# FSC-BT616

## Bluetooth 5.1 Specifications Wireless MCU Module Datasheet

**Version 2.2**

## Revision History

| Version | Data | Notes | |
|---|---|---|---|
| 1.0 | 2016/11/21 | Initial Version | Devin Wan |
| 1.1 | 2017/09/06 | Bluetooth low energy (BLE) 5.1 Specifications | Devin Wan |
| 1.2 | 2018/01/19 | Modify some redundant information, added Pin 23,24,25,26 instructions. | Devin Wan |
| 1.3 | 2018/02/06 | Modify the pin description of 9,10Pin. | Devin Wan |
| 1.4 | 2018/10/10 | 1. Correct the description of the error - does not support the SPP protocol<br>2. Modify the block diagram - built-in filter and 4MB SPI Flash IC | Devin Wan |
| 1.5 | 2019/06/12 | Corrected some erroneous decscription | Fish |
| 1.6 | 2019/08/29 | Increase the certification directory | Fish |
| 1.7 | 2019/10/10 | Increase the certification directory | Fish |
| 1.8 | 2019/10/18 | Feature update | Fish |
| 1.9 | 2020/04/30 | Increase power consumption parameters | Fish |
| 2.0 | 2020/11/03 | Update the pin definition to correspond to the chip | Fish |
| 2.1 | 2021/04/29 | Update module height | Fish |
| 2.2 | 2021/11/04 | Modify Bluetooth Version: Upgrade from BT5 to BT5.1<br>Change storage temperature：-40°C to +85°C | Marsh |
| | | | |



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# Contents

# 1. INTRODUCTION

## Overview

FSC-BT616 is a wireless microcontroller (MCU) targeting Bluetooth 5.1 low energy applications.

Very low active RF and MCU current and low-power mode current consumption provide excellent battery lifetime and allow for operation on small coin cell batteries and in energy-harvesting applications.

FSC-BT616 contains a 32-bit ARM® Cortex®-M3 core that runs at 48 MHz as the main processor and a rich peripheral feature set that includes a unique ultra-low power sensor controller. This sensor controller is ideal for interfacing external sensors and for collecting analog and digital data autonomously while the rest of the system is in sleep mode. Thus, FSC-BT616 is great for a wide range of applications where long battery lifetime, small form factor, and ease of use is important.

It supports GAP, ATT/GATT, SMP, L2CAP profiles. It integrates Baseband controller in a small package (Integrated chip antenna), so the designers can have better flexibilities for the product shapes.

## Features

- 2.4-GHz RF Transceiver Compatible With Bluetooth low energy (BLE) 5.1 Specifications
- Link Budget of 102 dB for BLE
- Integrate MCU to execute Bluetooth protocol stack.
- Postage stamp sized form factor,
- Low power
- Class 1.5 support(up to +5 dBm)
- The default UART Baud rate is 115.2Kbps and can support from 1200bps up to 921.6Kbps,.
- UART, I2C,SPI,12-bit ADC(200ks/S)data connection interfaces.
- Support the OTA upgrade.
- Bluetooth stack profiles support: LE HID, and all BLE protocols.
- PWM
- Support eight capacitance sensor button
- Integrated temperature sensor
- FCC, CE , IC and SRRC Certified
- Power Consumption In Sleep Mode (VDD_3V3 at 3.3V)
  - Discoverable：156.85uA
  - LE Connection：259.20uA
- Power Consumption In Working Mode (VDD_3V3 at 3.3 V)
  - Discoverable：1.86mA
  - LE Connection：2.07mA
  - LE Connection @ 115200bps：2.12mA

## Application

- Home and Building Automation
  - Connected Appliances
  - Lighting
  - Locks
  - Gateways
  - Security Systems
- Industrial
  - Logistics
  - Production and Manufacturing Automation
  - Asset Tracking and Management
  - HMI and Remote Display

– Access Control

- Retail
  – Beacons
  – Advertising
  – ESL and Price Tags
  – Point of Sales and Payment Systems
- Health and Medical
  – Thermometers
  – SpO2
  – Blood Glucose and Pressure Meters
  – Weight Scales
  – Hearing Aids
- Sports and Fitness
  – Activity Monitors and Fitness Trackers
  – Heart Rate Monitors
  – Running and Biking Sensors
  – Sports Watches
  – Gym Equipment
  – Team Sports Equipment
- HID
  – Voice Remote Controls
  – Gaming
  – Keyboards and Mice

## Module picture as below showing

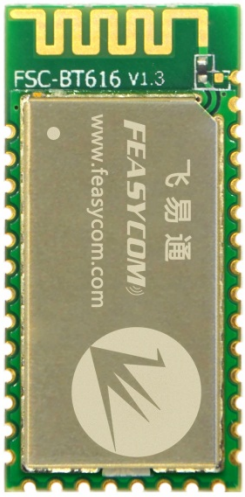



**Figure 1:** FSC-BT616 Picture

# 2. General Specification

**Table 1:** General Specifications

| Categories | Features | Implementation |
|---|---|---|
| Wireless Specification | Chip | TI CC2640R2F |
| | Bluetooth Version | Bluetooth low energy (BLE) 5.1 Specifications |
| | Frequency | 2.402 - 2.480 GHz |
| | Transmit Power | +5 dBm (Maximum) |
| | Receive Sensitivity | -95 dBm (Typical) |
| | Raw Data Rates (Air) | 2 Mbps(Bluetooth 5.1) |
| | Modulation | GFSK |
| Host Interface and Peripherals | UART Interface | TX, RX, CTS, RTS |
| | | General Purpose I/O |
| | | Default 115200,N,8,1 |
| | | Baudrate support from 1200 to 921600 |
| | | 5, 6, 7, 8 data bit character |
| | GPIO | 15(maximum – configurable) lines |
| | | O/P drive strength (4 mA) |
| | | Pull-up resistor (33 KΩ) control |
| | | Read pin-level |
| | I2C Interface | 1 (configurable from GPIO total). Up to 400 kbps |
| | SSI Interface | Up to 2 SSI interfaces with a frequency of up to 4 MHz |
| | | Support both master and slave mode |
| | | SPI, MICROWIRE, TI |
| | ADC Interface | Analog input voltage range: 1.8V ~ 3.8V |
| | | Supports single 12-bit SAR ADC conversion |
| | | 8 channels (configured from GPIO total) |
| | | Up to 200MSPS conversion |
| | PWM | 4 General-Purpose Timer Modules |
| | | Four General-Purpose Timer Modules<br>(Eight 16-Bit or Four 32-Bit Timers, PWM Each) |
| Profiles | Class Bluetooth | No Support |
| | Bluetooth Low Energy | GATT Client & Peripheral - Any Custom Services |
| | | BT5.1 Specifications |
| | | MFI Support |
| Maximum Connections | Classic Bluetooth | No Support |
| | Bluetooth Low Energy | 1Clients(TBD) |
| FW upgrade | | Over the Air |
| | | Xds |
| Supply Voltage | Supply | 1.8V ~ 3.8V |
| Power Consumption | | Max Peak Current(TX Power @ +5dBm TX): 20mA |
| | | Standby Doze (Wait event) - ~1mA (TBD) |
| | | Deep Sleep - 2uA(RTC Running and RAM/CPU Retention) (TBD) |

| | | |
|---|---|---|
| Physical | Dimensions | 13mm X 26.9mm X 2.2mm; Pad Pitch 1.5mm |
| Environmental | Operating | -40°C to +85°C |
| | Storage | -40°C to +85°C |
| Miscellaneous | Lead Free | Lead-free and RoHS compliant |
| | Warranty | One Year |
| Humidity | | 10% ~ 90% non-condensing |
| MSL grade: | | MSL 3 |
| ESD grade: | Human Body Model | All pins: ±2500V |
| | Charged device model | RF pins/ Non-RF pins: ±750V |
| | | |

# 3. HARDWARE SPECIFICATION

## 3.1 Block Diagram and PIN Diagram

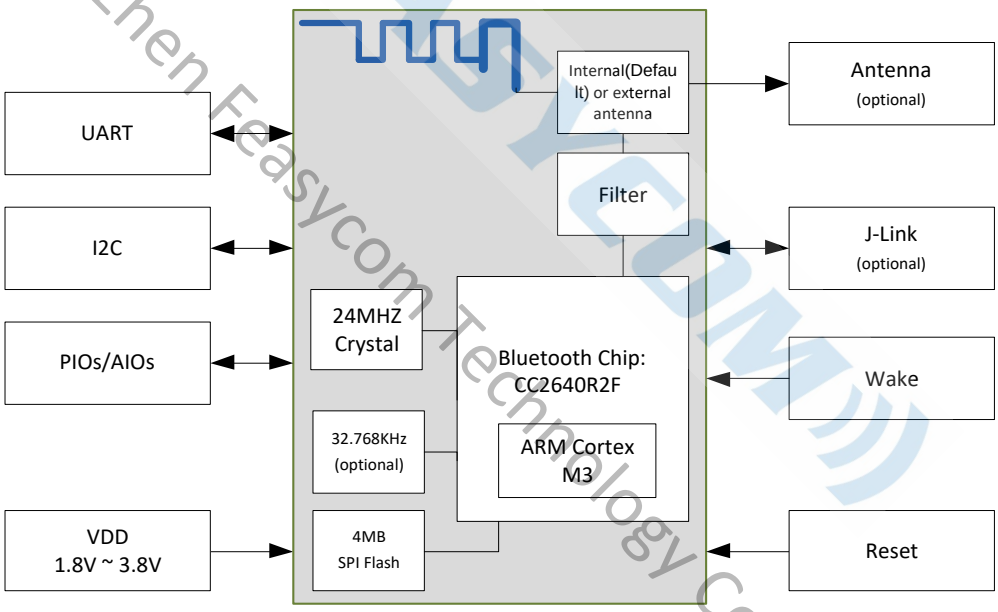



**Figure 2:** Block Diagram

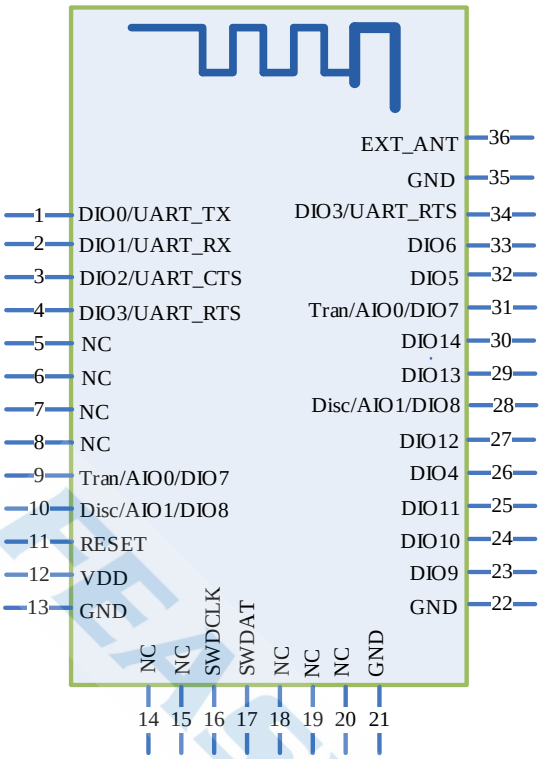



**Figure 3:** FSC-BT616 PIN Diagram(Top View)

## 3.2 PIN Definition Descriptions

**Table 2:** Pin definition

| Pin | Pin Name | Type | Pin Descriptions | Notes |
|---|---|---|---|---|
| 1 | DIO0/UART_TX | O | UART data output | Note 1 |
| 2 | DIO1/UART_RX | I | UART data input | Note 1 |
| 3 | DIO2/UART_CTS | I | UART clear to send active low<br>Alternative Function: Programmable input/output line | Note 1 |
| 4 | PIO3/UART_RTS | I/O | UART request to send active low<br>Alternative Function: Programmable input/output line | Note 1 |
| 5 | NC | | NC | |
| 6 | NC | | NC | |
| 7 | NC | | NC | |
| 8 | NC | | NC | |
| 9 | Tran/AIO0/DIO7 | I | Programmable input/output line<br>Alternative Function 1: Analogue programmable I/O line.<br>Alternative Function 2: Host MCU change UART transmission mode. | Note 1 |
| 10 | Disc/AIO1/DIO8 | I/O | Programmable input/output line<br>Alternative Function 1: Analogue programmable I/O line.<br>Alternative Function 2: Host MCU disconnect bluetooth. | Note 1 |
| 11 | RESET | I | External reset input: Active LOW, with an inter an internal pull-up.<br>Set this pin low reset to initial state. | |

| | | | | |
|---|---|---|---|---|
| 12 | VDD | Vdd | Power supply voltage 1.8V ~ 3.8V | |
| 13 | GND | Vss | Power Ground | |
| 14 | NC | | NC | |
| 15 | NC | | NC | |
| 16 | SWDCLK | I/O | Debugging through the clk line(Default) | Note 1 |
| 17 | SWDAT | I/O | Debugging through the data line(Default) | Note 1 |
| 18 | NC | | NC | |
| 19 | NC | | NC | |
| 20 | NC | | NC | |
| 21 | GND | Vss | Power Ground | |
| 22 | GND | Vss | Power Ground | |
| 23 | **DIO9** | I/O | Programmable input/output line<br>*** The I/O port for reuse.** | Note 6 |
| 24 | **DIO10** | I/O | Programmable input/output line<br>*** The I/O port for reuse.** | Note 6 |
| 25 | **DIO11** | I/O | Programmable input/output line<br>*** The I/O port for reuse.** | Note 6 |
| 26 | **DIO4** | I/O | Programmable input/output line<br>*** The I/O port for reuse.** | Note 6 |
| 27 | DIO12 | I/O | Programmable input/output line | |
| 28 | Disc/AIO1/DIO8 | I | Programmable input/output line<br>Alternative Function 1: Analogue programmable I/O line.<br>Alternative Function 2: Host MCU change UART transmission mode. | Note 1 |
| 29 | DIO13 | I/O | Programmable input/output line<br>Alternative Function: I2C CLK line (Default) | Note 1,3 |
| 30 | DIO14 | I/O | Programmable input/output line<br>Alternative Function: I2C DATA line (Default) | Note 1,3 |
| 31 | Tran/AIO0/DIO7 | I/O | Programmable input/output line<br>Alternative Function 1: Analogue programmable I/O line.<br>Alternative Function 2: Host MCU disconnect bluetooth. | Note 1 |
| 32 | DIO5 | I/O | Programmable input/output line<br>Alternative Function: LED(Default) | Note 1,4 |
| 33 | DIO6 | I/O | Programmable input/output line<br>Alternative Function: BT Status(Default) | Note 1,2 |
| 34 | DIO3/UART_RTS | I/O | UART request to send active low<br>Alternative Function: Programmable input/output line | Note 1 |
| 35 | GND | Vss | RF Ground | |
| 36 | EXT_ANT | O | RF signal output . | Note 5 |

**Module Pin Notes:**

| | |
|---|---|
| Note 1 | For customized module, this pin can be work as I/O Interface. |
| Note 2 | BT Status(Default)-- Disconnected: Low Level; Connected: High Level. |
| Note 3 | I2C Serial Clock and Data. |

| | |
|---|---|
| | It is essential to remember that pull-up resistors on both SCL and SDA lines are not provided in the module and MUST be provided external to the module. |
| Note 4 | LED(Default)-- Power On: Light Slow Shinning ; Connected: Steady Lighting. |
| Note 5 | By default, this PIN is an empty feet. This PIN can connect to an external antenna to improve the Bluetooth signal coverage.<br>If you need to use an external antenna, by modifying the module on the 0R resistance to block out the on-board antenna; Or contact Feasycom for modification. |
| Note 6 | This I / O port is shared with the internal SPI Flash chip. We do not recommend using this pin, floating processing.<br>This pin is only available when the module is not equipped with air-upgrade function. |
| | |

# 4. PHYSICAL INTERFACE

## 4.1 Power Supply

The transient response of the regulator is important. If the power rails of the module are supplied from an external voltage source, the transient response of any regulator used should be 20μs or less. It is essential that the power rail recovers quickly.

## 4.2 Reset

The module may be reset from several sources: Power-on Reset (POR), Low level on the nRESET Pin (nRST), Watchdog time-out reset (WDT), Low voltage reset (LVR) or Software Reset(SYSRESETREQ, CPU Reset, CHIPRST).

The RESET pin is an active low reset and is internally filtered using the internal low frequency clock oscillator. A reset will be performed between 1.5 and 4.0ms following RESET being active. It is recommended that RESET be applied for a period greater than 5ms.

At reset the digital I/O pins are set to inputs for bi-directional pins and outputs are tri-state. The PIOs have weak pull-ups.

## 4.3 General Purpose Analog IO

- 12-bit SAR ADC engine with up to 200KSPS conversion rate
- Conversion range: VSSA to VDDA (1.8 to 3.8 V)
- Temperature sensor

Twelve 12-bit 1 μs multi-channel ADC is integrated in the device.

The conversion range is between 1.8 V < VDD < 3.8 V. An analog watchdog block can be used to detect the channels, which are required to remain within a specific threshold window. A configurable channel management block of analog inputs also can be used to perform conversions in single, continuous, scan or discontinuous mode to support more advanced usages. The ADC can be triggered from the events generated by the general-purpose timers and the advanced-control timers with internal connection.

The temperature sensor can be used to generate a voltage that varies linearly with temperature. Each device is factory-calibrated to improve the accuracy and the calibration data are stored in the system memory area.

## 4.4 General Purpose Digital IO

There are 15 general purpose digital IOs defined in the module. All these GPIOs can be configured by software to realize various functions, such as button controls, LED drives or interrupt signals to host controller, etc. Do not connect them if not use.

The I/O type of each I/O pins can be configured by software individually as Input or Push-pull output mode. After the chip is reset, the I/O mode of all pins is input mode with no pull-up and pull-down enable. Each I/O pin has an individual pull-up and pull-down resistor which is about 30 kΩ ~ 50 kΩ for VDD and Vss.

## 4.5 RF Interface

For This Module, the default mode for antenna is internal ,it also has the interface for external antenna. If you need to use an external antenna, by modifying the module on the 0R resistance to block out the on-board antenna; Or contact Feasycom for modification.

The user can connect a 50 ohm antenna directly to the RF port.

- 2402–2480 MHz Bluetooth 4.2 and Bluetooth 5; 125-Kbps to 2-Mbps over the air data rate.
- TX output power of +5dBm.
- Receiver to achieve maximum sensitivity -95dBm @ 1 Mbps BLE.

## 4.6 Serial Interfaces

### 4.6.1 UART

FSC-BT616 provides one channels of Universal Asynchronous Receiver/Transmitters(UART)(Full-duplex asynchronous communications). The UART Controller performs a serial-to-parallel conversion on data received from the peripheral and a parallel-to-serial conversion on data transmitted from the CPU. Each UART Controller channel supports ten types of interrupts.

This is a standard UART interface for communicating with other serial devices. The UART interface provides a simple mechanism for communicating with other serial devices using the RS232 protocol.

When the module is connected to another digital device, UART_RX and UART_TX transfer data between the two devices. The remaining two signals, UART_CTS and UART_RTS, can be used to implement RS232 hardware flow control where both are active low indicators.

This module output is at 3.3V CMOS logic levels (tracks VCC). Level conversion must be added to interface with an RS-232 level compliant interface.

Some serial implementations link CTS and RTS to remove the need for handshaking. We do not recommend linking CTS and RTS except for testing and prototyping. If these pins are linked and the host sends data when the FSC-BT616 deasserts its RTS signal, there is significant risk that internal receive buffers will overflow, which could lead to an internal processor crash. This drops the connection and may require a power cycle to reset the module. We

recommend that you adhere to the correct CTS/RTS handshaking protocol for proper operation.

**Table 3:** Possible UART Settings

| Parameter | Possible Values | |
|---|---|---|
| Baudrate | Minimum | 1200 baud (≤2%Error) |
| | Standard | 115200bps(≤1%Error) |
| | Maximum | 921600bps(≤1%Error) |
| Flow control | | RTS/CTS, or None |
| Parity | | None, Odd or Even |
| Number of stop bits | | 1 /1.5/2 |
| Bits per channel | | 5/6/7/8 |

When connecting the module to a host, please make sure to follow .

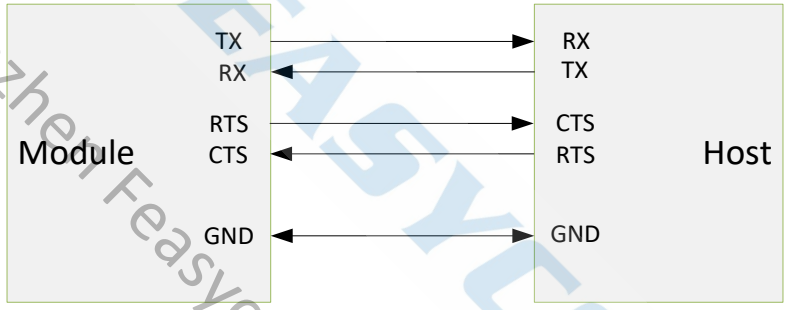



**Figure 4:** UART Connection

### 4.6.2 I²C Interface

- Up to two I²C bus interfaces can support both master and slave mode with a frequency up to 400KHZ.
- Provide arbitration function, optional PEC(packet error checking) generation and checking.
- Supports 7 –bit and 10 –bit addressing mode and general call addressing mode.

The I²C interface is an internal circuit allowing communication with an external I²C interface which is an industry standard two line serial interface used for connection to external hardware. These two serial lines are known as a serial data line (SDA) and a serial clock line (SCL). The I²C module provides two data transfer rates: 100 kHz of standard mode or 400kHz of the fast mode. The I²C module also has an arbitration detect function to prevent the situation where more than one master attempts to transmit data to the I²C bus at the same time. A CRC-8 calculator is also provided in I²C interface to perform packet error checking for I²C data.

## 4.7 SSI Interface

The SSIs are synchronous serial interfaces that are compatible with SPI, MICROWIRE, and Texas Instruments synchronous serial interfaces. The SSIs support both SPI master and slave up to 4 MHz.

## 4.8 PWM Interface

Timer 0 is a general-purpose timer module (GPTM), which provides two 16-bit timers. The GPTM can be configured to operate as a single 32-bit timer, dual 16-bit timers or as a PWM module.

# 5. ELECTRICAL CHARACTERISTICS

## 5.1 Absolute Maximum Ratings

Absolute maximum ratings for supply voltage and voltages on digital and analogue pins of the module are listed below. Exceeding these values causes permanent damage.

The average PIO pin output current is defined as the average current value flowing through any one of the corresponding pins for a 100mS period. The total average PIO pin output current is defined as the average current value flowing through all of the corresponding pins for a 100mS period. The maximum output current is defined as the value of the peak current flowing through any one of the corresponding pins.

**Table 4:** Absolute Maximum Rating

| Parameter | Min | Max | Unit |
|---|---|---|---|
| $V_{DD}$-$V_{SS}$ - DC Power Supply | -0.3 | +4.1 | V |
| $V_{IN}$ - Voltage on any digital pin | -0.3 | Vdd+0.3(max 4.1) | V |
| $V_{IN}$ - Voltage on ADC input (Voltage scaling enabled) | -0.3 | Vdd | V |
| $V_{IN}$ - Voltage on ADC input (Voltage scaling disabled, VDDS as reference) | -0.3 | VDD / 2.9 | V |
| Input RF level | | 5 | dBm |
| $T_{ST}$ - Storage Temperature | -40 | +85 | °C |
| $I_{IO}$ - Maximum Current sunk by a I/O pin | | 8 | mA |
| $I_{IO}$ - Maximum Current sourced by a I/O pin | | 8 | mA |

## 5.2 Recommended Operating Conditions

**Table 5:** Recommended Operating Conditions

| Parameter | Min | Type | Max | Unit |
|---|---|---|---|---|
| $V_{DD}$-$V_{SS}$ - DC Power Supply | 1.8 | 3.3 | 3.8 | V |
| $T_A$ - Operating Temperature | -40 | 25 | +85 | °C |
| $I_{IO}$ - Maximum Current sunk by a I/O pin | 2 | 4 | 6 | mA |
| $I_{IO}$ - Maximum Current sourced by a I/O pin | 2 | 4 | 6 | mA |

## 5.3 Input/output Terminal Characteristics

**Table 6:** DC Characteristics

| Parameter | Min | Type | Max | Unit |
|---|---|---|---|---|
| **$V_{DD}$ = 1.8V, $T_A$ = 25°C** | | | | |
| $V_{OH}$ - High Level Output Voltage, $I_{IO}$=8mA IOCURR = 2, high-drive GPIOs only | 1.32 | 1.54 | - | V |
| $V_{OL}$ - Low Level Output Voltage, $I_{IO}$=8mA IOCURR = 2, high-drive GPIOs only | - | 0.26 | 0.32 | V |
| $V_{OH}$ - High Level Output Voltage, $I_{IO}$=4mA , IOCURR = 1 | 1.32 | 1.58 | - | V |
| $V_{OL}$ - Low Level Output Voltage, $I_{IO}$=4mA , IOCURR = 1 | - | 0.21 | 0.32 | V |
| GPIO pullup current - Input mode, pullup enabled, Vpad = 0 V | - | 71.7 | - | uA |
| GPIO pulldown current - Input mode, pulldown enabled, Vpad = VDD | - | 21.1 | - | uA |
| GPIO high/low input transition, no hysteresis - IH = 0, transition between reading 0 and reading 1 | - | 0.88 | - | V |
| GPIO low-to-high input transition, with hysteresis - IH = 1, transition voltage for input read as 0 → 1 | - | 1.07 | - | V |
| GPIO high-to-low input transition, with hysteresis - IH = 1, transition voltage for input read as 1 → 0 | - | 0.74 | - | V |
| GPIO input hysteresis - IH = 1, difference between 0 → 1 and 1 → 0 points | - | 0.33 | - | V |
| | | | | |
| **$V_{DD}$ = 3.0V, $T_A$ = 25°C** | | | | |
| VOH - High Level Output Voltage, IIO=8mA IOCURR = 2, high-drive GPIOs only | - | 2.68 | - | V |
| VOL - Low Level Output Voltage, IIO=8mA IOCURR = 2, high-drive GPIOs only | - | 0.33 | - | V |
| VOH - High Level Output Voltage, IIO=4mA , IOCURR = 1 | - | 2.72 | - | V |
| VOL - Low Level Output Voltage, IIO=4mA , IOCURR = 1 | - | 0.28 | - | V |
| | | | | |
| **$V_{DD}$ = 3.8V, $T_A$ = 25°C** | | | | |
| GPIO pullup current - Input mode, pullup enabled, Vpad = 0 V | - | 280 | - | uA |
| GPIO pulldown current - Input mode, pulldown enabled, Vpad = VDD | - | 115 | - | uA |
| GPIO high/low input transition, no hysteresis - IH = 0, transition between reading 0 and reading 1 | - | 1.67 | - | V |
| GPIO low-to-high input transition, with hysteresis - IH = 1, transition voltage for input read as 0 → 1 | - | 1.94 | - | V |
| GPIO high-to-low input transition, with hysteresis - IH = 1, transition voltage for input read as 1 → 0 | - | 1.54 | - | V |
| GPIO input hysteresis - IH = 1, difference between 0 → 1 and 1 → 0 points | - | 0.43 | - | V |

| | | | | | |
|---|---|---|---|---|---|
| **$T_A$ = 25°C** | | | | | |
| VIH | - Lowest GPIO input voltage reliably interpreted as a High | - | - | 0.8 | VDD |
| VIL | - Lowest GPIO input voltage reliably interpreted as a LOW | 0.2 | - | - | VDD |

## 5.4 Analog Characteristics

**Table 7:** Specifications of 12-bit SARADC(voltage scaling enabled, unless otherwise noted.(1))

| Parameter | Min | Type | Max | Unit |
|---|---|---|---|---|
| $V_{DDA}$ - Operation Voltage | 1.8 | 3.3 | 3.8 | V |
| $R_{ADC}$ - Resolution | - | - | 12 | bit |
| $F_{SPS}$ - Sampling Rate | - | - | 200 | KSPS |
| Offset (Internal 4.3-V equivalent reference(2)) | - | 2 | - | LSB |
| Gain error (Internal 4.3-V equivalent reference(2)) | - | 2.4 | - | LSB |
| DNL(3) Differential nonlinearity | - | >–1 | - | LSB |
| INL(4) Integral nonlinearity | - | ±3 | - | LSB |
| **ENOB - Effective number of bits** | | | | |
| Internal 4.3-V equivalent reference(2), 200ksps,9.6-kHz input tone | - | 9.8 | - | bits |
| VDD as reference, 200 ksps, 9.6-kHz input tone | - | 10 | - | bits |
| Internal 1.44-V reference, voltage scaling disabled,32 samples average, 200ksps, 300-Hz input tone | - | 11.1 | - | bits |
| **THD - Total harmonic distortion** | | | | |
| Internal 4.3-V equivalent reference(2), 200 ksps,9.6-kHz input tone | - | -65 | - | dB |
| VDD as reference, 200ksps, 9.6-kHz input tone | - | -69 | - | dB |
| Internal 1.44-V reference, voltage scaling disabled,32 samples average, 200ksps, 300-Hz input tone | - | -71 | - | dB |
| **SINAD,SNDR - Signal-to-noise and distortion ratio** | | | | |
| Internal 4.3-V equivalent reference(2), 200ksps,9.6-kHz input tone | - | 60 | - | dB |
| VDD as reference, 200ksps, 9.6-kHz input tone | - | 63 | - | dB |
| Internal 1.44-V reference, voltage scaling disabled,32 samples average, 200ksps, 300-Hz input tone | - | 69 | - | dB |
| **SFDR - Spurious-free dynamic range** | | | | |
| Internal 4.3-V equivalent reference(2), 200ksps,9.6-kHz input tone | - | 67 | - | dB |
| VDD as reference, 200ksps, 9.6-kHz input tone | - | 72 | - | dB |
| Internal 1.44-V reference, voltage scaling disabled,32 samples average, 200ksps, 300-Hz input tone | - | 73 | - | dB |
| Conversion time - Serial conversion, time-to-output, 24-MHz clock | - | 50 | - | Clock-cycles |
| Current consumption - Internal 4.3-V equivalent reference(2) | - | 0.66 | - | mA |
| Current consumption - VDD as reference | - | 0.75 | - | mA |
| Reference voltage - VDDS as reference (Also known as RELATIVE) (input voltage scaling enabled) | - | VDD | - | V |
| Input impedance - | - | >1 | - | MΩ |

| | |
|---|---|
| | 200 ksps, voltage scaling enabled. Capacitive input, Input impedance depends on sampling frequency and sampling time |
| | |

(1) Using IEEE Std 1241™-2010 for terminology and test methods.

(2) Input signal scaled down internally before conversion, as if voltage range was 0 to 4.3 V.

(3) No missing codes. Positive DNL typically varies from +0.3 to +3.5, depending on device.

(4) For a typical example.

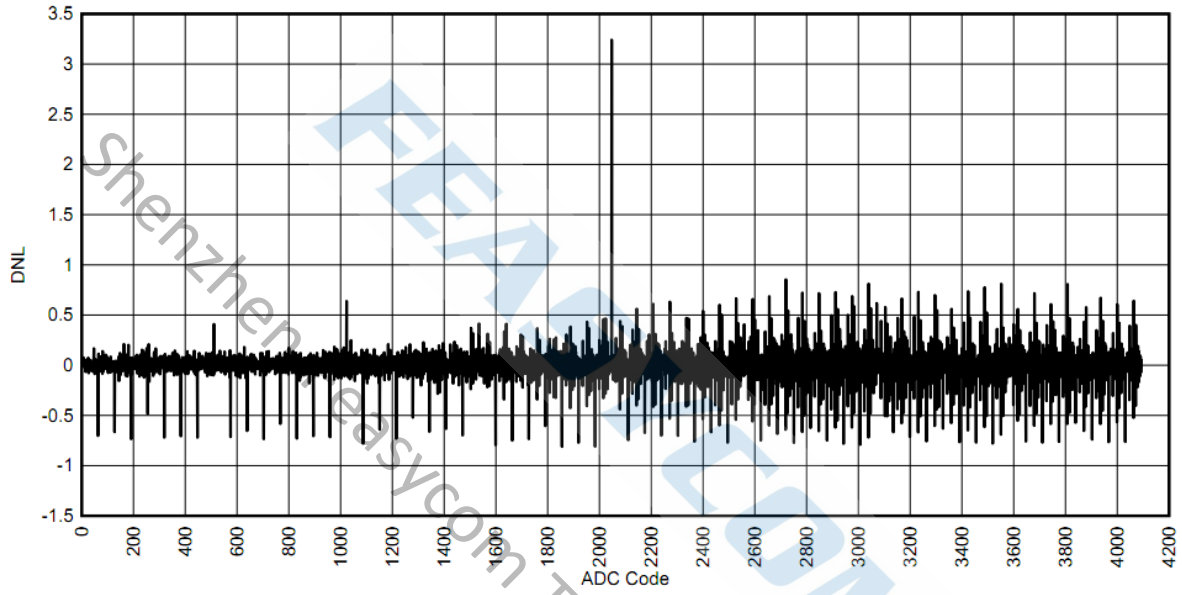



**Figure 5:** SoC ADC DNL vs ADC Code (Internal Reference)

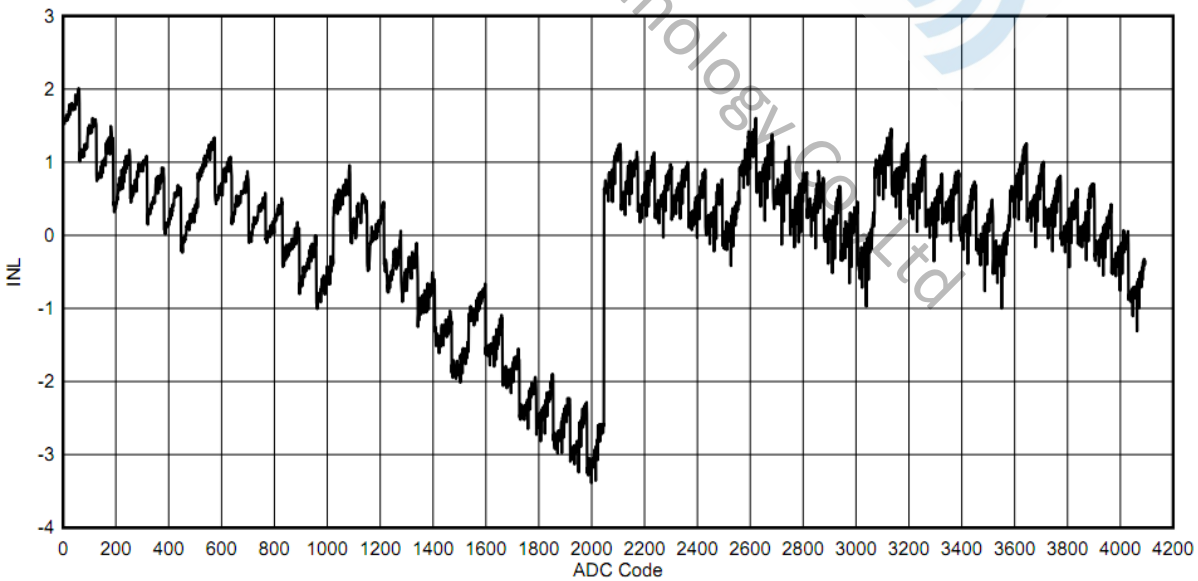



**Figure 6:** SoC ADC INL vs ADC Code (Internal Reference)

## 5.5 Temperature Sensor

**Table 8:** Temperature Sensor (reference design with Tc = 25°C, VDD = 3.0 V, unless otherwise noted)

| Parameter | Min | Type | Max | Unit |
|---|---|---|---|---|
| Resolution | - | 4 | - | °C |
| Range | -40 | - | +85 | °C |
| Accuracy | - | ±5 | - | °C |
| Supply voltage coefficient(1) | - | 3.2 | - | °C /V |

(1) Automatically compensated when using supplied driver libraries.

## 5.6 Battery Monitor

**Table 9:** Battery Monitor (reference design with Tc = 25°C, VDD = 3.0 V, unless otherwise noted)

| Parameter | Min | Type | Max | Unit |
|---|---|---|---|---|
| Resolution | - | 50 | - | mV |
| Range | 1.8 | - | 3.8 | V |
| Accuracy | - | 13 | - | mV |

## 5.7 Synchronous Serial Interface (SSI)

**Table 10:** Synchronous Serial Interface (SSI) (Tc = 25°C, VDD = 3.0 V, unless otherwise noted.)

| Parameter | Min | Type | Max | Unit |
|---|---|---|---|---|
| S1 $t_{clk\_per}$ (SSIClk period) - Device operating as SLAVE | 12 | - | 65024 | System clocks |
| S2 $t_{clk\_high}$ (SSIClk high time) - Device operating as SLAVE | - | 0.5 | - | $t_{clk\_per}$ |
| S3 $t_{clk\_low}$ (SSIClk low time) - Device operating as SLAVE | - | 0.5 | - | $t_{clk\_per}$ |
| S1 (TX only) $t_{clk\_per}$ (SSIClk period) - One-way communication to SLAVE Device operating as MASTER | 4 | - | 65024 | System clocks |
| S1 (TX and RX) $t_{clk\_per}$ (SSIClk period) - Normal duplex operation Device operating as MASTER | 8 | - | 65024 | System clocks |
| S2 $t_{clk\_high}$ (SSIClk high time) - Device operating as MASTER | - | 0.5 | - | $t_{clk\_per}$ |
| S3 $t_{clk\_low}$ (SSIClk low time) - Device operating as MASTER | - | 0.5 | - | $t_{clk\_per}$ |

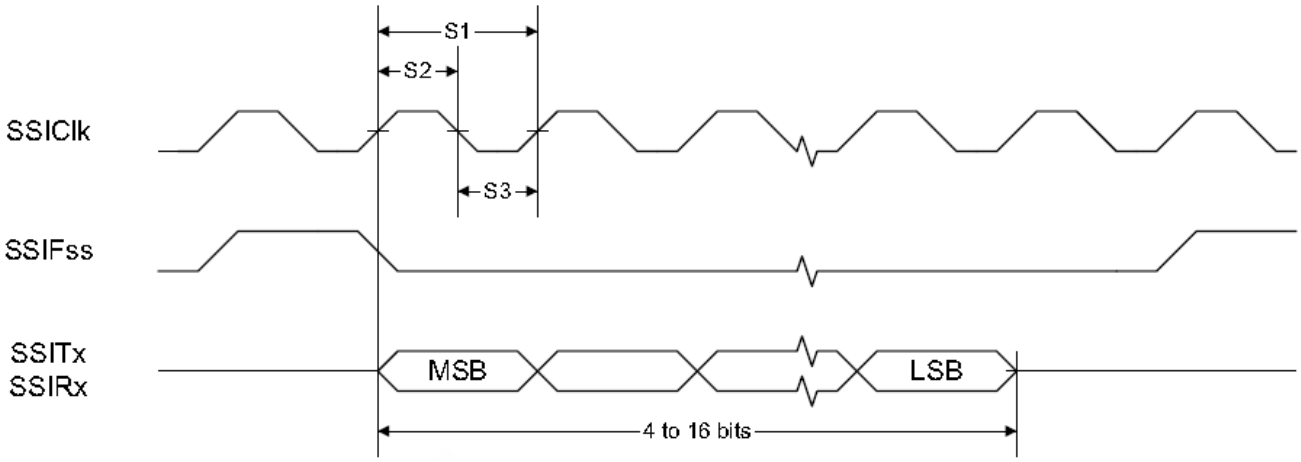



**Figure 7:** SSI Timing for TI Frame Format (FRF = 01), Single Transfer Timing Measurement

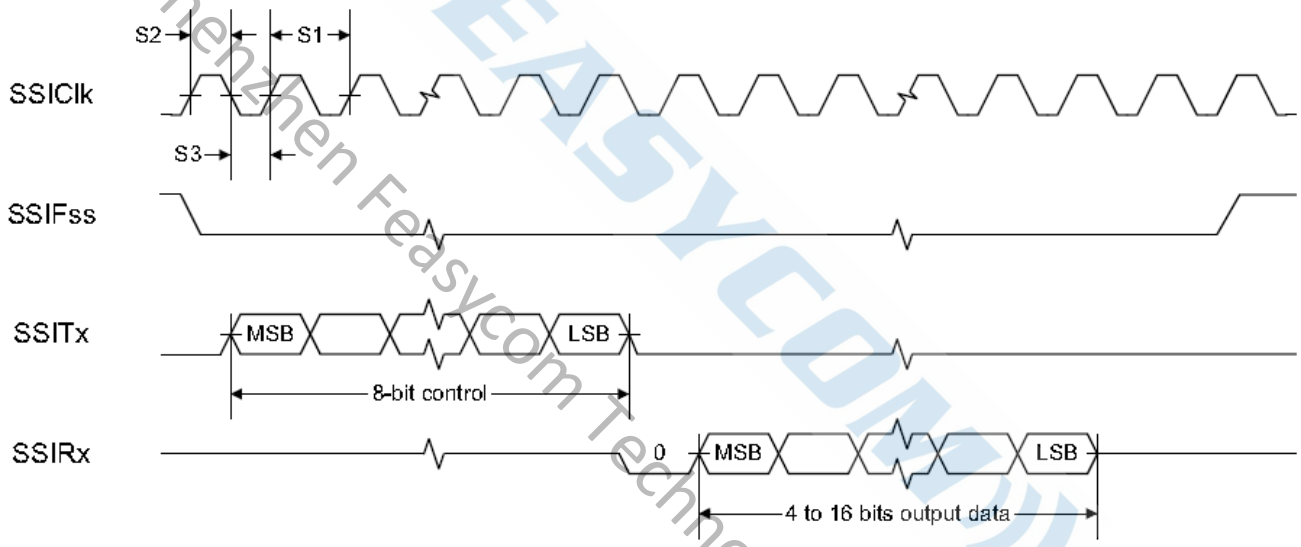



**Figure 8:** SSI Timing for MICROWIRE Frame Format (FRF = 10), Single Transfer

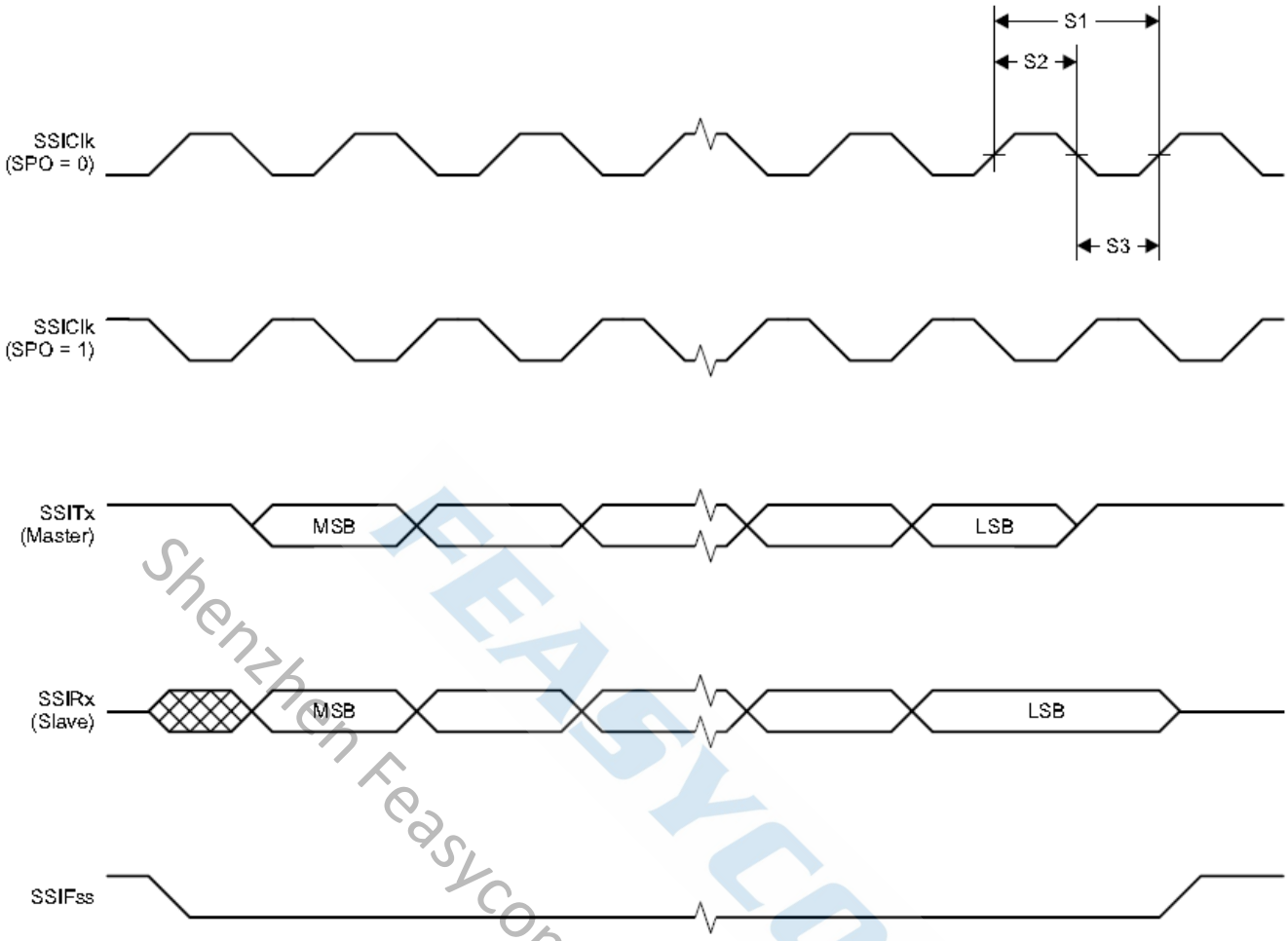



**Figure 9: SSI Timing for SPI Frame Format (FRF = 00), With SPH = 1**

## 5.8 Switching Characteristics

**Table 11:** Switching Characteristics

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| **WAKEUP AND TIMING** | | | | |
| Idle → Active | - | 14 | - | uS |
| Standby → Active | - | 151 | - | uS |
| Shutdown → Active | - | 1015 | - | uS |

## 5.9 Power consumptions

**Table 12:** Power consumptions

| Parameter | Test Conditions | Type | Unit |
|---|---|---|---|
| Discoverable | 24MHz Off , 32.768KHz On<br>Advert interval 500mS , Uart Off | ~42 | uA |
| | 24MHz Off , 32.768KHz On<br>Advert interval 500mS , Uart On | ~1.18 | mA |
| LE Connection | Connection Interval 18mS<br>24MHz Off , 32.768KHz On<br>Uart Off | ~49 | uA |
| | Connection Interval 18mS<br>24MHz On , 32.768KHz On<br>Uart On | 1.47 | mA |

# 6. MSL & ESD

**Table 13:** MSL and ESD

| Parameter | Test Conditions | | Value |
|---|---|---|---|
| MSL grade: | MSL 3(1) | | |
| ESD grade: | Human body model (HBM), per ANSI/ESDA/JEDEC JS001(2) | All pins | ±2500V |
| | Charged device model (CDM), per JESD22-C101(3) | RF pins | ±750V |
| | | Non-RF pins | ±750V |

(1)The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(2) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(3) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

# 7. RECOMMENDED TEMPERATURE REFLOW PROFILE

Prior to any reflow, it is important to ensure the modules were packaged to prevent moisture absorption. New packages contain desiccate (to absorb moisture) and a humidity indicator card to display the level maintained during storage and shipment. If directed to bake units on the card, please check the Picture below and follow instructions specified by IPC/JEDEC J-STD-033.

**Note:** The shipping tray cannot be heated above 65°C. If baking is required at the higher temperatures displayed in the Picture below, the modules must be removed from the shipping tray.

Any modules not manufactured before exceeding their floor life should be re-packaged with fresh desiccate and a new humidity indicator card. Floor life for MSL (Moisture Sensitivity Level) 3 devices is 168 hours in ambient environment 30°C/60%RH.

**Table 14**: Recommended baking times and temperatures

| MSL | 125°C Baking Temp. | | 90°C/≤ 5%RH Baking Temp. | | 40°C/ ≤ 5%RH Baking Temp. | |
|---|---|---|---|---|---|---|
| | Saturated @ 30°C/85% | Floor Life Limit + 72 hours @ 30°C/60% | Saturated @ 30°C/85% | Floor Life Limit + 72 hours @ 30°C/60% | Saturated @ 30°C/85% | Floor Life Limit + 72 hours @ 30°C/60% |
| 3 | 9 hours | 7 hours | 33 hours | 23 hours | 13 days | 9 days |

Feasycom surface mount modules are designed to be easily manufactured, including reflow soldering to a PCB. Ultimately it is the responsibility of the customer to choose the appropriate solder paste and to ensure oven temperatures during reflow meet the requirements of the solder paste. Feasycom surface mount modules conform to J-STD-020D1 standards for reflow temperatures.

The soldering profile depends on various parameters necessitating a set up for each application. The data here is given only for guidance on solder reflow.

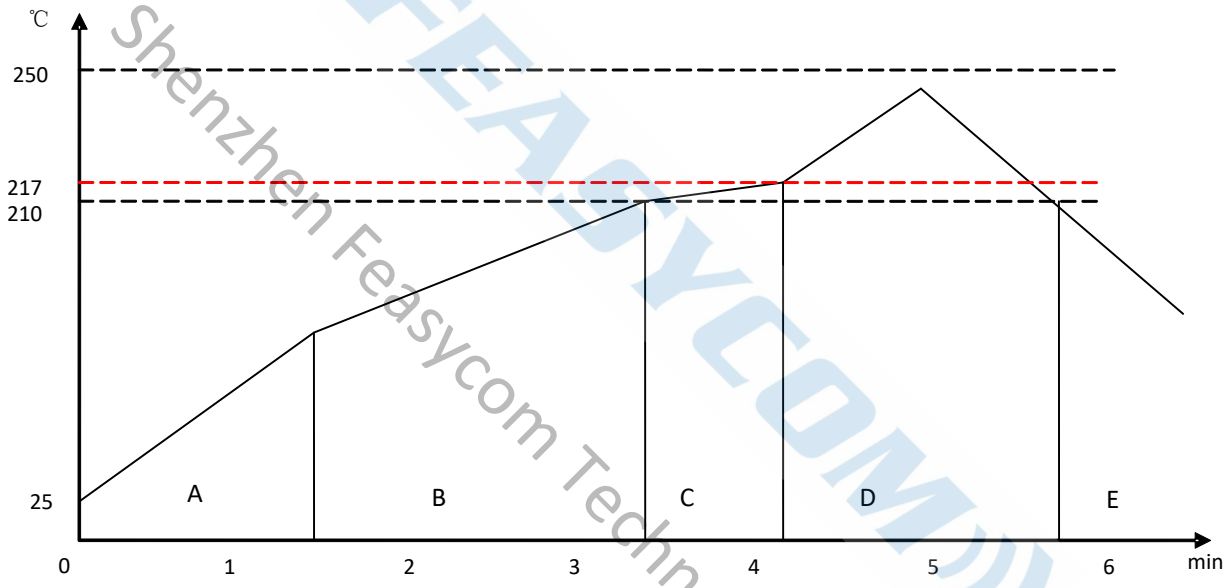



**Figure 10:** Typical Lead-free Re-flow

**Pre-heat zone (A)** — This zone raises the temperature at a controlled rate, **typically 0.5 – 2 °C/s**. The purpose of this zone is to preheat the PCB board and components to 120 ~ 150 °C. This stage is required to distribute the heat uniformly to the PCB board and completely remove solvent to reduce the heat shock to components.

**Equilibrium Zone 1 (B)** — In this stage the flux becomes soft and uniformly encapsulates solder particles and spread over PCB board, preventing them from being re-oxidized. Also with elevation of temperature and liquefaction of flux, each activator and rosin get activated and start eliminating oxide film formed on the surface of each solder particle and PCB board. **The temperature is recommended to be 150° to 210° for 60 to 120 second for this zone.**

**Equilibrium Zone 2 (C) (optional)** — In order to resolve the upright component issue, it is recommended to keep the temperature in 210 – 217 ° for about 20 to 30 second.

**Reflow Zone (D)** — The profile in the figure is designed for Sn/Ag3.0/Cu0.5. It can be a reference for other lead-free solder. The peak temperature should be high enough to achieve good wetting but not so high as to cause component discoloration or damage. Excessive soldering time can lead to intermetallic growth which can result in a brittle joint. The recommended peak temperature (Tp) is 230 ~ 250 °C. The soldering time should be 30 to 90 second when the temperature is above 217 °C.

**Cooling Zone (E)** — The cooling ate should be fast, to keep the solder grains small which will give a longer-lasting joint. **Typical cooling rate should be 4 °C.**

# 8. MECHANICAL DETAILS

## 8.1 Mechanical Details

- Dimension: 13mm(W) x 26.9mm(L) x 2.2 mm(H) Tolerance: ±0.2mm
- Module size: 13mm X 26.9mm Tolerance: ±0.5mm
- Pad size: 1mmX0.8mm Tolerance: ±0.1mm
- Pad pitch: 1.5mm Tolerance: ±0.1mm

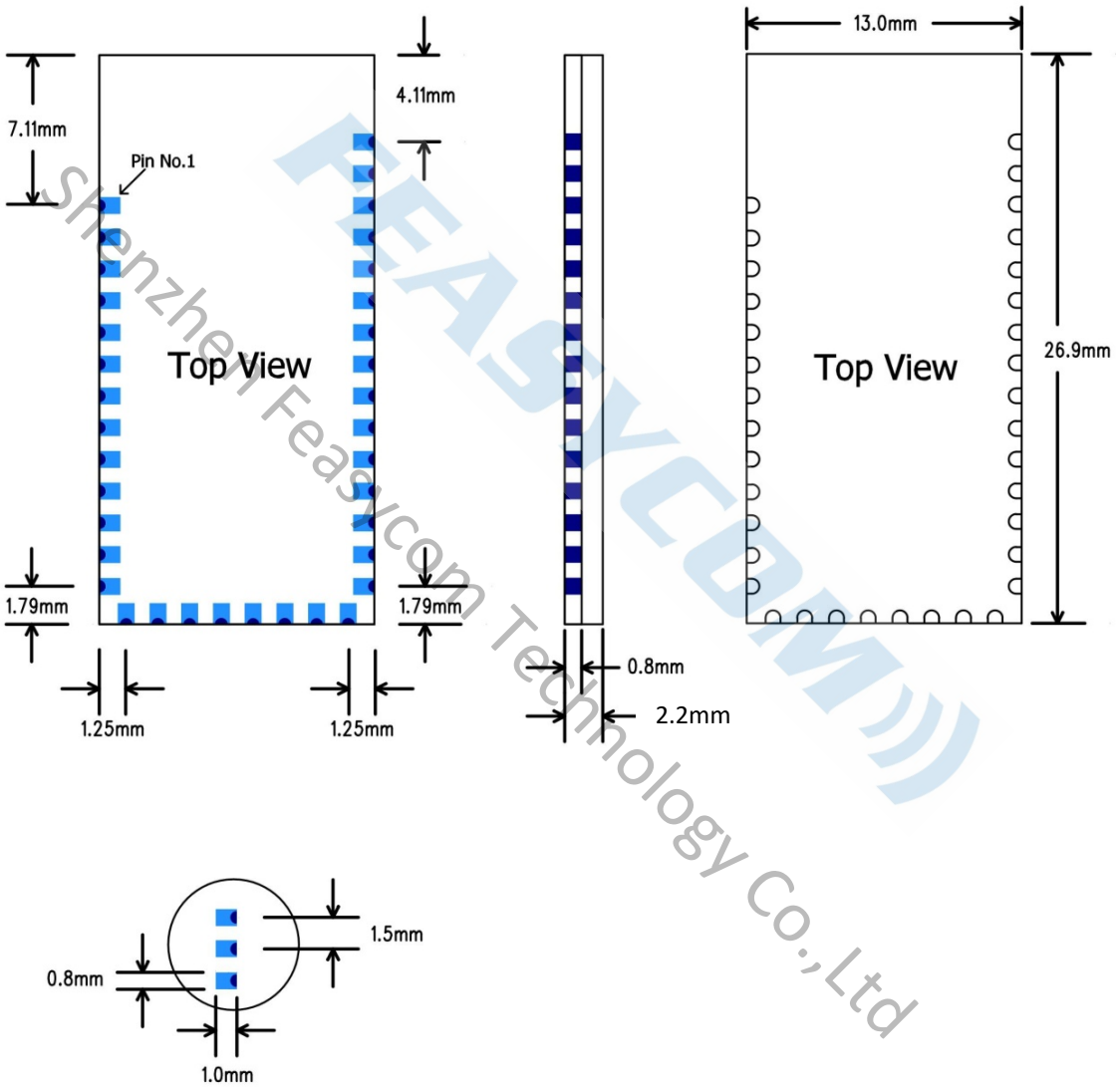



**Figure 11:** FSC-BT616 footprint

## 8.2 Host PCB Land Pattern and Antenna Keep-out for FSC-BT616

Please check the picture below for Pad Structure and Keep Out Area:

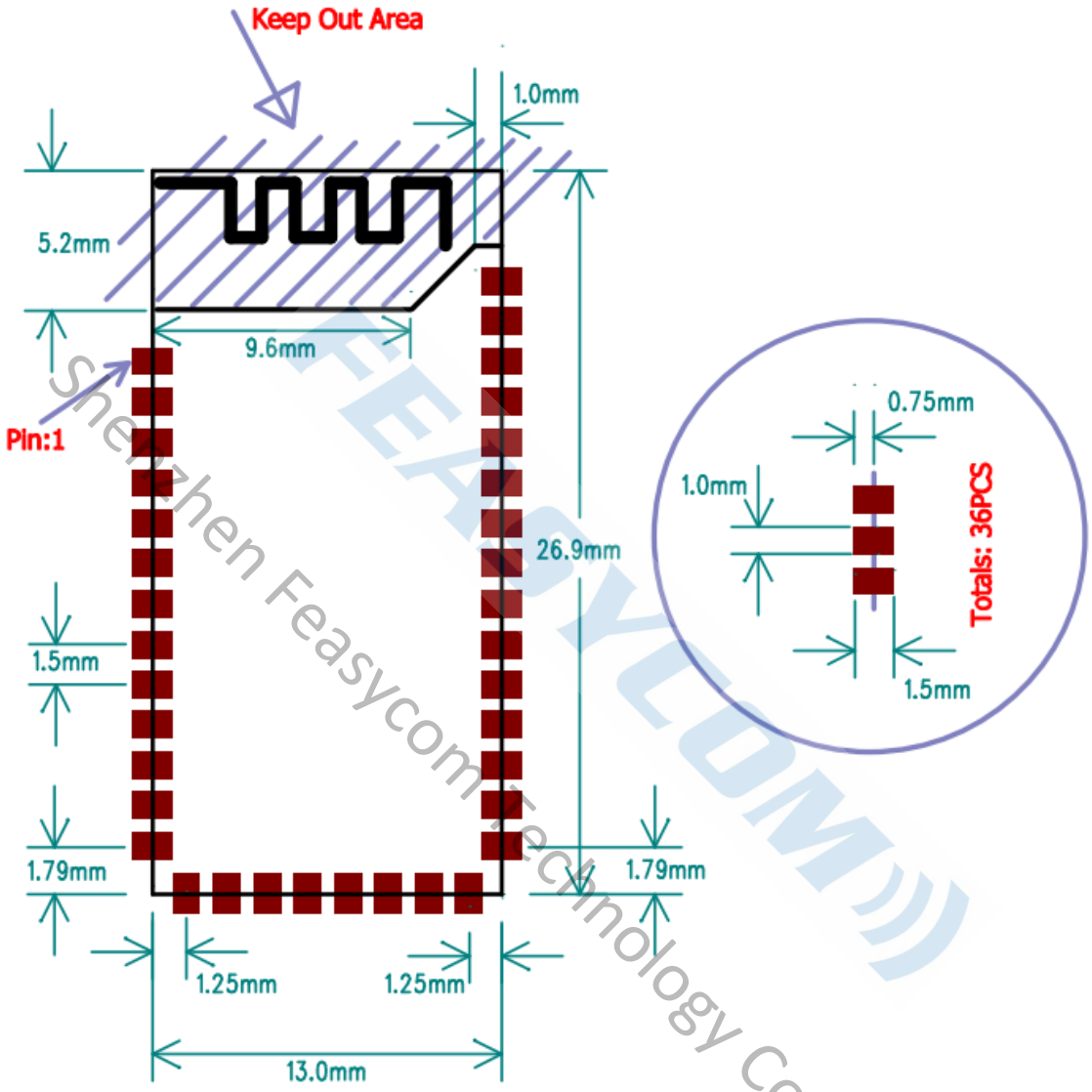



**Figure 12:** Host PCB-Top View

# 9. HARDWARE INTEGRATION SUGGESTIONS

## 9.1 Soldering Recommendations

FSC-BT616 is compatible with industrial standard reflow profile for Pb-free solders. The reflow profile used is dependent on the thermal mass of the entire populated PCB, heat transfer efficiency of the oven and particular type of solder paste used. Consult the datasheet of particular solder paste for profile configurations.

Feasycom will give following recommendations for soldering the module to ensure reliable solder joint and operation of the module after soldering. Since the profile used is process and layout dependent, the optimum profile should be studied case by case. Thus following recommendation should be taken as a starting point guide.

## 9.2 Layout Guidelines(Internal Antenna)

It is strongly recommended to use good layout practices to ensure proper operation of the module. Placing copper or any metal near antenna deteriorates its operation by having effect on the matching properties. Metal shield around the antenna will prevent the radiation and thus metal case should not be used with the module. Use grounding vias separated max 3 mm apart at the edge of grounding areas to prevent RF penetrating inside the PCB and causing an unintentional resonator. Use GND vias all around the PCB edges.

The mother board should have no bare conductors or vias in this restricted area, because it is not covered by stop mask print. Also no copper (planes, traces or vias) are allowed in this area, because of mismatching the on-board antenna.

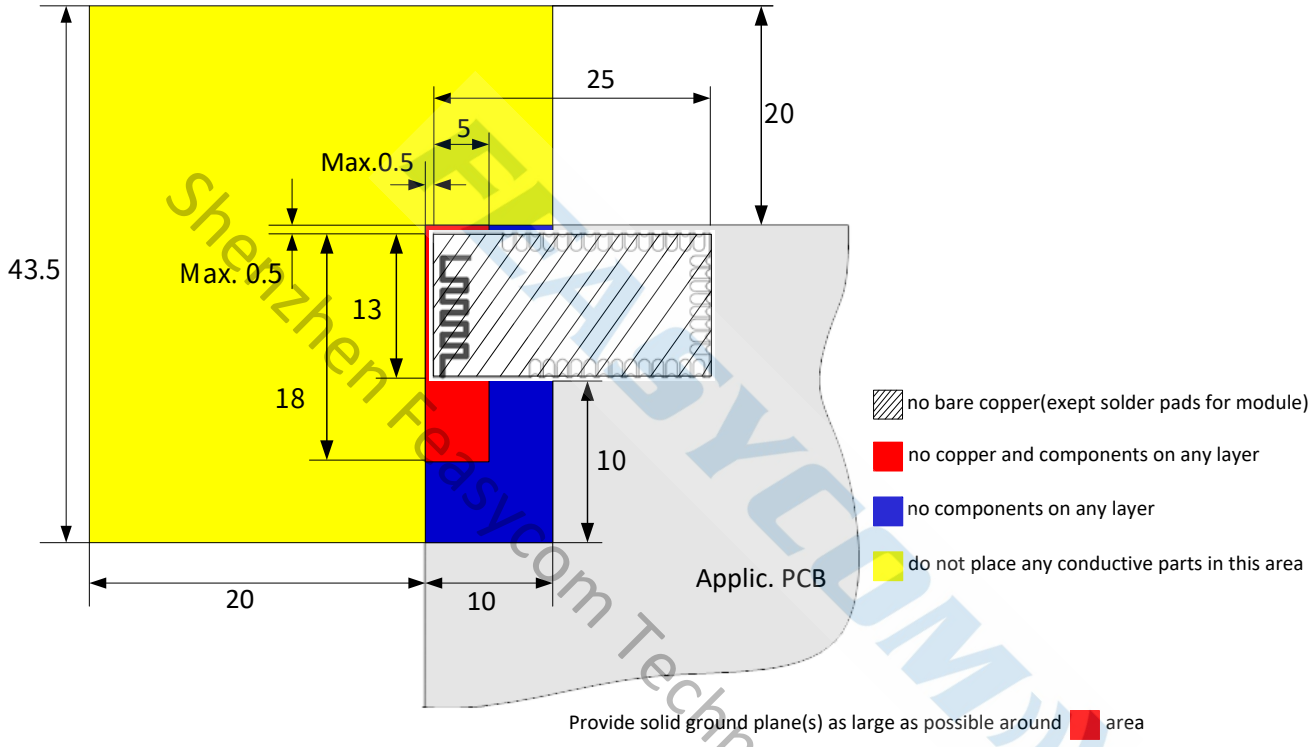



**Figure 13:** FSC-BT616 Restricted Area (Unit: mm)

Following recommendations helps to avoid EMC problems arising in the design. Note that each design is unique and the following list do not consider all basic design rules such as avoiding capacitive coupling between signal lines. Following list is aimed to avoid EMC problems caused by RF part of the module. Use good consideration to avoid problems arising from digital signals in the design.

Ensure that signal lines have return paths as short as possible. For example if a signal goes to an inner layer through a via, always use ground vias around it. Locate them tightly and symmetrically around the signal vias. Routing of any sensitive signals should be done in the inner layers of the PCB. Sensitive traces should have a ground area above and under the line. If this is not possible, make sure that the return path is short by other means (for example using a ground line next to the signal line).

## 9.3 Layout Guidelines(External Antenna)

Placement and PCB layout are critical to optimize the performances of a module without on-board antenna designs. The trace from the antenna port of the module to an external antenna should be 50Ω and must be as short as possible to avoid any interference into the transceiver of the module. The location of the external antenna and RF-IN port of the module should be kept away from any noise sources and digital traces. A matching network might be needed in between the external antenna and RF-IN port to better match the impedance to minimize the return loss.

As indicated in picture below, RF critical circuits of the module should be clearly separated from any digital circuits on the system board. All RF circuits in the module are close to the antenna port. The module, then, should be placed in this way that module digital part towards your digital section of the system PCB.

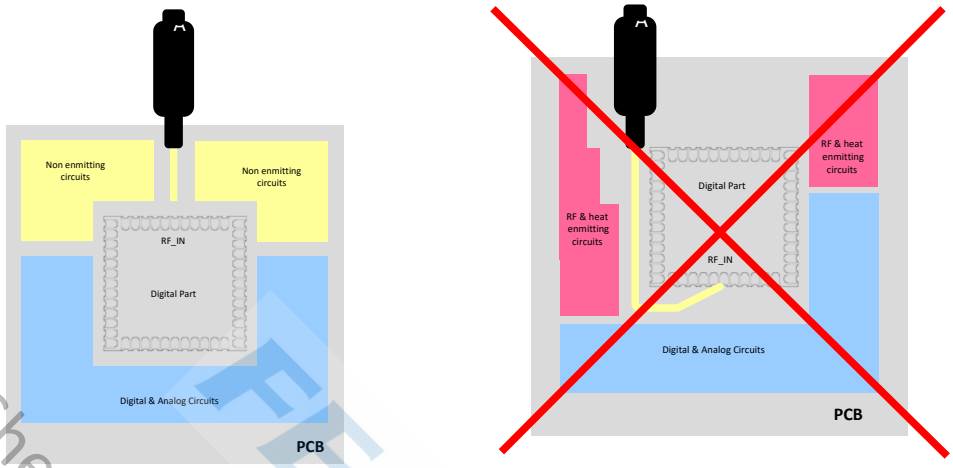



**Figure 14:** Placement the Module on a System Board

### 9.3.1 Antenna Connection and Grounding Plane Design

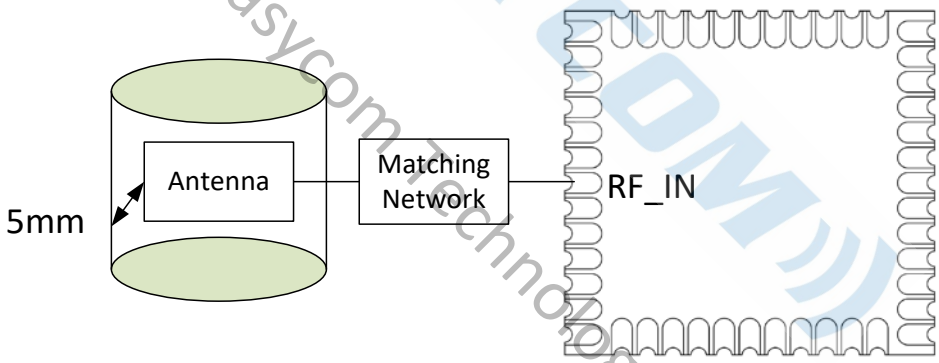



**Figure 15:** Leave 5mm Clearance Space from the Antenna

General design recommendations are:

- The length of the trace or connection line should be kept as short as possible.
- Distance between connection and ground area on the top layer should at least be as large as the dielectric thickness.
- Routing the RF close to digital sections of the system board should be avoided.
- To reduce signal reflections, sharp angles in the routing of the micro strip line should be avoided. Chamfers or fillets are preferred for rectangular routing; 45-degree routing is preferred over Manhattan style 90-degree routing.

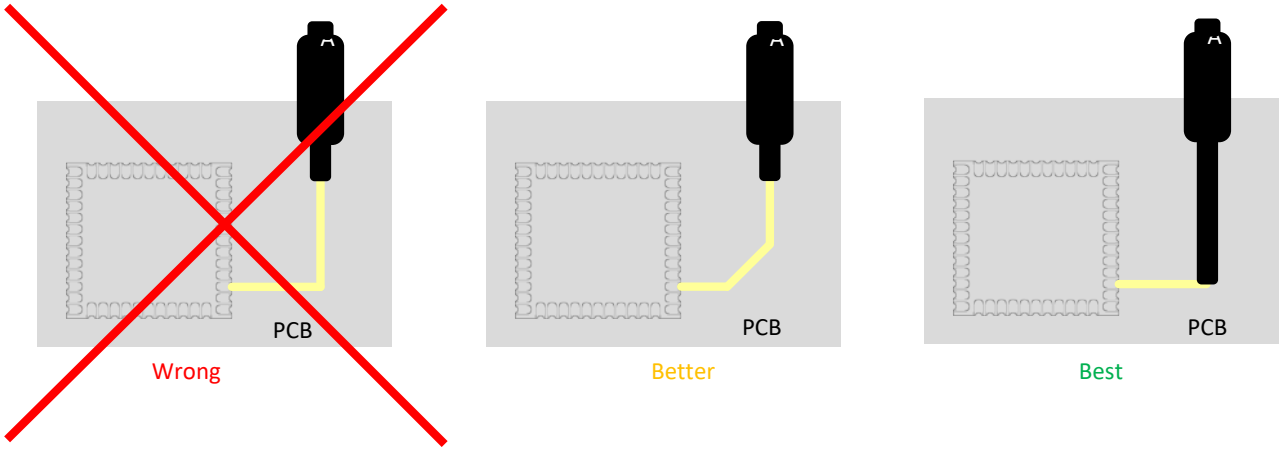



**Figure 16:** Recommended Trace Connects Antenna and the Module

- Routing of the RF-connection underneath the module should be avoided. The distance of the micro strip line to the ground plane on the bottom side of the receiver is very small and has huge tolerances. Therefore, the impedance of this part of the trace cannot be controlled.
- Use as many vias as possible to connect the ground planes.

# 10. PRODUCT PACKAGING INFORMATION

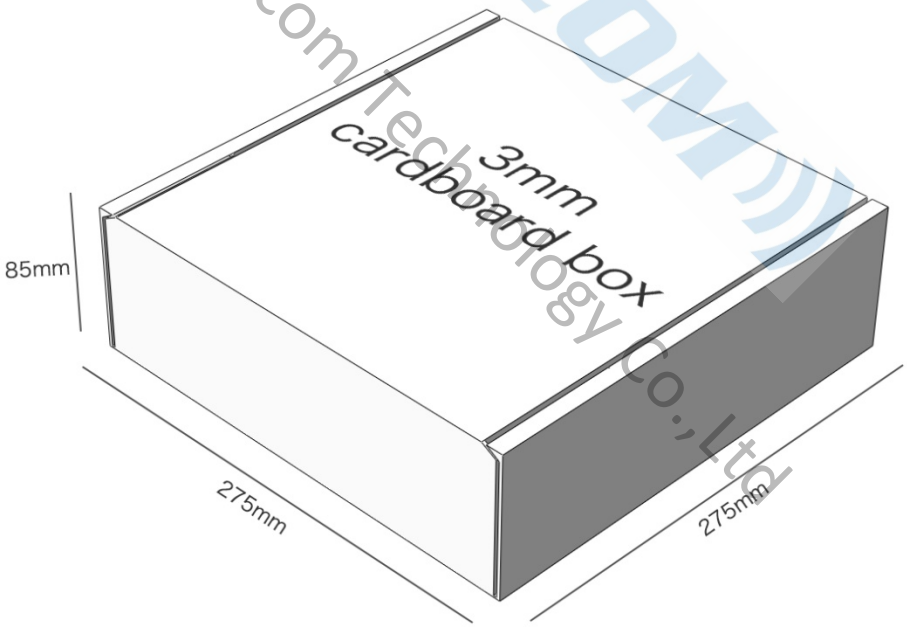
## 10.1 Default Packing

a, Tray vacuum

b, Tray Dimension: 180mm * 195mm


**Figure 17:** Tray vacuum

## 10.2 Packing box(Optional)




* If require any other packing, must be confirmed with customer

* Package: 1000PCS Per Carton (Min Carton Package)

**Figure 18:** Packing Box

# 11. CERTIFICATION

## 11.1 Certificate picture

Has passed FCC, CE , IC and SRRC certification.

TCB

GRANT OF EQUIPMENT AUTHORIZATION

Certification

Issued Under the Authority of the Federal Communications Commission By:

Intertek Testing Services NA, Inc.
70 Codman Hill Road
Boxborough, MA 01719

Date of Grant: 09/06/2018
Application Dated: 09/06/2018

**Shenzhen Feasycom Technology Co.,Ltd**
**Room 2004A, 20th Floor, Huichao Technology**
**Building, Jinhai Road, Xixiang, Baoan District,,**
**Shenzhen,**
**China**

**Attention: Wan Zhifu**

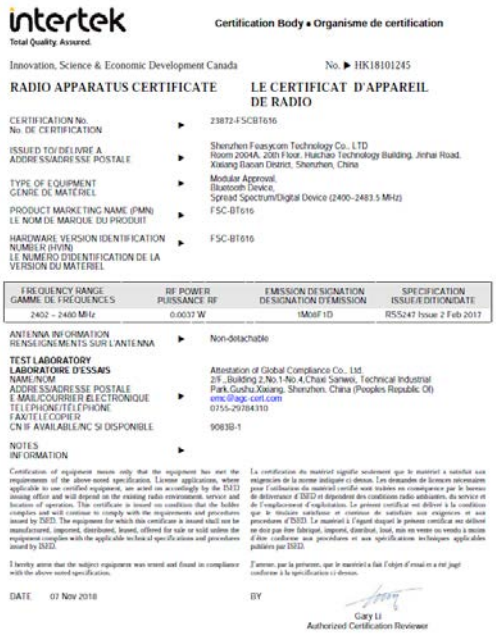
**NOT TRANSFERABLE**

EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE, and is VALID ONLY for the equipment identified hereon for use under the Commission's Rules and Regulations listed below.

**FCC IDENTIFIER:** 2AMWOFSC-BT616
**Name of Grantee:** Shenzhen Feasycom Technology Co.,Ltd
**Equipment Class:** Digital Transmission System
**Notes:** Bluetooth Module
**Modular Type:** Single Modular

| Grant Notes | FCC Rule Parts | Frequency Range (MHz) | Output Watts | Frequency Tolerance | Emission Designator |
|---|---|---|---|---|---|
| | 15C | 2402.0 - 2480.0 | 0.0037 | | |

The output power listed is conducted. This device must not be co-located or operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures. Approval is limited to OEM installations only. OEM integrators must be provided with antenna installation instructions and labeling requirements for finished products. OEM integrators and end-users must be provided with transmitter operation conditions for satisfying RF exposure compliance. OEM integrators are instructed to ensure that the end user has no manual instructions to remove or install the device.



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RADIO APPARATUS CERTIFICATE — LE CERTIFICAT D'APPAREIL DE RADIO

| | | |
|---|---|---|
| CERTIFICATION No. / No. DE CERTIFICATION | ▶ | 23872-FSCBT616 |
| ISSUED TO/DELIVRE A / ADDRESS/ADRESSE POSTALE | ▶ | Shenzhen Feasycom Technology Co., LTD<br>Room 2004A, 20th Floor, Huichao Technology Building, Jinhai Road,<br>Xixiang Baoan District, Shenzhen, China |
| TYPE OF EQUIPMENT / GENRE DE MATÉRIEL | ▶ | Modular Approval,<br>Bluetooth Device,<br>Spread Spectrum/Digital Device (2400~2483.5 MHz) |
| PRODUCT MARKETING NAME (PMN) / LE NOM DE MARQUE DU PRODUIT | ▶ | FSC-BT616 |
| HARDWARE VERSION IDENTIFICATION NUMBER (HVIN) / LE NUMERO D'IDENTIFICATION DE LA VERSION DU MATÉRIEL | ▶ | FSC-BT616 |

| FREQUENCY RANGE / GAMME DE FREQUENCES | RF POWER / PUISSANCE RF | EMISSION DESIGNATION / DESIGNATION D'EMISSION | SPECIFICATION / ISSUE/EDITION/DATE |
|---|---|---|---|
| 2402 ~ 2480 MHz | 0.0037 W | 1M0F1D | RSS247 Issue 2 Feb 2017 |

| | | |
|---|---|---|
| ANTENNA INFORMATION / RENSEIGNEMENTS SUR L'ANTENNA | ▶ | Non-detachable |
| TEST LABORATORY / LABORATOIRE D'ESSAIS<br>NAME/NOM<br>ADDRESS/ADRESSE POSTALE<br>E-MAIL/COURRIER ELECTRONIQUE<br>TELEPHONE/TÉLÉPHONE<br>FAX/TELECOPIER<br>CN IF AVAILABLE/NC SI DISPONIBLE | ▶ | Attestation of Global Compliance Co., Ltd<br>2/F., Building 2, No.1-No.4, Chaxi Sanwei, Technical Industrial Park, Gushu, Xixiang, Shenzhen, China (Peoples Republic Of)<br>emc@agc-cert.com<br>0755-29784310<br>90838-1 |
| NOTES / INFORMATION | ▶ | |

Certification of equipment means only that the equipment has met the requirements of the above noted specification. License applications, where applicable to one certified equipment, are acted on accordingly by the ISED issuing office and will depend on the existing radio environment, service and location of operation. This certificate is issued on condition that the holder complies and will continue to comply with the requirements and procedures issued by ISED. The equipment for which this certificate is issued shall not be manufactured, imported, distributed, leased, offered for sale or sold unless the equipment complies with the applicable technical specifications and procedures issued by ISED.

I hereby attest that the subject equipment was tested and found in compliance with the above noted specification.

La certification du matériel signifie seulement que le matériel a satisfait aux exigences de la norme indiquée ci-dessus. Les demandes de licences nécessaires pour l'utilisation du matériel certifié sont traitées en conséquence par le bureau de délivrance d'ISED et dépendent des conditions radio ambiantes, du service et de l'emplacement d'exploitation. Le présent certificat est délivré à la condition que le titulaire satisfasse et continue de satisfaire aux exigences et aux procédures d'ISED. Le matériel à l'égard duquel le présent certificat est délivré ne doit pas être fabriqué, importé, distribué, loué, mis en vente ou vendu à moins d'être conforme aux procédures et aux spécifications techniques applicables publiées par ISED.

J'atteste, par la présente, que le matériel a fait l'objet d'essais et a été jugé conforme à la spécification ci-dessus.

DATE 07 Nov 2018 — BY

Gary Li
Authorized Certification Reviewer

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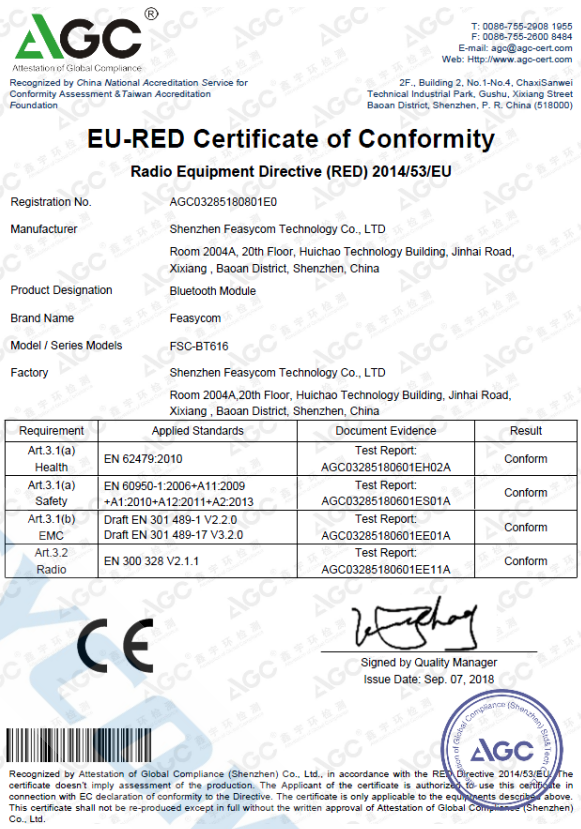

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2F., Building 2, No.1-No.4, ChaxiSanwei Technical Industrial Park, Gushu, Xixiang Street Baoan District, Shenzhen, P. R. China (518000)

## EU-RED Certificate of Conformity

**Radio Equipment Directive (RED) 2014/53/EU**

| | |
|---|---|
| Registration No. | AGC03285180801E0 |
| Manufacturer | Shenzhen Feasycom Technology Co., LTD |
| | Room 2004A, 20th Floor, Huichao Technology Building, Jinhai Road, Xixiang , Baoan District, Shenzhen, China |
| Product Designation | Bluetooth Module |
| Brand Name | Feasycom |
| Model / Series Models | FSC-BT616 |
| Factory | Shenzhen Feasycom Technology Co., LTD |
| | Room 2004A,20th Floor, Huichao Technology Building, Jinhai Road, Xixiang , Baoan District, Shenzhen, China |

| Requirement | Applied Standards | Document Evidence | Result |
|---|---|---|---|
| Art.3.1(a) Health | EN 62479:2010 | Test Report: AGC03285180601EH02A | Conform |
| Art.3.1(a) Safety | EN 60950-1:2006+A11:2009 +A1:2010+A12:2011+A2:2013 | Test Report: AGC03285180601ES01A | Conform |
| Art.3.1(b) EMC | Draft EN 301 489-1 V2.2.0 Draft EN 301 489-17 V3.2.0 | Test Report: AGC03285180601EE01A | Conform |
| Art.3.2 Radio | EN 300 328 V2.1.1 | Test Report: AGC03285180601EE11A | Conform |

CE

Signed by Quality Manager
Issue Date: Sep. 07, 2018

Recognized by Attestation of Global Compliance (Shenzhen) Co., Ltd., in accordance with the RED Directive 2014/53/EU. The certificate doesn't imply assessment of the production. The Applicant of the certificate is authorized to use this certificate in connection with EC declaration of conformity to the Directive. The certificate is only applicable to the equipments described above. This certificate shall not be re-produced except in full without the written approval of Attestation of Global Compliance (Shenzhen) Co., Ltd.

# 无线电发射设备
Radio Transmission Equipment
# 型号核准证
Type Approval Certificate

深圳市飞易通科技有限公司：

根据《中华人民共和国无线电管理
In accordance with the provisions on the Radio
条例》，经审查，下列无线电发射设备
Regulations of the People's Republic of China , the following
符合中华人民共和国无线电管理规定和
radio transmission equipment , after examination , conforms
技术标准，其核准代码为：CMIIT ID:2019DP8769
to the provisions with its CMIIT ID:

有效期：五年
Validity

（发证机关）
Sealed by issuing authority
2019年9 月 11日
Year Month Date

编号： 2019-8769
Number

设备名称：蓝牙模块
Equipment Name

设备型号：FSC-BT616
Equipment Type

主要功能：数据传输
Main Functions

调制方式：GFSK
Modulation Mode

主要技术参数及其指标值：
Main Technical Parameters

频率范围：2400-2483.5MHz
Frequency Range

频率容限：≤20ppm
Frequency Tolerance

发射功率：≤20dBm(EIRP)
Transmitting Power

占用带宽：≤3MHz
Occupied Bandwidth

杂散发射限值：≤-30dBm
Spurious Emission Limits

（核发单位章）
Sealed by issuing authority
2019年9 月 11日
Year Month Date

# 12. APPLICATION SCHEMATIC