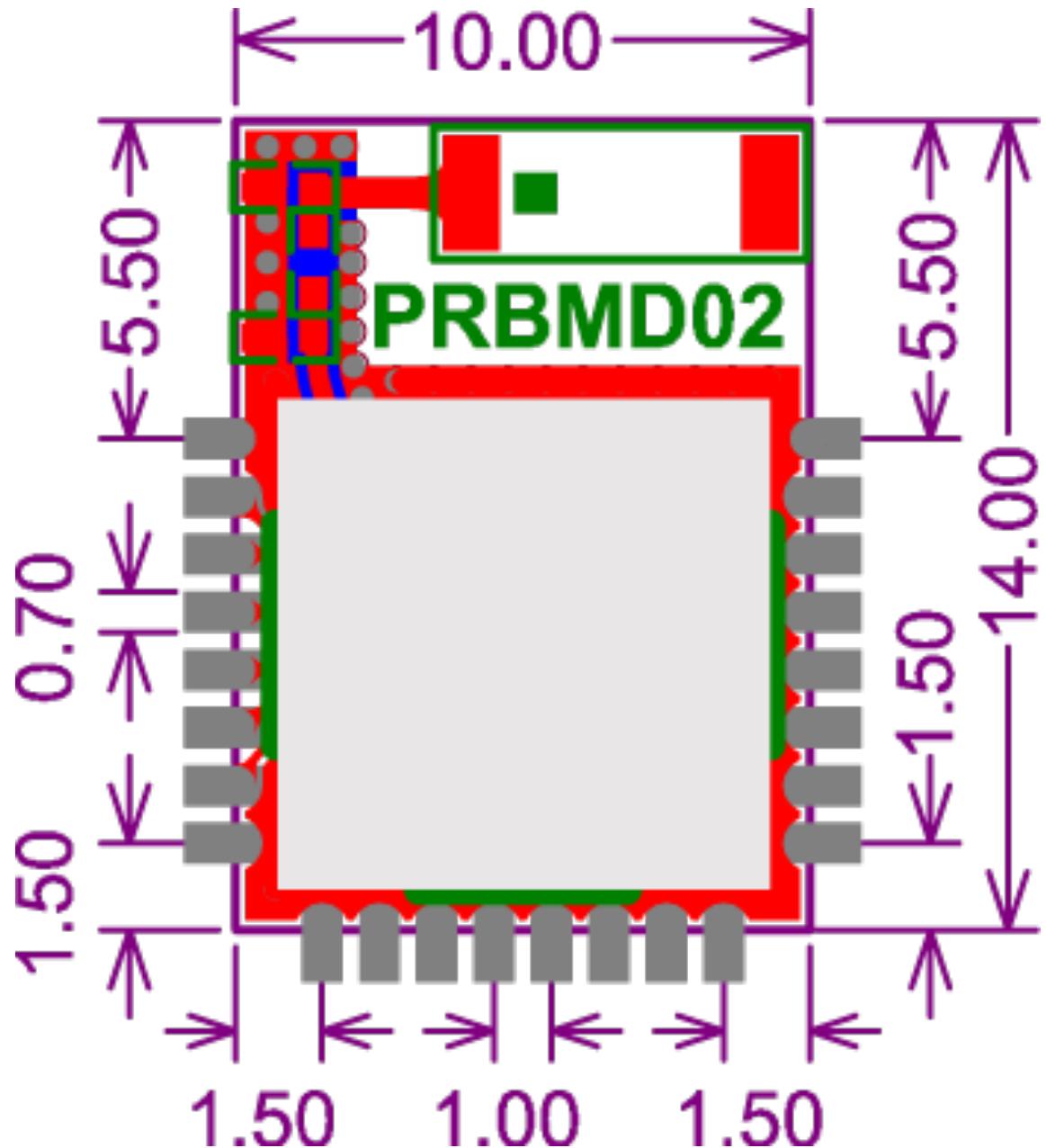
- 32bit Cortex™-M0 processor with 2.4GHz wireless
  - Single-scale 32-bit multiplier
  - Nested Vector Interrupt Controller (NVIC)
  - Up to 48MHz
  - ARMv6M architecture, Thumb ISA but no ARM ISA
  - Up to 32 interprets embedded NVIC
- Sleep / deep sleep mode
- On board chip antenna
- On board 16MHz crystal
- Internal 32K RC network
- On board DC/DC converter
- 128KB Flash, 64KB SRAM, 8K cache
- Small form factor: 10 x 14mm
- High GPIOs count : up to 19
- Soft configurable interfaces: PWM (6), PDM (2), I2C (2), SPI (2), UART (2)
- JTAG for debugging
- Up to Five channels 12bit ADC (Single ended)
- Programmable Gain Amplifier (PGA)
- Bluetooth v5.0 compliant Protocol Stack (BLE)
- Low power consumption (1 $\mu$ A when sleep; 0.3 $\mu$  when OFF)
- Supports SIG\_Mesh feature: Friend node, Low Power node, Proxy node and Relay node
- Sensitivity up to -103dBm @125Kbps
- Tx power from -20 to +10dBm
- FCC, CE and TELEC certification (in progress)

## Pin assignment



pin	name	Description	Alternative
1	GND	Power ground	
2	P23	GPIO	1. ADC input 1; 2. Mic bias
3	P24	GPIO	ADC input 2
4	P25	GPIO	ADC input 8
5	P31	GPIO	
6	P32	GPIO	
7	P33	GPIO	
8	P34	GPIO	
9	P00	GPIO	
10	P01	GPIO	
11	P02	GPIO	SWD debug data in
12	P03	GPIO	SWD debug clock
13	TM	Mode select pin	
14	P09	GPIO	
15	P10	GPIO	
16	RST	RESET	
17	VDD	VDD, 1.8 - 3.6V	
18	P14	GPIO	ADC input 3
19	P15	GPIO	1. ADC input 4; 2. MIC bias output
20	P16	GPIO	32768 oscillator in
21	P17	GPIO	32768 oscillator out
22	P18	GPIO	1. ADC input 7; 2. PGA negative input
23	P20	GPIO	1. ADC input 9; 2 PGA positive input
24	GND	GND	

## Dimension



Unit: mm

thickness: 3mm

## Specifications (major parameters)

	Description	Typical value
General	Operation voltage	1.8V to 3.6V DC
	Operation current	Advertising: Average - 3mA; Max peak - 9mA Connected Average - 3.18mA; Max peak - 9mA
	SLEEP mode current * needed firmware activation	Sleep mode: 1uA, with 32768Hz RTC
	OFF mode current	0.3uA
	Microcontroller	32-bit ARM Cortex M0, PHY6222
	GPIO	19 configurable
	Oscillators	16MHz crystal oscillator 32kHz RC oscillator (internal)
	Digital I/O	X2 Hardware SPI master UART
RF	Frequency band	2.4GHz ISM ( 2.40000 – 2.4835GHz)
	Modulation	GFSK
	Data rate	250kbps, 1 Mbps, 2 Mbps
	TX Power	-20 to +10dBm in 4dB steps
	Sensitivity	-97dBm @ 1Mbps Bluetooth LE -103dBm @125kbps Bluetooth LE
	RF Range (indoor)	~100m
Environment	Storage temperature	-40 to 125°C
	Operation temperature	-40 to 85°C
	Moisture sensitivity level	3
	ESD Human Body Model Class2	2kV
Flash memory	Endurance	100000 write/erase cycles
	Retention	10 year @ 40°C

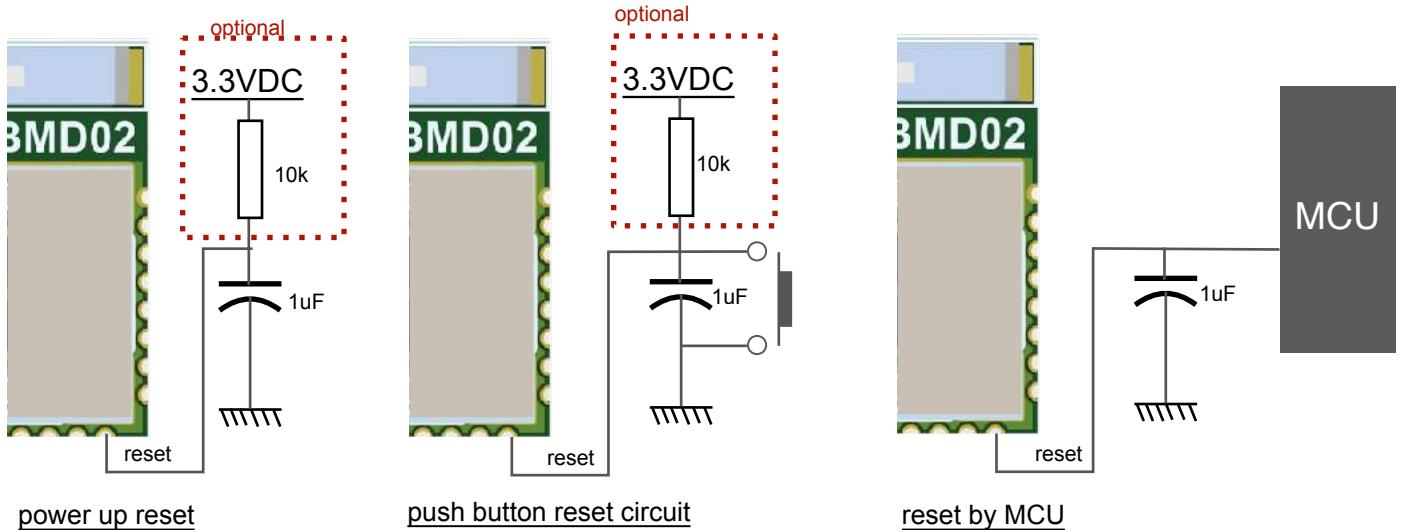
	Description	Typical
Radio current consumption	Tx only at 0dBm, with internal DC-DC@3V	typ. 4.6mA
	Rx only, with internal DC-DC@3V	typ. 4mA
Transmitter	RF max output power	10dBm
	RF min output power	-20dBm
	OBW for BLE, 1Mbps, 20dB occupy-bandwidth for BLE modulation 1Mbps	1100KHz
	OBW for BLE, 2Mbps, 20dB occupy-bandwidth for BLE modulation 2Mbps	2300KHz
	OBW for GFSK, 500Kbps, 20dB occupy-bandwidth for GFSK modulation 2Mbps	1100KHz
	OBW for GFSK, 125bps, 20dB occupy-bandwidth for GFSK modulation 2Mbps	1100KHz
Receiver		
BLE 1Mbps GFSK RX	Rx sensitivity, 1Mbps BLE ideal transmitter, 37 Byte BER=1E-3	-99dBm
	co-channel rejection , modulated interferer in channel, 37 Byte BER=1E-3	-6I/C dB
	Selectivity +/-1MHz , Wanted signal at -67dBm, modulated interferer at +/- 1MHz, 37 Byte BER=1E-3	7 I/C dB
	Selectivity +/-2MHz Wanted signal at -67dBm, modulated interferer at 45 +/- 2MHz, 37 Byte BER=1E-3	45 I/C dB
	Selectivity +/-3MHz Wanted signal at -67dBm, modulated interferer at +/- 3MHz, 37 Byte BER=1E-3	50 I/C dB
	Selectivity +/-4MHz Wanted signal at -67dBm, modulated interferer at 50 +/- 4MHz, 37 Byte BER=1E-3	50 I/C dB
	Selectivity +/-5MHz or more Wanted signal at -67dBm, modulated interferer at >= +/- 5MHz, 37 Byte BER=1E-3	55 I/C dB
	Selectivity Imag frequency Wanted signal at -67dBm, modulated interferer at image frequency, 37 Byte BER=1E-3	22 I/C dB
	Intermodulation Wanted signal at 2402MHz, -64dBm, Two interferers at 2405 and 2408 MHz respectively, at the given power level, 37 Byte BER=1E-3	-20dBm
	Carrier Frequency Offset Tolerance	+- 350KHz
	Sample Clock Offset Tolerance	+-120ppm

Description		Typical
Receiver		
BLE 2Mbps GFSK RX	Rx sensitivity, 500kbps BLE ideal transmitter, 37 Byte BER=1E-3	-96dBm
	co-channel rejection , modulated interferer in channel, 37 Byte BER=1E-3	-6I/C dB
	Selectivity +-1MHz, Wanted signal at -67dBm, modulated interferer at +/- 1MHz, 37 Byte BER=1E-3	-5 I/C dB
	Selectivity +-2MHz Wanted signal at -67dBm, modulated interferer at the +/- 2MHz, 37 Byte BER=1E-3	9 I/C dB
	Selectivity +-3MHz Wanted signal at -67dBm, modulated interferer at +/- 3MHz, 37 Byte BER=1E-3	30 I/C dB
	Selectivity +-4MHz Wanted signal at -67dBm, modulated interferer at 50 +/- 4MHz, 37 Byte BER=1E-3	40 I/C dB
	Selectivity +-5MHz or more Wanted signal at -67dBm, modulated interferer at >=+/- 5MHz, 37 Byte BER=1E-3	55 I/C dB
	Selectivity Imag frequency Wanted signal at -67dBm, modulated interferer at image frequency, 37 Byte BER=1E-3	22 I/C dB
	Intermodulation Wanted signal at 2402MHz, -64dBm, Two interferers at 2405 and 2408 MHz respectively, at the given power level, 37 Byte BER=1E-3	-20dBm
	Carrier Frequency Offset Tolerance	+- 350KHz
	Sample Clock Offset Tolerance	+-120ppm
	Rx sensitivity, 2Mbps BLE ideal transmitter, 37 Byte BER=1E-3	-100dBm
500Kbps GFSK RX	co-channel rejection , modulated interferer in channel, 37 Byte BER=1E-3	-4 I/C dB
	Selectivity +-1MHz, Wanted signal at -67dBm, modulated interferer at +/- 1MHz, 37 Byte BER=1E-3	10 I/C dB
	Selectivity +-2MHz Wanted signal at -67dBm, modulated interferer at the +/- 2MHz, 37 Byte BER=1E-3	45 I/C dB
	Selectivity +-3MHz Wanted signal at -67dBm, modulated interferer at +/- 3MHz, 37 Byte BER=1E-3	50 I/C dB
	Selectivity +-4MHz Wanted signal at -67dBm, modulated interferer at 50 +/- 4MHz, 37 Byte BER=1E-3	50 I/C dB
	Selectivity +-5MHz or more Wanted signal at -67dBm, modulated interferer at >=+/- 5MHz, 37 Byte BER=1E-3	55 I/C dB
	Selectivity Imag frequency Wanted signal at -67dBm, modulated interferer at image frequency, 37 Byte BER=1E-3	24 I/C dB
	Intermodulation Wanted signal at 2402MHz, -64dBm, Two interferers at 2405 and 2408 MHz respectively, at the given power level, 37 Byte BER=1E-3	-19dBm
	Carrier Frequency Offset Tolerance	+- 350KHz
	Sample Clock Offset Tolerance	+-120ppm

	Description	Typical
Receiver		
125Kbps GFSK Rx	Rx sensitivity, 125kbps BLE ideal transmitter, 37 Byte BER=1E-3	-105 dBm
	co-channel rejection , modulated interferer in channel, 37 Byte BER=1E-3	-1 I/C dB
	Selectivity +-1MHz , Wanted signal at -67dBm, modulated interferer at +/- 1MHz, 37 Byte BER=1E-3	-11 I/C dB
	Selectivity +-2MHz Wanted signal at -67dBm, modulated interferer at the +/- 2MHz, 37 Byte BER=1E-3	45 I/C dB
	Selectivity +-3MHz Wanted signal at -67dBm, modulated interferer at +/- 3MHz, 37 Byte BER=1E-3	50 I/C dB
	Selectivity +-4MHz Wanted signal at -67dBm, modulated interferer at 50 +/- 4MHz, 37 Byte BER=1E-3	50 I/C dB
	Selectivity +-5MHz or more Wanted signal at -67dBm, modulated interferer at >= +/- 5MHz, 37 Byte BER=1E-3	55 I/C dB
	Selectivity Imag frequency Wanted signal at -67dBm, modulated interferer at image frequency, 37 Byte BER=1E-3	28 I/C dB
	Intermodulation Wanted signal at 2402MHz, -64dBm, Two interferers at 2405 and 2408 MHz respectively, at the given power level, 37 Byte BER=1E-3	-18dBm
	Carrier Frequency Offset Tolerance	+- 350KHz
	Sample Clock Offset Tolerance	+-120ppm
RSSI specifications	RSSI Dynamic Range	70 dB
	RSSI Accuracy RSSI accuracy valid in range -100 to -30dBm	+-2dB
	RSSI resolution Total 7bits, from 0 to 127	1 dB
	RSSI period	8us

## Reset the module

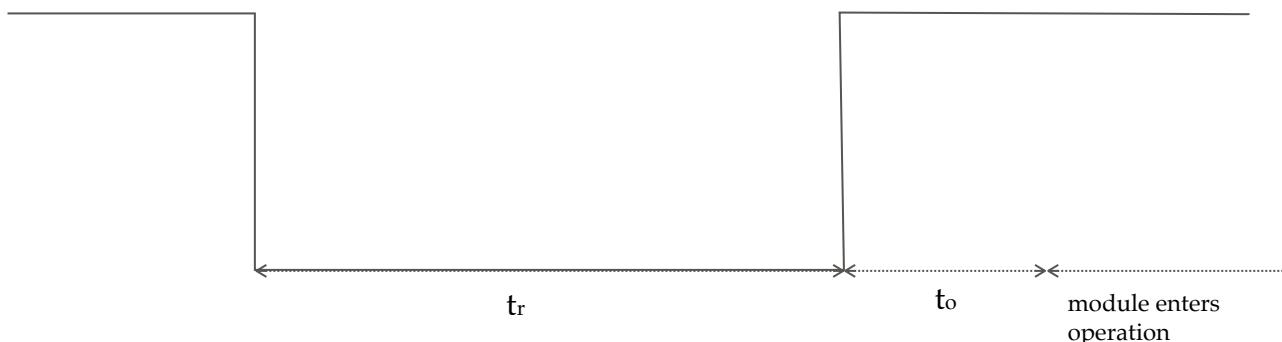
The reset pin connection could be one of the following:



Reset pin contains internal pull up, and external pull up circuit is optional.

A low signal will reset the module, and the timing is illustrated as following:

Reset



$t_r$  = at least  $1\mu s$

$t_o$  =  $500\mu s$

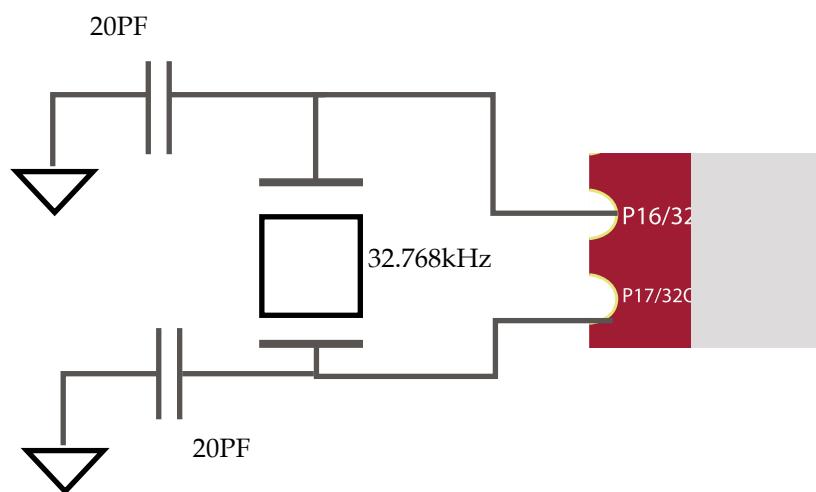
## The clock

### Main clock

PRBMD02 embeds with a 16MHz main oscillator, and it is software configurable up scale to higher internal frequency: 32M, 48M, 64M or 96MHz. By default it is not up scaled.

### RTC

If 32.768kHz crystal is not installed (pin P16 and P17), internal RC oscillator circuit can be then enable by firmware and be use as real time clock. This internal RC oscillator circuit will be calibrated periodically. External 32.768KHz circuit is illustrated as below:



## Firmware programming

User is able to program their own developed firmware (with SDK) into PRBMD0x. The programming procedure is as following, programming software, PhyPlusKit.exe (for window) must be pre-installed, and UART-USB dongle may be needed:

1. Connect TM pin (pin 10) to 3.3V
2. Connect Tx and Rx (P09 and P10) pin to UART dongle
3. On PhyPlusKit, select the proper COM port and Baud Rate (default: 115200)
4. Click Erase to erase current firmware in PRBMD02
5. Load the firmware and click Write to program into PRBMD02
6. Connect TM pin to low level and apply reset. New firmware then starts to operate.

## GPIO and interfaces

Every GPIO can be configured as Input, Output and Interrupt, and can also be configured as weak pull-up, strong pull-up, weak pull-low or floating mode.

Except ADC, all interfaces are possible to map to different GPIOs by software. The interface including:

1. I2C: it supports 100KHz and 400KHz modes, 7-bit and 10-bit address
2. I2S: either master or slave mode can be enabled
3. UART: Asynchronous Rx/Tx, up to almost 1Mbps, supports parity and 9 bit-data
4. PWM: 6 channels PWM is multiplex with GPIO, and the frequency is base on the main clock (16MHz) as the following equation:

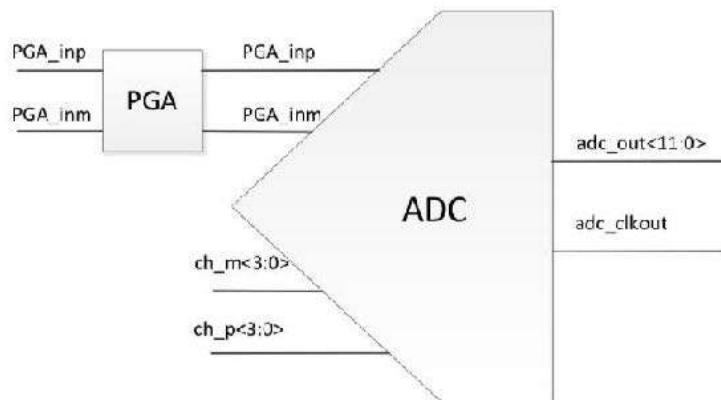
$$\text{Freq\_PWM} = 16\text{MHz} / (\text{N\_prescaler} \times \text{N\_top\_count});$$

where the value in N\_top\_count register controls the frequency and the Duty cycle is controlled by the following equation:

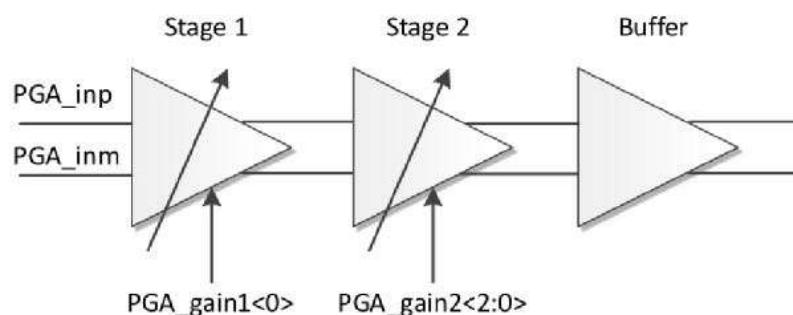
$$\text{Duty\_cycle\_PWM} = \text{N\_threshold} / \text{N\_top\_count}$$

where the value in N\_threshold, together with N\_top\_count, control the duty cycle

5. Quadrature decoder: it can interface and decode signal from quadrature-encoded sensor, both mechanical and optical sensors. Input debounce filters is included.
6. Keypad: it supports up to 16 rows by 18 columns key matrix. Multi-key-press support and de-bounce time is configurable.
7. Analog to Digital converter (ADC) : Up to 10 12-bit SAR ADC, and two inputs are with PGA, which provides a software configurable 0 to 42dB with 3dB steps.



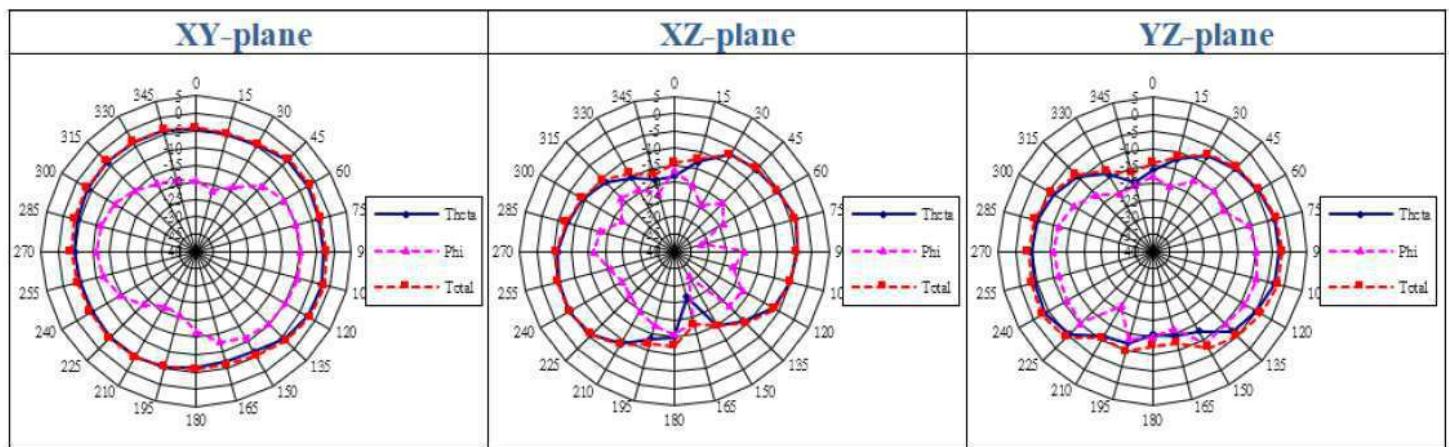
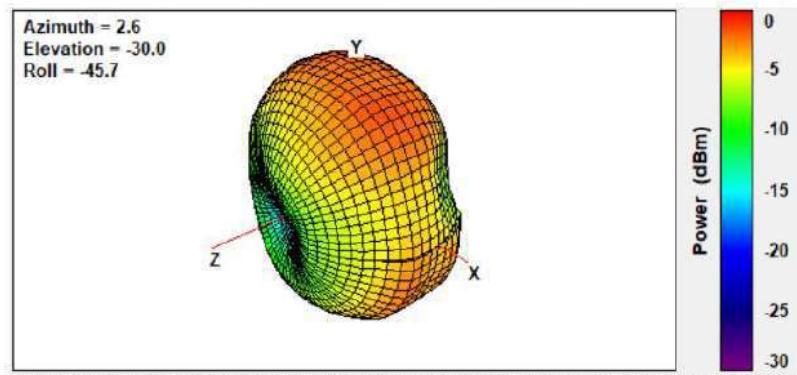
8. PGA provides 42dB gain range from 0dB to 42dB in 3dB steps.



# RF characteristic

PRBMD02 RF characteristic is illustrated as following:

2.45GHz



## PRBMDxx family comparison



	PRBMD00	PRBMD02
<b>Core chip</b>	Cortex™ -M0	Cortex™ -M0 with SWD
<b>Dimension</b>	12x18mm	10x14mm
<b># of GPIO</b>	33 GPIOs	19 GPIOs
<b>Operation voltage</b>	2.5 - 6V	1.8-3.6
<b>Flash</b>	512KB	128KB
<b>SRAM</b>	138KB	64KB
<b>ROM</b>	128KB	96KB
<b>Cache</b>	N/A	8KB
<b>e-fuse</b>	N/A	256bit
<b>ADC</b>	8 channel, 12 bits	7 channels, 12 bit
<b>PGA</b>	N/A	1
<b>PWM</b>	6 channels	6 channels
<b>I2S</b>	4 channels	N/A
<b>SPI</b>	2 channels	2 channels
<b>I2C</b>	2 channels	2 channels
<b>UART</b>	1 channels	2 channels
<b>Current (Sleep, OFF)</b>	2uA, 0.8uA	1uA, 0.3uA
<b>Tx Power</b>	-20 to +10dBm in 4dB steps	-20 to 10dBm in 3dB steps
<b>Sensitivity</b>		
<b>Operation temperature</b>	-10 to 60C	

## Points to note

- IO pins pull high/low resistance:
  - Floating: Hi-Z
  - Strong pull up:  $150\text{K}\Omega$
  - Weak pull up:  $1\text{M}\Omega$
  - Pull down:  $100\text{k}\Omega$
- P1, P15, P16, P17 do not support FullMUX, and only treated as GPIO.
- Except TM / P16 and P17, all GPIO support interrupt and wakeup
- Single-end ADC pins: P11, P23, P24, P14 and P15
- Differential ADC pins: P18-P25; P14-P24; P20-P15
- Two modes available for ADC: bypass and attenuation:
  - By-pass mode
    - Without attenuation, input range should be 0-0.8V
  - Attenuation mode
    - Attenuation circuit enable, and input range is 0.3.2V

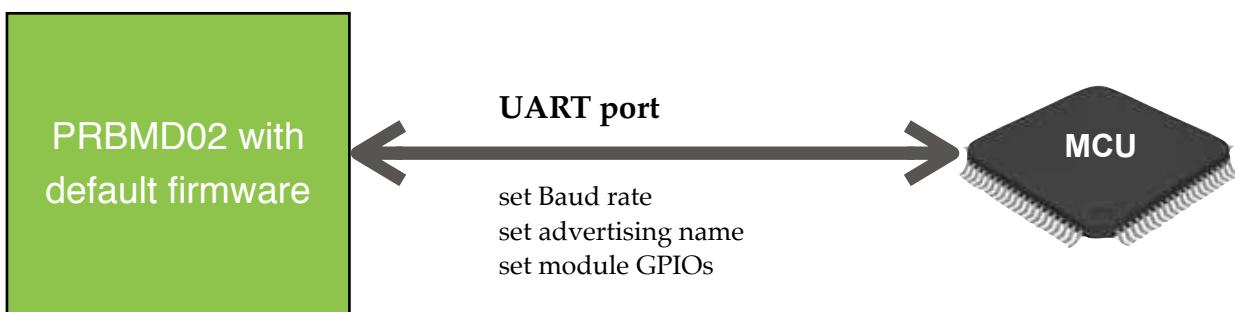
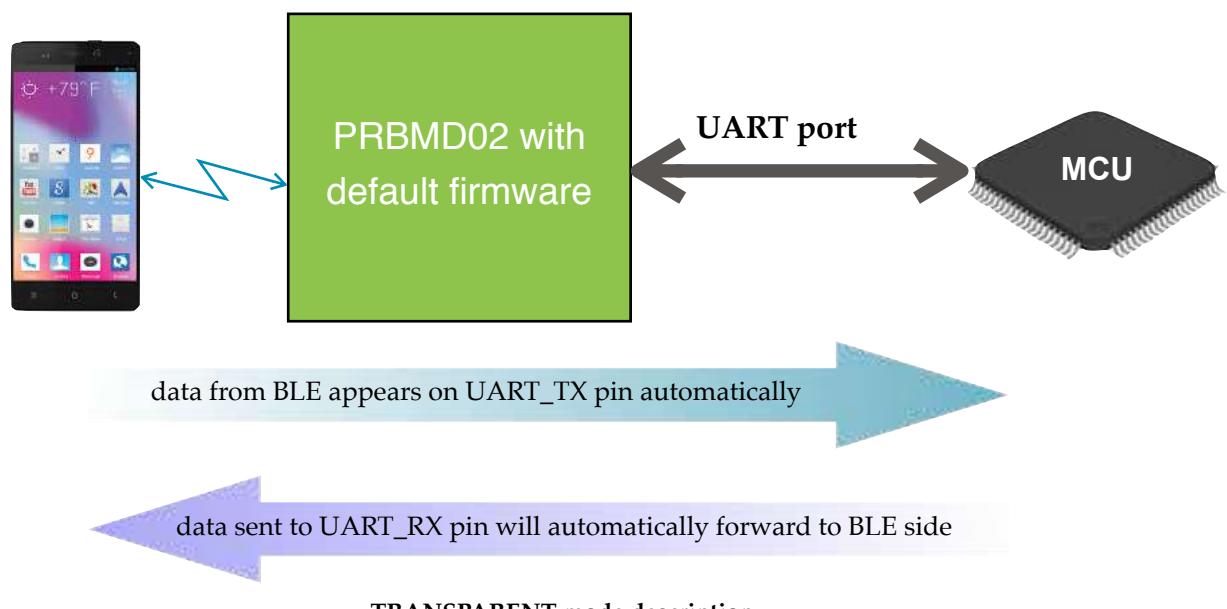
# Firmware information

## Default firmware

PRBMD02 comes with default UART-BT firmware, allowing user able to enable their product with BT feature without any extra engineer resources. The firmware basic feature is to tunnel data between UART port and Bluetooth device (Transparent mode). User can develop their own firmware by SDK as well if default firmware is not applicable.

### AT-CMD and Transparent Modes

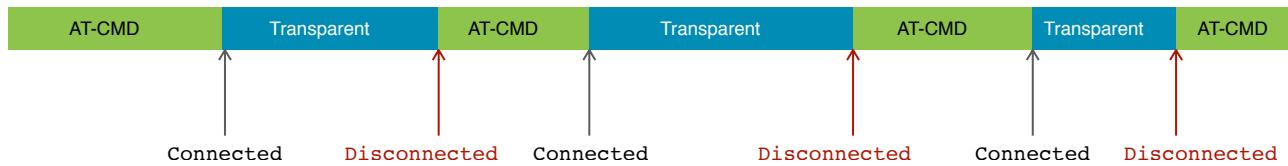
The firmware contains two modes: AT-CMD mode and Transparent mode. In AT-CMD mode, PRBMD02 accepts AT-command from UART port and change the configuration; in Transparent mode, ALL data from UART port will forward to Bluetooth and vice versa.



AT-CMD mode description

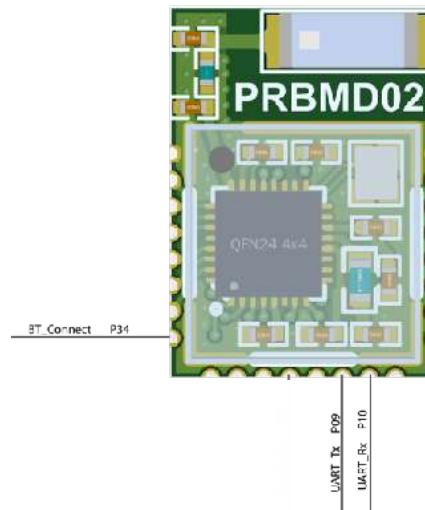
## Mode switching

The switching between AT-CMD and Transparent mode is automatically. When PRBMD02 is NOT connected with smartphone, tablet..., PRBMD02 will enter AT-CMD mode and AT-command will be accepted from UART port; and once PRBMD02 is connected to with smartphone or any other BT device, PRBMD02 will automatically go into Transparent mode, and all data from UART, even AT-CMD, will be treated as data and send out to BT side. The operation is illustrated as following:



## Pin definition

The PRBMD02 default firmware mainly defined some pins of PRBMD02 as following:



Pin assignment in PRBMD02

**P34:** BT\_Connect, it is used to connect with LED to indicate the BT connection status. Before connection, this pin will toggle at about 2Hz frequency, and after a connection is established, this pin will turn to LOW status

**P09:** UART\_Tx, Firmware define it as Tx pin of UART, which is supposed to be connect to UART Rx pin of MCU or other device.

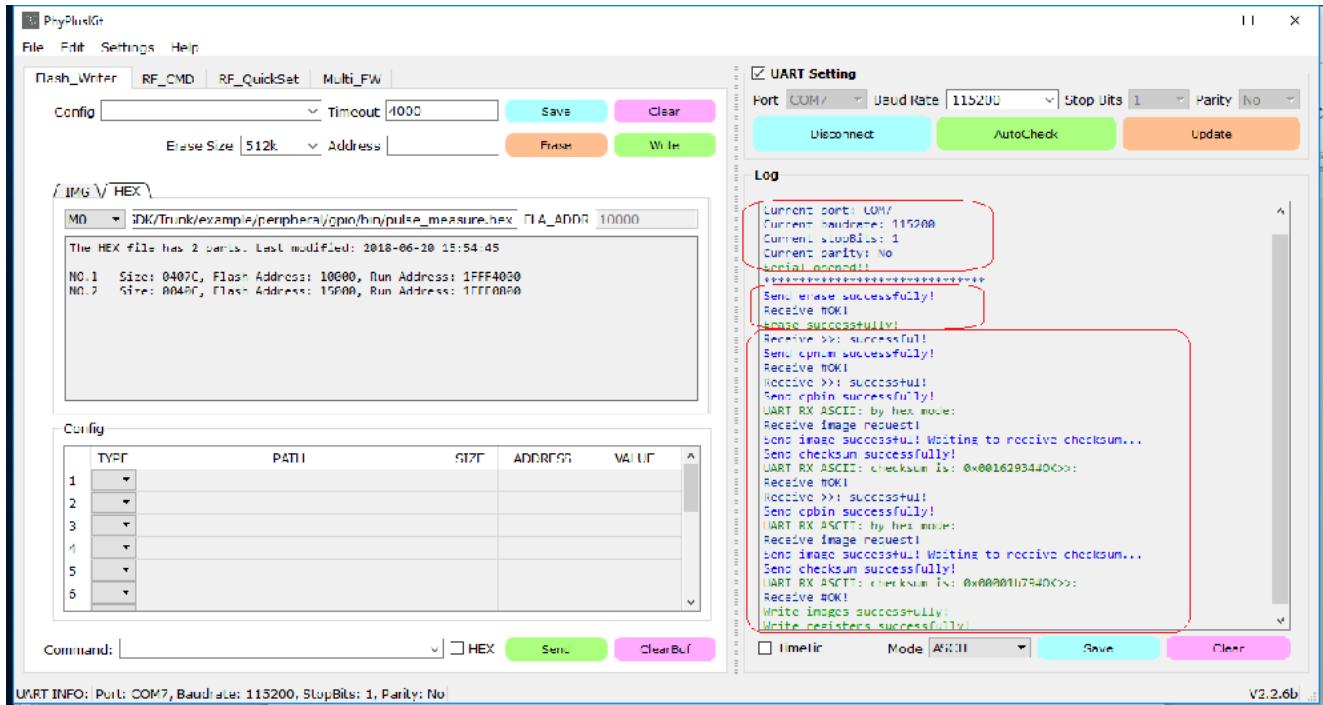
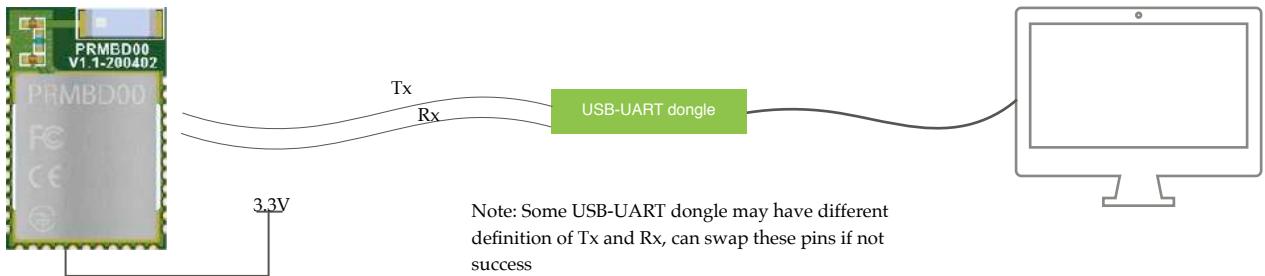
**P10:** UART\_Rx, Firmware define it as Rx pin of UART, which is supposed to be connect to UART Tx pin of MCU or other device.

## AT-command

AT-command in AT-CMD mode are listed as below:

	Action	enquiry	return value	set	return value
BT related	set/get ID	<b>AT+ID?</b>	Current address	<b>AT+ID=addr</b> addr format: xx:xx:xx:xx:xx:xx	
	Help	<b>AT+HELP</b>	List all AT commands and status		
	Reset			<b>AT+RESET</b>	
	Factory Default setting (reset needed)			<b>AT+DEFAULT</b>	- BAUD = 115200, TXP = 0, NAME = PRBMD02
	Change name	<b>AT+NAME?</b>	- current name Default:PRBMD02	<b>AT+NAME= New name</b>	
	Start advertising			<b>AT+BDCS</b>	
	Stop advertising			<b>AT+BDCE</b>	
	Get/Set Tx power level	<b>AT+TXP?</b>	0-4 0: 5dBm 1: 0dBm 2: -5dBm 3: -20dBm 4: -10dBm	<b>AT+TXP=y</b> y= 0-4	
	BAUD rate	<b>AT+SPEED?</b>	Current baud	<b>AT+SPEED=BAUD</b> , BAUD = 4800, 9600, 14400, 19200, 38400, 57600, 115200 and 5000000	- New BAUD if success note: data byte, parity and stop bit are fixed at 8,N,1
UART and GPIO	Define a pin as BT_Connect LED pin			<b>AT+LED=xx</b> , xx=GPIO	
	Enable BT_Connect LED			<b>AT+LEDON</b>	
	Disable BT_Connect LED			<b>AT+LEDOFF</b>	
	Read and set IO pin (except P09 and P10)	<b>AT+GPIO xx=?</b> xx:available GPIO	1 or 0	<b>AT+GPIOxx=y</b> xx:available GPIO	y= 0 or 1, where 0 is low level and 1 is high level
	All GPIO HIGH			<b>AT+HIGH</b>	
	All GPIO LOW			<b>AT+LOW</b>	

# Firmware programming



PhyPlusKit interface

Note: More information will be described in PRBMD0x Programming document.

## MAC address

Unless otherwise instructed, each PRBMD02 will be shipped with KATP pre-programmed but no MAC address is pre-programmed. User can program their own MAC address by PhyPlusKit. It is important to be reminded that **MAC address can be only written once and cannot be re-written**.

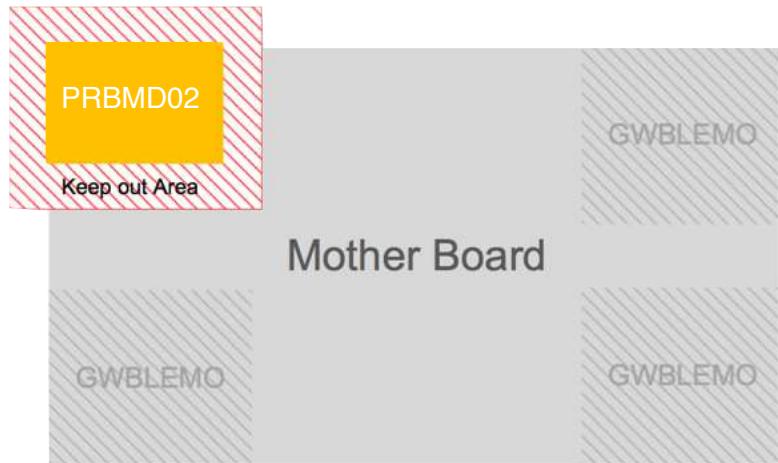
TYPE	PATH	SIZE	ADDRESS	VALUE
1	MAC			56:78:90:98:76:54
2				
3				
4				

## Mounting guide

PRBMD02 is RF sensitive; in order to obtain the best performance, it is recommended to mount the module at corner of mother board, and with some marginal space.

Also, keep it away from metal components, such like speakers, transformers, batteries, big aluminum capacitors, heat sinks and Metal Panels.

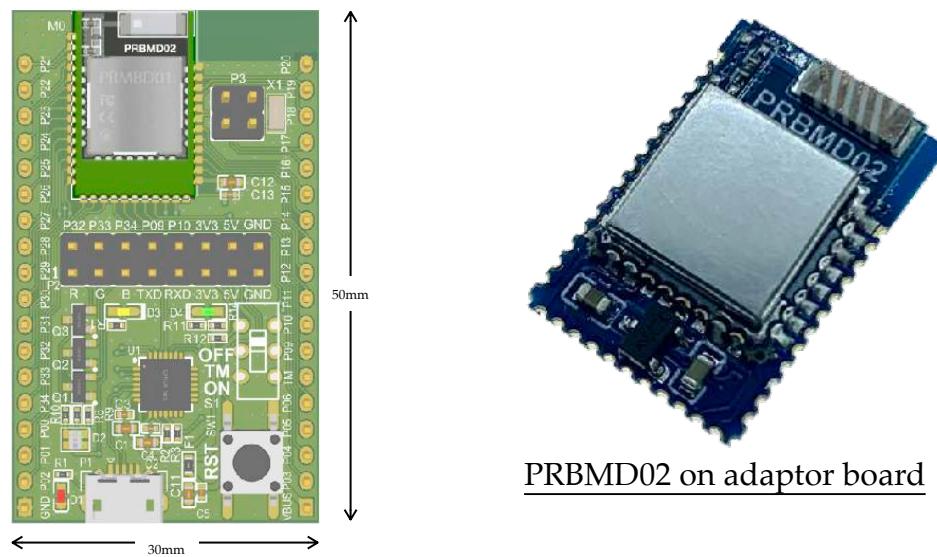
The figure below illustrates how to mount the PRBMD02 module. Improper mounting will decrease the RF performance dramatically.



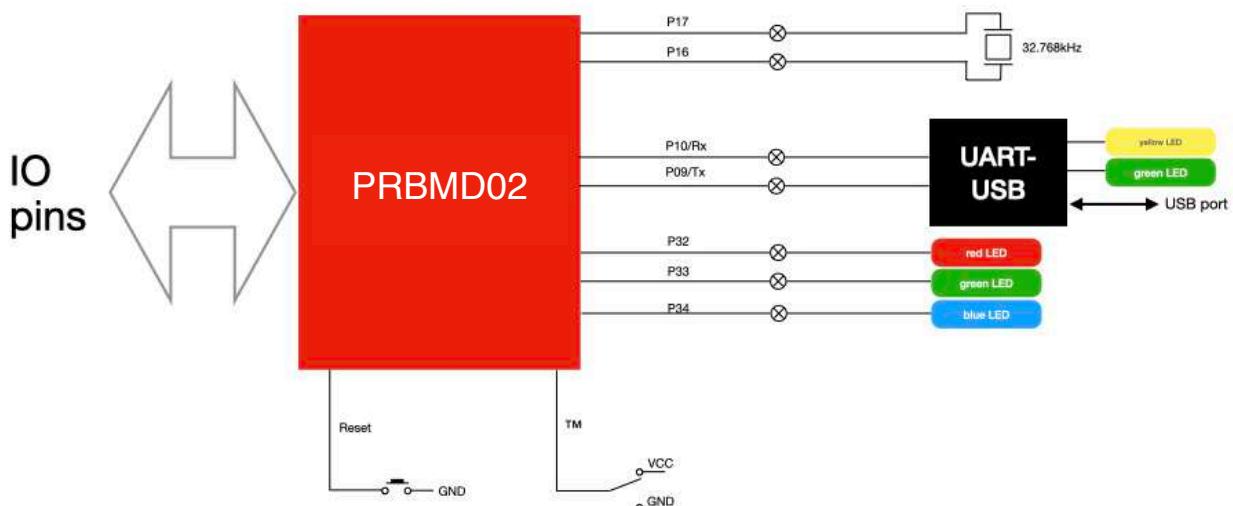
# Evaluation Board

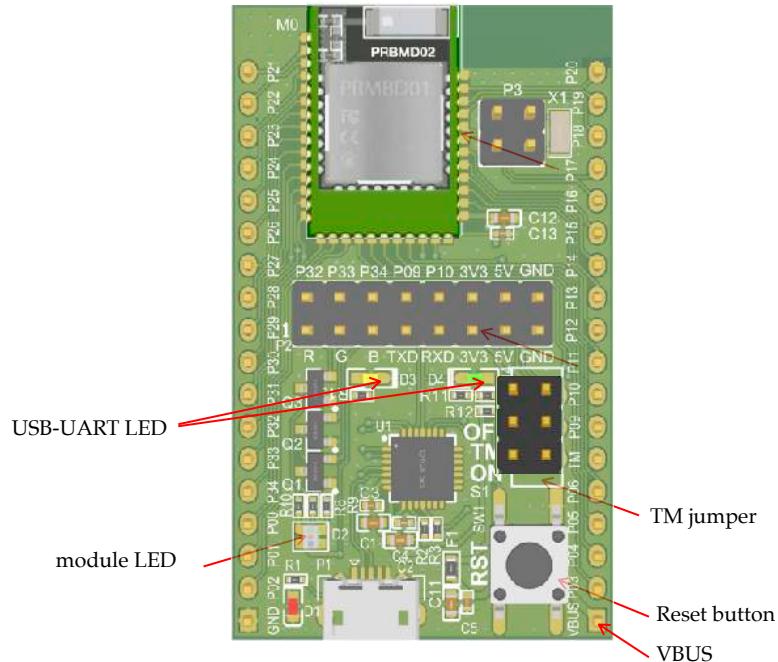
Evaluation board (EVB) is available, helping engineer for the firmware development. It is in DIP form factor, allows engineer to connect with external circuit easily for debugging and testing. EVB for PRBMD02 is same as EVB for PRBMD00, and an adaptor board that convert PRBMD02 pin to connect with the EVB

The EVB is illustrated as following:



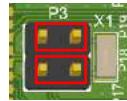
The EVK is in DIP format with PRBMD02 (and adaptor board) on it, and with on board 32.768KHz crystal and UART-USB chip, allow user to test and program the module easily. PRBMD02 is pre-programmed with the UART-BT tunnelling firmware. Below is the block diagram of the EVK:





### 1. 32K jumper:

Since P16,P17 are multiplex with external 32.768KHz oscillator, this jumper allows the PRBMD02 to be connected with the on board 32.768KHz oscillator.



### 2. LED & UART jumper:

This jumper allows the module to be connected with on-board LED and the on-board USB-UART chip. Connecting 5V allows PRBMD02 to be powered from USB. Connecting 3V3 will provide a 3.3VDC to the rest of the board

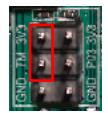


### 3. TM Jumper

PRBMD02 goes into firmware programming mode if TM pin is connected to the 3V3 pin.

### 4. Reset button

Pressing this button to reset PRBMD02 module



### 5. USB-UART LED:

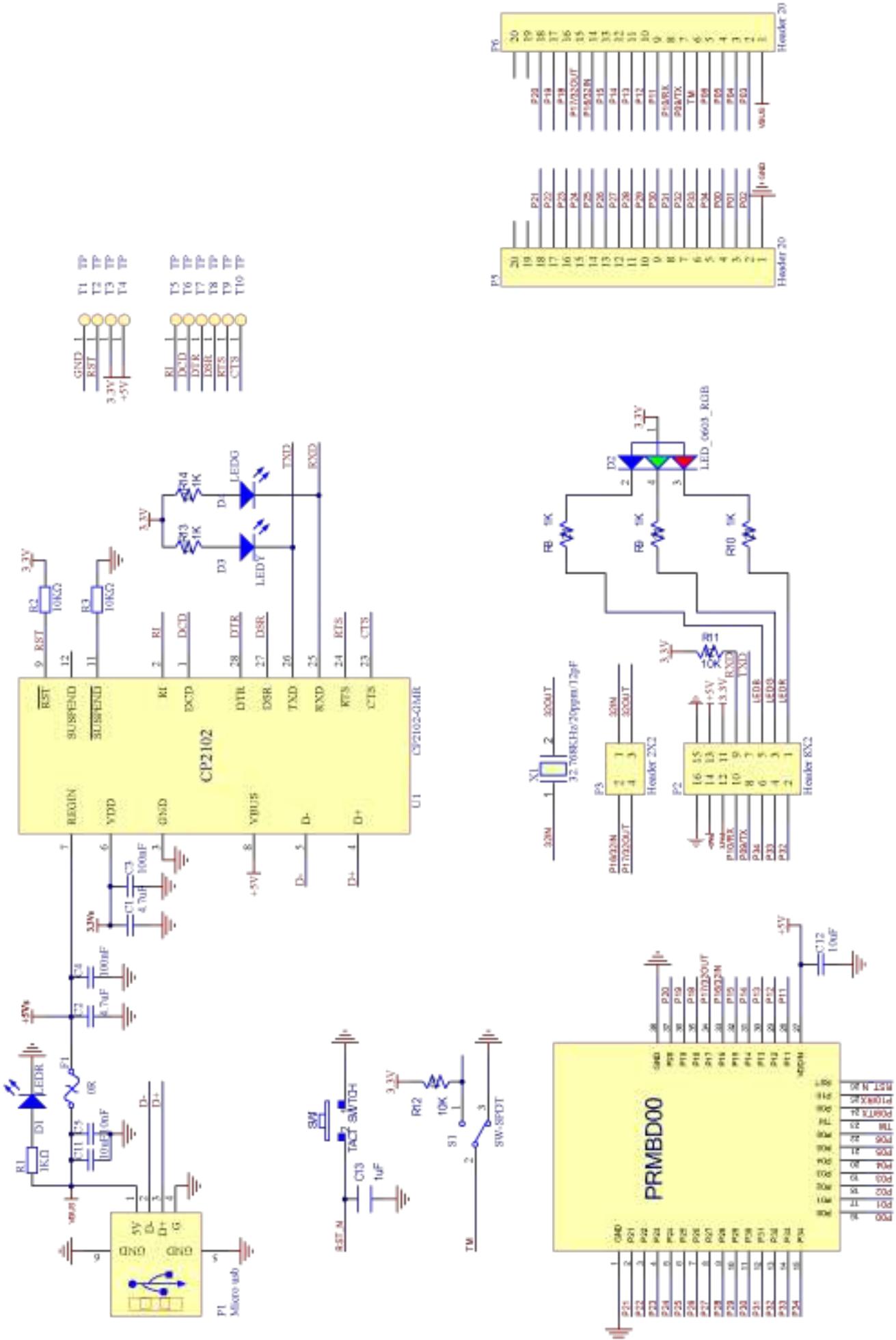
LEDs indicate UART traffic, yellow LED represents TXD and green LED represents RXD

### 6. module LED:

LEDs connect to the LED & UART jumper, user can make use of these LED by shorting the jumper.

### 7. VBus pin:

The EVK can be powered by USB port, or a 5VDC can be applied to this pin to power up the board.



# Firmware development and SDK

User is allowed to developed their own firmware for PRBMD02 through SDK as following:

1. copy SDK to a working directory
2. install MDK Keil5 for ARM IDE
3. Example code in SDK can now be edit and compiled.

Experience on ARM core firmware development will be very helpful for development the firmware.

The SDK for PRBMD02 including the following resource:

PHY62XXSDK	
components	; SDK components, including BLE API, GATT profile, drivers and other components
example	; example
ble_central	;
ble_peripheral	;
alternate_iBeacon	; alternate iBeacon example
ancs	; Apple Notification Center Service example
bleI2C_RawPass	; I2S tunnelling example
bleSmartPeripheral	; General peripheral example
bleUart-RawPass	; UART tunnelling example
eddystone	; eddystone example
HIDKeyboard	; HID example
hrs	; Heart rate profile example
iBeacon	; iBeacon example
otaDemo	; Basic OTA example
pwmLight	; example of LED control by PWM, by BLE command
RawAdv	; simple broadcasting example, for tire pressure monitor
Sensor_Broadcast	;
wrist	; General example for sport bracelet
wrist_aptm	; General example, real time timer base on AP Timer + OSAL Timer
XIPDemo	; Example of running within flash, for application not requiring realtime response
OTA	;
OTA_internal_flash	; OTA bootloader
OTA_upgrade_2ndboot	; Special example for upgrading OTA bootloader
peripheral	;
adc	; ADC driver example
ap_timer	; AP timer driving example
fs	; File system example
gpio	; GPIO demo example
kscan	; 4x4 keypad example
lcd_ST7789VW	; 240x240 TFT display example
pwm	; PWM demo example
qdec	; QDEC demo example
spiflash	; SPI ext. device example
voice	; Audio sampling example
voice_sbc	; SBC coding format audio sampling example
watchdog	; Watchdog example
lib	; lib and .h document, including Bluetooth stack and Font library
font	; Font resource document
misc	; ROM symbol table and others

Note: SDK for PRBMD02 (PHY6222 core) is different from the SDK for PRBMD00 (PHY6212 core).

# Service

## Firmware programming

K-Solution provide pre-programming service, so that PRBMD02 will be shipped with firmware pre-programmed. Service charge is needed.

## Software service from K-Solution

K-Solution also provides firmware develop service for PRBMD02 module, hence customer do not need to spend their resource on the firmware development.

These services requires NRE charge. For the details, please contact our local sales representative or distributor.

## Hardware design service

K-Solution can also provide circuit design service base on PRBMD02, so that customer can simply focus on the ID of their product.

## Circuit board production service

With our partners factory, K-Solution is able to provide SMT-ed PCB with PRBMD02 to customers, and helping customer the assembly their products.

## Certification service

K-Solution could introduce our partnered test lab to customer for their product certification, where K-Solution could facilitate the process.

## Certifications

A372-3769-EE14-1BE6

### 방송통신기자재등의 적합등록 필증

Registration of Broadcasting and Communication Equipments

상호 또는 성명 Trade Name or Registrant	주식회사 오스틴일렉트릭
기자재명칭(제품명칭) Equipment Name	Bluetooth Tiny 5.0 module
기기부호/추가 기기부호 Equipment code /Additional Equipment code	LARN8
기본모델명 Basic Model Number	PRBMD02
파생모델명 Series Model Number	
등록번호 Registration No.	R-R-1Ae-PRBMD02
제조자/제조국가 Manufacturer/Country of Origin	K solution Co.,LTD / 중국
등록연월일 Date of Registration	2022-04-29
기타 Others	

위 기자재는 「전파법」 제58조의2 제3항에 따라 등록되었음을 증명합니다.

It is verified that foregoing equipment has been registered under the Clause 3, Article 58-2 of Radio Waves Act.

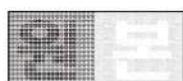
2022년(Year) 04월(Month) 29일(Day)



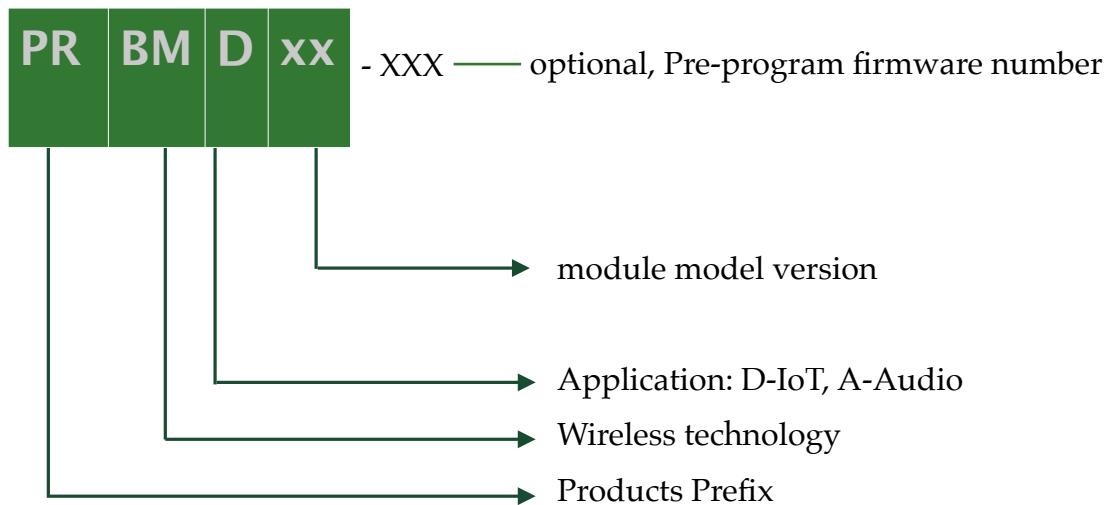
국립전파연구원장

Director General of National Radio Research Agency

※ 적합등록 방송통신기자재는 반드시 "적합성평가표시"를 부착하여 유통하여야 합니다.  
위반시 과태료 처분 및 등록이 취소될 수 있습니다.



## Ordering part number



Available part number:

PRBMD00 - PHY6212 core BT5 module, on board chip antenna, 38 pins, 12 x 18 mm, standard UART firmware, chip antenna, metal shielding and certifications

PRBMD01 - PHY6212 core BT5 module, on board chip antenna, 38 pins, 12 x 18 mm standard UART firmware, chip antenna, no metal shielding and no certification, on board DC-DC removed, Build-to-order

PRBMD02 - PHY6222 core BT5 module, 10 x 14 mm, standard UART firmware, chip antenna, metal shielding and certifications

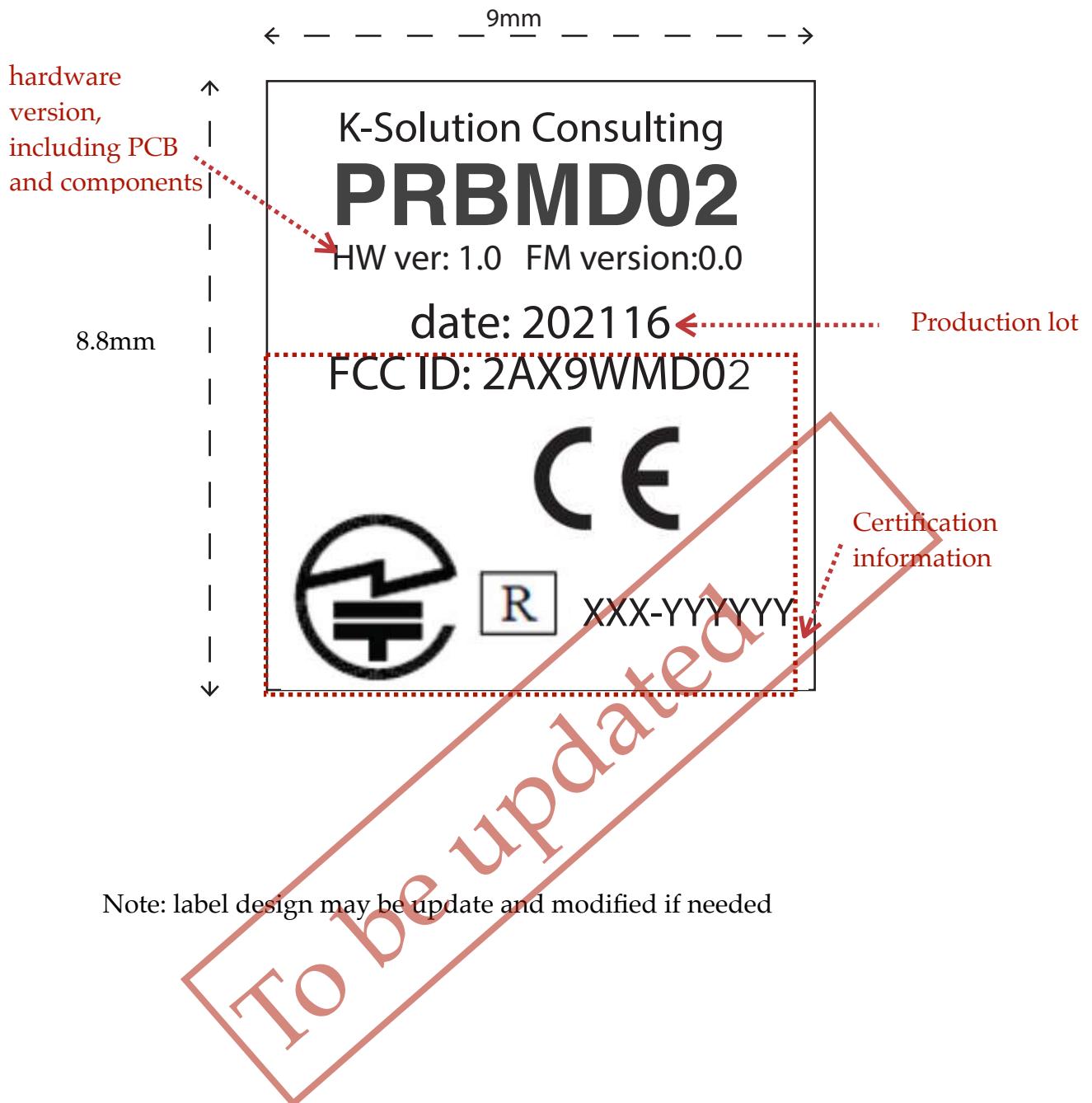
PRBMD03 - PHY6222 core BT5 module, 10 x 14 mm, standard UART firmware, chip antenna, without metal shielding nor certifications

PRBMD12 - PHY6222 core BT5 module, 10 x 14 mm, standard UART firmware, PCB antenna.

PRBMDEVK - Evaluation board with PRBMD00 on board

PRBMDEVK2 - Evaluation board with PRBMD02 on board

## Label



# Conformity

## FCC regulatory conformance :

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two

conditions:

- (1) This device may not cause harmful interference.
- (2) This device must accept any interference received, including interference that may cause  
undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio / TV technician for help

NOTE: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

## RF Exposure

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

## ORIGINAL EQUIPMENT MANUFACTURER (OEM) NOTES

The OEM must certify the final end product to comply with unintentional radiators (FCC Sections 15.107 and 15.109) before declaring compliance of the final product to Part 15 of the FCC rules and regulations. Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change.

The OEM must comply with the FCC labeling requirements. If the module's label is not visible when installed, then an additional permanent label must be applied on the outside of the finished product which states: "Contains transmitter module FCC ID: **xxxxxxxxxx**". Additionally, the following statement should be included on the label and in the final product's user manual: "This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:  
(1) This device may not cause harmful interferences, and  
(2) this device must accept any interference received, including interference that may cause undesired operation."

The module is limited to installation in mobile or fixed applications. Separate approval is required for all other operating configurations, including portable configuration with respect to Part 2.1093 and different antenna configurations.

A module or modules can only be used without additional authorizations if they have been tested and granted under the same intended end - use operational conditions, including simultaneous transmission operations. When they have not been tested and granted in this manner, additional testing and/or FCC application filing may be required. The most straightforward approach to address additional testing conditions is to have the grantee responsible for the certification of at least one of the modules submit a permissive change application. When having a module grantee file a permissive change is not practical or feasible, the following guidance provides some additional options for host manufacturers. Integrations using modules where additional testing and/or FCC application filing(s) may be required are: (A) a module used in devices requiring additional RF exposure compliance information (e.g., MPE evaluation or SAR testing); (B) limited and/or split modules not meeting all of the module requirements; and (C) simultaneous transmissions for independent collocated transmitters not previously granted together.

This Module is full modular approval, it is limited to OEM installation ONLY.

Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change. (OEM) Integrator has to assure compliance of the entire end product include the integrated Module. Additional measurements (15B) and/or equipment authorizations (e.g. Verification) may need to be addressed depending on co-location or simultaneous transmission issues if applicable. (OEM) Integrator is reminded to assure that these installation instructions will not be made available to the end user

**Operating Frequency :** (Bluetooth LE) 2402-2480MHz

**RF output power(Max) :** -3.08dBm

Manufacturer information:

Company name: K-Solution Consulting Co. Ltd

Address : Blk. H, 11/f, Yuet Wah mansion, 39 Yuet Wah street, KwunTong, HK

**CAUTION :**

1. EUT Temperature: 0°C ~ +50°C.
2. Input: DC 3.3V
3. The device complies with RF specifications when the device used at 5 mm from your body, and the holder must not be of metal composition.

RF exposure information: The EIRP power of the device at maximal case is below the exempt condition, 20mW specified in EN62479: 2010. RF exposure assessment has been performed to prove that this unit will not generate the harmful EM emission above the reference level as specified in EC Council Recommendation(1999/519/EC).

Hereby, K-Solution Consulting Co. Ltd. declares that the radio equipment type PRBMD02 is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the following internet address: [www.k-sol.com.hk](http://www.k-sol.com.hk)

## Package

Standard package of PRBMD02 is anti-electro static plastic tray, where each tray should able to contain xx pcs PRBMD02. Dimension of each tray is xxxx mm.



Note: package format is subject to change in order to enhance the efficiency

## PRBMD0x comparison

	PRBMD00	PRBMD01	PRBMD02	PRBMD03	PRBMD12
<b>Core chip</b>	PHY6212	PHY6212	PHY6222	PHY6222	PHY6222
<b>MCU core</b>	M0	M0	M0	M0	M0
<b>RAM (Byte)</b>	<b>138K</b>	<b>138K</b>	<b>64K</b>	<b>64K</b>	<b>64K</b>
<b>FLASH (Byte)</b>	<b>512K</b>	<b>512K</b>	<b>128K</b>	<b>128K</b>	<b>128K</b>
<b>Cache (Byte)</b>	0	0	8K	8K	8K
<b>SDK</b>	available	available	available	available	available
<b>BT ver</b>	<b>5.2</b>	<b>5.2</b>	<b>5.2</b>	<b>5.2</b>	<b>5.2</b>
<b>Metal shielding</b>	✓	✗	✓	✓	✗
<b>MESH</b>	✓	✓	✓	✓	✓
<b>Audio</b>	✓	✗	✗	✗	✗
<b>GPIO</b>	33	19	19	19	19
<b>Antenna</b>	chip	chip	chip	chip	PCB
<b>32768Hz OSC</b>	external	external	external	external	external
<b>main clock</b>	16MHz	16MHz	16MHz	16MHz	16MHz
<b>Tx power max</b>	<b>10dBm</b>	<b>10dBm</b>	<b>10dBm</b>	<b>10dBm</b>	<b>10dBm</b>
<b>Sensitivity @1M</b>	<b>-97dBm</b>	<b>-97dBm</b>	<b>-97dBm</b>	<b>-97dBm</b>	<b>-97dBm</b>
<b>Operating current</b>	670uA	670uA	460uA	460uA	460uA
<b>Idle current</b>	0.7uA	0.7uA	<b>0.3uA</b>	<b>0.3uA</b>	<b>0.3uA</b>
<b>Operating voltage</b>	<b>3.3-6V</b>	1.8-3.6V	1.8-3.6V	1.8-3.6V	1.8-3.6V
<b>Certification</b>	FCC, CE, TELEC	N/A	FCC, CE, TELEC	N/A no shielding	TBC
<b>Status</b>	in production	Build-to-order	designing	designing	planning

## PRBMD0x power consumption test result

The following is are power consumption testing result of PRBMD0x under different conditions.

testing condition	model	PRBMD00	PRBMD02	
3. 3V+0dbm+16M+RC32K+sleep	EVK	with DCDC	without DCDC	with DCDC
	with SDK	2. 1. 0	3. 1. 1	3. 1. 1
	time(ms)	power (uA)	power (uA)	power (uA)
advertising	100	202. 67	338	190
	500	46. 33	80	55
	1000	27	40	29
	1500	21. 67	31	24
	2000	19	25	20
	100	118	223	120
	200	61	/	/
	300	50	/	/
	400	37	/	/
	500	30. 33	60	35
connected	1000	/	40	24
	1500	/	33	21
	2000	/	32	19
Typical sleep mode (Advertisement off, a RAM block + a SRAM block + CPU auto wakeup periodically)	7. 73uA	10uA	10uA	
standby mode (Advertisement ON and one block of SRAM)	/	3uA	3uA	
off mode (only Advertisement ON)	1. 37uA	1uA	1uA	
Tx system peak current (including CPU)	8. 07mA	10mA	6. 7mA	
Rx system peak current (including CPU)	7. 43mA	9. 8mA	5. 1mA	
Note:				
Typical sleep mode	The CPU and most peripherals go to sleep. Support 32KHZ RTC/I0/interrupt/event wake-up, this mode is controlled by the OS itself, and the application does not need to intervene			
standby mode	Except for Advertisement is ON and 1 RAM area memory retention, the CPU and other peripherals all go to sleep. Only the RAM0 area contents are maintained. Only supports I0 wake-up			
off mode	Except for Advertisement is ON, the CPU and other peripherals go to sleep. After waking up, it is equivalent to a system restart. Only supports I0 wake-up			
SRAM	Each sram consumes about 2uA, 5 blocks for PRBMD00, 3 blocks for PRBMD02			

# Revision History

2021-03-02	version 0.5
2021-12-16	version 0.9
2022-04-01	version 0.99

## INTEGRATION TO THE END PRODUCT

The Transceiver Module, model 2AX9WMD02 has to be installed and used in accordance with the technical description/installation instructions provided by the manufacturer.

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01

### 2.2 List of applicable FCC rules

CFR 47 FCC PART 15 SUBPART C has been investigated. It is applicable to the modular transmitter

### 2.3 Specific operational use conditions

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

### 2.4 Limited module procedures

Not applicable

### 2.5 Trace antenna designs

Not applicable

### 2.6 RF exposure considerations

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body.

### 2.7 Antennas

This radio transmitter 2AX9WMD02 has been approved by Federal Communications Commission to operate with the antenna types listed below , with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

### 2.8 Label and compliance information

The final end product must be labeled in a visible area with the following " Contains FCC ID: 2AX9WMD02".

### 2.9 Information on test modes and additional testing requirements

Host manufacturer is strongly recommended to confirm compliance with FCC requirements for the transmitter when the module is installed in the host.

### 2.10 Additional testing, Part 15 Subpart B disclaimer

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B.

FCC ID : 2AX9WMD02

## Reference

ADC Application Note  
ANCS Application Note  
Font Application Note  
GPIO Application Note  
OTA Note  
SDK Application Guide  
MESH Application Guide  
KATP product brief

## Contact information

### Head quarter:

K-Solution Consulting Co. Ltd.

web: [www.k-sol.com.hk](http://www.k-sol.com.hk)

Tel: +852-91983405

Fax: +852 3013 8763

E-mail: [sales@k-sol.com.hk](mailto:sales@k-sol.com.hk)