

PTR54L05S Dual-Core Module

- Bluetooth® 6.x
- 128MHz ARM® Cortex™ M33 & 128MHz RISC-V Coprocessor



Product Introduction

The PTR54L05S is a coin-sized embedded system-level ultra-low-power Bluetooth multi-protocol module based on the Nordic nRF54L05. The module integrates an Arm® Cortex-M33 processor core and a RISC-V coprocessor with a processor clock frequency of up to 128MHz, and the processors are optimized for specific workloads. The module is equipped with ample integrated internal memory, excellent performance, and ample memory, making it ideal for IoT products, running machine learning (ML) models, and edge sensor fusion applications.

The PTR54L05S module helps simplify design, reduce costs, and speed up time to market. With professional design, strict quality control, and relevant certifications, the module can help customers quickly bring products to the global market without worries.

Features:

- System-on-Module based on Nordic nRF54L05
- Support Bluetooth Low Energy
- Support Bluetooth Low Energy 6.x
- 4 Mbps PHY
- 1 ARM® Cortex™ M33 processor, 1 RISC-V coprocessor
- 0.5MB NVM, 96KB RAM
- 13 general-purpose I/Os
- Up to +8dBm output RF power
- -104dBm sensitivity@125 kbps Bluetooth
- 14-bit ADC, Comparator, Low Power Comparator
- I2S Audio interface

- Size: about 15mm × 10mm
- Pulse Density Modulation Interface N
- RTC、 7x Timer、 2 x QDEC 5x SPI/
- TWI/ UART、 3x PWM

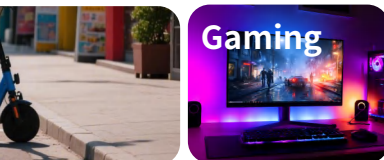
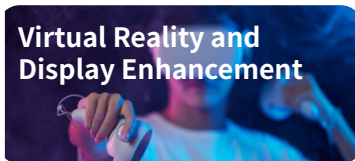
Main Processor

- 128 MHz ARM® Cortex™ M33
- TrustZone、 Floating point unit (FPU)
- Digital signal processor (DSP)
- 96 KB RAM

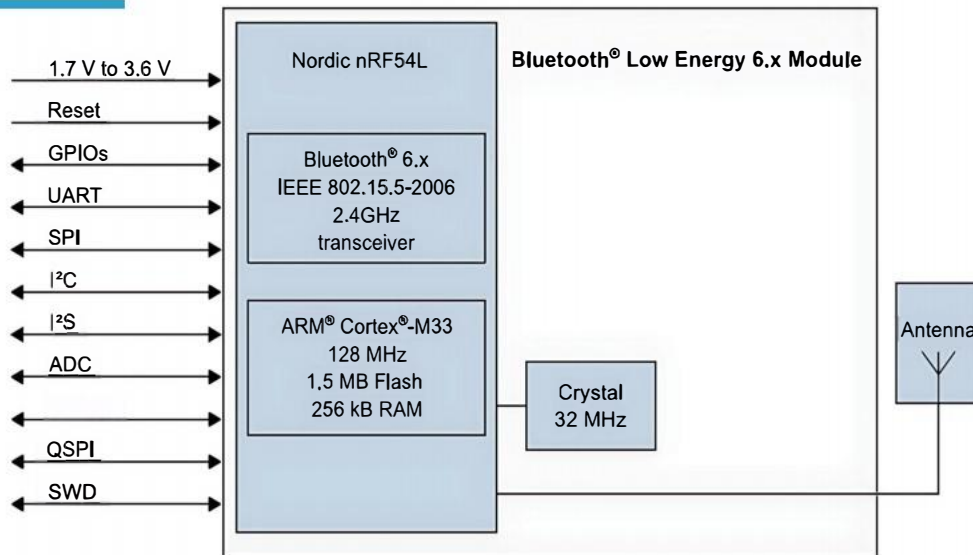
Coprocessor

- 128MHz RISC-V processor

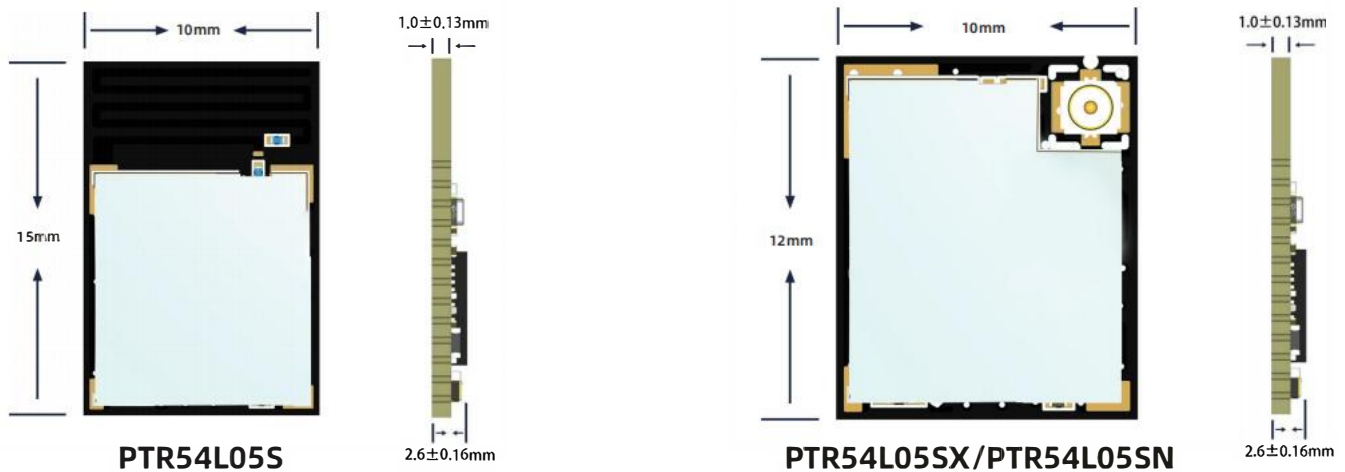
Typical Applications:



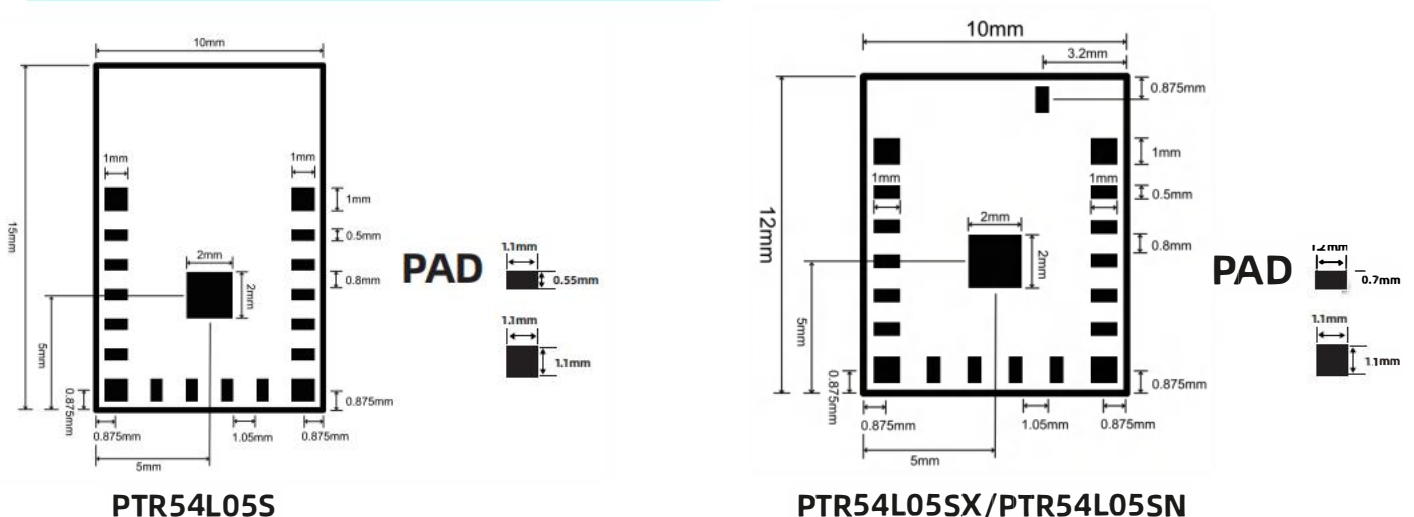
Module Internal Block Diagram:



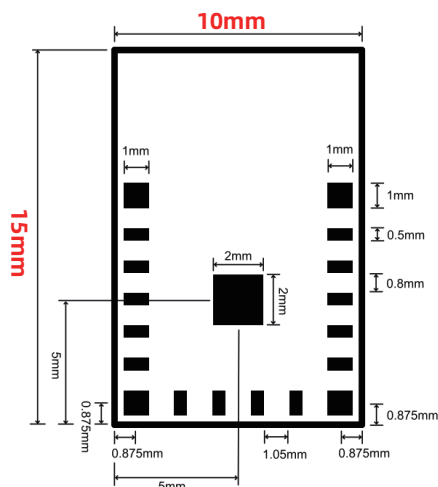
Module Mechanical Dimensions:



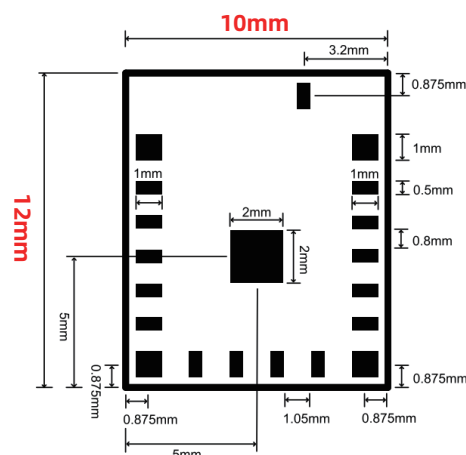
Recommended PCB land pads:



Mechanical Details:



PTR54L05S



PTR54L05SX/PTR54L05SN

Port capabilities:

GPIO ports have their own properties, the following is a list of all GPIO ports (P[n]) in the system.

- P0 low-power domain – These I/O pins can wake the system up from System OFF or System ON sleep, and can be accessed by all peripherals in the low-power domain.
- P1 peripheral domain – These I/O pins can wake the system up from System OFF or System ON sleep, and can be accessed by all peripherals in the peripheral domain.
- P2 MCU domain – These I/O pins are faster and can be used for high-speed signals such as trace or fast serial peripheral communication. GPIO P2 cannot wake the system from sleep. P2 does not have the GPIO SENSE or DETECT mechanism, or GPIOTE.

Peripherals must use pins in their own domain. However, some P2 pins can be used for select serial interfaces in the peripheral domain when the device is in Constant Latency sub-power mode. This is not the most power-efficient way of connecting these serial interfaces, but adds flexibility when designing a circuit board. Peripherals cannot mix pins from different ports. All pins must be on the same port.

The following table lists the port special functions and characteristics.

Port	Wakeup Source	Extra Hing Drive Strength (E0E1)	Pin Sense/Detect	GPIOTE	Maximum Speed [MHz]
P0	Yes	No	Yes	Yes	8
P1	Yes	No	Yes	Yes	8
P2	No	Yes	No	No	64

Dedicated pins:

Some pins on the device are dedicated for a specific purpose. GPIO pin routing and configuration is flexible. Some pins have limitations or recommendations for configuration and use.

Peripheral	Description
UARTE20/21	Can use any pin on P1. Can connect across power domains to dedicated pins on P2.
SPIM00	Has dedicated pins on P2. For 32 MHz operation, the pins must be configured using extra high drive E0/E1 configuration in the DRIVE0/1 fields of the PIN_CNF GPIO register.
SPIM20/21	Can use any pins on P1; Can be connect across power domains to dedicated pins on P2.
SPIM20/21	Can use any pins on P1; Can connect across power domains to dedicated pins on P2.
TRACE	Has dedicated pins that must be configured using extra high drive E0/E1 configuration in the DRIVE0/1 fields of the PIN_CNF GPIO register.
GRTC	Has dedicated pins for clock and PWM output.
TAMPC	Has dedicated pins for active shield input and output.
FLPR	Uses dedicated pins on P2 for emulated peripherals such as QSPI.
RADIO	Uses dedicated pins on P1 for antenna switch control (DFEGPIO for direction finding).
NFC	Uses dedicated pins P1.02 and P1.03

For SPI, TWI, PDM, I2S, TRACE, GRTC, the peripheral signals must use dedicated clock pins. Dedicated clock pins have been optimized to ensure correct timing relationship between clock and data signals for these peripherals. Clock pins can also be used as regular I/O data pins.

The peripheral data signal must be configured to use pins close to the clock pin. This ensures that the internal paths from the peripheral to the pin have the same delay, so that the data and clock signals reach the pins at the same time.

For high-speed signals, the printed circuit board (PCB) layout must use short PCB traces of identical length. This makes sure any delays are kept to a minimum, with close to identical delay on the clock and data path.

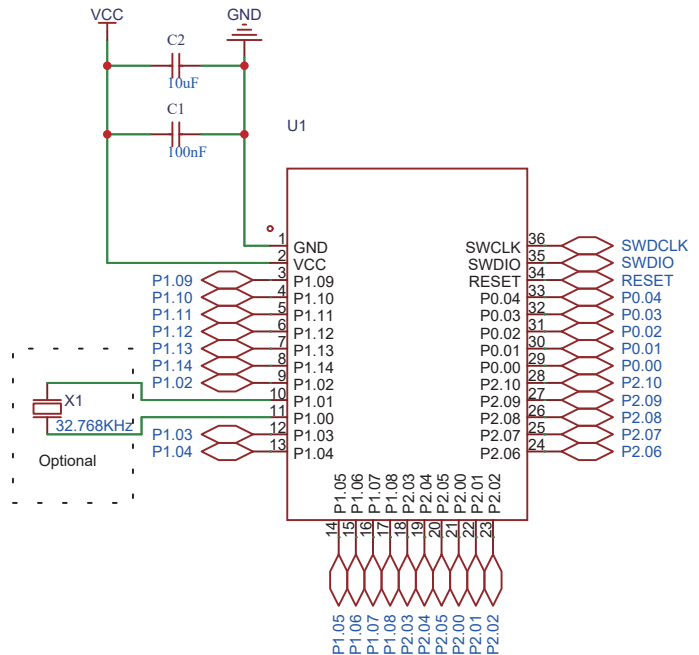
Module Pin Description:

Pin No	Name	Pin Type	Note
1	GND	GND	Ground
2	VCC	Supply	+1.7~3.6V
3	P1.09	General purpose I/O	
4	P1.10	General purpose I/O	
5	P1.11_AIN4	General purpose I/O_AIN4	
6	P1.12_AIN5	General purpose I/O_AIN5	
7	P1.00_XL1	General purpose I/O	
8	P1.01_XL2	General purpose I/O	
9	P1.04_AIN0	General purpose I/O	
10	P2.02_SPI.SDI/ SDO	General purpose I/O	
11	P2.05_SPIM.CS	General purpose I/O	
12	P2.06_TRACECLK/ SPI.SCK	General purpose I/O	
13	P2.09_TRACEDATA(2)/ SPI.SDI/ SDO	General purpose I/O	
14	RESET	External reset	Pin reset with on-chip pull-up
15	SWCLK	debug/program data port	
16	SWDIO	debug/program clock port	
17	GND	GND	Ground

Module Application Reference Schematic:

1. To ensure the stability and reliability of the system, the power supply must have reliable filtering, such as capacitors **C1** and **C2** shown in the diagram.

2. The module employs an internal low-frequency clock. If an external low-frequency crystal oscillator is required, a low-frequency crystal (**X1**) can be externally connected to the corresponding pins, as shown in the figure below, and the appropriate software settings should be made.



PCB Layout on Host PCB:

- MUST locate PTR module close to the edge of PCB.
- Use solid GND plane on inner layer (for best EMC and RF performance).
- All module GND pins MUST be connected to host PCB GND.
- Place GND vias close to module GND pads as possible.
- Unused PCB area on surface layer can be flooded with copper but place GND vias regularly to connect the copper flood to the inner GND plane.
- Route traces to avoid noise being picked up on supply and AIN (analogue) and SIO (digital) traces.
- Ensure no exposed copper is on the underside of the module.

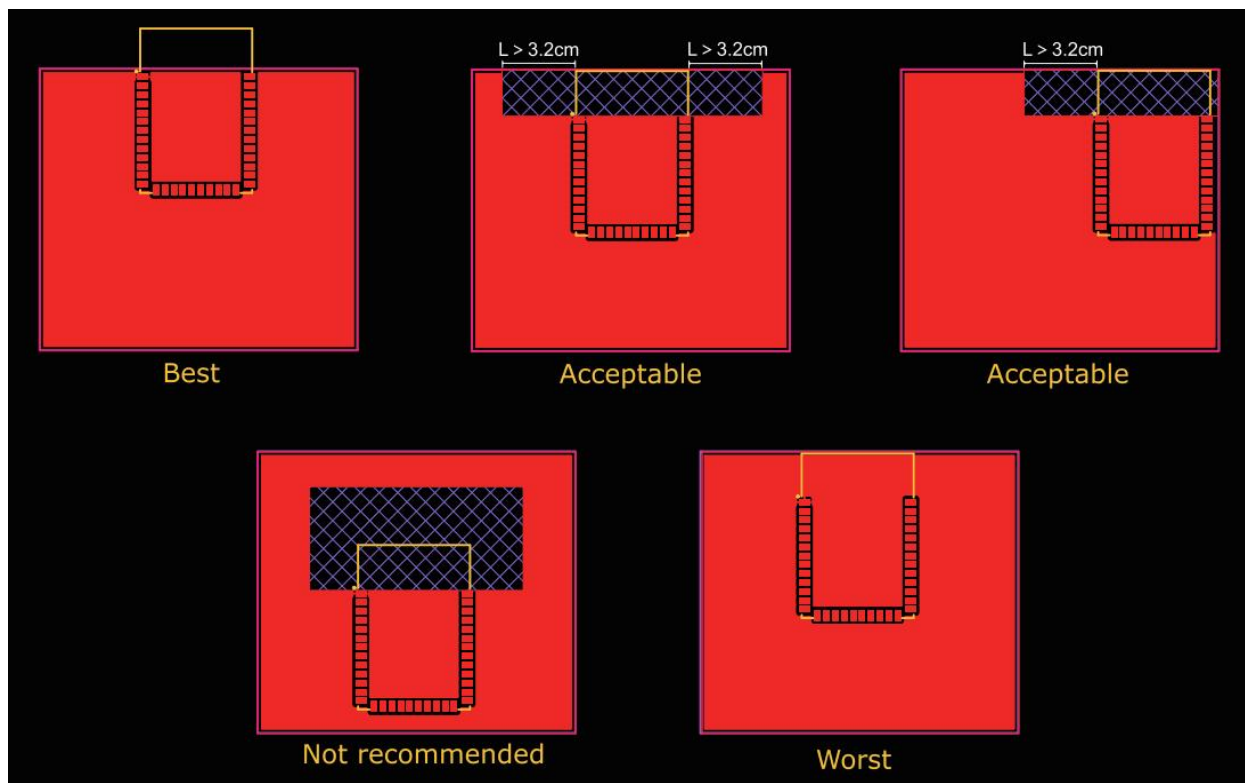
Antenna Keep-out and Proximity to Metal or Plastic:

- Minimum safe distance for metals without seriously compromising the antenna is 40 mm top/bottom and 30 mm left or right.
- Metal close to the PCB trace monopole antenna (bottom, top, left, right, any direction) will have degradation on the antenna performance.
- Any metal closer than 20 mm will begin to significantly degrade performance (S11, gain, radiation efficiency).
- It is best that you test the range with a mock-up (or actual prototype) of the product to assess effects of enclosure height (and materials, whether metal or plastic).

Module Recommended Placement :

BLE modules are RF devices that require a proper placement on PCB to ensure optimal performance. The antenna on the PCB has (about) an omnidirectional radiation pattern. To maximize antenna efficiency, an adequate grounding plane must be provided under the module. However, the areas underneath and surrounding the antenna area must be free of copper. The position of the module on the host board and overall design of the product enclosure contribute to antenna performance. Poor design affects radiation patterns and can result in reflection, diffraction, and/or scattering of the transmitted signal thus limiting the range.

- Never place the ground plane or route copper traces directly underneath the antenna portion of the module.
- Never place the antenna close to metallic objects.
- Keep wiring, components, and objects away from antenna.
- Do not place the antenna in a metallic or metalized plastic enclosure.
- Enclosure walls should be 1cm or more away from the antenna in all directions.
- If possible, mount antenna overhanging the edge of the host board (motherboard). Add an uninterrupted ground plane on host board, directly underneath the top shielded zone of the module, up to the PCB edge. Adding a ground plane allows traces to be run on the bottom side of the host board if required.
- If antenna cannot be mounted in overhanging position, then provisions must be made to keep area clear of copper as recommended in diagram.



Specifications:

Parameters	Min	Typical	Max	Unit
Radio				
Operating frequency	2402		2480	MHz
Maximum output power		+8		dBm
Receiving sensitivity, @BLE 1 Mbps		-96		dBm
Receiving sensitivity, @BLE 125 kbps		-104		dBm
Power consumption				
Transmit peak current (0dBm)		5		mA
Receive peak current (BLE @ 1Mbps)		3.2		mA
System sleep current		0.6		uA
Operating temperature				
Operating temperature range	-40		85	°C
	Extended Industrial temperature -40 to +105°C can be customized			
Supply voltage				
VDD	1.7		+3.5	V

Absolute Maximum Ratings:

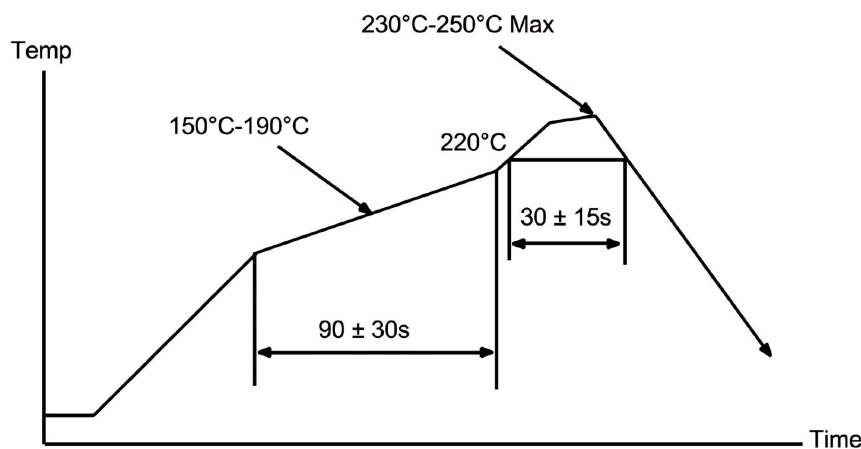
Parameters	Min	Max	Unit
Supply voltage			
VDD	-0.3	+3.6	V
VSS		0	V
I/O Pin voltage			
VI/O, VDD ≤3.6 V	-0.3	VDD+0.3	V
VI/O, VDD >3.6 V	-0.3	+3.6	V

Note: Forcibly exceeding one or more limit values will cause permanent damage to the module.

Reflow Soldering:

Recommendation for RoHS reflow process is according to Jedec J–STD-020 and 033 standard profiles.

- SMT reflows: It is recommended to one-time soldering;
- SMT mounting: it is recommended to bake at 60°C - 75°C for 24 hours before SMT mounting;
- During the SMT chip processing, electrostatic protection measures need to be properly taken;
- Below is the temperature-Time Profile for Reflow Soldering;



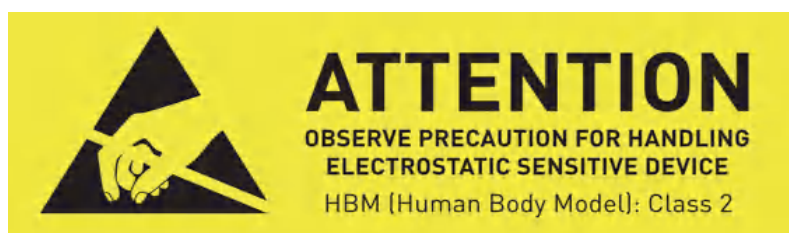
Application Notes:

Design Description

- (1) The recommendations in this manual must be followed to ensure that the module operates properly.
- (2) The power supply of the module must be a stable voltage without AC ripple. If noise is present, appropriate filtering and decoupling must be performed.
- (3) After the module is installed, no mechanical stress should be applied to the module.
- (4) Keep the module away from other high-frequency devices that may interfere with operation, such as other transmitters and devices that generate high-frequency signals.
- (5) Avoid static electricity, electrostatic discharge and high voltage, which may cause damage to the module. Operators must wear anti-static rings and implement electrostatic protection measures to prevent human static electricity from damaging the chip and firmware.
- (6) Care should be taken to avoid abnormal supply voltage of the chip on the module due to poor welding short circuit or open circuit of the main board power supply circuit, resulting in chip damage.

Transport and Storage

- (1) During the production and transportation of the module, please take protective measures to prevent the precision parts on the module from being damaged (it is recommended to use anti-collision materials to buffer the reflow furnace exit and assembly, testing, and transportation processes to avoid collisions).
- (2) Do not expose the module to the following conditions: corrosive gases such as Cl₂, H₂S, NH₃, SO₂ or NO_x, extreme humidity or salty air, long-term exposure to direct sunlight, and temperatures exceeding the specified storage temperature.
- (3) Do not apply mechanical stress to the module.
- (4) Avoid dropping or impacting the module.
- (5) Avoid static electricity, electrostatic discharge, and high voltage, which may cause damage to the module.



Moisture sensitivity

The module is a humidity-sensitive component. During the reflow soldering operation, please strictly follow the regulations of IPC/ JEDEC IPC/ JEDEC IPC/ JEDEC J-STDSTD-020. The module should be baked, dried and dehumidified before assembly.

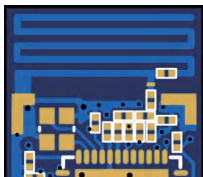
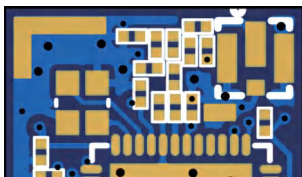


Life support applications

The modules are not designed for life support applications. Customers who use or sell products for these applications must agree to do so at their own risk.

Ordering Information:

Model	Description
PTR54L05S	Full Bluetooth 6.x multi-protocol embedded system-level module, onboard PCB antenna
PTR54L05SX	Full Bluetooth 6.x multi-protocol embedded system-level module, external antenna through IPEX socket
PTR54L05SN	Full Bluetooth 6.x multi-protocol embedded system-level module, external antenna via module's antenna pin PAD

PTR54L05S 	PTR54L05SX/PTR54L05SN 
---	--

Customized hardware and software development and design services

We have many years of rich experience in the field of intelligent IoT wireless connection modules, and can provide a wide range of customized hardware and software design and module manufacturing services, sharing advanced wireless product technology with you. Our customized development services include but are not limited to the following:

- Customized hardware design, including module, RF and antenna design
- Low-power Bluetooth firmware development
- iOS and Android App development
- Cloud platform development

About Trademarks

The Bluetooth® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc. Other marks and logos are trademarks or registered trademarks of their respective owners.

Rights Statement

- We are not responsible for the user's products or applications. We do not assume any authorized use of patents or intellectual property rights.
- The contents of this manual are protected by copyright laws and regulations. Without our prior written authorization, no one may copy or transcribe this manual in any way, or transmit all or any part of this manual in any form over any wired or wireless network, or compile or translate it into any other format, text or code.
- We have carefully proofread and checked this manual, but cannot guarantee that this manual is completely free of errors and omissions. We reserve the right to amend, modify and/or improve the product and/or its specifications at any time without prior notice.

FCC Statement

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, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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 important announcement

Important Note:

Radiation Exposure Statement

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.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Country Code selection feature to be disabled for products marketed to the US/Canada.

This device is intended only for OEM integrators under the following conditions:

1. The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2. The transmitter module may not be co-located with any other transmitter or antenna,

As long as the conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Important Note:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling

The final end product must be labeled in a visible area with the following"

Contains FCC ID: **2AA72-PTR54L05S** "

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01r01

2.2 List of applicable FCC rules

CFR 47 FCC PART 15 SUBPART C 15.247,15.207,15.209 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 & your body.

2.7 Antennas

This radio transmitter **FCC ID:2AA72-PTR54L05S** 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.

Antenna No.	Model No. of antenna:	Type of antenna:	Gain of the antenna (Max.)	Frequency range:
Bluetooth	/	PCB Antenna	1.22dBi	2402-2480MHz

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following" Contains **FCC ID:2AA72-PTR54L05S**".

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.

Operation frequency:2402MHz-2480MHz

Channel Number: 40 channels

Modulation Technology:GFSK for Bluetooth

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.

2.11 Note EMI Considerations

Host manufacture is recommended to use KDB 996369 D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.

2.12 How to make changes

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. According to the KDB 996369 D02 Q&A Q12, For EMC/radio-parameter compliance purposes, when an evaluation is done by the grantee or host provider and there are no additional emissions generated due to simultaneous-transmission operations compared to single transmitter operations testing (i.e., not transmitting simultaneously), it is not necessary to file the additional simultaneous transmission test data. The host manufacturer is responsible for ensuring compliance with the applicable FCC rules for the transmitters operating individually and simultaneously. This includes compliance for the summation of all emissions from all outputs occupying the same or overlapping frequency ranges, as defined by the applicable rules.