PRBMD00 Bluetooth 5 ready module

Data sheet version 1.5

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Introduction

Base on PHY+ Microelectronics' PHY6212* Bluetooth 5 ready core chip, PRBMD00 BT 5 ready module provides a reliable and easy BT5 solution, allowing user, even without any RF design experience, brings their 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.

PRBMD00 family consists of two models: PRBMD01 and PRBMD00. PRBMD01 provides a tiny form factors which is suitable for application with limited space; where PRBMD00 provide more GPIOs, provide higher flexibility to user.

PRBMD00 is FCC, CE and Telec certified module, which reduces customer's resource for qualification and allows product to be time to market.

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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

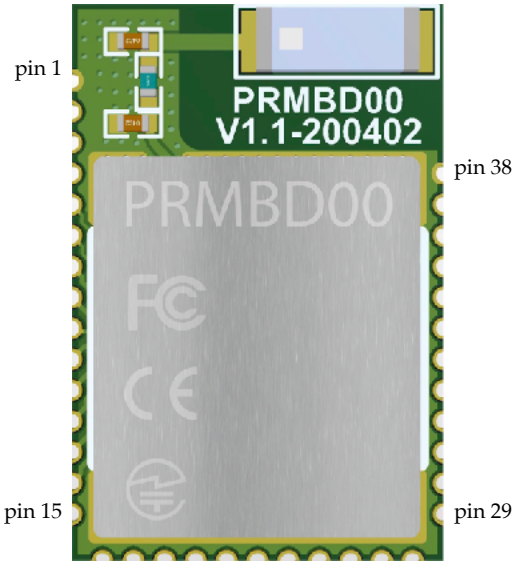
*PHY62xx QDID is 112181

Hardware information

Features

- 32bit Cortex™-M0 processor with 2.4GHz wireless
- On board chip antenna
- On board 16MHz crystal
- Internal 32K RC network
- On board DC/DC converter
- 512KB Flash, 138KB SRAM
- Small form factor: 10mm x 14m (PRBMD01); 12 x 18mm (PRBMD00)
- High GPIOs count : up to 31 (PRBMD00)
- Soft configurable interfaces: PWM (6), I2S (4), PDM (2), I2C (2), SPI (2), UART (1)
- JTAG for debugging
- Up to eight channels 12bit ADC (8)
- Bluetooth v5.0 compliant Protocol Stack (BLE)
- Low power consumption (2μA when sleep; 0.7μ when OFF)
- Support SIG_Mesh feature: Friend node, Low Power node, Proxy node and Relay node
- Sensitivity up to -103dBm @125Kbps
- Tx power up to +10dBm
- FCC, CE and TELEC certification

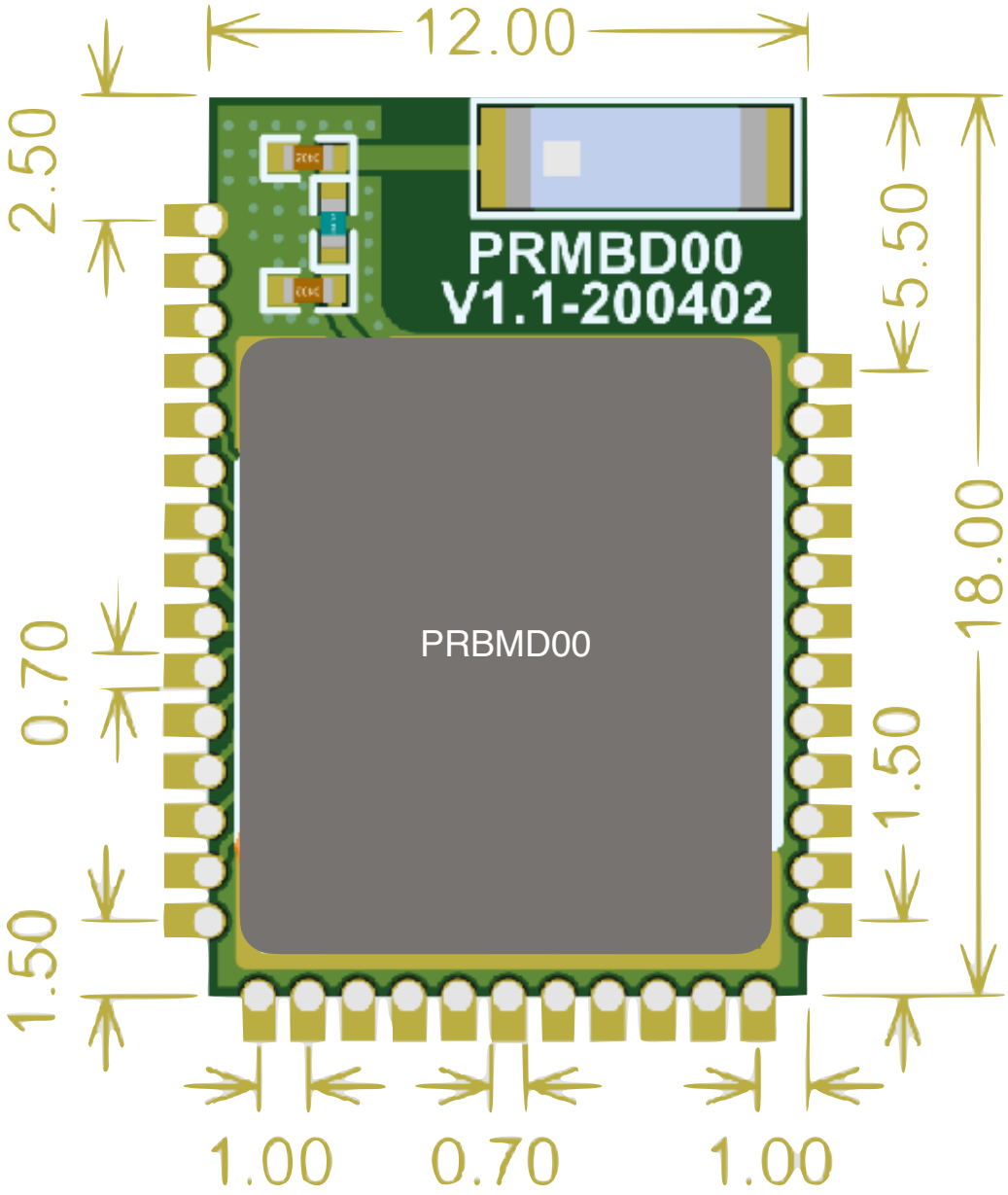
Pin assignment



pin	name	Description
1	GND	Power ground
2	P21	GPIO
3	P22	GPIO
4	P23	GPIO
5	P24	GPIO
6	P25	GPIO
7	P26	GPIO
8	P27	GPIO
9	P28	GPIO
10	P29	GPIO
11	P30	GPIO
12	P31	GPIO
13	P32	GPIO
14	P33	GPIO
15	P34	GPIO
16	P00	GPIO
17	P01	GPIO
18	P02	GPIO
19	P03	GPIO
20	P04	GPIO

pin	name	Description
21	P05	GPIO
22	P06	GPIO
23	TM	Mode select, pull high for firmware programming
24	P09	GPIO/UART TX
25	P10	GPIO/UART RX
26	RST	Module power input
27	VDD	VDD, 2.5 to 6V
28	P11	GPIO/AIO0
29	P12	GPIO/AIO1
30	P13	GPIO/AIO2
31	P14	GPIO/AIO3
32	P15	GPIO/AIO4
33	P16	GPIO/32K IN/ AIO5
34	P17	GPIO/32 OUT/AIO6
35	P18	GPIO/AIO7
36	P19	GPIO/AIO8
37	P20	GPIO/AIO9
38	GND	Power Ground

Dimension



Unit: mm

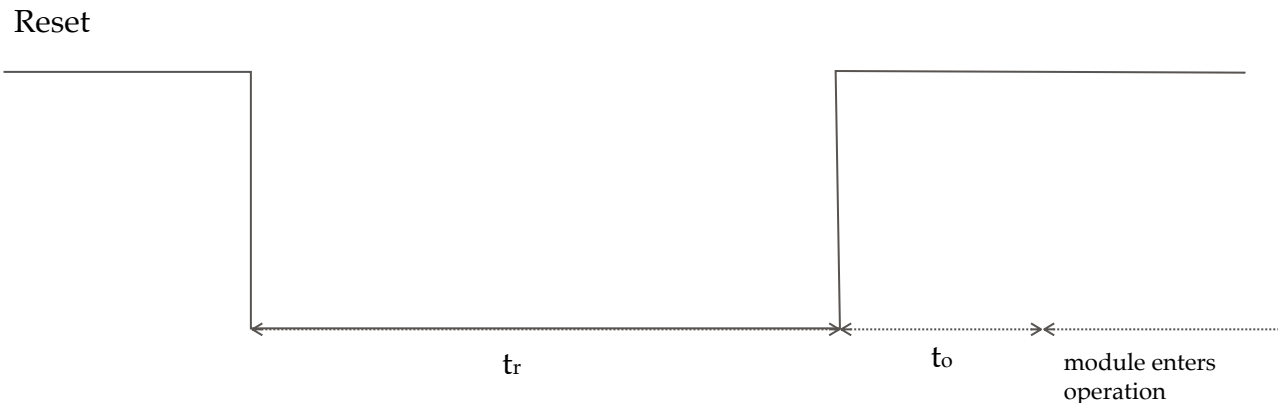
Electrical Specification

	Description	Typical
General	Operation voltage	2.5V to 6V DC (PRBMD00)
	Operation current (PRBMD00) * base on the default firmware	Advertising: Average - 3mA; Max peak - 9mA Connected Average - 3.18mA; Max peak - 9mA
	SLEEP mode current * needed firmware activate	Sleep mode: ~3uA, with 32768Hkz RTC
	OFF mode current	TBC
	Microcontroller	32-bit ARM Cortex M0
	GPIO	35 configurable (PRBMD00)
	Oscillators	16MHz crystal oscillator 32kHz RC oscillator (internal)
	Digital I/O	X2 Hardware SPI master UART
	Operation temperature	TBC
RF	Frequency band	2.4GHz ISM (2.40000 – 2.4835GHz)
	Modulation	GFSK
	Data rate	250kbps, 1 Mbps, 2 Mbps
	TX Power	-20 to +4dBm in 4dB steps
	Sensitivity	-91dBm Bluetooth low energy -94dBm at 250kb -88dBm at 1Mbs -83dBm at 2Mbs
	RF Range (indoor)	15m

Table 1 Electrical Specification

Reset the module

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

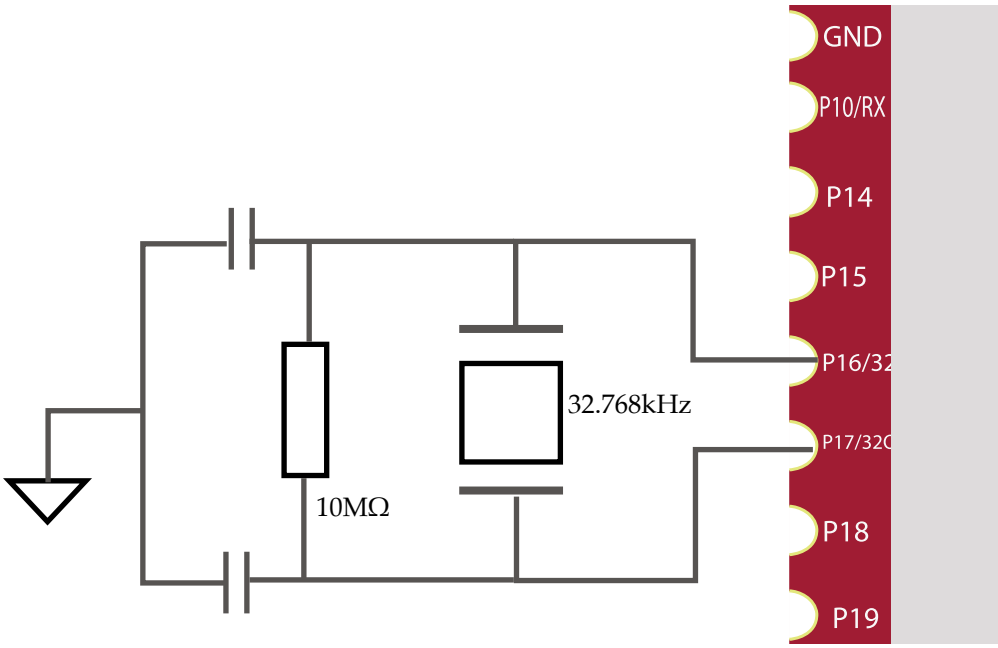


t_r = at least $1\mu s$
$t_o = 500\mu s$

The clock

Main clock
PRBMD0x 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:



Using external crystal as RTC

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 of PRBMD00; and pin 7 of PRBMD01) 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 PRBMD00
5. Load the firmware and click Write to program into PRBMD00
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:

   Freq_PWM=16MHz/(N_prescaler x N_top_count);

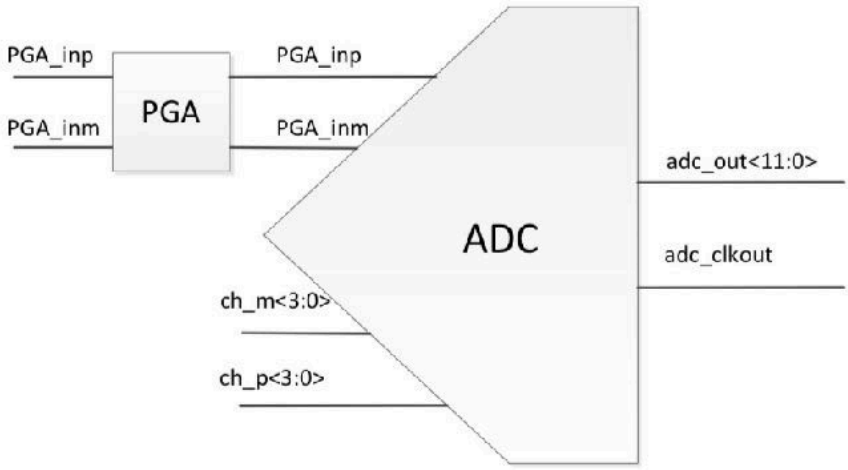
   where the value in N_top_count register controls the frequency

   and the Duty cycle is controlled by the following equation:

   Duty_cycle_PWM=N_threshold/N_top_count

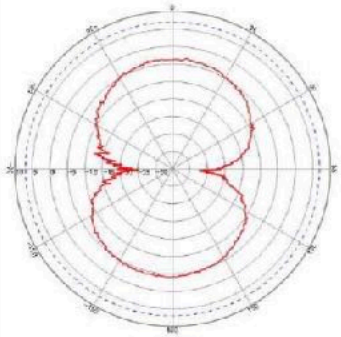
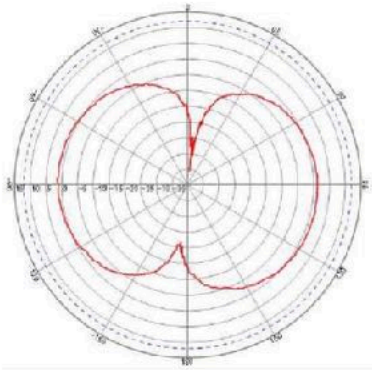
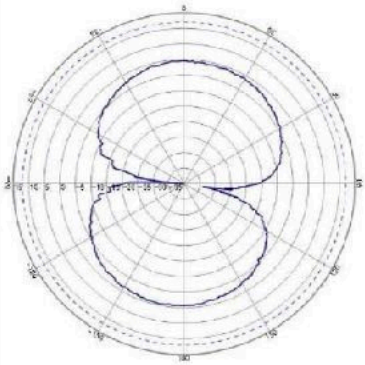
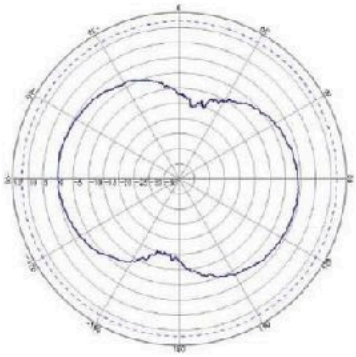
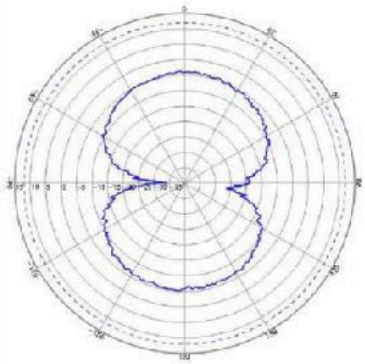
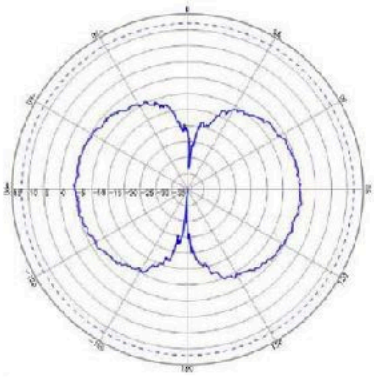
   where the value in N_threshold, together with N_top_count, control the duty cycle

5. Quadrature decoder: it can interface and decode signal from quadrature-encoded sensor, both mechanical and optical sensors. Input debounce filters is included.
6. Keyscan: it supports up to 16 rows by 18 columns key matrix. Multi-key-press support and de-bounce time is configurable.
7.
8. 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.



Antenna characteristic

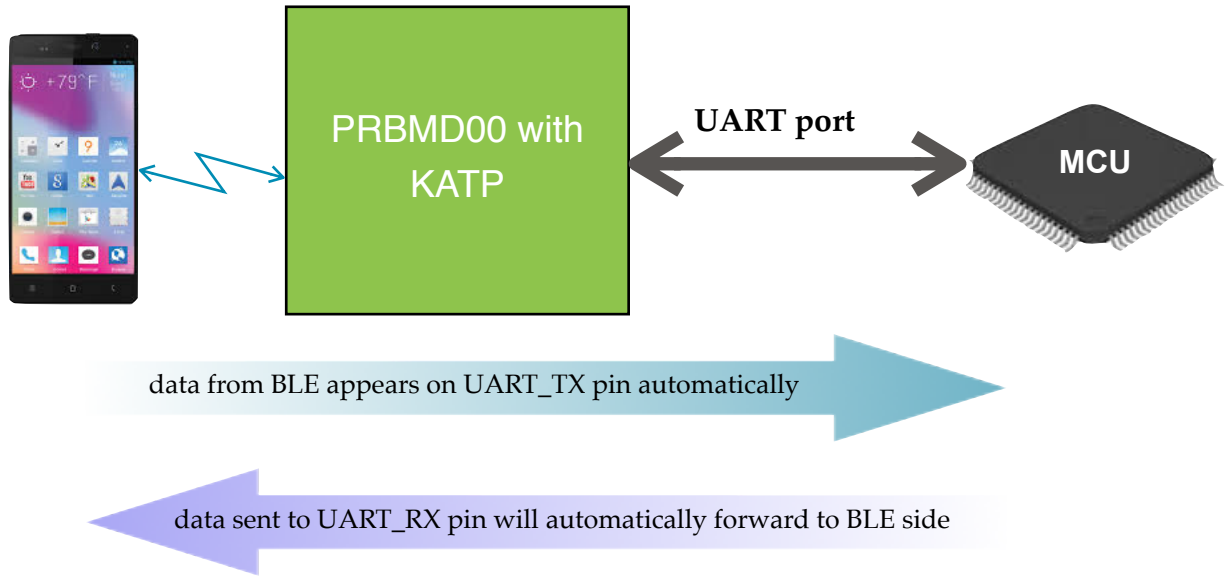
The chip antenna characteristic is illustrated as following:

	Vertical	Horizontal
XY	 Gain -3.16 dBi	 Gain 2.29dBi
YZ	 Gain -0.36dBi	 Gain 0.45dBi
ZX	 Gain -3.31dBi	 Gain -3.73dBi

Firmware information

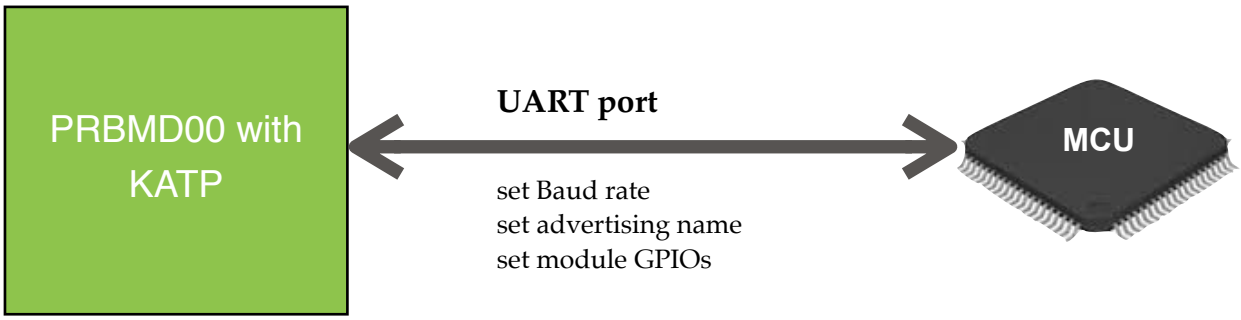
Default firmware

PRBMD00 comes with default UART-BT firmware (firmware name: KATP), allowing user able to enable their product with BT feature without any extra engineer resources. The basic feature of KATP is to tunnel data between UART port Bluetooth device (Transparent mode). User can develop their own firmware by SDK as well.



TRANSPARENT mode description

It also provides a AT-CMD mode for configuration:



AT-CMD mode description

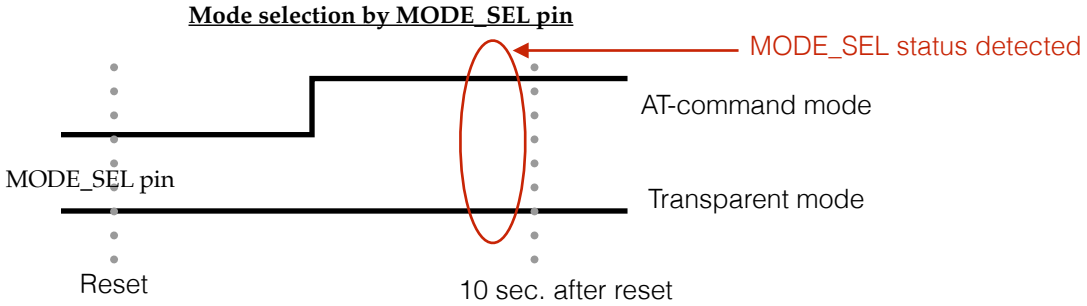
Sending a test mode command in AT-CMD mode will force KATP to testing mode, which allows user to fix the RF channel and power. Test mode is only for testing or certification purpose only.

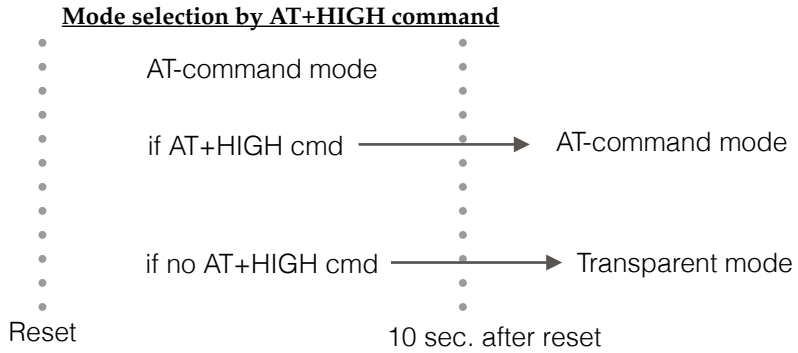
Mode selection

KATP will enter either AT-CMD or Transparent mode by the status of MODE_SEL pin (P34) at 10 sec after reset or power up. If the pin is HIGH, PRBMD00 will enter AT-CMD mode, otherwise will enter Transparent mode.

In the 10-sec window, KATP will be at AT-CMD mode first, if command "AT+HIGH" is issue within this window, KATP will then stay at AT-CMD mode after the window period. It provide an alternative way to enter different mode.

In the AT-CMD mode, user is allowed to change settings of PRBMD00, such as UART speed, Bluetooth name…etc. The table below lists all the available AT-CMD.





In AT-CMD mode, data can also tunnel between UART and Bluetooth. Any data from Bluetooth side will pass to UART port; Any data not started with "AT+" will be deemed as data and will pass to Bluetooth side.

Default setting

The default setting of KATP are: BUAD=115200; NAME= PRBMD00. User is able to change them in AT-CMD mode. There are two ways to change these setting to default value: 1. AT+DEFAULT command in AT-CMD mode; 2. Pull P03 to ground level while reset or power will also make KATP revert to default setting.

Sleep mode

KATP will put PRBMD00 into sleep mode automatically after a while of idle.

LED indication

KATP uses pin P34 as LED indication (sink), which indicates the connection status. It will flash at the rate of 20ms per second while advertising, and will turn on after connection is built.

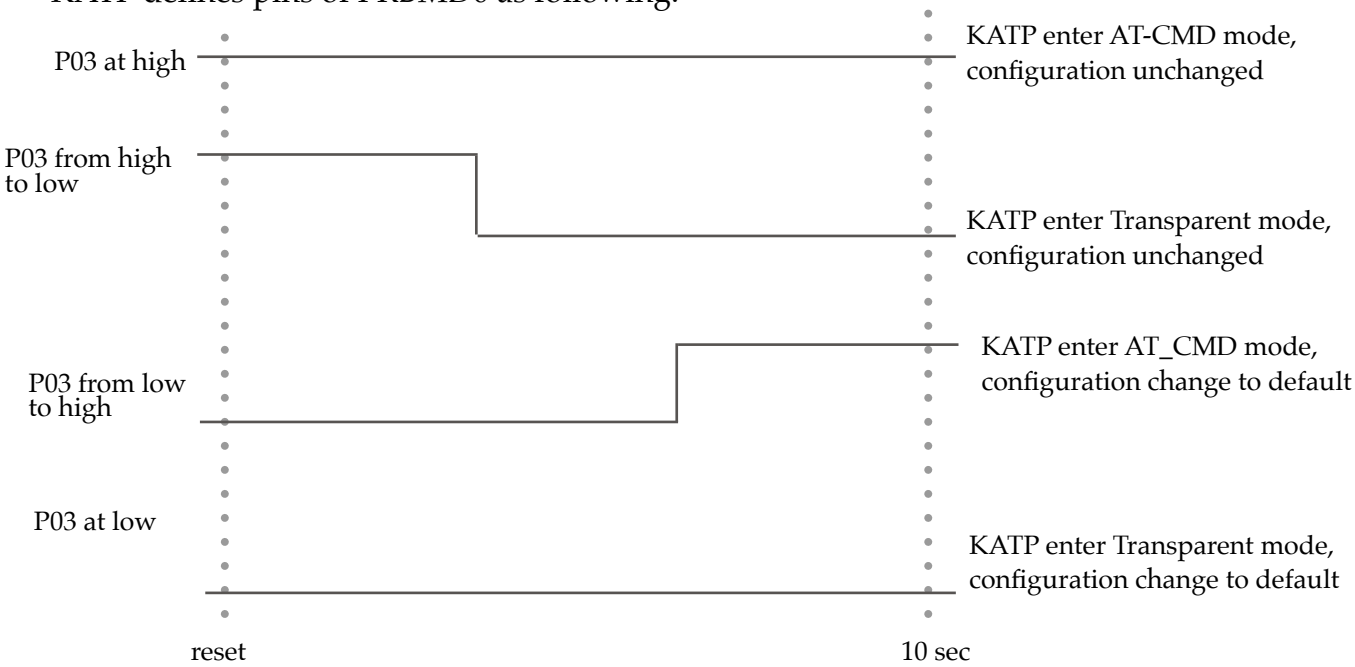
Pin P03

Since P03 is assigned two features, mode selection and default value, by KATP, here is a diagram for further description

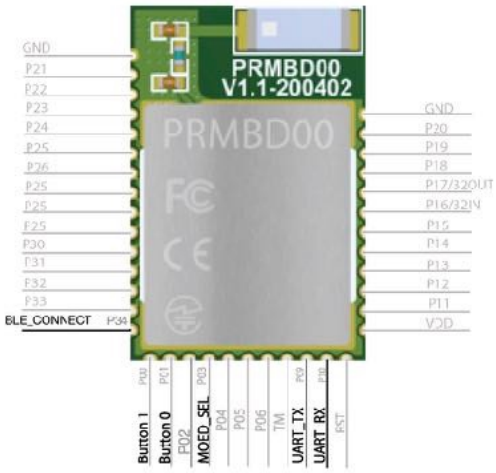
P03 will be detected at the first 5 sec after reset to determine return-to-default or not, and will determine to enter AT-CMD or Transparent mode at the 10 sec.

Pin assignment

KATP defines pins of PRBMD0 as following:



PRBMD00 pin	Function in KATP firmware	Description
P34	BLE_Connect (for LED)	Indicates BT connection: Flash when advertising; Solid when connected
P03	MODE_SEL	Goes to AT-CMD or Transparent mode after reset.
P09	UART_TX	UART transmit - connect to Rx of external device
P10	UART_RX	UART receive - connect to Tx of external device

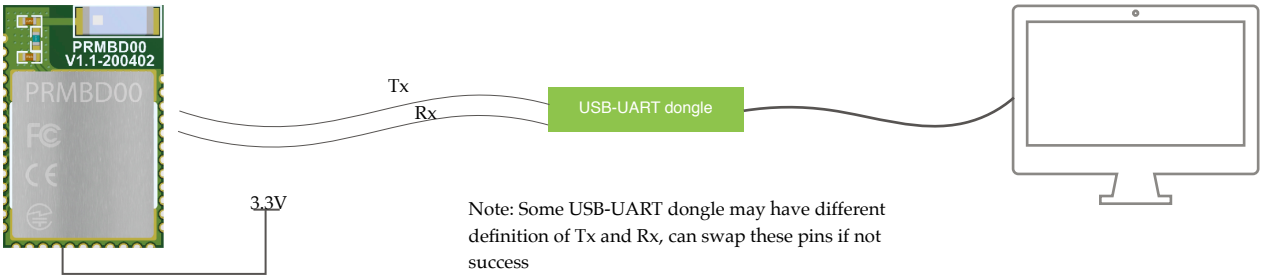


Pin assignment in PRBMD00

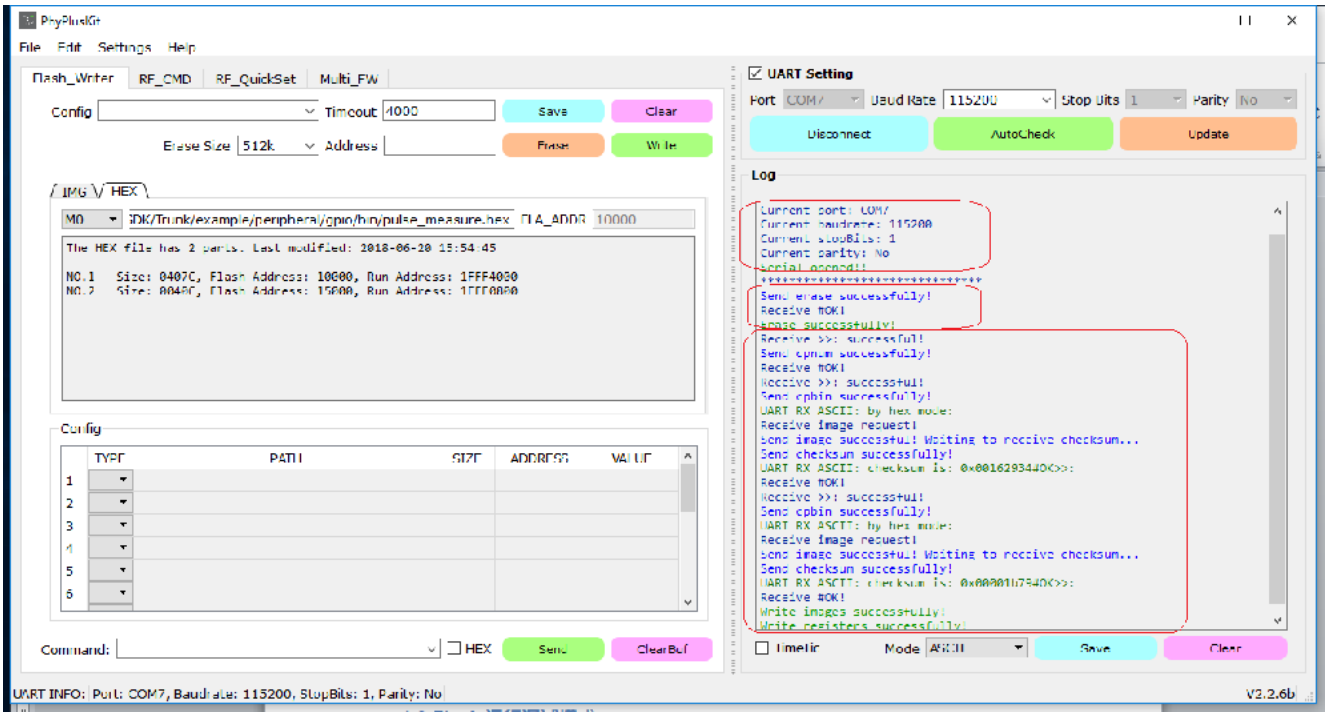
AT-Command list in AT-CMD mode

	Action	enquiry	return value	set	return value
System	MAC addr *	**AT+ID?**	Current address		
	Help	**AT+HELP**	All AT commands		
	Reset			**AT+RESET**	
	Factory Default			**AT+DEFAULT**	- BAUD = 115200, TXP = 0, NAME = PRBMD00, Flow control disabled
	Exit AT-CMD mode			**AT+EXIT** - enter transparent mode from AT-CMD	
BLE	Change name	**AT+NAME?**	- current name Default:PRBMD00	**AT+NAME= New name**	
	Start advertising			**AT+BDCS**	
	Stop advertising			**AT+BDCE**	
UART and GPIO	BAUD rate	**AT+SPEED?**	Current baud	**AT+SPEED=BAUD**, BAUD = 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200	- New BAUD if success note: data byte, parity and stop bit are fixed at 8,N,1
	Turn P34 off			**AT+LEDOFF** - turn P34 off; P34 will turn on once it is connected, use this command to turn it off for saving power	
	Read and set IO pin	**AT+GPIOxx=?** xx:04-33	level of the GPIO pin	**AT+GPIOxx=y** xx:04-33	y= 0 or 1, where 0 is low level and 1 is high level
RF test	Set all GPIO high			**AT+HIGH**	
	Set all GPIO low			**AT+LOW**	
	Fix a Tx channel #			**AT+TXa=b** a= modulation data, 0: PRBS9 1: 1111000 2: 10101010 b= 0-39 Tx channel i.e.: AT+TX1=20	
	Fix a Rx channel#			**AT+RX=c** c=0-39 channel	
	TX power	**AT+TXP?**	Current TX Power value	**AT+TXP= p** p : -20, -15, -10, -6, -5, -3, 0, 3, 4, 5	- new value

Firmware programming



Note: Some USB-UART dongle may have different definition of Tx and Rx, can swap these pins if not success

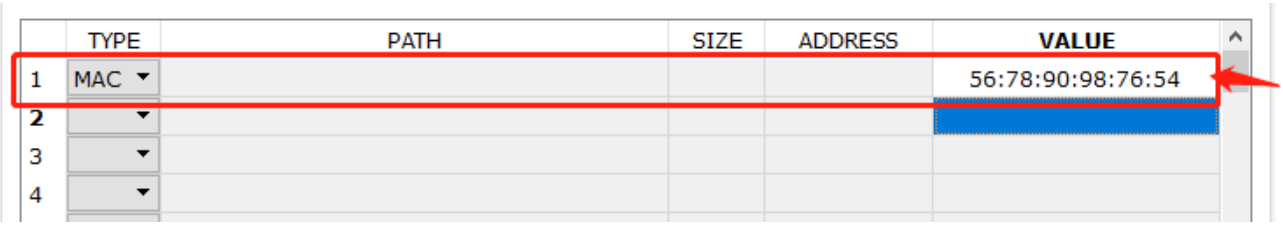


PhyPlusKit interface

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

MAC address

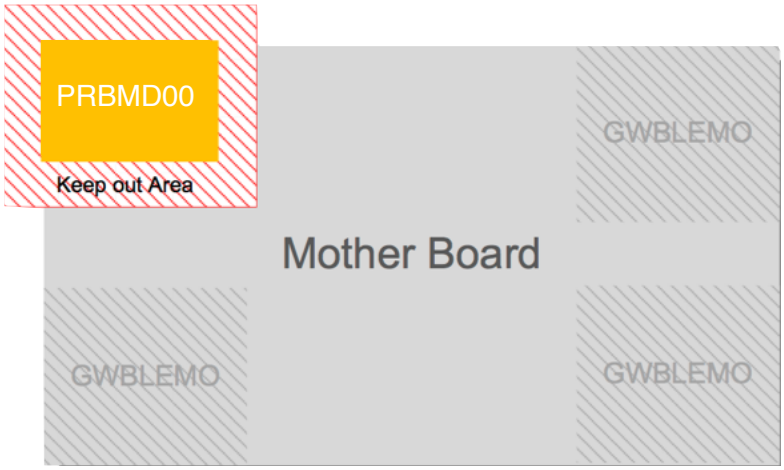
Unless otherwise instructed, each PRBMD00 will be shipped with KATP pre-programmed but no MAC address is pre-programmed. User can program their own MAC address by PhyPlusKit. It is important to be reminded that ***MAC address can be only writen once and cannot be re-writen.***



* MAC address can be programmed by PHY Plus Kit only, and it can be programmed for one time only.
\# Reset is needed to leave the AT+RX=c and AT+TXa=b command.

Mounting guide

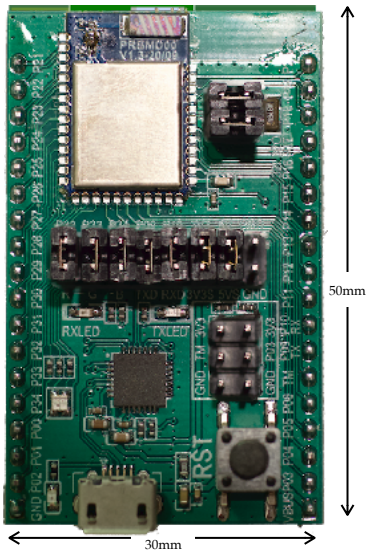
PRBMD00 is RF sensitive; in order to obtain the best performance, it is recommended to mount the module at corner of mother board, and with some marginal space.
Also, keep it away from metal components, such like speakers, transformers, batteries, big aluminum capacitors, heat sinks and Metal Panels.
The figure below illustrates how to mount the PRBMD00 module. Improper mounting will decrease the RF performance dramatically.



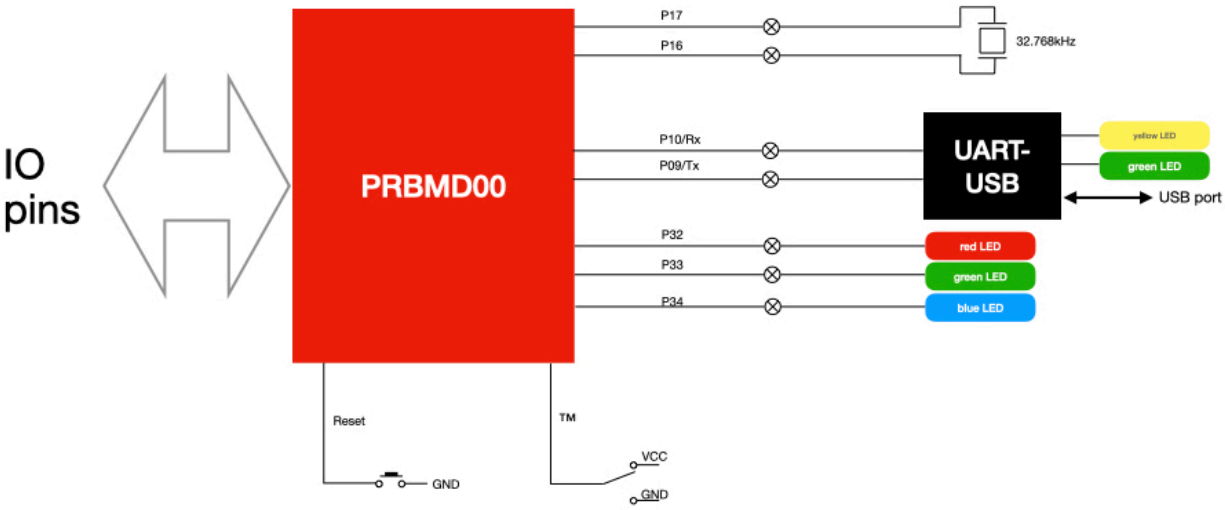
Evaluation Board

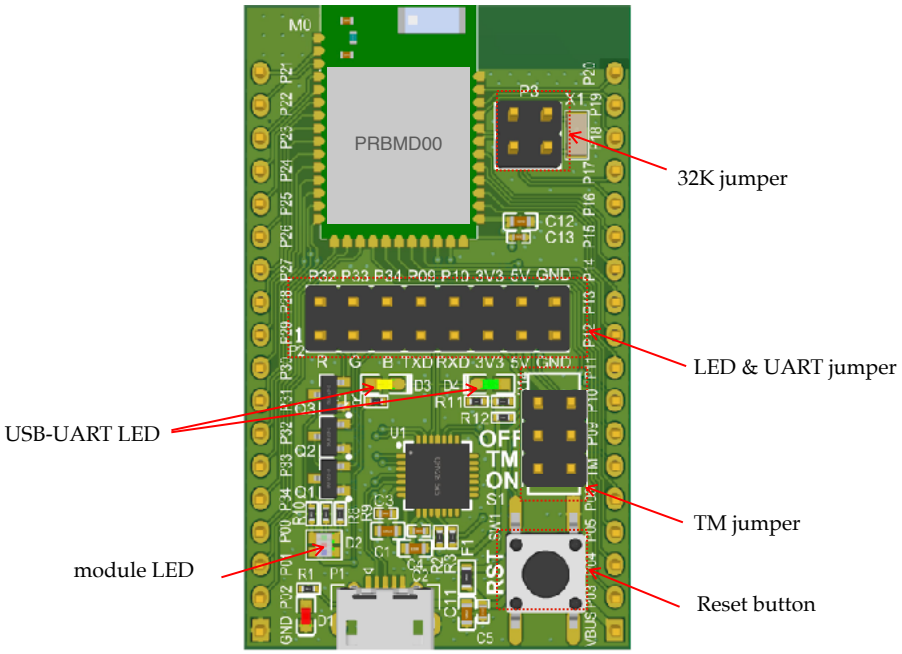
Evaluation board (EVB) for PRBMD00 is available, helping engineer for the firmware development. It is in DIP form factor, allows engineer to connect with external circuit easily for debugging and testing.

The EVB is illustrated as following:

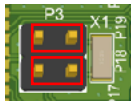


The EVK is in DIP format with PRBMD00 on it, and with on board 32.768KHz crystal and UART-USB chip, allow user to test and program the module easily. PRBMD00 is pre-programmed with the UART-BT tunnelling firmware. Below is the block diagram of the EVK:



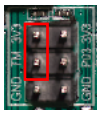


1. 32K jumper:
   Since P16,P17 are multiplex with external 32.768KHz oscillator, this jumper allows the PRBMD00 to connected with the on board 32.768JKHz oscillator.

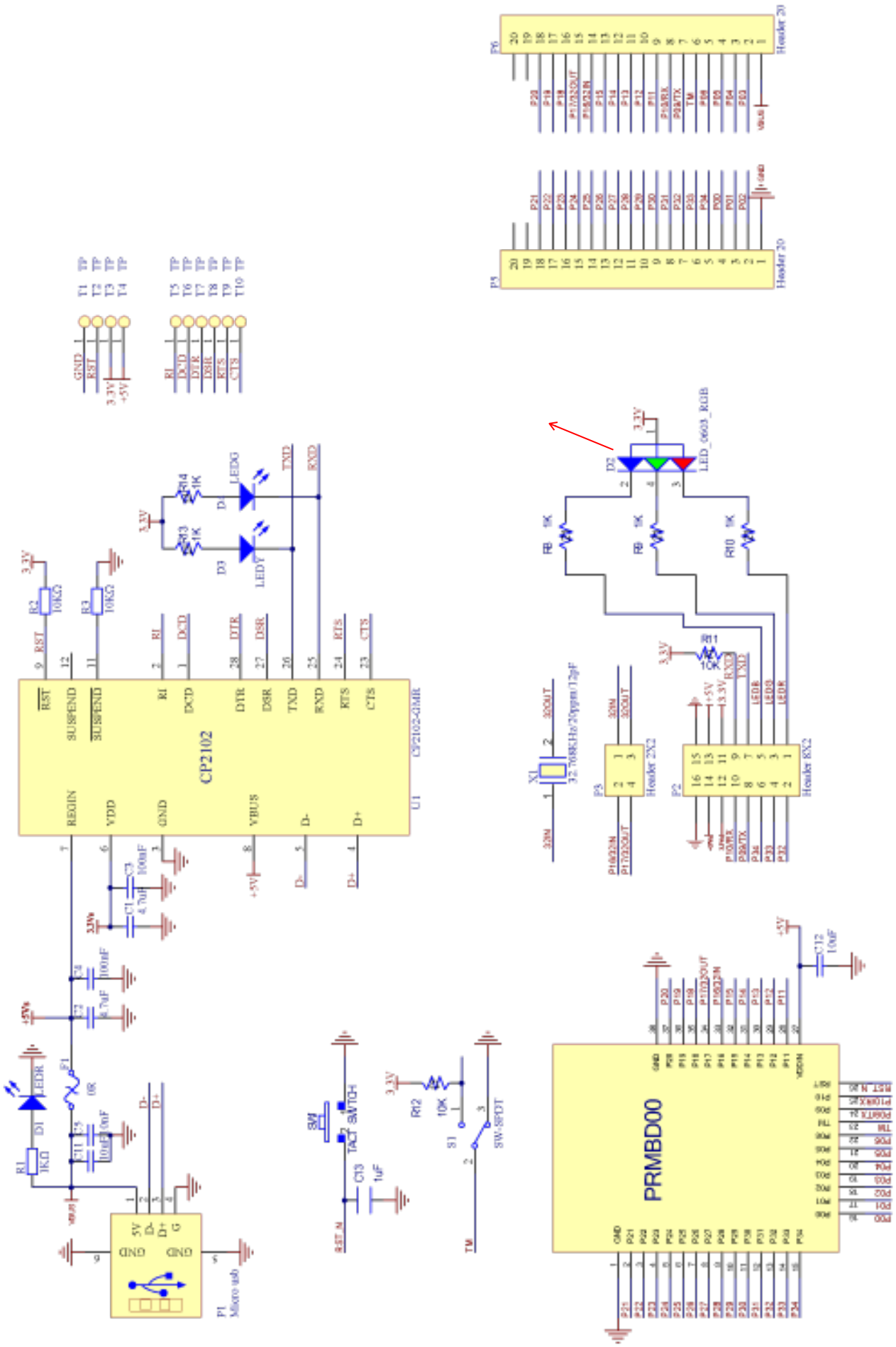


2. LED & UART jumper:
   This jumper allows the module to connected with on-board LED and the on-board USB-UART chip. Connecting 5V allow PRBMD00 to be powered from USB. Connecting 3V3 will provides a 3.3VDC to the rest of the board

3. TM Jumper
   PRBMD00 goes into firmware programming mode if TM pin is connected to the 3V3 pin.



4. Reset button
   Pressing this button to reset PRBMD00 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 makes 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.


CP2102
PRMBD00
Header 20
Header 2X2
Header 8X2
LED_0603_RGB
Micro usb
SW-SPDT
TACT SWTCH

Firmware development and SDK

User is allowed to developed their own firmware for PRBMD00 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 PRBMD00 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 boardcasting 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
```

Please contact us for the details of the SDK.

Service

Firmware programming
K-Solution provide pre-programming service, so that PRBMD00 will be shipped with firmware pre-programmed. Service charge is needed.

Software service from K-Solution
K-Solution also provides firmware develop service for PRBMD00 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 PRBMD00, 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 PRBMD00 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

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: **2AX9WMD00**". 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

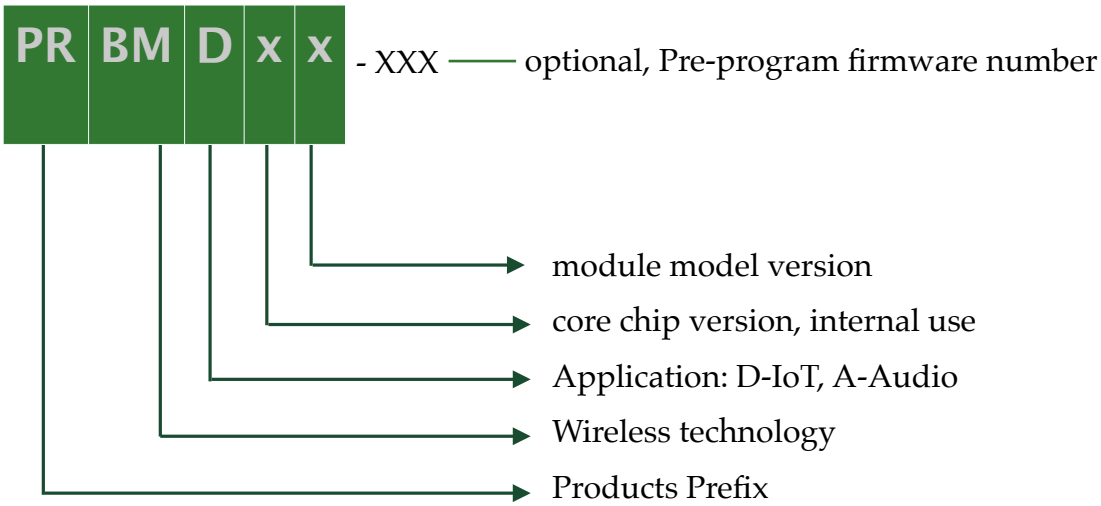
Operating Frequency：（Bluetooth LE）2402-2480MHz
RF output power(Max)：4dBm

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 PRBMD00 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

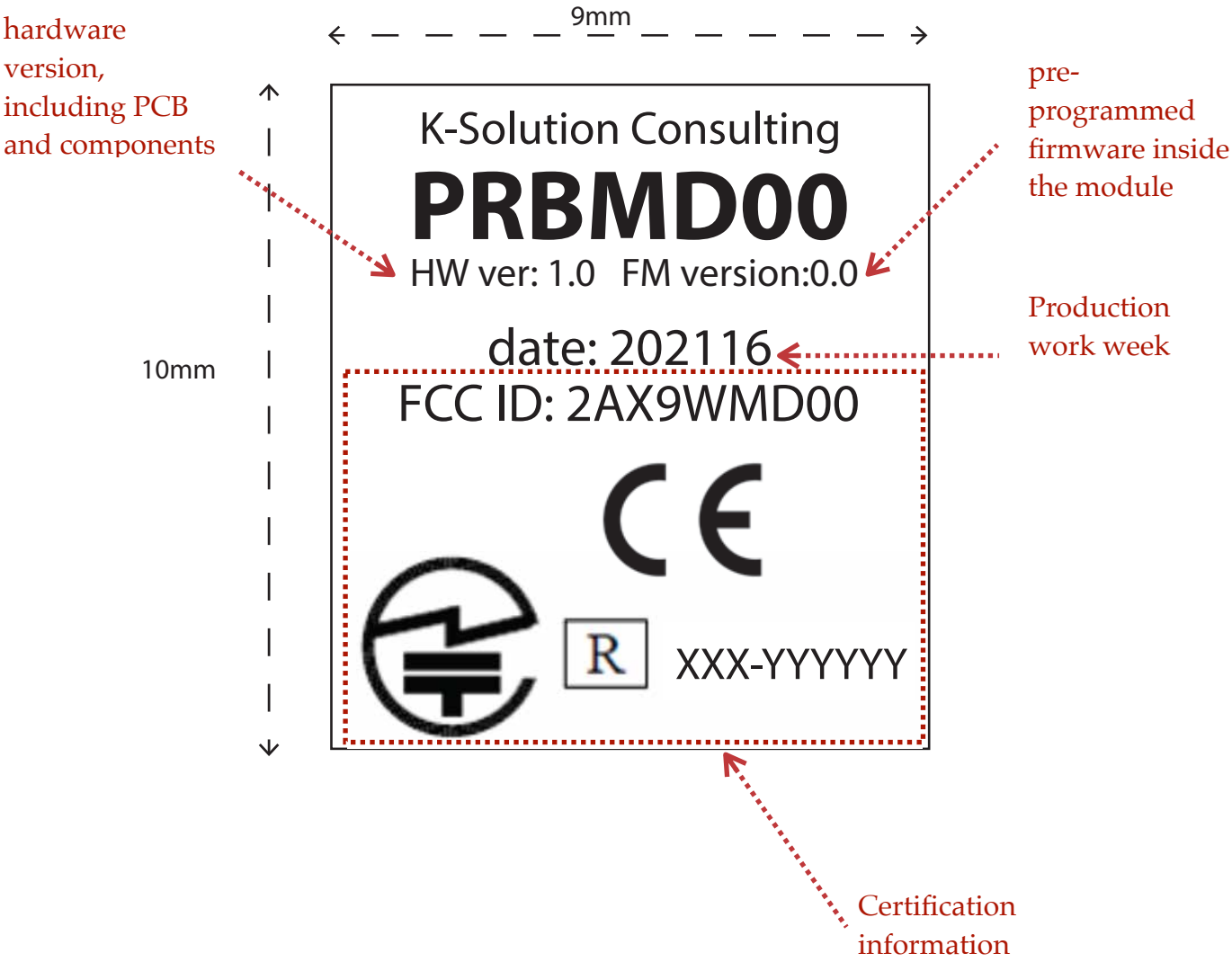
Ordering part number



Available part number:

PRBMD00 - BT5 module, on board chip antenna, 38 pins, 12 x 18 mm, standard UART firmware
PRBMD01 - BT5 module, on board chip antenna, 24 pins, 10 x 14 mm standard UART firmware
PRBMDEVK - Evaluation board with PRBMD00 on board

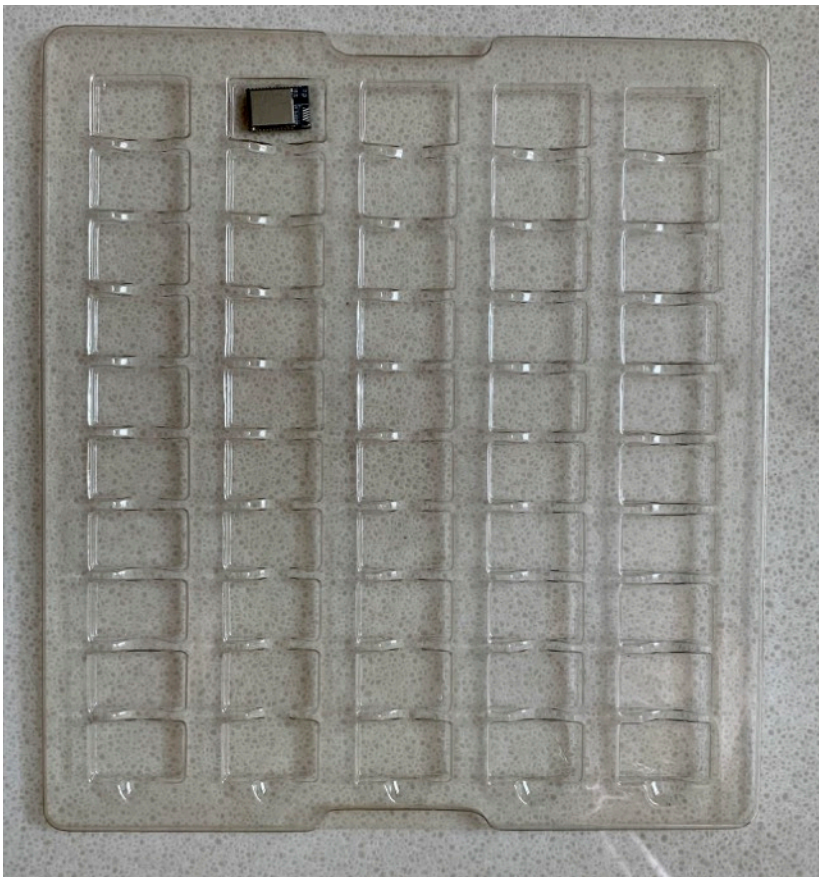
Label



Note: label design may be update and modified if needed

Package

Standard package of PRBMD00 is plastic tray, where each tray should able to contain 40 pcs PRBMD00. H



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

Revision History

2020-04-20	version 0.9
2020-08-17	version 1.1
	AT-CMD list updated
2020-08-28	version 1.2
	Current consumption test result added
2020-10-07	EVK information updated
2020-12-02	version 1.4
	Adding package and label information
	Adding Conformity
2020-12-04	version 1.5
	Adding RED conformity

Reference

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

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