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# PRBMD0x Bluetooth 5 ready module

Data sheet version 1.3



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## Disclaimer

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## Introduction

Base on PHY+ Microelectronics' PHY6212\* Bluetooth 5 ready core chip, PRBMD0x 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.

PRBMD0x 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.

PRBMD0x is FCC, CE and Telec certified module, which reduces customer's resource for qualification and allows product to be time to market.



picture here



Picture here



Picture here

## 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

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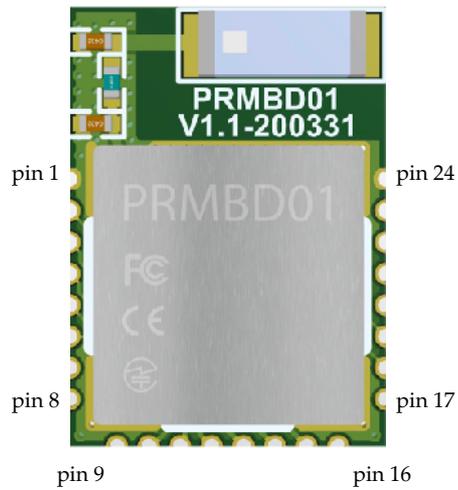
# Hardware information

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## 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 ( $2\mu\text{A}$  when sleep;  $0.7\mu$  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, KCC and TELEC certifications (in progress)

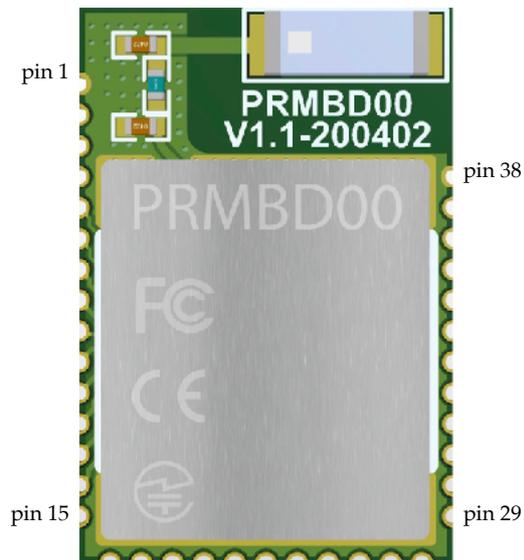
## Pin assignment



PRMBD01 pin assignment

pin	name	Description
1	GND	Power ground
2	P23	GPIO
3	P24	GPIO
4	P25	GPIO
5	P31	GPIO
6	P32	GPIO
7	P33	GPIO
8	P34	GPIO
9	P00	GPIO
10	P01	GPIO
11	P02	GPIO
12	P03	GPIO
13	TM	Mode select, pull high for firmware programming
14	P09/TX	GPIO/UART Tx

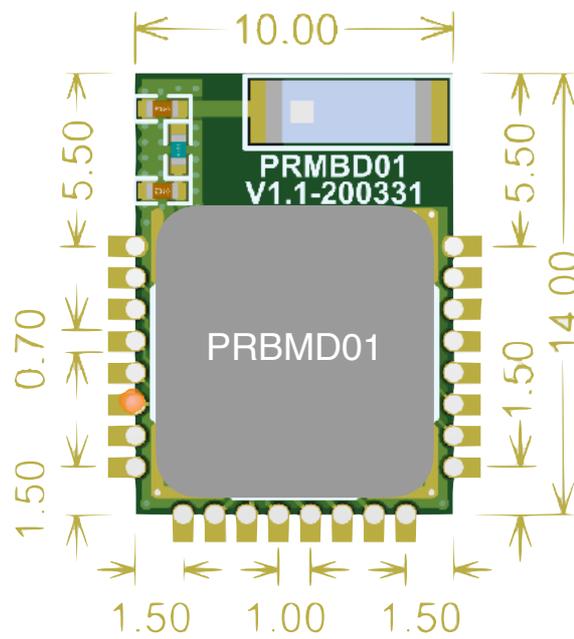
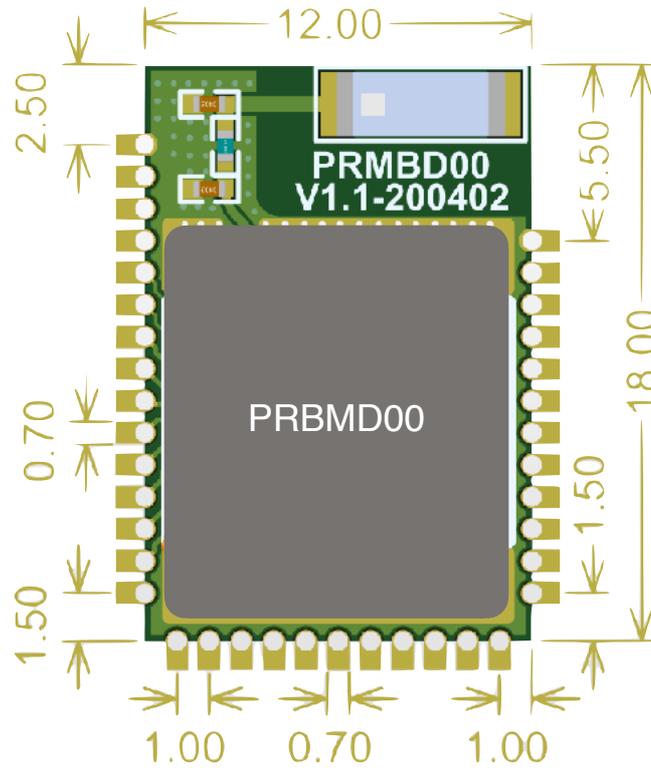
pin	name	Description
15	P10/Rx	GPIO/ UART Rx
16	RST	Reset, Active low
17	VDD33	VDD, 3.3 to 3.6VDC
18	P14	GPIO/ AIO3
19	P15	GPIO/ AIO4
20	P16/32IN	GPIO/ 32.768kHz crystal in/ AIO5
21	P17/32OUT	GPIO/ 32.768kHz crystal out/ AIO6
22	P18	GPIO/ AIO7
23	P20	GPIO/ AIO8
24	GND	Power GND



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
21	P05	GPIO
22	P06	GPIO
23	TM	Mode select, pull high for firmware programming
24	P09	GPIO/UART TX

pin	name	Description
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

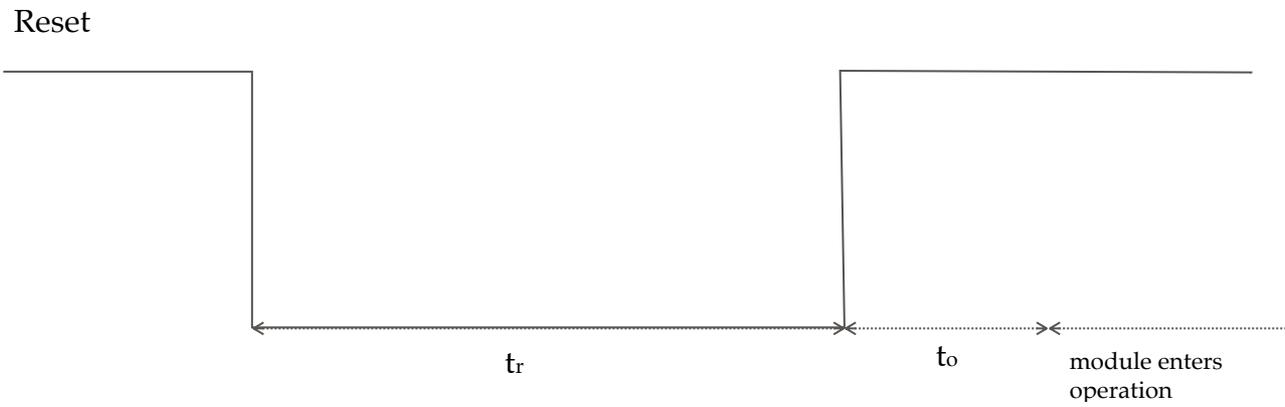
## Electrical Specification

	Description	Typical
<b>General</b>	Operation voltage	1.8V to 3.6V DC (PRMD01) 2.5V to 6V DC (PRMD00)
	Operation current (PRBMD00) * base on the default firmware	Advertising: Average - 3mA; Max peak - 9mA Connected Average - 3.18mA; Max peak - 9mA
	SLEEP mode current (PRBMD00 and PRBMD01) * needed firmware activate	Sleep mode: ~3uA, with 32768Hz RTC
	OFF mode current	TBC
	Microcontroller	32-bit ARM Cortex M0
	GPIO	19 configurable (PRMD01) 35 configurable (PRMD00)
	Oscillators	16MHz crystal oscillator 32kHz RTC oscillator (internal)
	Digital I/O	X2 Hardware SPI master UART
	Operation temperature	TBC
<b>RF</b>	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)	to be determined

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## Reset the module

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



$t_r = \text{at least } 1\mu\text{s}$   
 $t_o = 500\mu\text{s}$

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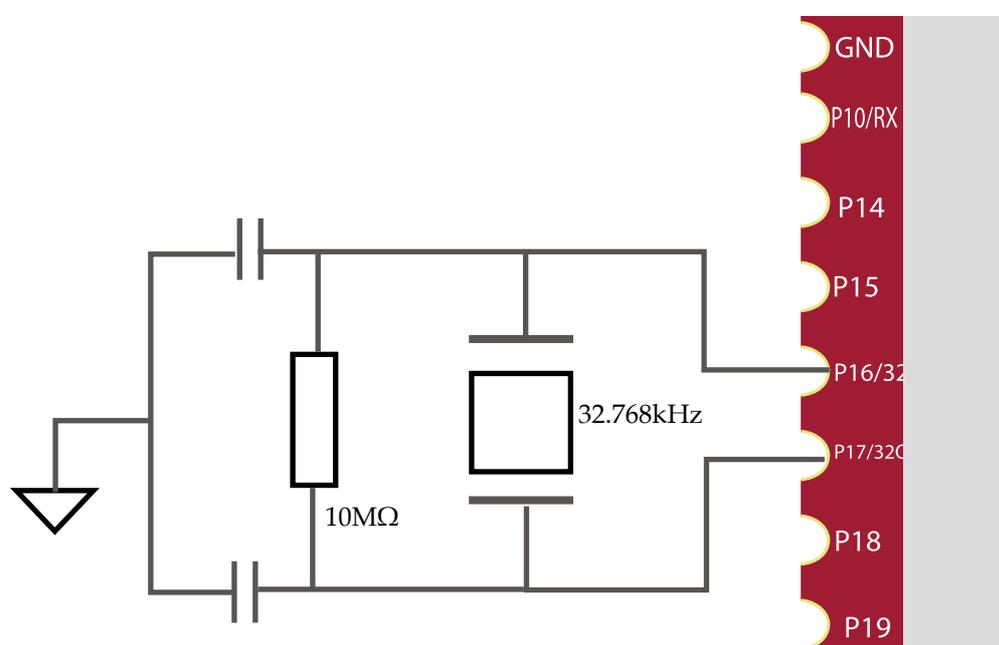
## The clock

### Main clock

PRMD0x 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

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## Firmware programming

User is able to program their own developed firmware (with SDK) into PRMD0x. 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 PRBMD0x
5. Load the firmware and click Write to program into PRBMD0x
6. Connect TM pin to low level and apply reset. New firmware then starts to operate.

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## 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:

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

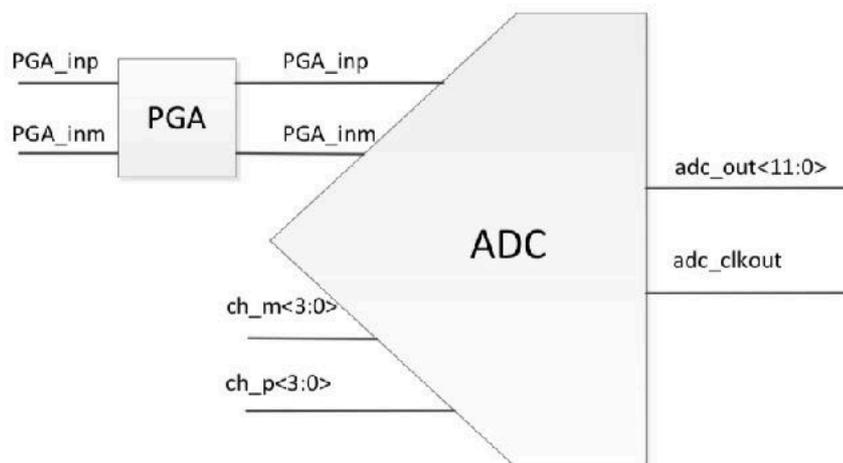
where the value in N\_top\_count register controls the frequency

and the Duty cycle is controlled by the following equation:

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

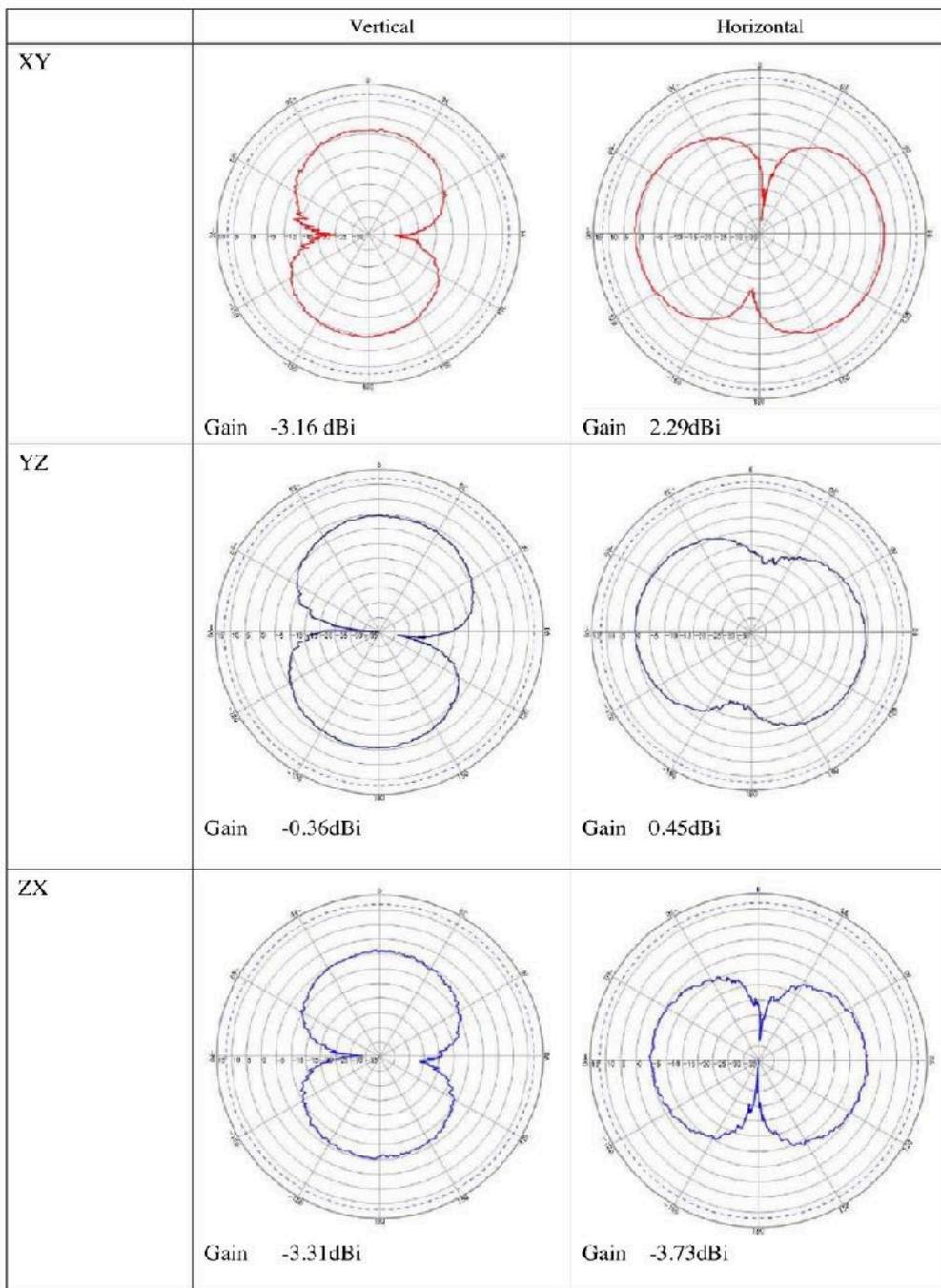
where the value in N\_threshold, together with N\_top\_count, control the duty cycle

5. Quadrature decoder: it can interface and decode signal from quadrature-encoded sensor, both mechanical and optical sensors. Input debounce filters is included.
6. 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:

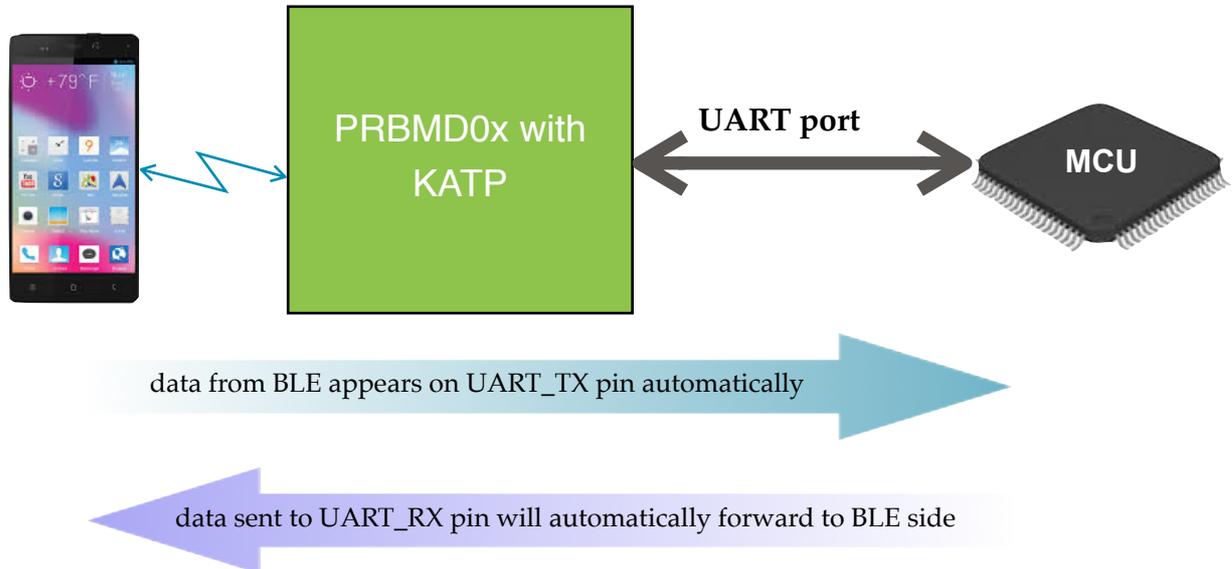


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# Firmware information

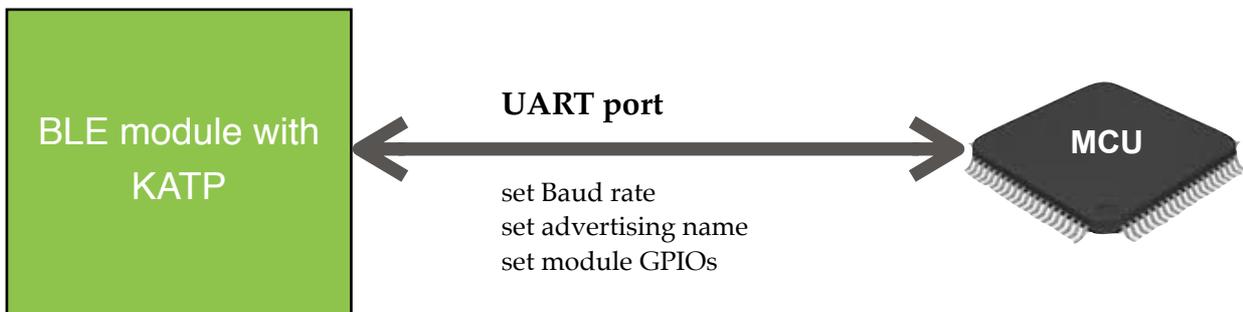
## Default firmware

PRBMD0x 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

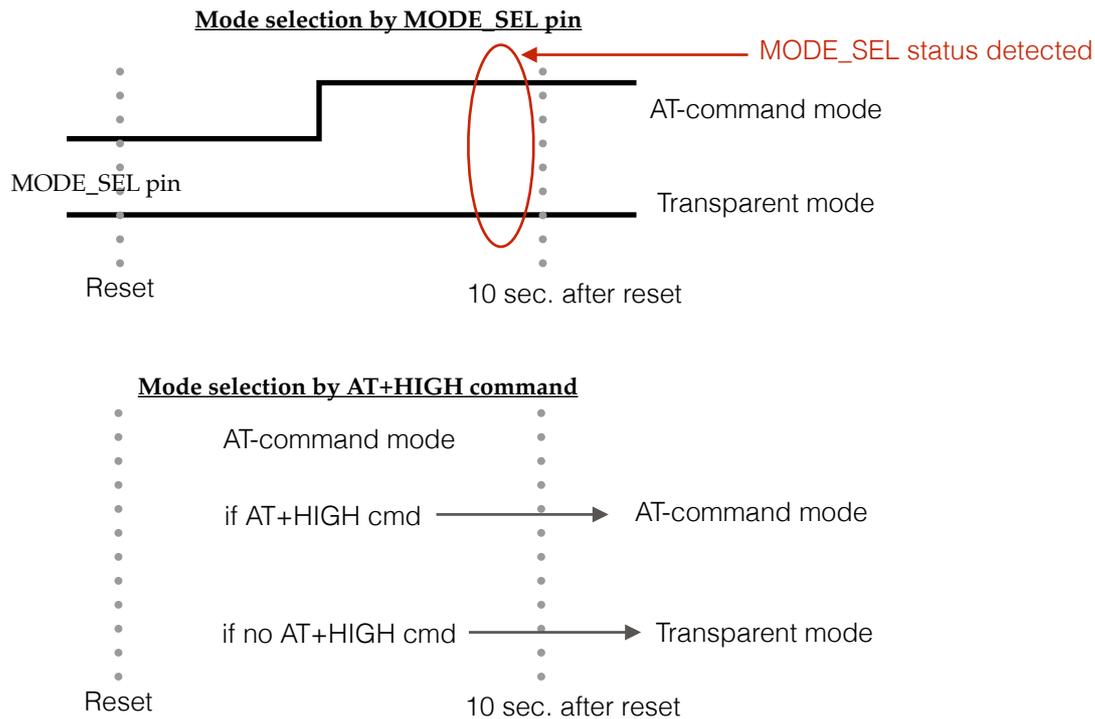
Sending a test mode command in AT-CMD mode will force KATP to testing mode, which allow user to fix the RF channel and power. Test mode is only for testing or certification purpose only.

## 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, PRBMD0x 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 PRBMD0x, 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= PRBMD0x. 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

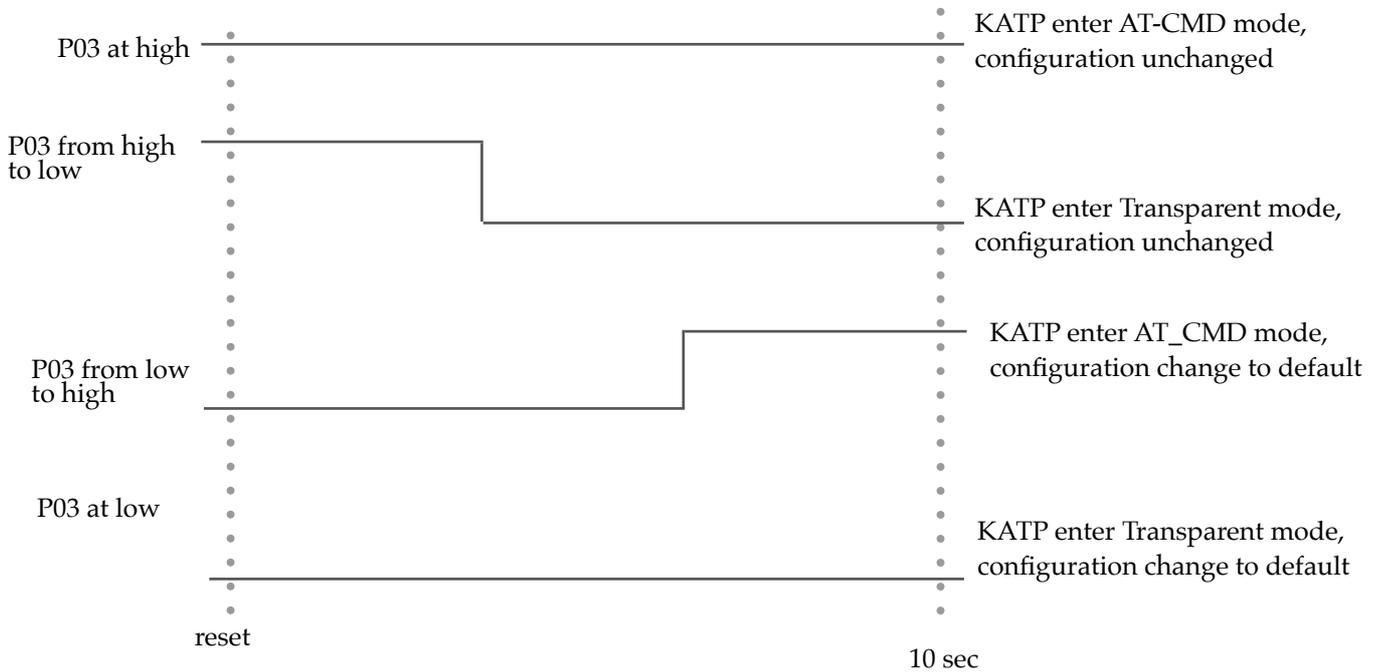
KATP will put PRBMD0x into sleep mode automatically after a while of idle.

## 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

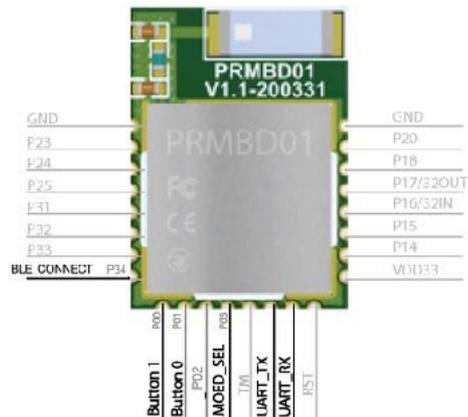


P03 will be detected at the first 5 sec after reset to determine return-to-default or not, and will determine to enter AT-CMD or Transparent mode at the 10 sec.

### Pin assignment

KATP defines pins of PRBMD0 as following:

PRBMD0x 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



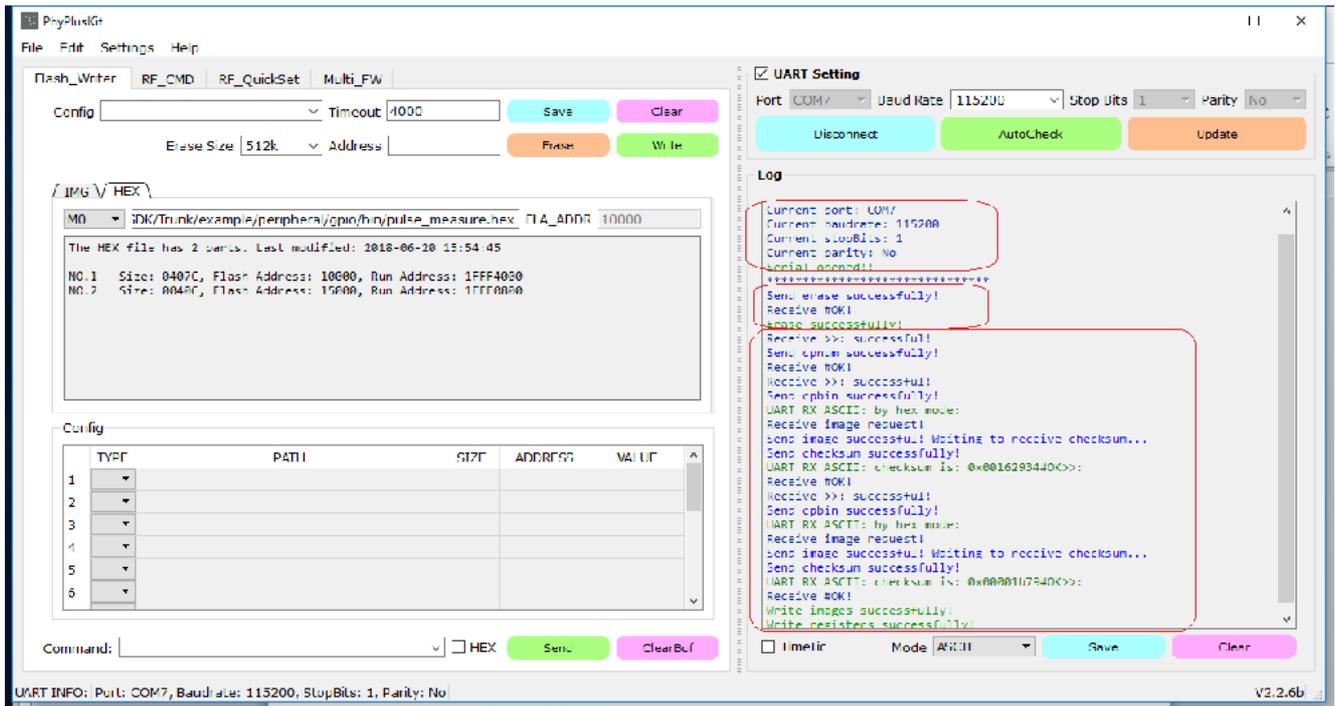
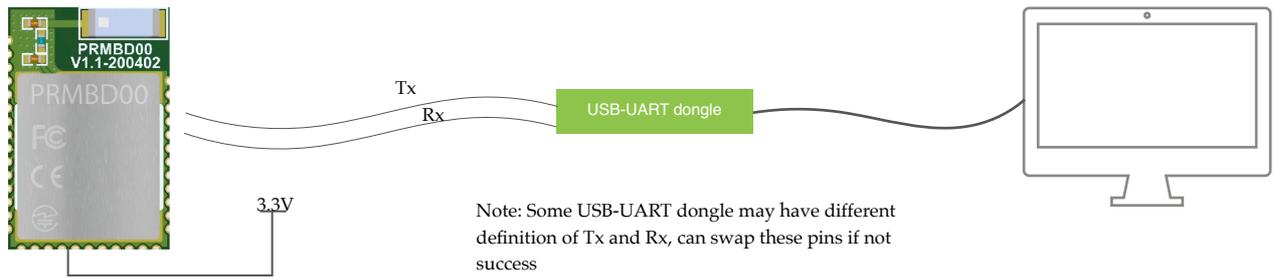
## AT-Command list in AT-CMD mode

	Action	enquiry	return value	set	return value
System	MAC addr *	<b>AT+ID?</b>	Current address		
	Help	<b>AT+HELP</b>	All AT commands		
	Reset			<b>AT+RESET</b>	
	Factory Default			<b>AT+DEFAULT</b>	- BAUD = 115200, TXP = 0, NAME = PRBMD0x, Flow control disabled
	Exit AT-CMD mode			<b>AT+EXIT</b> - enter transparent mode from AT-CMD	
BLE	Change name	<b>AT+NAME?</b>	- current name Default:PRBMD0x	<b>AT+NAME= New name</b>	
	Start advertising			<b>AT+BDCS</b>	
	Stop advertising			<b>AT+BDCE</b>	
UART and GPIO	BAUD rate	<b>AT+SPEED?</b>	Current baud	<b>AT+SPEED=BAUD</b> , 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			<b>AT+LEDOFF</b> - 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	<b>AT+GPIOxx=? xx:04-33</b>	level of the GPIO pin	<b>AT+GPIOxx=y xx:04-33</b>	y= 0 or 1, where 0 is low level and 1 is high level
RF test	Set all GPIO high			<b>AT+HIGH</b>	
	Set all GPIO low			<b>AT+LOW</b>	
	Fix a Tx channel #			<b>AT+TXa=b</b> a= modulation data, 0: PRBS9 1: 1111000 2: 10101010 b= 0-39 Tx channel i.e.: AT+TX1=20	
	Fix a Rx channel#			<b>AT+RX=c</b> c=0-39 channel	
	TX power	<b>AT+TXP?</b>	Current TX Power value	<b>AT+TXP= p</b> p : -20, -15, -10, -6, -5, -3, 0, 3, 4, 5	- new value

\* 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.

# Firmware programming



PhyPlusKit interface

Note: More information will be described in PRMD0x Programming document.

## MAC address

Unless otherwise instructed, each PRMBD0x 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					

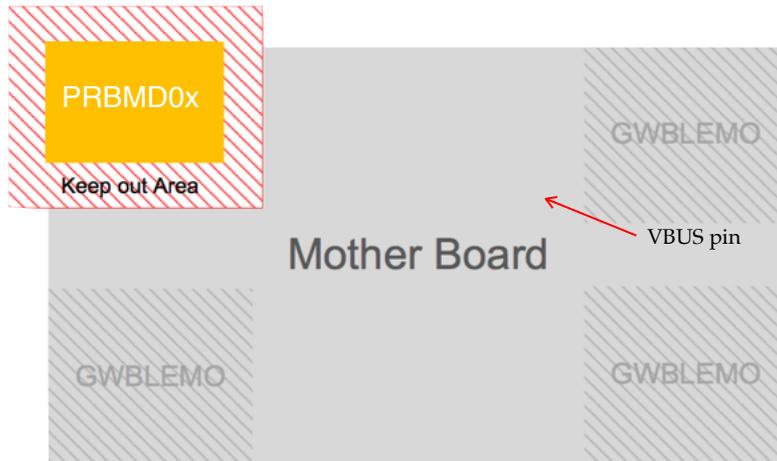
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## Mounting guide

PRBMD0x 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.

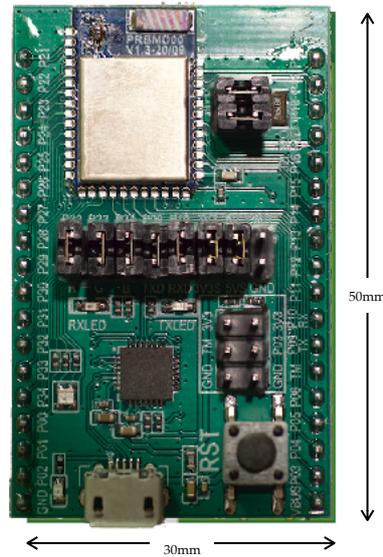
The figure below illustrates how to mount the PRBMD0x module. Improper mounting will decrease the RF performance dramatically.



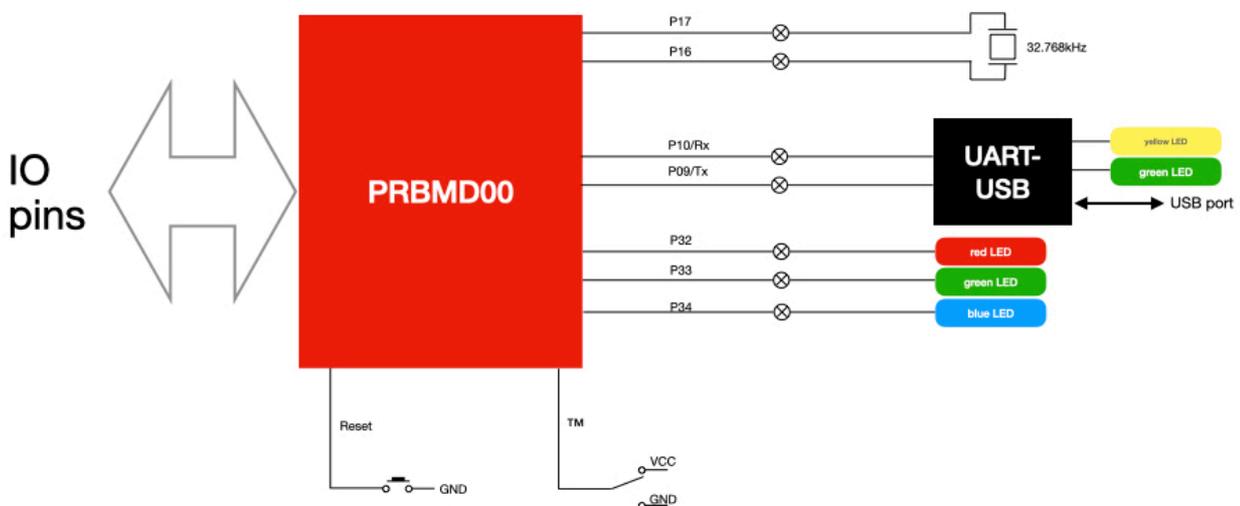
# Evaluation Board

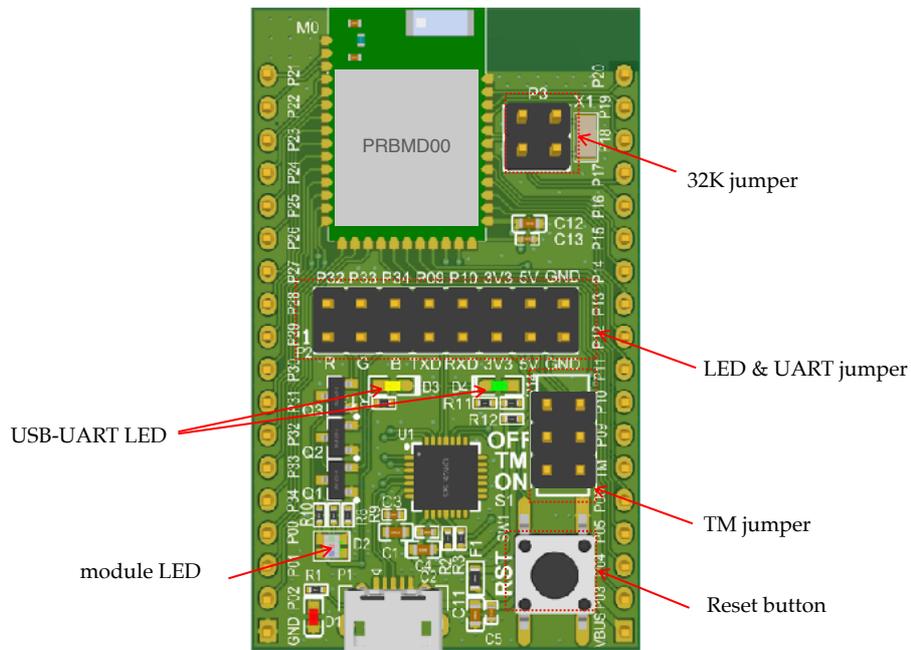
Evaluation board (EVB) for PRBMD0x is available, helping engineer for the firmware development. It is in DIP form factor, allows engineer to connect with external circuit easily for debugging and testing.

The EVB is illustrated as following:

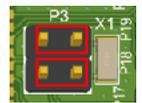


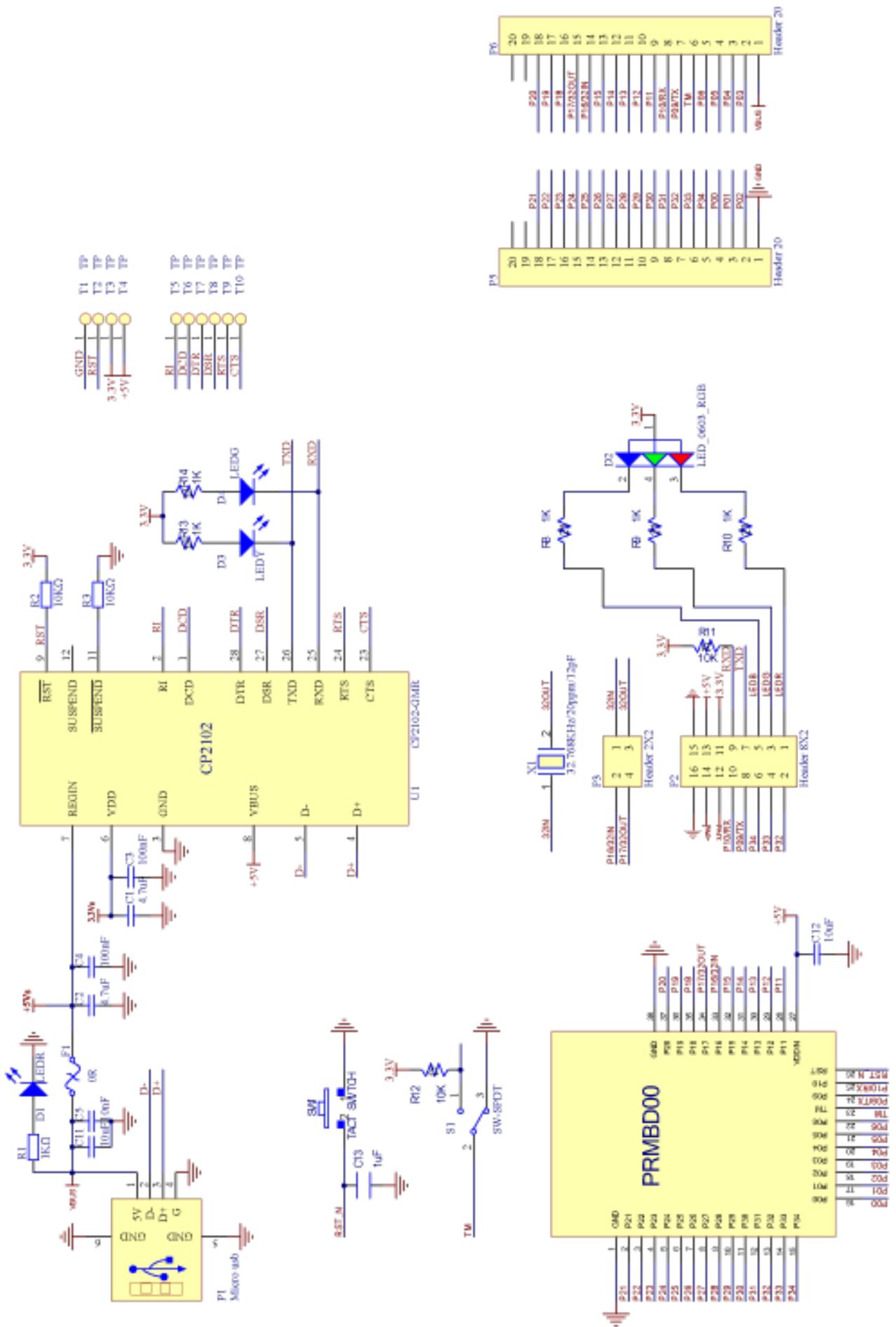
The EVK is in DIP format with PRBMD00 on it, and with on board 32.768KHz crystal and UART-USB chip, allow user to test and program the module easily. PRBMD00 is pre-programmed with the UART-BT tunnelling firmware. Below is the block diagram of the EVK:





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.





## Firmware development and SDK

User is allowed to developed their own firmware for PRBMD0x 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 PRBMD0x 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.

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## Service

### **Firmware programming**

K-Solution provide pre-programming service, so that PRBMD0x will be shipped with firmware pre-programmed. Service charge is needed.

### **Software service from K-Solution**

K-Solution also provides firmware develop service for PRBMD0x 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 PRBMD0x, 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 PRBMD0x 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



CE



Telec



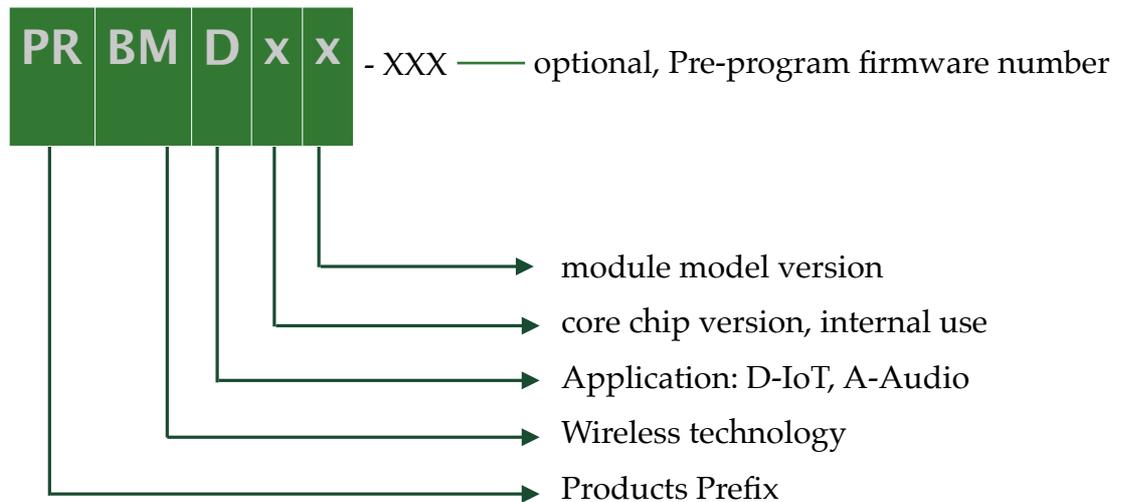
IC



FCC

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## 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

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## 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

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## 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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