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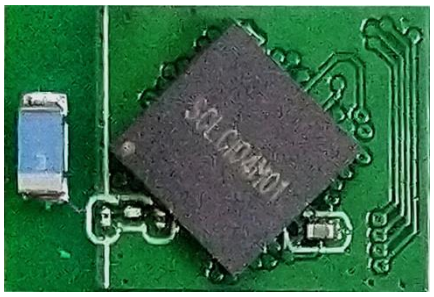
ITM-8412



Bluetooth® 5.0 Module Datasheet

V1.02

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
2024/12/06	- Update layout and circuit reference	Pendro Wu	1.0.2
	-		

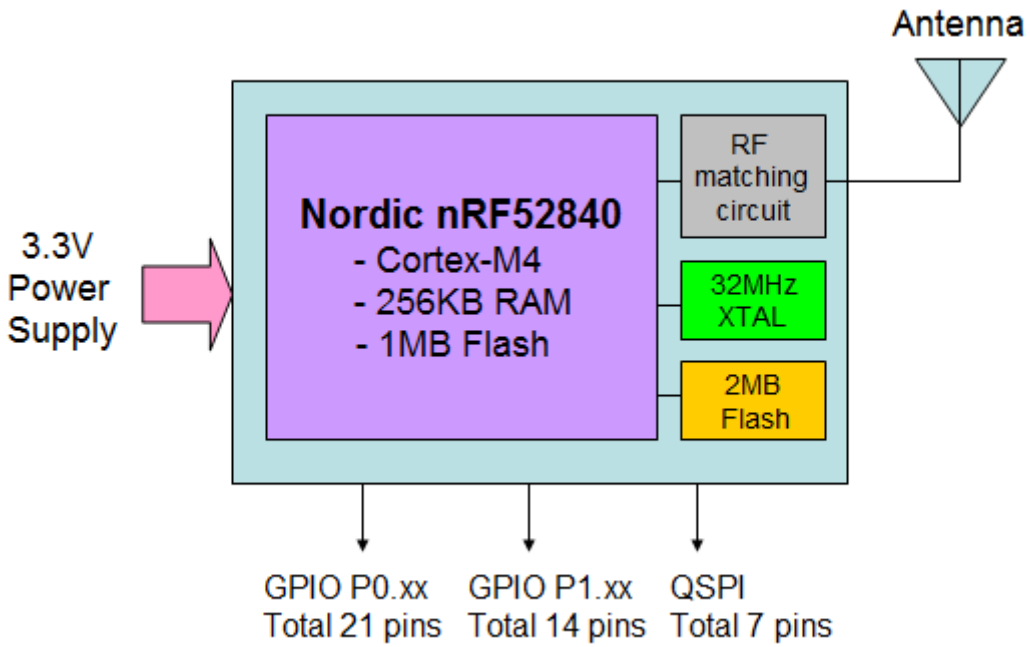
Contents

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 SCLCI04M05 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 SCLCI04M05 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 µA at 3 V in System OFF mode, no RAM retention
    - 1.5 µA 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 μA typical standby current
  - 0.1 μA 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)

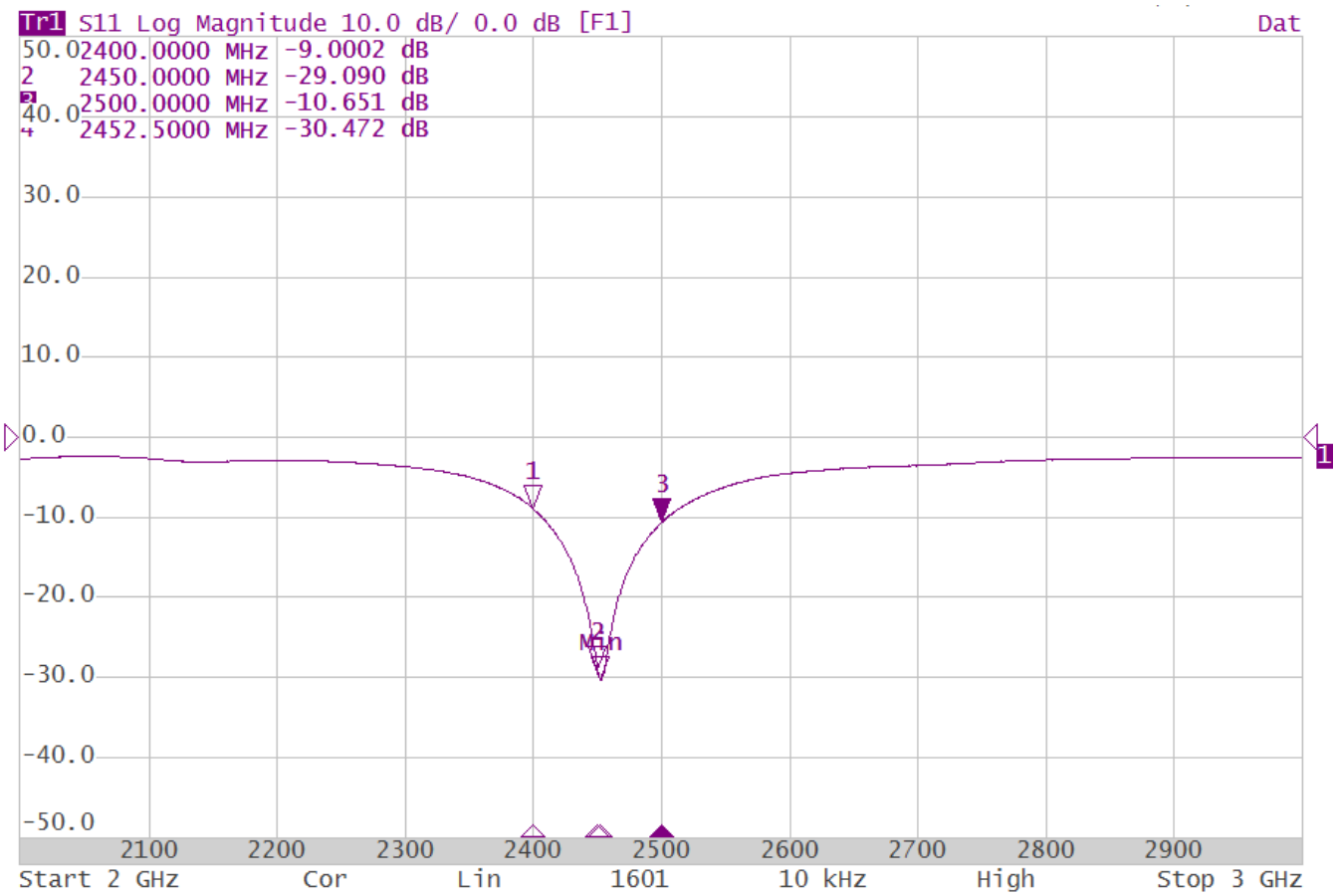
Parameters	Conditions (VDD=3.0V)	Min.	Typ.	Max.	Unit
Frequency Range		2402		2480	MHz
Maximum Output Power		--	--	8	dBm
Power Control Range			28		dB
Power Accuracy			±4		dB

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	11.0 uA (Typical)
Deep Power-Down Current	0.1 uA (Typical)

4. Antenna

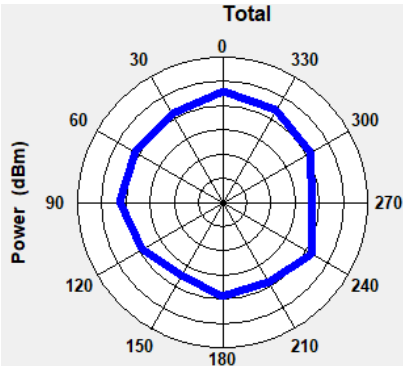
4.1 S11 Parameter



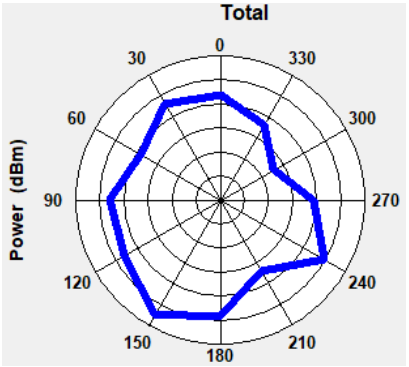
4.2 Gain Pattern

Passive Test (Free Space)

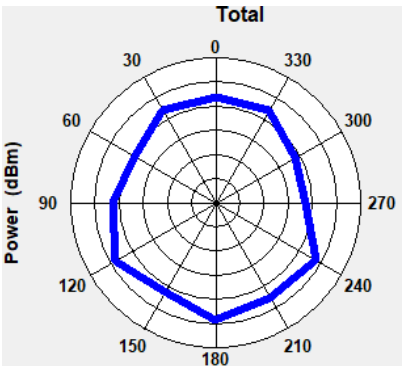
XY



XZ

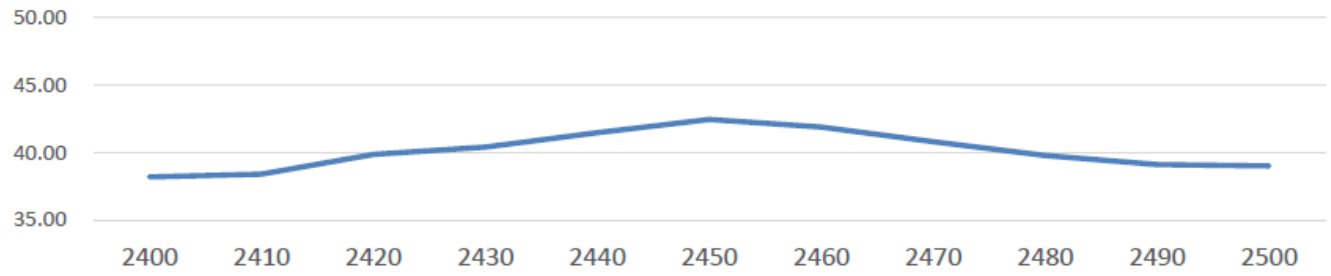


YZ



4.3 Efficiency

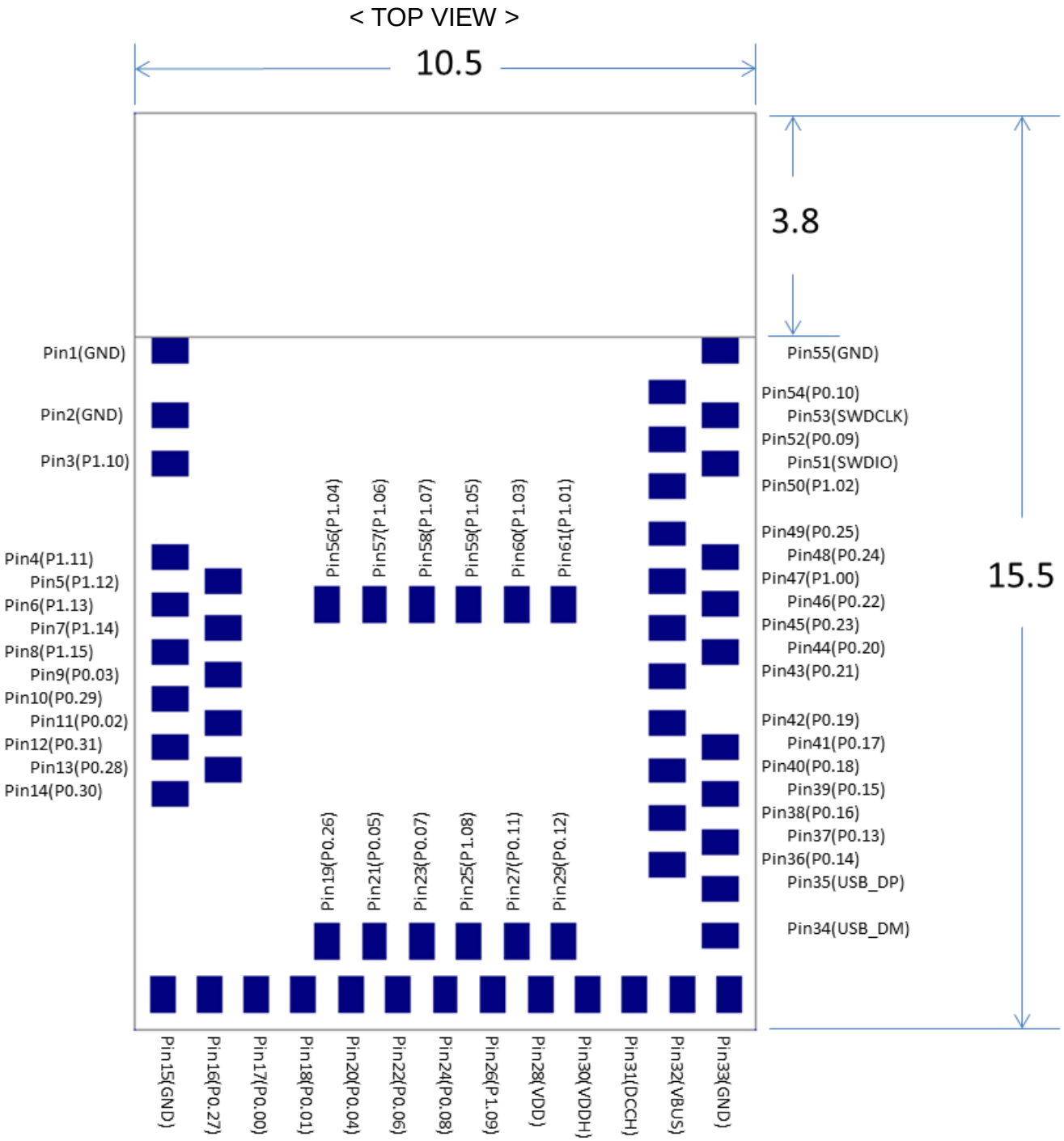
2400MHz~2500MHz (Average Efficiency = 40%)



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
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

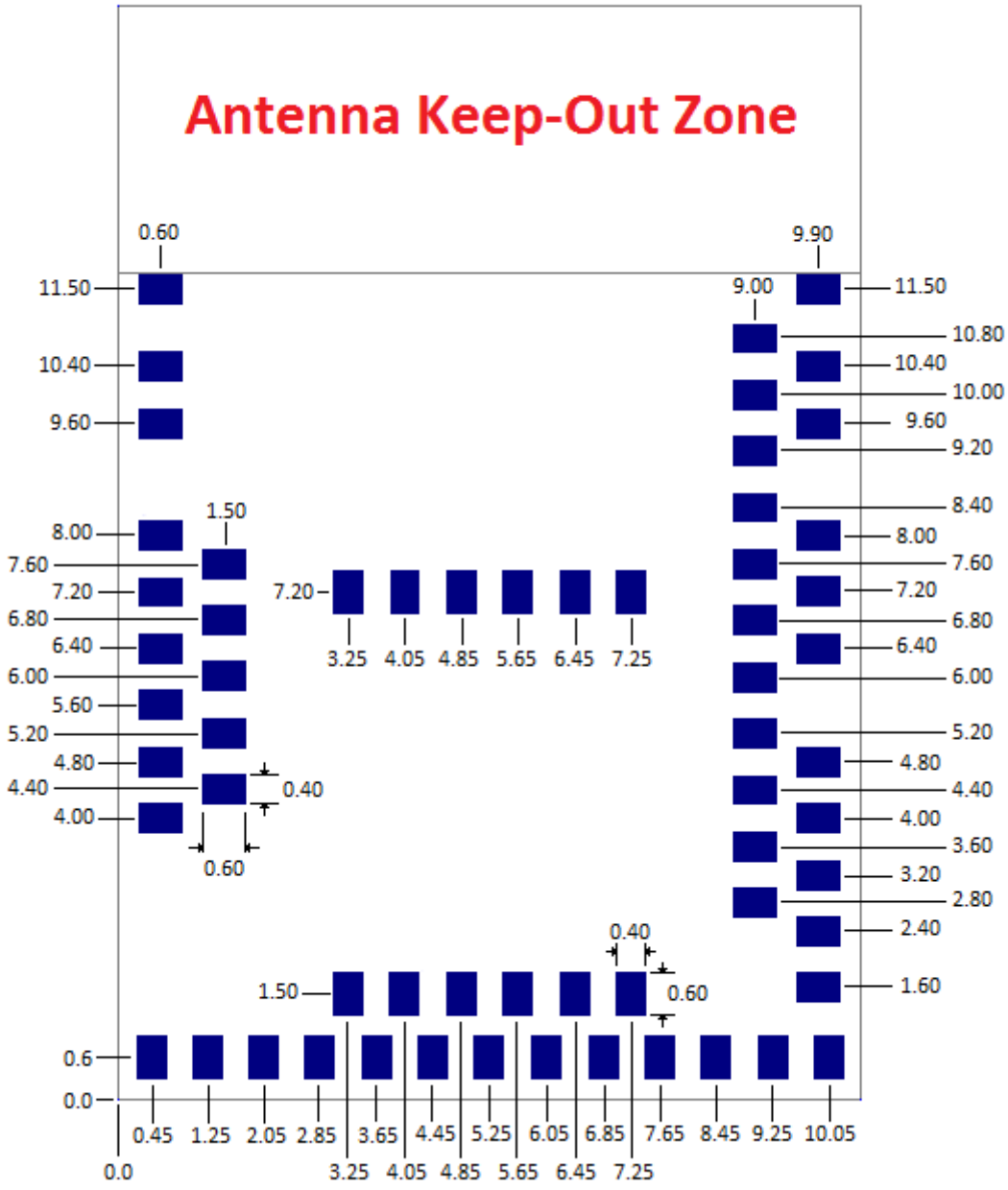
P1.00 ---- QSPI0_CS
P0.21 ---- QSPI0_SIO0
P0.15 ---- QSPI0_SIO1
P0.22 ---- QSPI0_SIO2
P0.19 ---- QSPI0_SIO3
P0.25 ---- QSPI0_SCLK

6. Dimensions

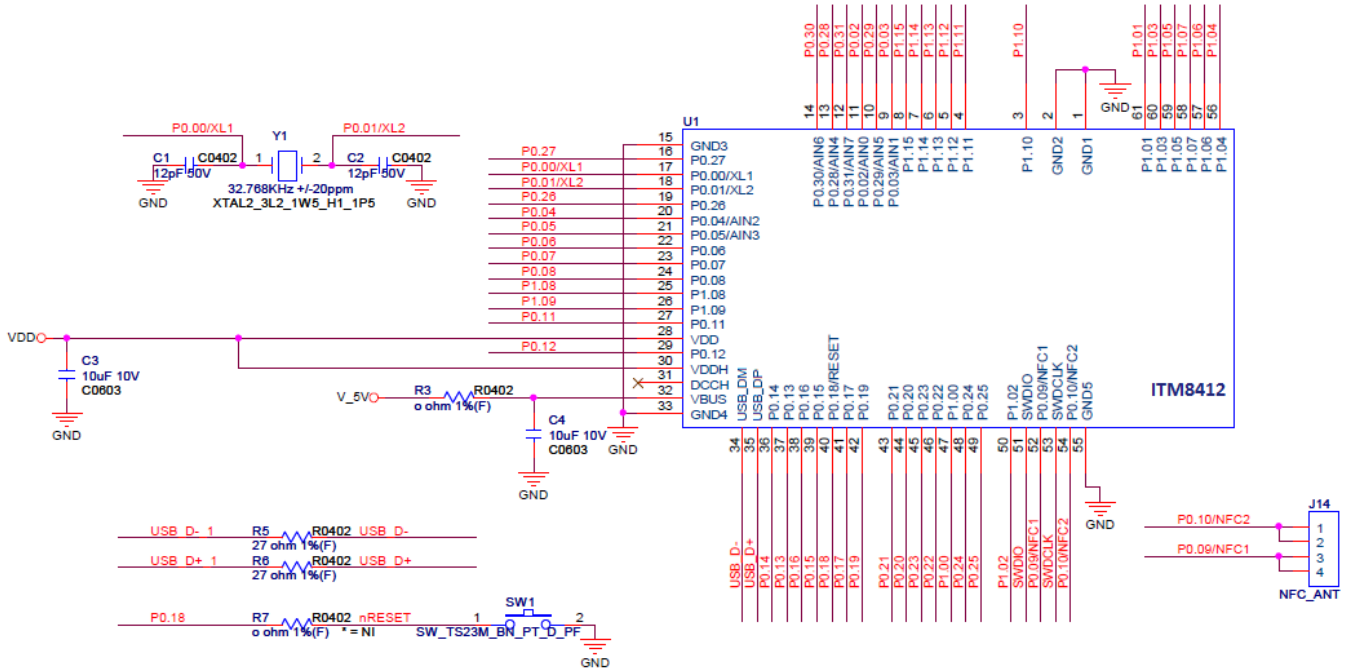
6.1 Layout Recommendation

(Unit: mm)

< TOP VIEW >



7. Reference Design

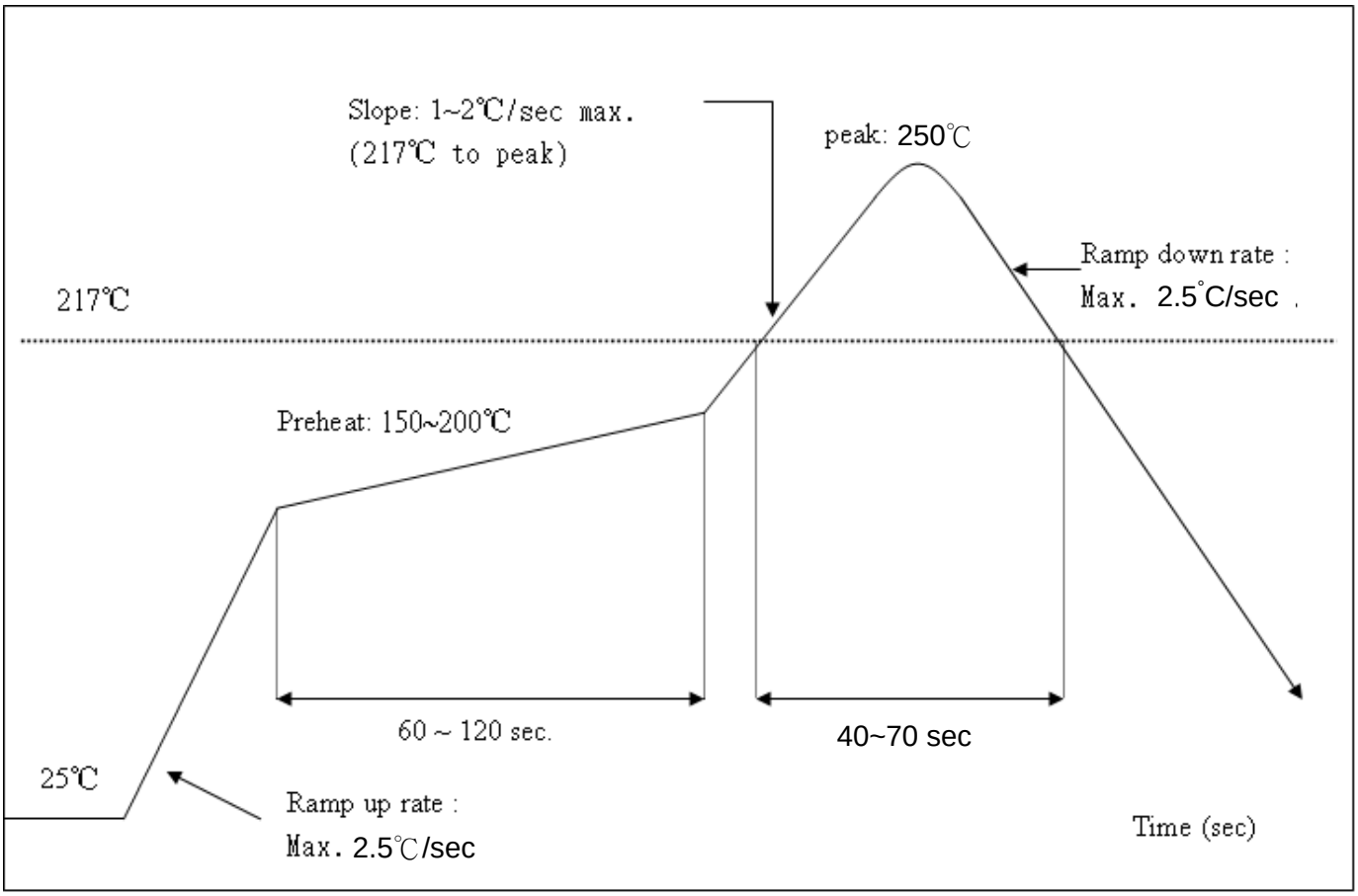


8. Recommended Reflow Profile

Referred to IPC/JEDEC standard.

Peak Temperature : <250°C

Number of Times : ≤2 times

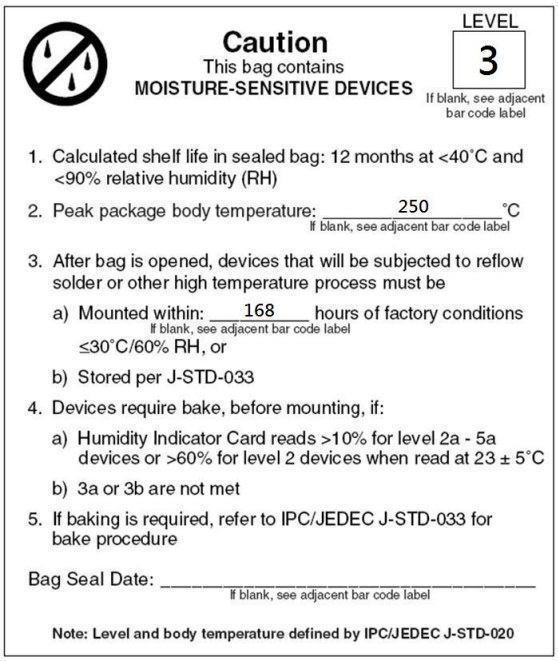


9. Packing Information

9.1 Label

Label A → Anti-static and humidity notice

Label B → MSL caution / Storage Condition



Label C → Inner box label

R 201-220678

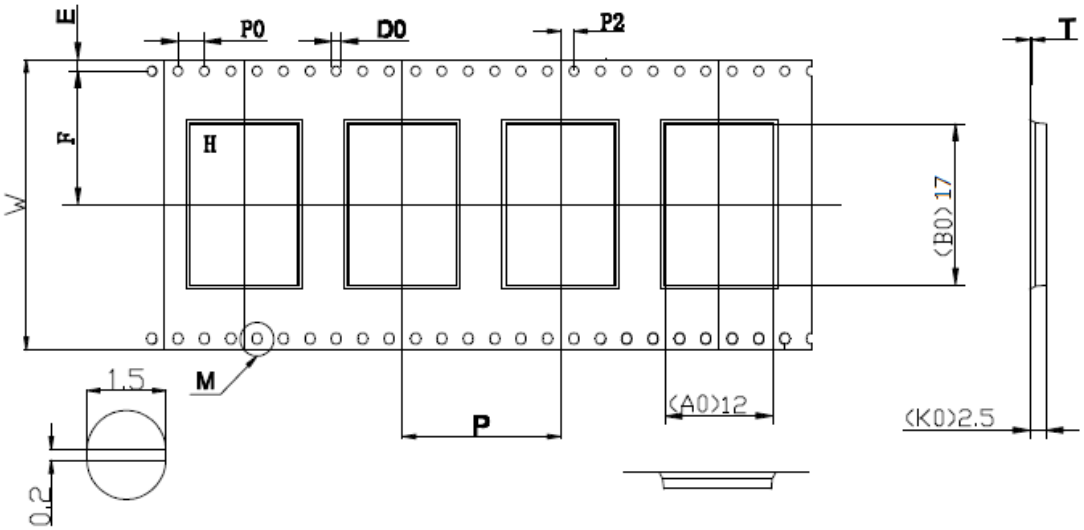
Part Number	ITM8412
Lot D/C	
Quantity	1500 PCS

Label D → Carton box label

R 201-220678

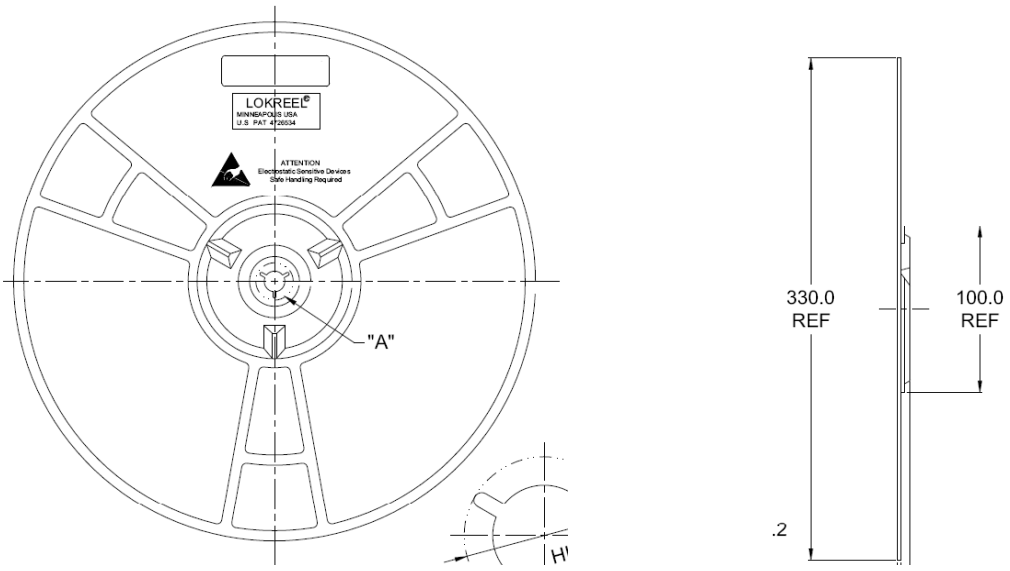
Part Number	ITM8412
PO NO	
Quantity	7500 PCS

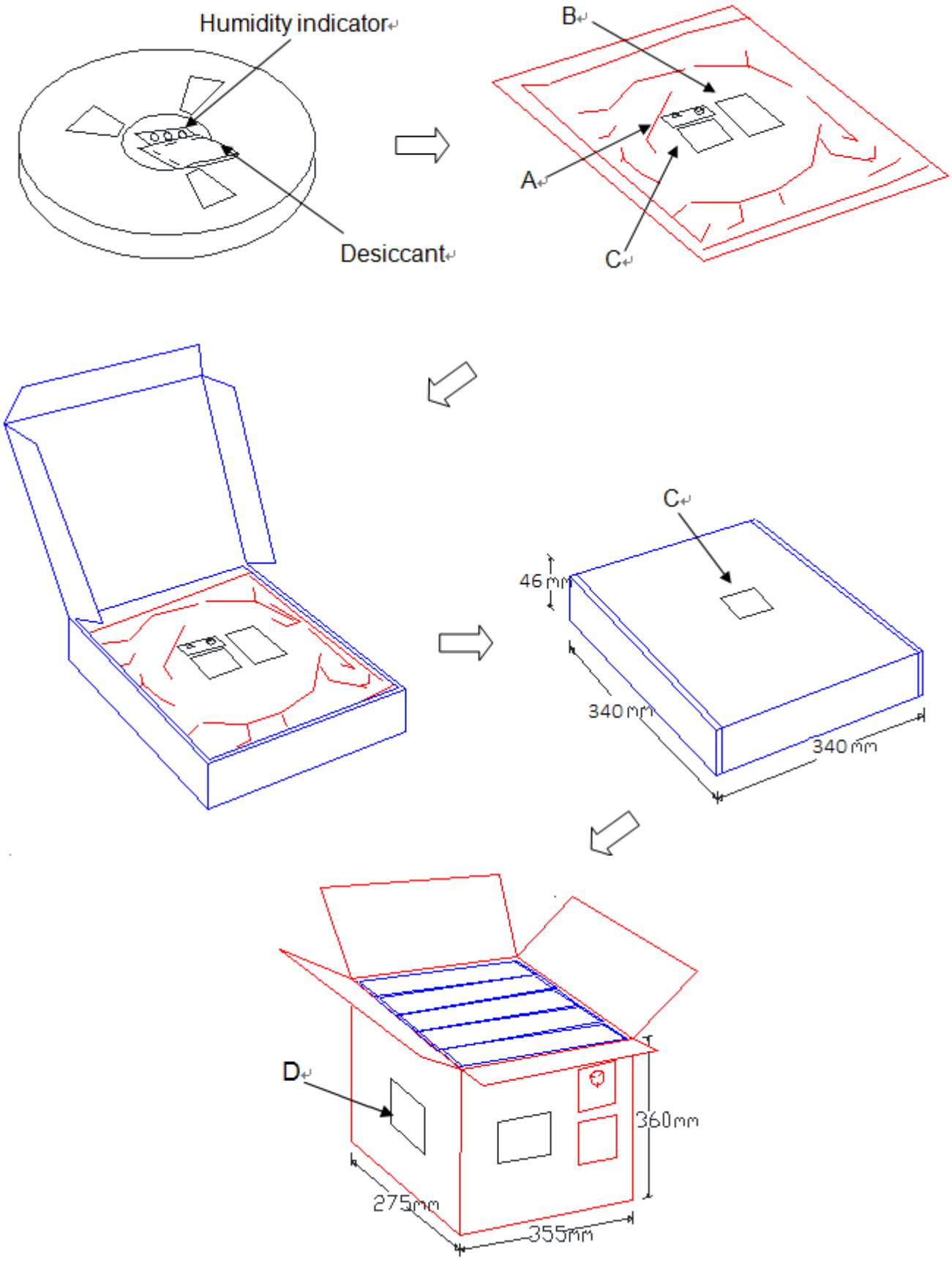
9.2 Dimension



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.




Humidity indicator
Desiccant
B
A
C
C
46mm
340mm
340mm
D
360mm
275mm
355mm