



ITM-8412

Bluetooth[®] 5.0 Module Datasheet

V1.01

Revision History

Date	Revision Content	Revised By	Version
2022/06/20	- Initial released (Preliminary)	Issac Chen	0.1
2022/06/27	- Update embedded flash size	Issac Chen	0.2
2022/09/16	- Update antenna and packing information	Issac Chen	0.3
2022/11/11	- Formal Release	Issac Chen	1.0
2023/01/12	- Update Storage/MSL/Label	Issac Chen	1.0.1
	-		

Contents

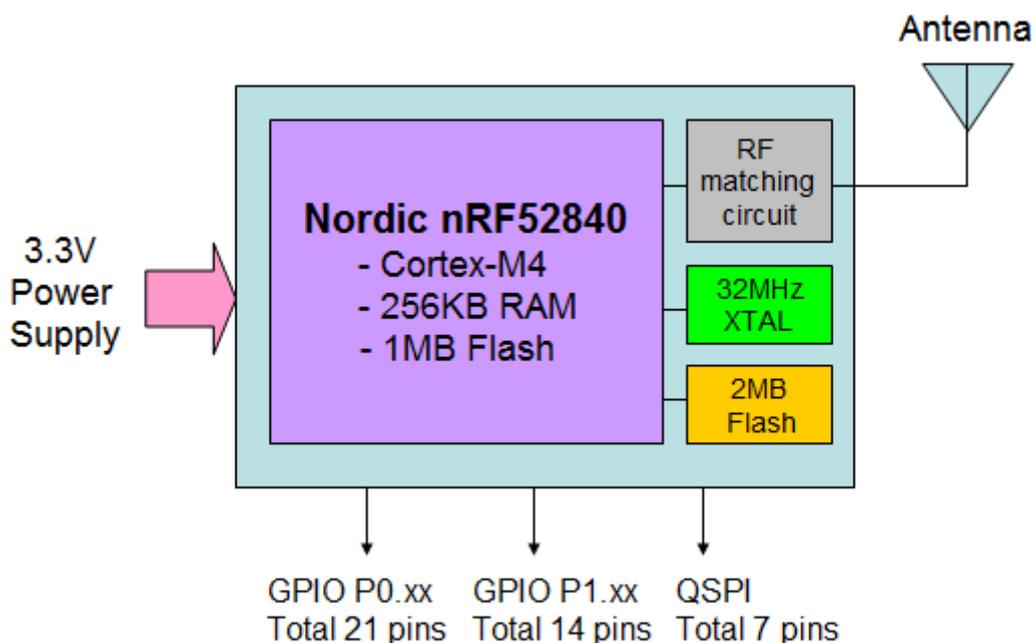
Revision History	1
Contents	2
1. General Description	3
2. Features	4
3. General Specification	8
3.1 Voltages	8
3.1.1 Absolute Maximum Ratings	8
3.1.2 Recommended Operating Ratings	8
3.2 RF Specification (RX)	9
3.3 RF Specification (TX).....	9
3.4 Power Consumption	9
4. Antenna	10
4.1 S11 Parameter.....	10
4.2 Gain Pattern	10
4.3 Efficiency	11
5. Pin Assignments	12
5.1 PCB Pin Outline (10.5mm x 15.5mm x 2.0mm)	12
5.2 Pin Definition	13
6. Dimensions	16
6.1 Layout Recommendation.....	16
7. Reference Design	18
8. Recommended Reflow Profile	19
9. Packing Information	20
9.1 Label.....	20
9.2 Dimension.....	21

1. General Description

iTM-8412 module features a fully integrated 2.4GHz radio transceiver and baseband processor for Bluetooth 5.0 applications. It can be used as a standalone application-specific communication processor or as a wireless data link in hosted MCU systems where ultra-low power is critical. It supports flexible memory architecture for storing profiles, stacks and custom application codes, and can be updated using Over-The-Air (OTA) technology.

iTM-8412 module uses SCLC104M05 SiP (Silicon-in-Package) which integrates Nordic nRF52840, 2MB SPI flash, 32MHz crystal and passive component inside. It combines the excellent performance of a leading RF transceiver with a low-power ARM Cortex-M4 and rich powerful supporting features and peripherals. It also contains 256KB RAM, and 1MB+2MB flash memory.

The block diagram for SCLC104M05 SiP is shown as below.



2. Features

Main Chip

- Bluetooth® 5, IEEE 802.15.4-2006, 2.4 GHz transceiver
 - -95 dBm sensitivity in 1 Mbps Bluetooth® low energy mode
 - -103 dBm sensitivity in 125 kbps Bluetooth® low energy mode (long range)
 - -20 to +8 dBm TX power, configurable in 4 dB steps
 - On-air compatible with nRF52, nRF51, nRF24L, and nRF24AP Series
 - Supported data rates:
 - ◆ Bluetooth® 5 – 2 Mbps, 1 Mbps, 500 kbps, and 125 kbps
 - ◆ IEEE 802.15.4-2006 – 250 kbps
 - ◆ Proprietary 2.4 GHz – 2 Mbps, 1 Mbps
 - Single-ended antenna output (on-chip balun)
 - 128-bit AES/ECB/CCM/AAR co-processor (on-the-fly packet encryption)
 - 4.8 mA peak current in TX (0 dBm)
 - 4.6 mA peak current in RX
 - RSSI (1 dB resolution)
- ARM® Cortex®-M4 32-bit processor with FPU, 64 MHz
 - 212 EEMBC CoreMark® score running from flash memory
 - 52 µA/MHz running CoreMark from flash memory
 - Watchpoint and trace debug modules (DWT, ETM, and ITM)
 - Serial wire debug (SWD)
- Rich set of security features
 - ARM® TrustZone® Cryptocell 310 security subsystem
 - ◆ NIST SP800-90A and SP800-90B compliant random number generator
 - ◆ AES-128 – ECB, CBC, CMAC/CBC-MAC, CTR, CCM/CCM*
 - ◆ Chacha20/Poly1305 AEAD supporting 128- and 256-bit key size
 - ◆ SHA-1, SHA-2 up to 256 bits
 - ◆ Keyed-hash message authentication code (HMAC)
 - ◆ RSA up to 2048-bit key size
 - ◆ SRP up to 3072-bit key size
 - ◆ ECC support for most used curves, including P-256 (secp256r1) and

Ed25519/Curve25519

◆ Application key management using derived key model

- Secure boot ready
 - Flash access control list (ACL)
 - Root-of-trust (RoT)
 - Debug control and configuration
 - Access port protection (CTRL-AP)
- Secure erase
- Flexible power management
 - 1.7 V to 3.6 V supply voltage range
 - Automated peripheral power management
 - Fast wake-up using 64 MHz internal oscillator
 - 0.4 μ A at 3 V in System OFF mode, no RAM retention
 - 1.5 μ A at 3 V in System ON mode, no RAM retention, wake on RTC
- 1 MB flash and 256 KB RAM
- Advanced on-chip interfaces
 - USB 2.0 full speed (12 Mbps) controller
 - QSPI 32 MHz interface
 - High-speed 32 MHz SPI
 - Type 2 near field communication (NFC-A) tag with wake-on field
 - ◆ Touch-to-pair support
 - Programmable peripheral interconnect (PPI)
 - 48 general purpose I/O pins
 - EasyDMA automated data transfer between memory and peripherals
- Nordic SoftDevice ready with support for concurrent multiprotocol
- 12-bit, 200 ksps ADC – 8 configurable channels with programmable gain
- 64 level comparator
- 15 level low-power comparator with wake-up from System OFF mode
- Temperature sensor
- 4x four channel pulse width modulator (PWM) unit with EasyDMA

- Audio peripherals – I2S, digital microphone interface (PDM)
- 5x 32-bit timer with counter mode
- Up to 4x SPI master/3x SPI slave with EasyDMA
- Up to 2x I2C compatible two-wire master/slave
- 2x UART (CTS/RTS) with EasyDMA
- Quadrature decoder (QDEC)
- 3x real-time counter (RTC)
- Single crystal operation

Embedded Flash

- 16 M-bit Serial Flash
 - 2048K-Byte
 - 256 Bytes per programmable page
- Standard/Dual/Quad SPI
 - Standard SPI: SCLK, CS#, SI, SO, WP#, HOLD#
 - Dual SPI: SCLK, CS#, IO0, IO1, WP#, HOLD#
 - Quad SPI: SCLK, CS#, IO0, IO1, IO2, IO3
- High Speed Clock Frequency
 - 104MHz for fast read with 30PF load
 - Dual I/O Data transfer up to 208Mbits/s
 - Quad I/O Data transfer up to 416Mbits/s
- Software/Hardware Write Protection
 - Write protect all/portion of memory via software
 - Enable/Disable protection with WP# pin
 - Top/Bottom block protection
- Endurance and Data Retention
 - Minimum 100,000 Program/Erase Cycles
 - 20-year data retention typical
- Allows XiP (eXecute in Place) Operation
 - High speed Read reduce overall XiP instruction fetch time

- Continuous Read with Wrap further reduce data latency to fill up SoC cache
- Fast Program/Erase Speed
 - Page Program time: 1ms typical
 - Sector Erase time: 100ms typical
 - Block Erase time: 0.3s/0.5s typical
 - Chip Erase time: 10s typical
- Flexible Architecture
 - Uniform Sector of 4K-Byte
 - Uniform Block of 32/64K-Byte
- Low Power Consumption
 - 11 μ A typical standby current
 - 0.1 μ A typical deep power down current
- Advanced Security Features
 - 128-bit Unique ID for each device
 - Serial Flash Discoverable parameters (SFDP) register
 - 2x1024-Byte Security Registers With OTP Locks
- Single Power Supply Voltage
 - Full voltage range: 1.65-3.6V

3. General Specification

Operating	Temperature: -30°C to 85°C Relative Humidity : ≤ 80%
Storage	Temperature: -40°C to 85°C Relative Humidity : ≤ 60%

3.1 Voltages

3.1.1 Absolute Maximum Ratings

Symbol	Description	Min.	Max.	Unit
VDD	Input supply Voltage	-0.3	3.6	V

3.1.2 Recommended Operating Ratings

Test conditions: At room temperature				
Symbol	Min.	Typ.	Max.	Unit
VDD	1.7	3.0	3.6	V

Test conditions: At operating temperature -30°C ~ 85°C				
Symbol	Min.	Typ.	Max.	Unit
VDD	1.7	3.0	3.6	V

3.2 RF Specification (RX)

Parameters	Conditions (VDD=3.0V)	Min.	Typ.	Max.	Unit
Frequency Range		2402		2480	MHz
RX Sensitivity < 30.8% PER	LE 1Mbps		-94		dBm
	LE 2Mbps		-92		dBm
	LE 125Kbps		-103		dBm
	LE 500Kbps		-99		dBm
Maximum Input Level			0		dBm

3.3 RF Specification (TX)

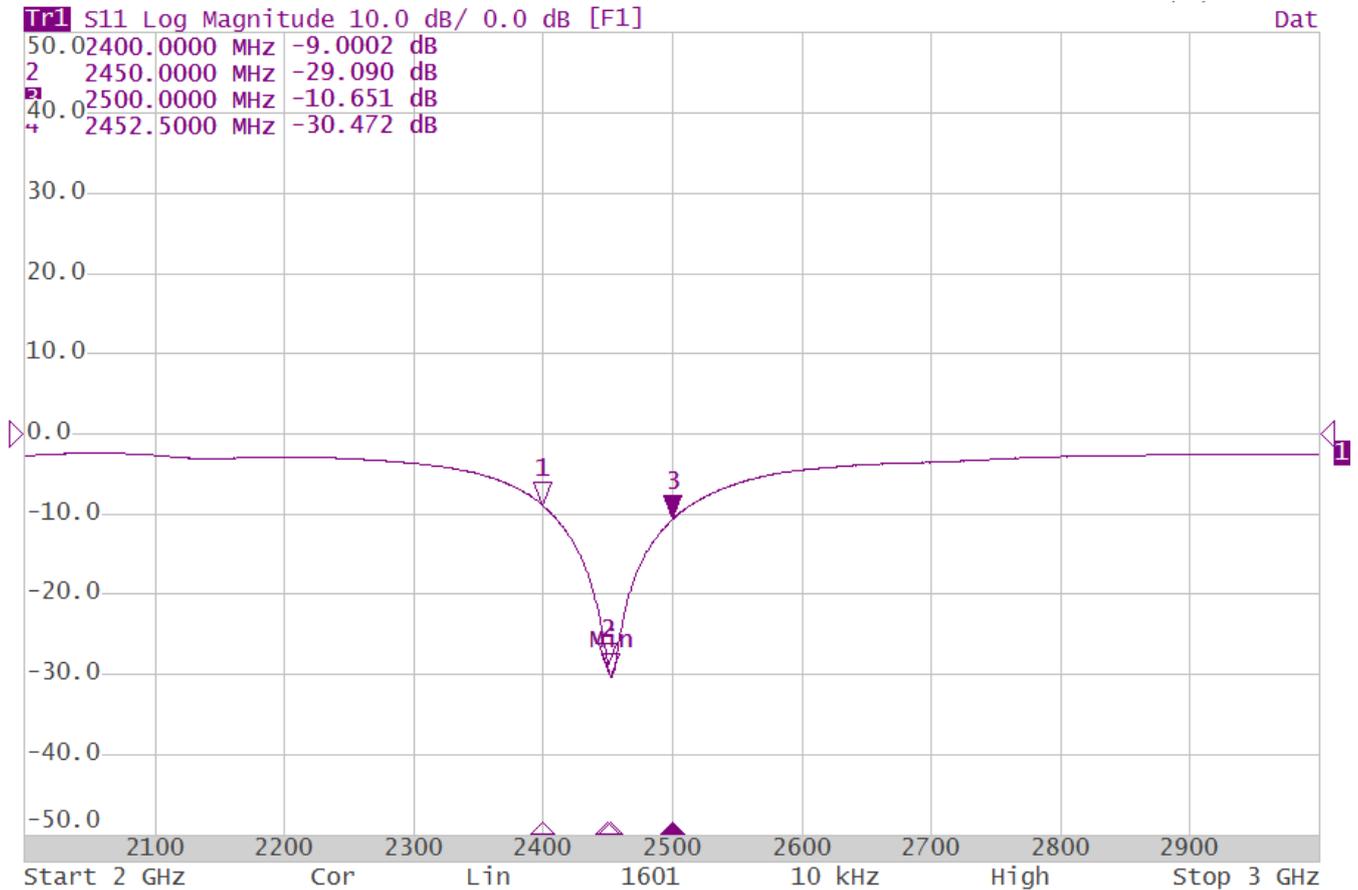
Parameters	Conditions (VDD=3.0V)	Min.	Typ.	Max.	Unit
Frequency Range		2402		2480	MHz
Maximum Output Power		--	--	8	dBm
Power Control Range			28		dB
Power Accuracy			±4		dB

3.4 Power Consumption

Main Chip	
Radio Power Consumption (Regulator = DC-DC):	
RX Mode (1Mbps)	6.3 mA (Typical)
TX Mode (0.0 dBm / 1Mbps)	6.4 mA (Typical)
TX Mode (8.0 dBm / 1Mbps)	16.4 mA (Typical)
Low Power Mode:	
Deep LPS (Wakeup by GPIO, timer)	2.35 uA (Typical)
Power Down (Wakeup by RESET)	0.40 uA (Typical)
Embedded Flash	
Operating Current	
Read (Clock=50MHz/Quad-SPI mode)	4.0 mA (Typical)
Write/Erase	15.0 mA (Typical)
Standby Current	
Deep Power-Down Current	0.1 uA (Typical)

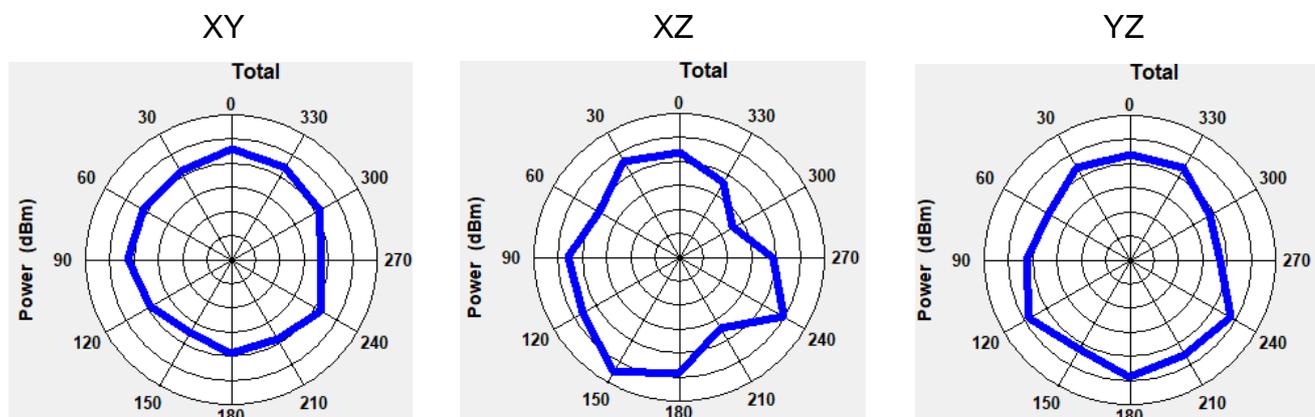
4. Antenna

4.1 S11 Parameter



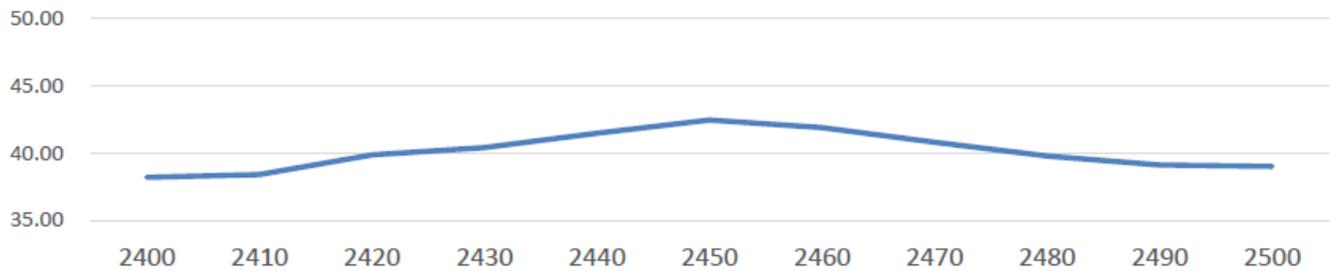
4.2 Gain Pattern

Passive Test (Free Space)



4.3 Efficiency

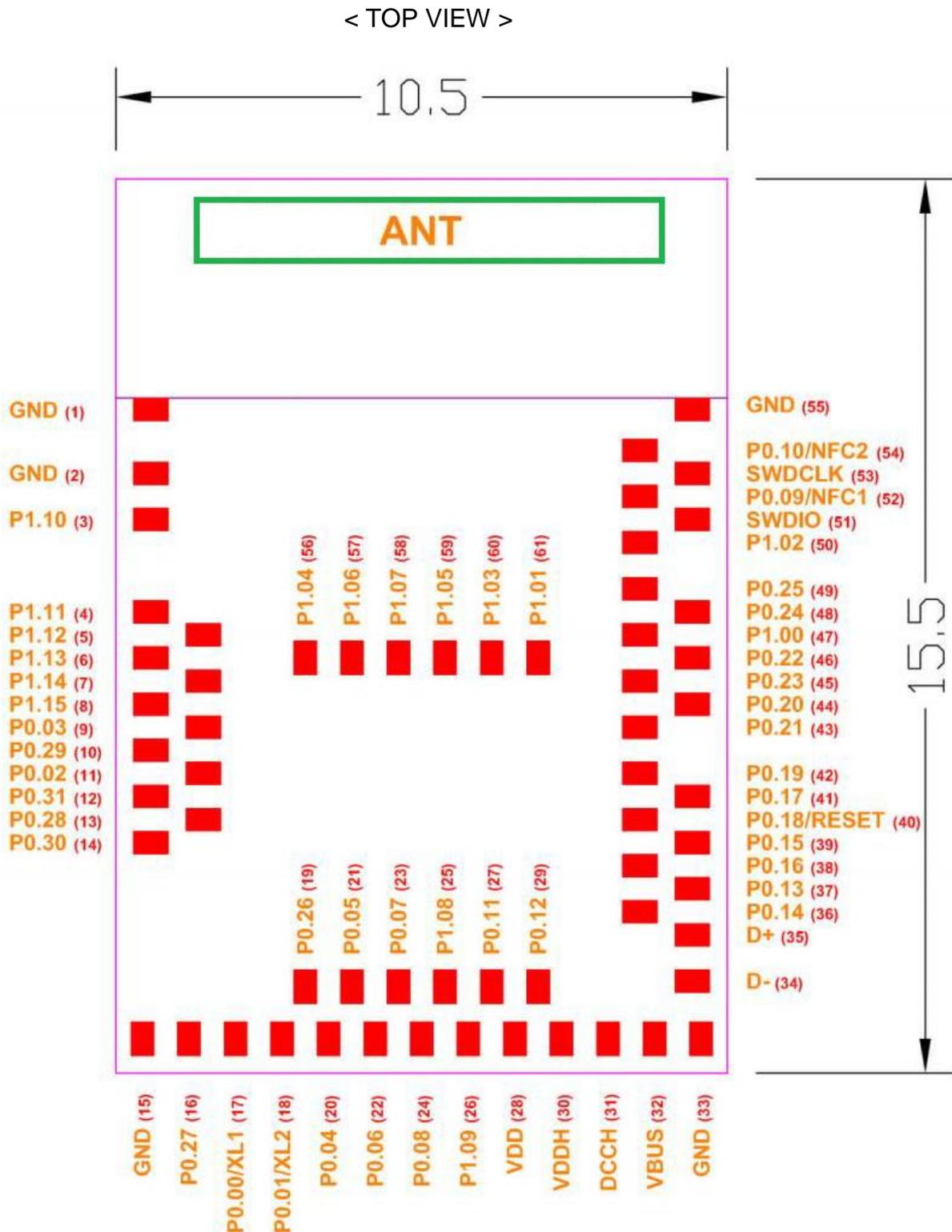
2400MHz~2500MHz (Average Efficiency = 40%)



Frequency (MHz)	2400	2410	2420	2430	2440	2450	2460	2470	2480	2490	2500
Efficiency (%)	38.20	38.39	39.85	40.41	41.47	42.45	41.89	40.80	39.76	39.10	39.00
Gain (dBi)	1.02	1.16	1.41	1.77	2.16	2.84	2.18	1.98	1.86	1.72	1.55

5. Pin Assignments

5.1 PCB Pin Outline (10.5mm x 15.5mm x 2.0mm)



5.2 Pin Definition

Pin No.	Pin-Define	Type	Description
1	GND	G	Ground
2	GND	G	Ground
3	P1.10	DIO	GPIO P1.10 (Std. Drive/Low Freq. IO only).
4	P1.11	DIO	GPIO P1.11 (Std. Drive/Low Freq. IO only)
5	P1.12	DIO	GPIO P1.12 (Std. Drive/Low Freq. IO only)
6	P1.13	DIO	GPIO P1.13 (Std. Drive/Low Freq. IO only)
7	P1.14	DIO	GPIO P1.14 (Std. Drive/Low Freq. IO only)
8	P1.15	DIO	GPIO P1.15 (Std. Drive/Low Freq. IO only)
9	P0.03/AIN1	DIO/AI	GPIO P0.03 (Std. Drive/Low Freq. IO only) / Analog Input 1
10	P0.29/AIN5	DIO/AI	GPIO P0.29 (Std. Drive/Low Freq. IO only) / Analog Input 5
11	P0.02/AIN0	DIO/AI	GPIO P0.02 (Std. Drive/Low Freq. IO only) / Analog Input 0
12	P0.31/AIN7	DIO/AI	GPIO P0.31 (Std. Drive/Low Freq. IO only) / Analog Input 7
13	P0.28/AIN4	DIO/AI	GPIO P0.28 (Std. Drive/Low Freq. IO only) / Analog Input 4
14	P0.30/AIN6	DIO/AI	GPIO P0.30 (Std. Drive/Low Freq. IO only) / Analog Input 6
15	GND	G	Ground
16	P0.27	DIO	GPIO P0.27
17	P0.00/XL1	DIO/AI	GPIO P0.00 / 32.768kHz Crystal Input
18	P0.01/XL2	DIO/AI	GPIO P0.01 / 32.768kHz Crystal Input
19	P0.26	DIO	GPIO P0.26
20	P0.04/AIN2	DIO/AI	GPIO P0.04 / Analog Input 2
21	P0.05/AIN3	DIO/AI	GPIO P0.05 / Analog Input 3
22	P0.06	DIO	GPIO P0.06
23	P0.07/TRACECLK	DIO	GPIO P0.07 / Trace Buffer Clock
24	P0.08	DIO	GPIO P0.08
25	P1.08	DIO	GPIO P1.08
26	P1.09/TRACEDATA3	DIO	GPIO P1.09 / Trace Buffer Data[3]
27	P0.11/TRACEDATA2	DIO	GPIO P0.11 / Trace Buffer Data[2]
28	VDD	P	Power Supply

ITM-8412 Datasheet

29	P0.12/TRACEDATA1	DIO	GPIO P0.12 / Trace Buffer Data[1]
30	VDDH	P	NC or connected to VDD (Not Support High Voltage Mode)
31	DCCH	P	NC (DCCH Not Support)
32	VBUS	P	5V Input for USB 3.3V Regulator
33	GND	G	Ground
34	USB_DM	AIO	USB DM Signal
35	USB_DP	AIO	USB DP Signal
36	P0.14	DIO	GPIO P0.14
37	P0.13	DIO	GPIO P0.13
38	P0.16	DIO	GPIO P0.16
39	P0.15 / FLASH_SIO1	DIO	GPIO P0.15 / Connect with QSPI0_SIO1
40	P0.18 / nRESET	DIO	GPIO P0.18 / Configurable as System Reset
41	P0.17	DIO	GPIO P0.17
42	P0.19 / FLASH_SIO3	DIO	GPIO P0.19 / Connect with QSPI0_SIO3
43	P0.21 / FLASH_SIO0	DIO	GPIO P0.21 / Connect with QSPI0_SIO0
44	P0.20	DIO	GPIO P0.20
45	P0.23	DIO	GPIO P0.23
46	P0.22 / FLASH_SIO2	DIO	GPIO P0.22 / Connect with QSPI0_SIO2
47	P1.00 / FLASH_CS	DIO	GPIO P1.00 / Connect with QSPI0_CS
48	P0.24	DIO	GPIO P0.24
49	P0.25 / FLASH_SCLK	DIO	GPIO P0.25 / Connect with QSPI0_SCLK
50	P1.02	DIO	GPIO P1.02 (Std. Drive/Low Freq. IO only)
51	SWDIO	DIO	Serial Wire Debug I/O
52	P0.09 / NFC1	DIO / AI	GPIO P0.09 (Std. Drive/Low Freq. IO only) / NFC Antenna Input 1
53	SWDCLK	DIO	Serial Wire Debug Clock
54	P0.10 / NFC2	DIO / AI	GPIO P0.10 (Std. Drive/Low Freq. IO only) / NFC Antenna Input 2
55	GND	G	Ground
56	P1.04	DIO	GPIO P1.04 (Std. Drive/Low Freq. IO only)
57	P1.06	DIO	GPIO P1.06 (Std. Drive/Low Freq. IO only)
58	P1.07	DIO	GPIO P1.07 (Std. Drive/Low Freq. IO only)
59	P1.05	DIO	GPIO P1.05 (Std. Drive/Low Freq. IO only)
60	P1.03	DIO	GPIO P1.03 (Std. Drive/Low Freq. IO only)
61	P1.01	DIO	GPIO P1.01 (Std. Drive/Low Freq. IO only)

Note:

Main chip I/O link to embedded flash as below

P1.00 ---- QSPI0_CS

P0.21 ---- QSPI0_SIO0

P0.15 ---- QSPI0_SIO1

P0.22 ---- QSPI0_SIO2

P0.19 ---- QSPI0_SIO3

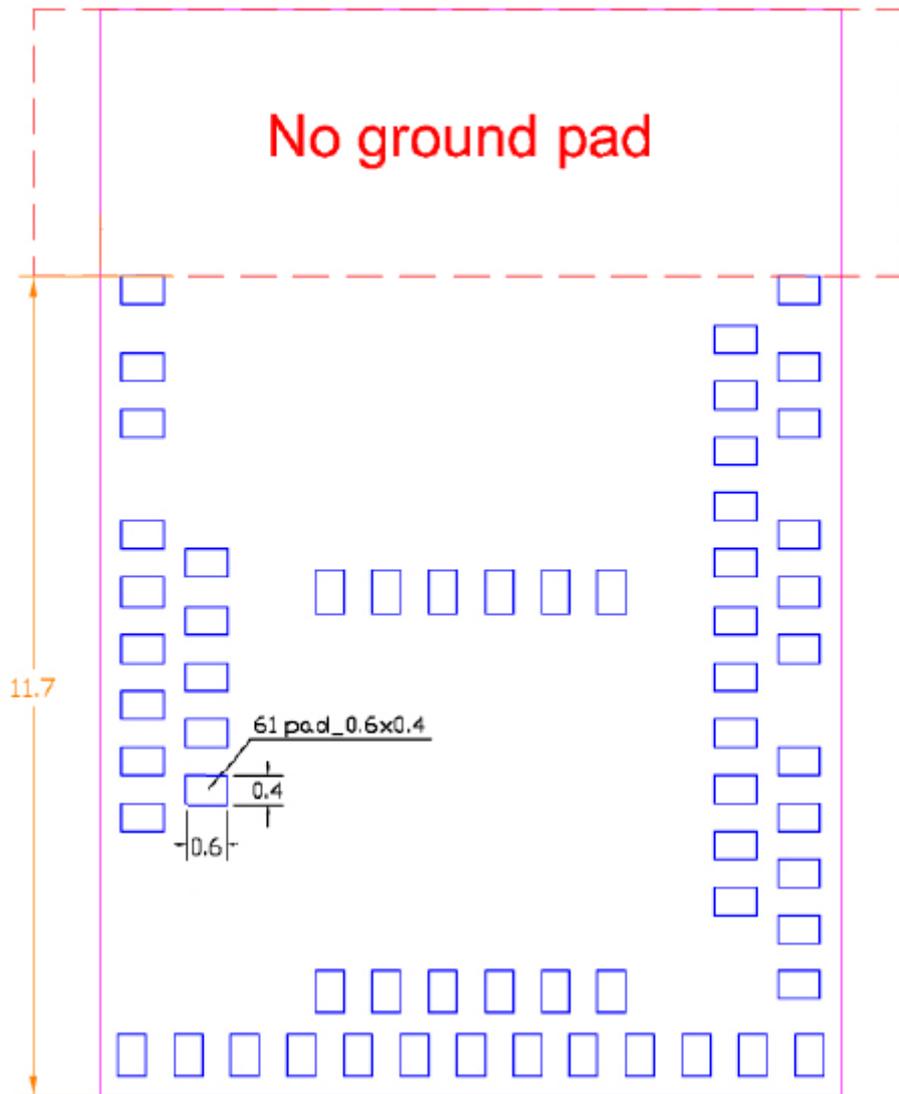
P0.25 ---- QSPI0_SCLK

6. Dimensions

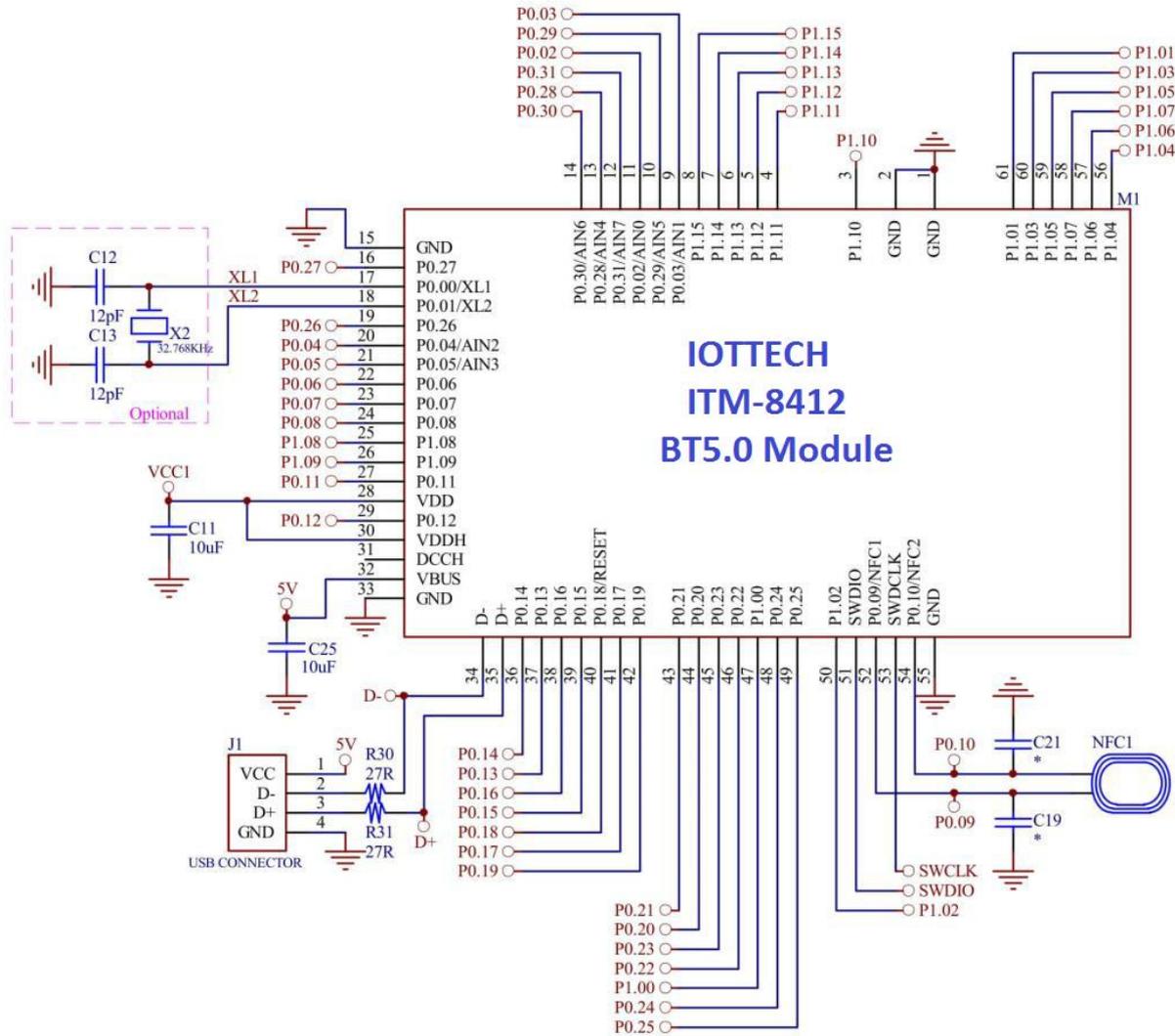
6.1 Layout Recommendation

(Unit: mm)

< TOP VIEW >



7. Reference Design

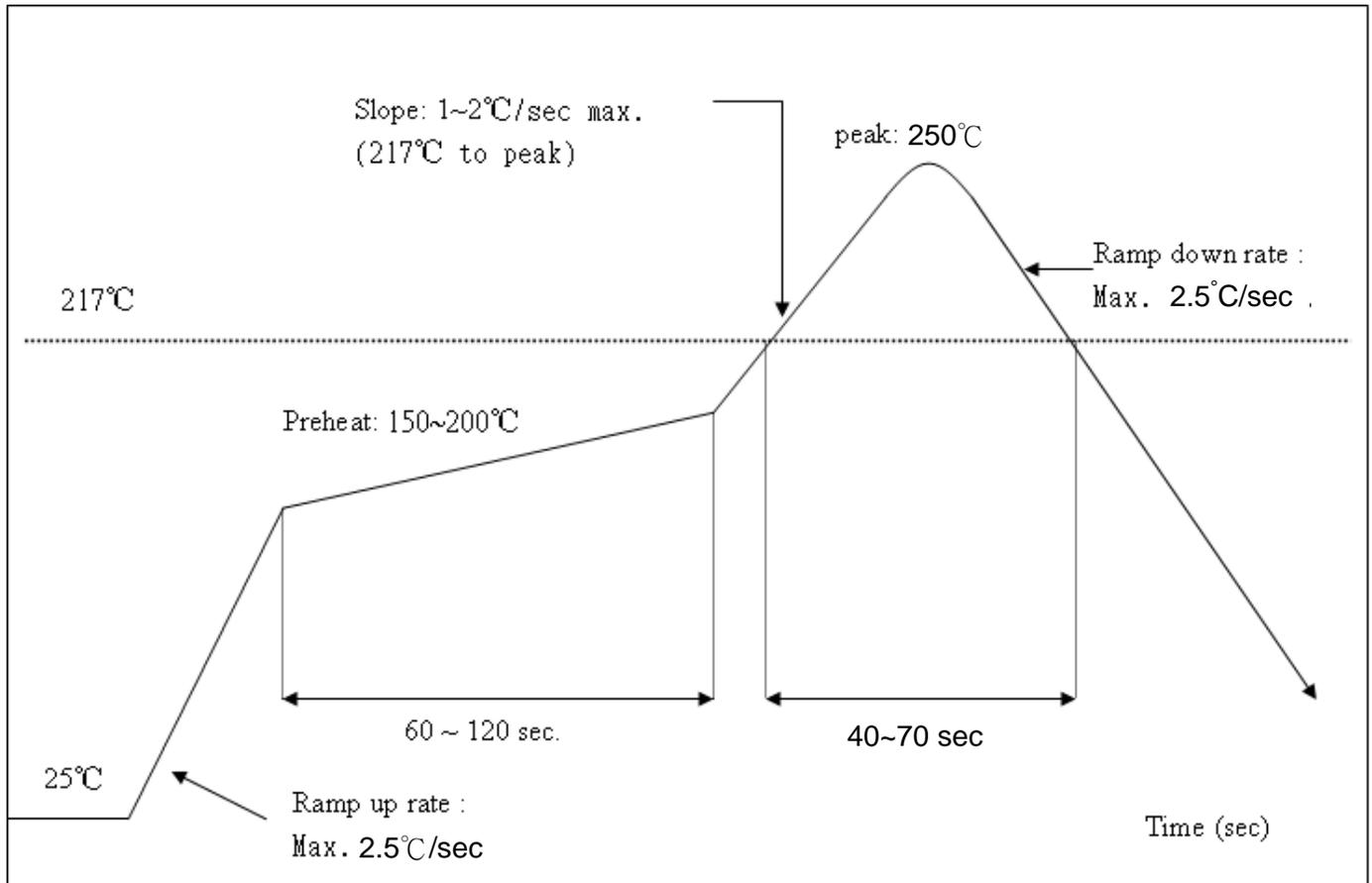


8. Recommended Reflow Profile

Referred to IPC/JEDEC standard.

Peak Temperature : <250°C

Number of Times : ≤2 times



9. Packing Information

9.1 Label

Label A → Anti-static and humidity notice

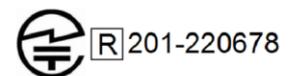
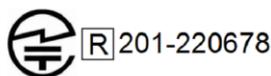


Label B → MSL caution / Storage Condition

	Caution This bag contains MOISTURE-SENSITIVE DEVICES	LEVEL 3 <small>If blank, see adjacent bar code label</small>
	<ol style="list-style-type: none"> Calculated shelf life in sealed bag: 12 months at <math><40^{\circ}\text{C}</math> and <math><90\%</math> relative humidity (RH) Peak package body temperature: <u>250</u> °C <small>If blank, see adjacent bar code label</small> After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be <ol style="list-style-type: none"> Mounted within: <u>168</u> hours of factory conditions <small>If blank, see adjacent bar code label</small> ≤30°C/60% RH, or Stored per J-STD-033 Devices require bake, before mounting, if: <ol style="list-style-type: none"> Humidity Indicator Card reads >10% for level 2a - 5a devices or >60% for level 2 devices when read at 23 ± 5°C 3a or 3b are not met If baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure 	
Bag Seal Date: _____ <small>If blank, see adjacent bar code label</small>		
<small>Note: Level and body temperature defined by IPC/JEDEC J-STD-020</small>		

Label C → Inner box label

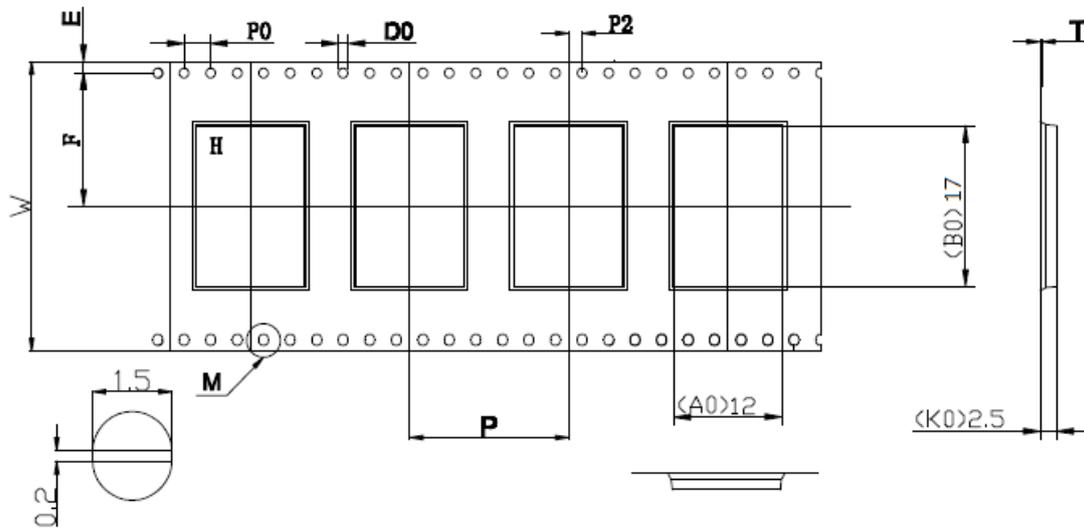
Label D → Carton box label



Part Number	ITM8412
Lot D/C	
Quantity	1500 PCS

Part Number	ITM8412
PO NO	
Quantity	7500 PCS

9.2 Dimension



Symbol	AO	BO	KO	PO	P	P2
Spec	12.0±0.10	17.0±0.10	2.50±0.10	3.00±0.10	17.0±0.10	2.00±0.10
Symbol	W	T	E	F	DO	
Spec	44.0±0.30	0.30±0.05	1.75±0.10	20.2±0.10	1.50±0.10	

1. 10 sprocket hole pitch cumulative tolerance ±0.20.
2. Carrier camber is within 1 mm in 250 mm.
3. Material : Black Conductive Polystyrene Alloy.
4. All dimensions meet EIA-481-D requirements.
5. Thickness : 0.30±0.05mm.
6. Packing length per 22" reel : 98.5 Meters.(1:3)
7. Component load per 13" reel : 1500 pcs.

