Product utilizing with SESUB Technology

[SESUB : Semiconductor Embedded in SUBstrate]

Bluetooth V4.1 Smart (Low Energy) Module

Type : SESUB-PAN-D14580

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Features

- **General**
  - Bluetooth V4.1 Smart (Low Energy) standard compatible module, its size of 3.5mm x 3.5mm x 1.0mm, only possible using TDK proprietary SESUB technology embedding Dialog Semiconductor DA14580 IC and integrating the function required components.
  - DA14580 IC, 16MHz crystal for system clock, Inductor and capacitor built-in a module.
  - Space saving, $<13mm^2$ total package size compared with $30mm^2$ as discrete solution.
  - Module maximum Height is 1.2mm.
  - Total 36 user pins with 0.5mm pad pitch in solder bumped BGA finish.
  - Maximum 12 General purpose user I/Os.
  - Complete module solution allowing just plug and play to the antenna, giving designers more flexibility in small area required applications.
  - All development tools provided by Dialog Semiconductor for DA14580 package IC can be used for this module without any modification.
  - Embedded Bluetooth-Stack from Dialog Semiconductor available.

- **RF**
  - Support 2.4GHz Bluetooth V4.1 Smart (Low Energy) Single mode.
  - Tx Output Power up to 0 dBm.
  - Current Consumption for RF communication (at VBAT 3.0V).
    Tx: 5.0mA, Rx: 5.4mA
  - -94dBm receiver sensitivity.
  - Suitable for Systems Targeting Compliance With Radio Frequency Regulations:
    FCC CFR47 Part15 (USA), ARIB STD-T66 (Japan), ETSI 300 328 and EN 300 440 Class2 (Europe)

- **Microcontroller**
  - High-Performance and Low-Power ARM Cortex-M0 Microcontroller Core with 16MHz clock.
  - Reference clock : 16MHz crystal integrated within a module.
  - Sleep clock: User can use external 32.768kHz crystal optionally if required.

- **Memories**
  - 32kB of In-System-Programmable OTP (One-Time-Programmable) Memory:
    for storing Bluetooth profiles as well as custom application code.
  - 84kB ROM for Stack.
  - 42kB System SRAM.
  - 8kB Retention SRAM.
    for storing sensitive data and connection information while in Deep Sleep mode.

- **Peripherals**
  - 2 UARTs with hardware flow control up to 1M Baud.
  - I2C Bus Interface at 100kHz and 400kHz speed.
  - SPI+^{TM} interface.
  - 32kHz Sleep Timer with Capture.
  - 4-Channels 10-bit ADC.
  - AES-128 bit encryption processor.

- **Development Tools**
  - SESUB-PAN-D14580 EVK: This TDK development kit provides basic function evaluation and software development environment, which includes an evaluation module with SPI connected a 128kB serial ROM (SP14808) and its mother board (SP14809).
  - Evaluation board for RF characteristic measurements: SP14817 evaluation board provides a hardware. Pin-Out compatible with Dialog Semiconductor "DA14580 Development Kit (PRO) Mother Board".
  - Capable to use Dialog Semiconductor Connection Manager ^{TM} and Smart Snippets ^{TM} Software.
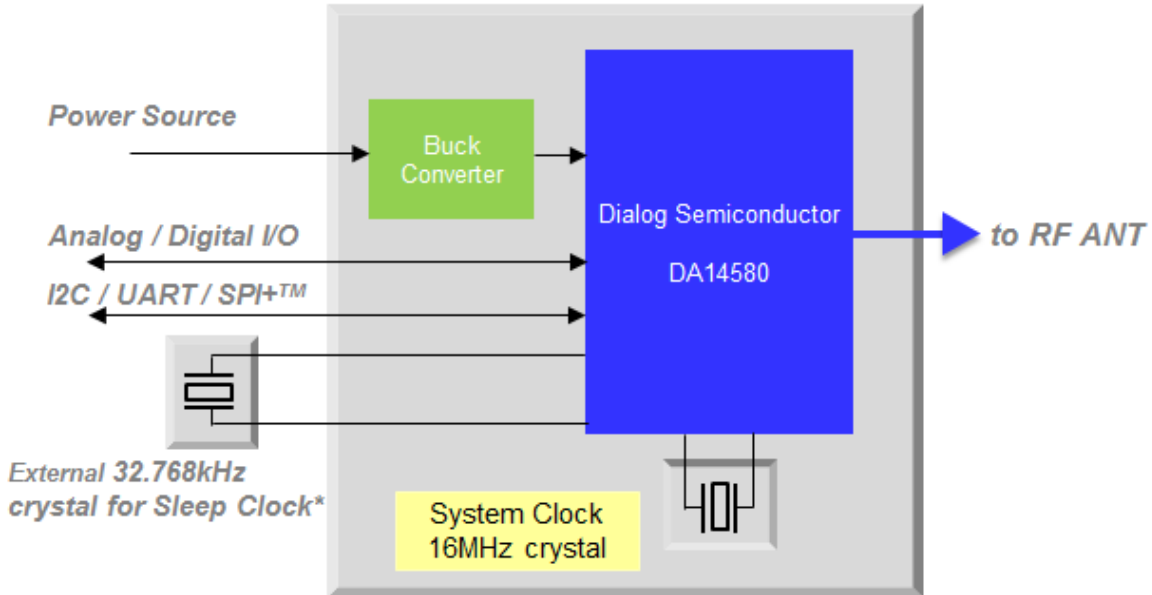
- **Applications**
  - Human-Interface Devices (Mouse, Remote Control).
  - Sports and Leisure Equipment.
  - Fitness / Healthcare Products.
  - Sensor Monitoring Products.
  - Intelligent Tag Products.
  - Gaming Devices.
  - Tablet Stylus Pen Products.
  - Wearable Products.
  - Mobile Phone Accessories.
  - Digital Consumer Electronics.

Block Diagram

The module block diagram is shown in Figure 1.

Figure 1 Module Block Diagram

Remark *

External 32.768 kHz crystal or external 32.768 kHz clock input from other device can be used as optional.

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Module Schematic

The module Schematic is shown in Figure 2.

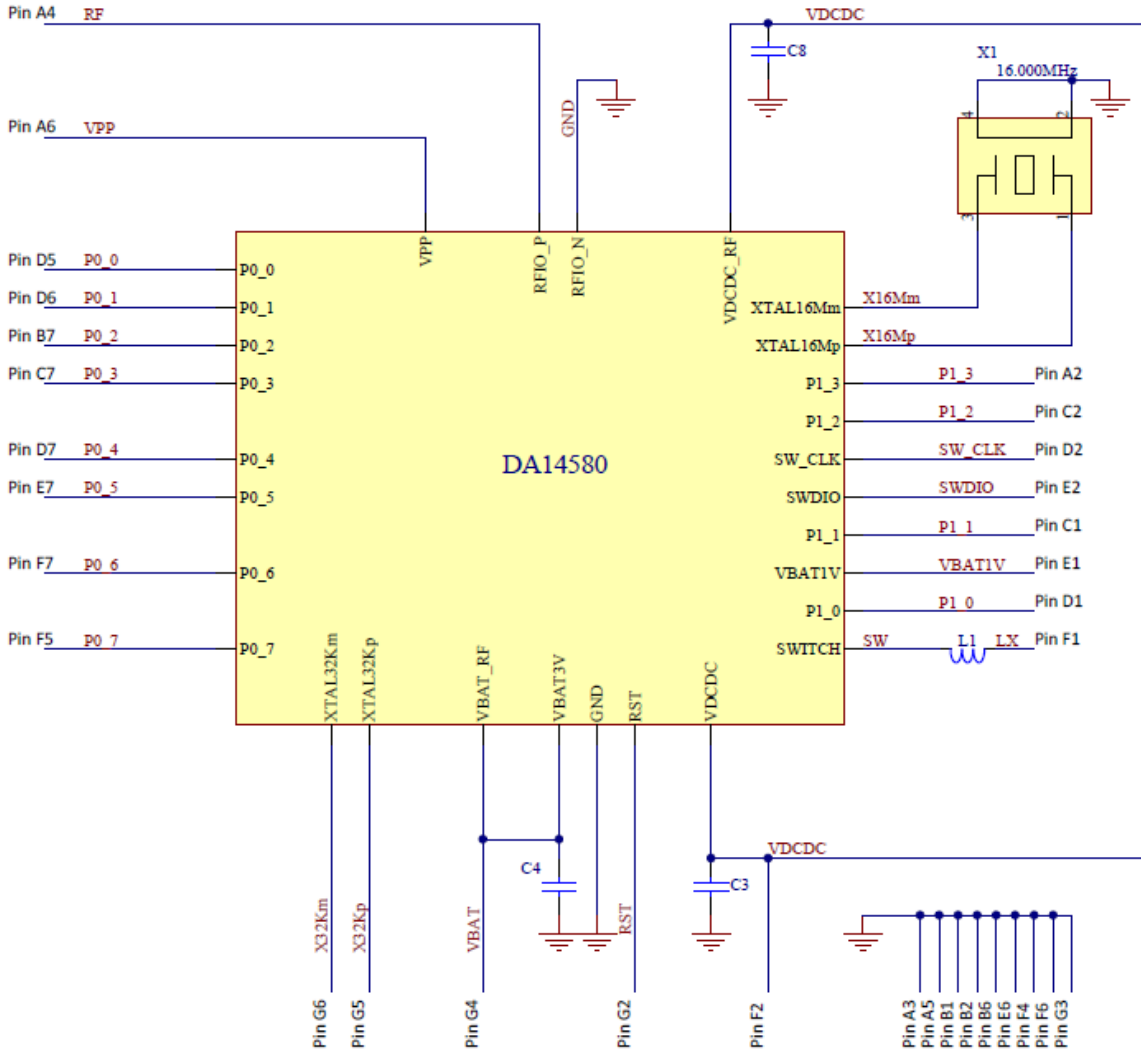**Figure 2 Module Schematic**

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Absolute Maximum Ratings

Over operating room temperature range (unless otherwise noted)

Item	VALUE	UNIT
Supply voltage range	-0.1 to 3.6	V
Storage temperature range	-40 to +85	℃
ESD (Charged Device Model)	200	V
ESD (Human Body Model)	1000	V

Recommended Operating Conditions

Over operating room temperature range (unless otherwise noted)

Parameter	Description	Conditions	Min	Typ	Max	UNIT
VBAT	Supply voltage range *	Pin VBAT1V is tied to ground during the operation.	2.35		3.3	V
VPP	Programming voltage	Supply voltage on pin VPP during OTP programming	6.6	6.7	6.8	V
Ta	Operational temperature range	Ambient temperature	-20		+70	℃

Remark:

* Supply voltage on VBAT3V with utilizing a buck converter application. (see Figure **5** in detail)

  And, cold boot should not be performed if voltage is less than 2.5 V because of possible corruption during OTP data mirroring. Trim values programmed in the OTP as well as the application image, should be copied into RAM while VBAT3V >= 2.5 V.

Digital Signal Input / Output DC Characteristics*

Over operating room temperature range (unless otherwise noted)

Parameter	Description	Conditions	Min	Typ	Max	UNIT
V_{IH_dig}	HIGH level input voltage		0.84			V
V_{IL_dig}	LOW level input voltage				0.36	V
I_{IH_dig}	HIGH level input current	Vin=2.5V	-1		1	μA
I_{IL_dig}	LOW level input current	Vin=0V	-1		1	μA

Remark:

* Refer to a specification of "Dialog DA14580 Datasheet" for other Digital Signal Input / Output DC Characteristics.

Electrical Characteristics

Condition of Ta=25℃+/-10℃ and VBAT = 3V

Parameter	Conditions	Value			UNIT
		Min	Typ	Max	
Rx mode current *	Typical application with buck converter		5.4		mA
Tx mode current *	Typical application with buck converter		5.0		mA
Deep sleep current	8kB retention RAM active, Running from XTAL32K oscillator		0.8		µA

Remark:

   Current value may be changed based on power supplying mode to the module. (see Figure **5** in detail)

General RF Characteristics

Condition of Ta=25℃+/-10℃, VBAT=3V (unless otherwise noted)

PARAMETER	Conditions	Value			UNIT
		Min	Typ	Max	
Center Frequency		2402	-	2480	MHz
Channel Spacing		-	2	-	MHz
Number of RF Channels		-	40	-	Ch
RF Port Impedance		-	50	-	Ohm

RF Characteristics

Condition of Ta=25℃+/-10℃, VBAT = 3V and fc=2440MHz (Unless otherwise noted)

PARAMETER	Conditions	Value			UNIT
		Min	Typ	Max	
Tx Output power level	Maximum output power setting	-6	0	-	dBm
Tx Frequency accuracy	Maximum output power setting	-150	0	+150	kHz
Tx modulation characteristics					
Delta F1$_{avg}$		225		275	kHz
Receiver Sensitivity level [measured by Packet Error Rate]	Packet error rate : ≤ 30.8%			-70	dBm

Mechanical Dimensions

The module mechanical dimensions are shown in Figure 3.
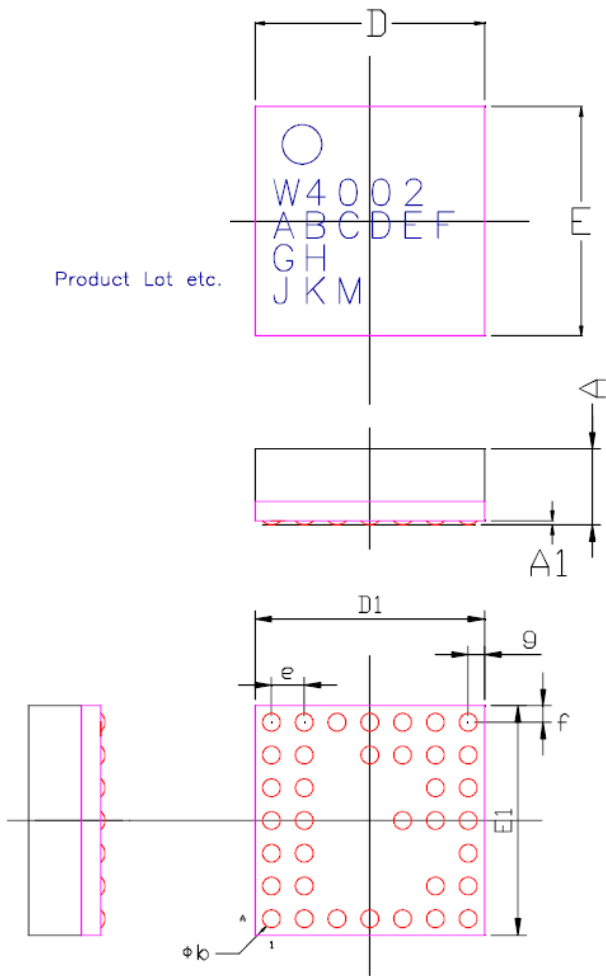
Symbol	Dimension in mm		
	MIN	NOM	MAX
A	---	1.0	1.2
A1	---	(0.045)	---
b	---	0.27	---
D	3.4	3.5	3.6
E	3.4	3.5	3.6
D1		3.5	
E1		3.5	
e		0.5	
f	---	0.25	---
g	---	0.25	---

Figure 3 Module Mechanical Dimensions

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Module Pin-Out

The module Pin-Out and names are shown in Figure 4 and Table 1.

Top (SMD Side) View

	1	2	3	4	5	6	7
A	NC	P1_3	GND	RF	GND	VPP	NC
B	GND	GND				GND	P0_2
C	P1_1	P1_2					P0_3
D	P1_0	SW_CLK			P0_0	P0_1	P0_4
E	VBAT1V	SWDIO				GND	P0_5
F	LX	VDCDC		GND	P0_7	GND	P0_6
G	NC	RST	GND	VBAT	X32Kp	X32Km	NC

Figure 4 Module Pin-Out

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Table 1 PIN Descriptions

Pin Nr	Pin Name	Pin Type	Description
A1	NC	NC	No Connection
A2	P1_3	Digital I/O	Port1.3
A3	GND	Ground	Tied to ground
A4	RF	Analog	RF Input / Output to antenna (impedance 50 ohm)
A5	GND	Ground	Tied to ground
A6	VPP	Power	This pin have to be used while OTP programming & testing. For OTP programming: VPP=6.7V +/- 0.1V For OTP normal operation: Leave VPP floating
A7	NC	NC	No Connection
B1	GND	Ground	Tied to ground
B2	GND	Ground	Tied to ground
B6	GND	Ground	Tied to ground
B7	P0_2	Digital I/O	Port0.2
C1	P1_1	Digital I/O	Port1.1
C2	P1_2	Digital I/O	Port1.2
C7	P0_3	Digital I/O	Port0.3
D1	P1_0	Digital I/O	Port1.0
D2	SW_CLK / P1_4	Digital I/O	JTAG Clock signal. Can also be used as Port1.4.
D5	P0_0	Digital I/O	Port0.0
D6	P0_1	Digital I/O	Port0.1
D7	P0_4	Digital I/O	Port0.4
E1	VBAT1V	Power	***See remark below (Figure 5 in detail)***
E2	SW_DIO / P1_5	Digital I/O	JTAG Data input/output. Bidirectional data and control communication. Can also be used as Port1.5.
E6	GND	Ground	Tied to ground
E7	P0_5	Digital I/O	Port0.5
F1	LX	Power	***See remark below (Figure 5 in detail)***
F2	VDCDC	Power	***See remark below (Figure 5 in detail)***
F4	GND	Ground	Tied to ground
F5	P0_7	Digital I/O	Port0.7
F6	GND	Ground	Tied to ground
F7	P0_6	Digital I/O	Port0.6
G1	NC	NC	No Connection
G2	RST	Digital I/O	Reset Input (active high) Must be connected to the ground if not used
G3	GND	Ground	Tied to ground
G4	VBAT	Power	Connect to power source (a battery cell) ***See remark below (Figure 5 in detail)***
G5	X32Kp	Analog Clock	32.768kHz crystal 1 (Input)
G6	X32Km	Analog Clock	32.768kHz crystal 2 (Output)
G7	NC	NC	No Connection

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Programing information on OTP

Table 2 Programing information on OTP

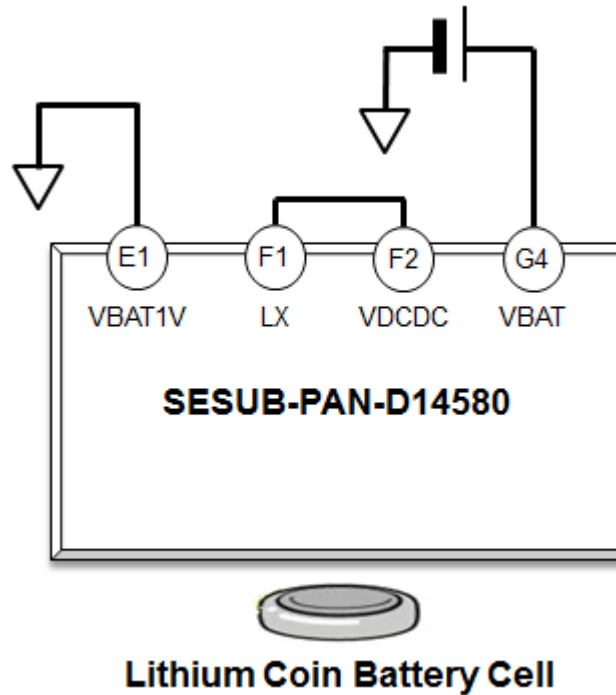| Name	OTP Address
XTAL 16M Trim	0x47F8C
BD ADDRESS	0x47FD4
	0x47FD8

Power Supply Circuit Connections in Customer Application

For Lithium coin battery cell use:
LX (F1) is tied to VDCDC (F2) in customer PCB trace pattern.
Coin cell is tied to VBAT (G4) and VBAT1V (E1) is tied to GND in customer PCB trace pattern.

Circuit connection for lithium coin battery cell power supply use

Figure 5 **Variations of Power Supply connection in Customer Application**

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Evaluation Board Information

SP14817 evaluation board is fully pins compatible to Dialog Semiconductor's evaluation daughter board. The SP14817 evaluation board can be connected to Dialog Semiconductor's Evaluation Mother Board. (See reference information in following section.) Figure 6 is shown the SP14817 evaluation board.
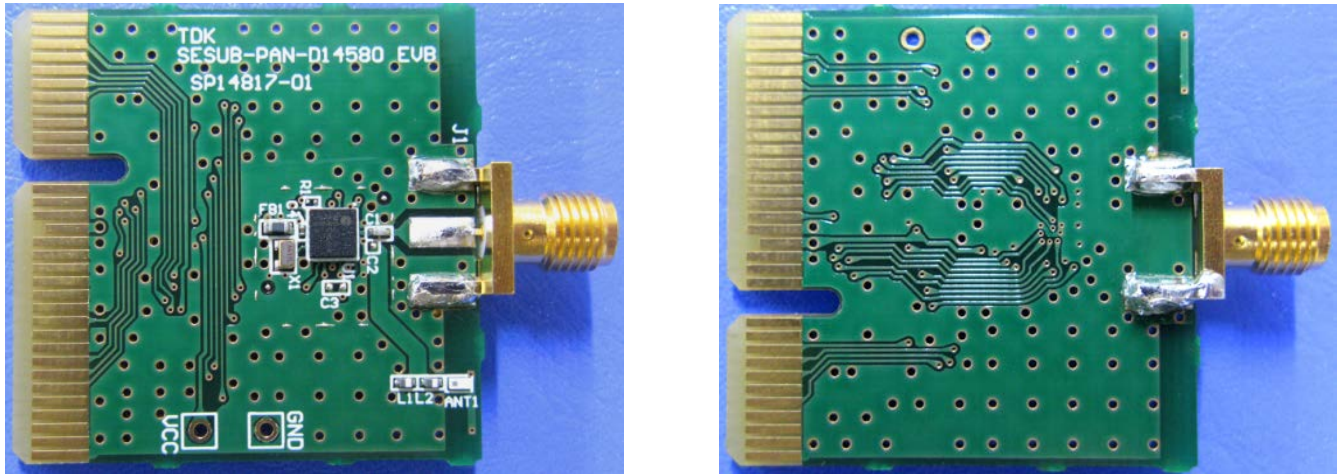
(a)   SP14817 (Side-A)   (b)   SP14817 (Side-B)
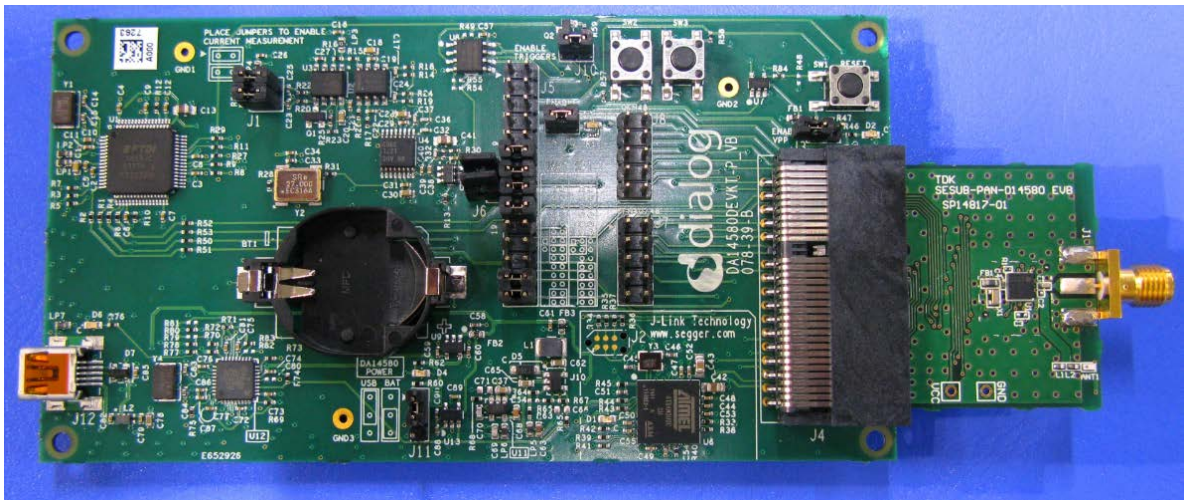
Figure 6 SP14817 on DA14580 Pro Development Kit

SP14817 evaluation board has two options for 32.768 kHz clock source.

a) External 32.768kHz sleep clock input

External 32.768 kHz clock can be input from other microcontroller as for sleep clock.

b) 32.768kHz crystal unit mounting

A 32.768 kHz crystal Unit can be mounted on SP14817 EM Board standalone operations without other microcontroller output clock signal as optional.

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Evaluation Kit Information

- SESUB-PAN-D14580 EVK is "Plug and Play" for quick and easy user experience.
- SESUB-PAN-D14580 EVK consists of SP14808 evaluation module and SP14809 mother board.
- SP14808 evaluation module integrates an RF antenna and is certified by Japanese radio law and the FCC.
- SP14808 integrates an SPI connected nonvolatile EEPROM and 32.768 kHz crystal resonator, which enables the customer to re-program the firmware without losing many hardware during software development or evaluation phase.
- SP14808 has a board-to-board connector and can be changed to another SP14808 evaluation module easily during customer evaluation and/or firmware development.
- SP14809 evaluation mother board integrates a USB-UART convertor and a voltage regulator for OTP (One Time Programmable) memory writing on SESUB-PAN-D14580, which enables programming of the onboard EEPROM or the integrated OTP memory without using an external programing tool.
- SP14809 can be powered by external batteries for standalone evaluation as well as internally via USB power supply source.
- SP14809 has an external IC Socket for I2C based peripheral device connection (i.e. accelerometer, gyro or pressure sensor which has I2C interface).
- SP14809 has jumper pins which enables customer to measure current under operational conditions
- SP14809 has break out terminals from SESUB-PAN-D14580 module which enables connection of peripherals or allows to connection to customer's application PCB.

SP14808	SP14809
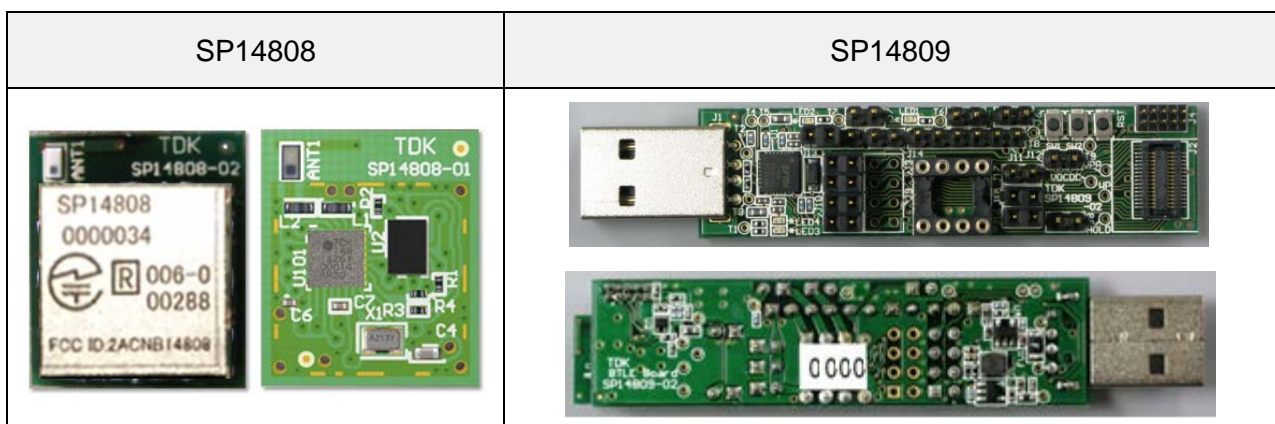
Figure 7 SESUB-PAN-D14580EVK Evaluation Kit

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Marking Specification
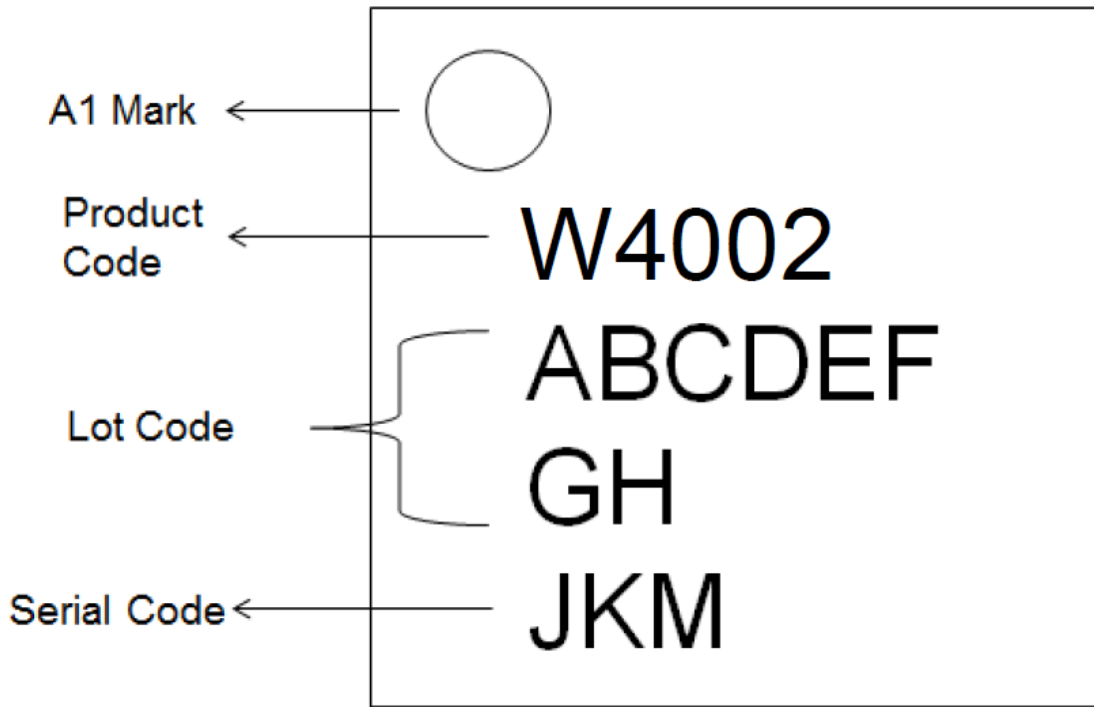
Figure 8 Module Marking Explanation
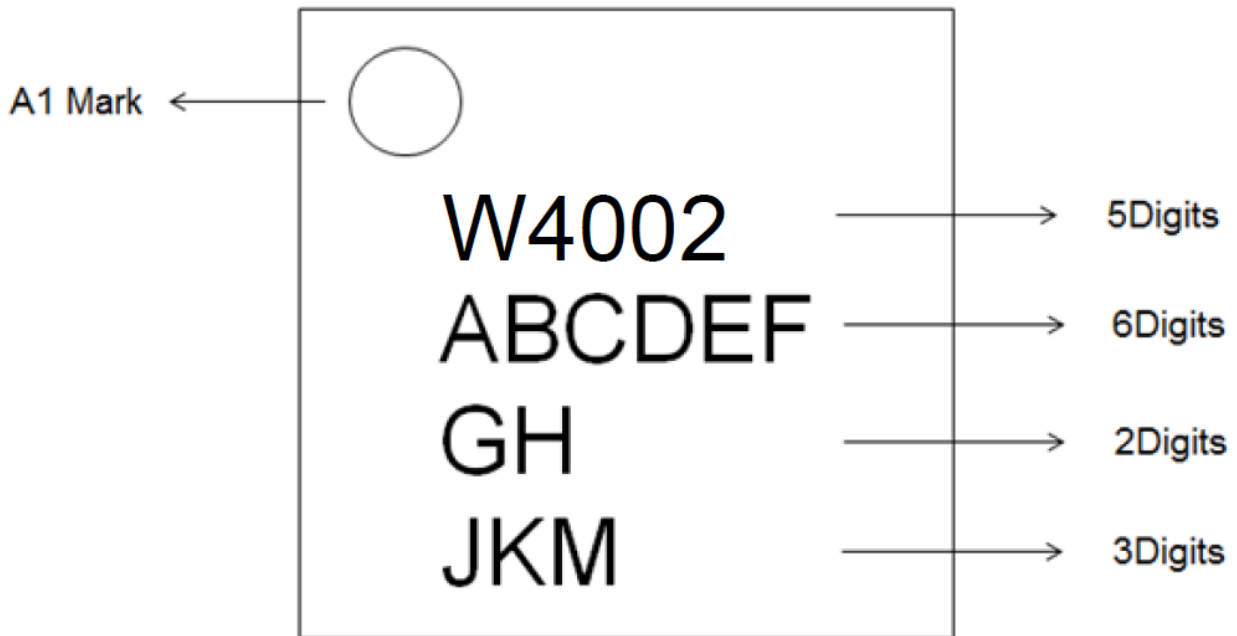
Figure 9 Module codes

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PCB Foot Print Design Guide

The recommended PCB foot print for the module is shown in Figure 10 and Figure 11.

- SESUB-PAN-D14580 is located in the area shown in yellow dotted line.
- Module terminal capture land pads diameter is Φ0.27mm, and opening diameter of solder resist is
- Φ0.37mm.
- This example PCB (EVB) has 2 layers (FR-4).
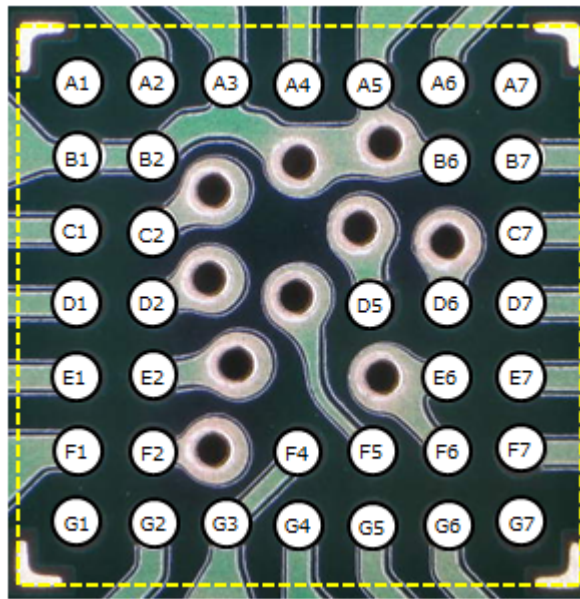
Figure 10 SESUB-PAN-D14580 PCB foot print Design
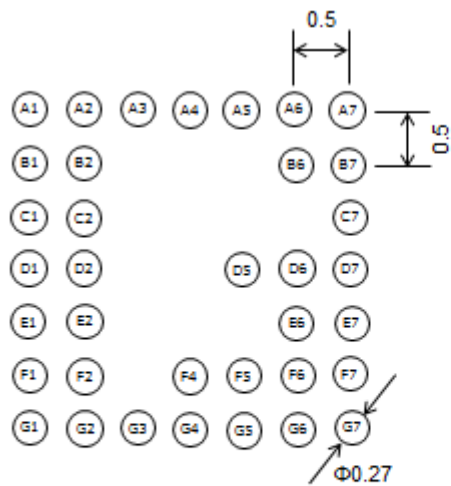
Pad Opening Definition

Cu

Φ0.27
Φ0.37
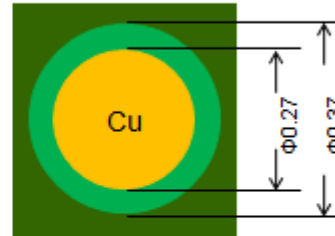
Non-Solder Mask Defined

Notice
Module user pads have solder bumps on it.
Pre-soldering is required on customer PCB
pads for the module.

PCB TOP VIEW

Unit in mm

Figure 11 Recommended PCB foot print Design

Recommended Solder Stencil Design

The recommended solder stencil design for the module is shown in Figure 12.
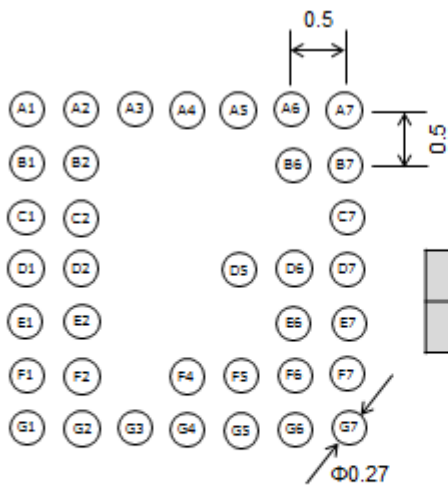
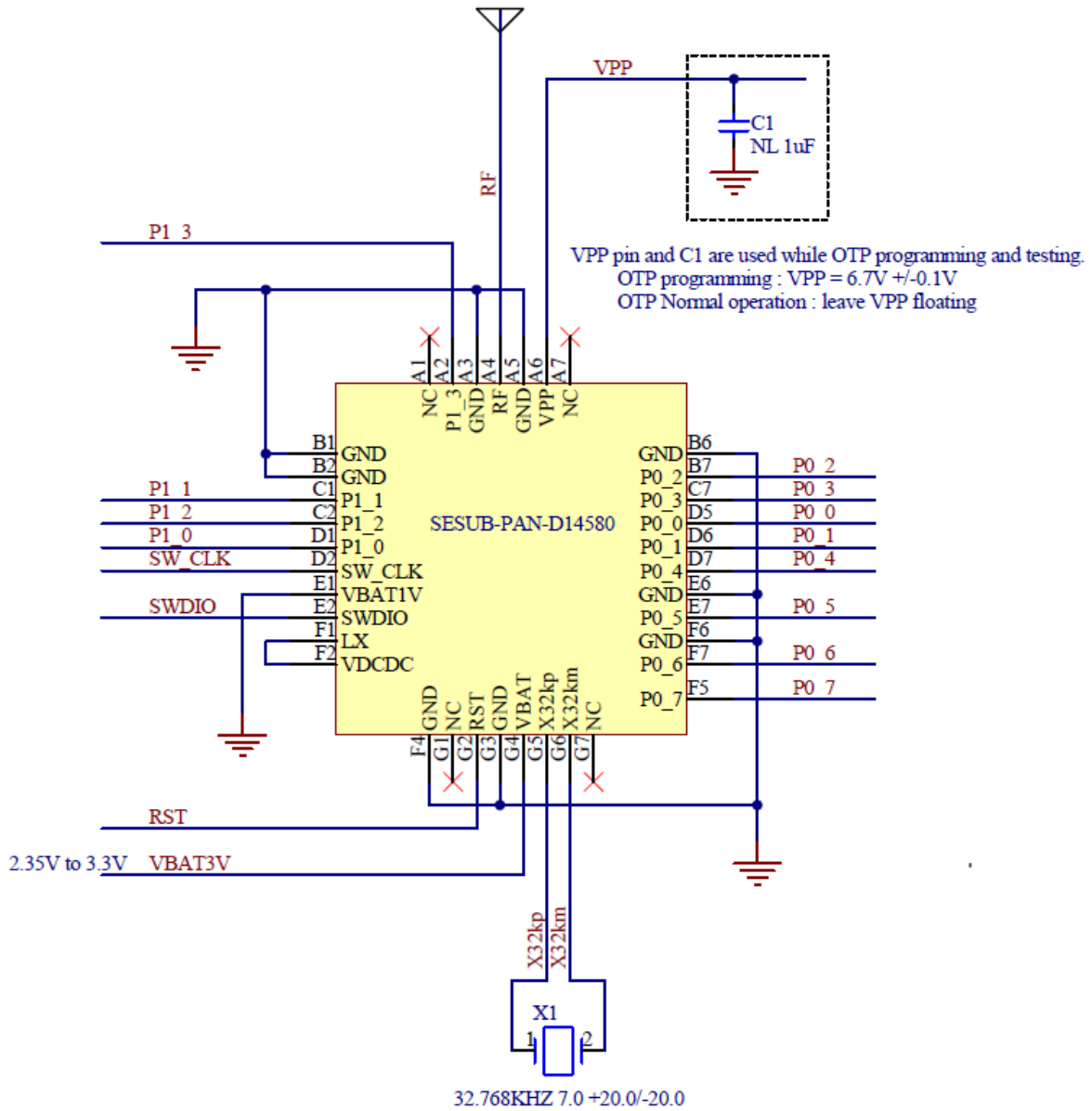| Item	Recommendation
Stencil Metal Thickness	0.08

PCB TOP VIEW

Unit in mm

Figure 12 Recommended solder stencil Design

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Application Circuit Example

VPP

C1
NL 1uF

VPP pin and C1 are used while OTP programming and testing.
OTP programming : VPP = 6.7V +/-0.1V
OTP Normal operation : leave VPP floating

SESUB-PAN-D14580

32.768KHZ 7.0 +20.0/-20.0

Supply voltage on VBAT3V with utilizing a buck converter application.

And, cold boot should not be performed if voltage is less than 2.5V because of possible corruption during OTP data mirroring.

Trim values programmed in the OTP as well as the application code image, should be copied into RAM while VBAT3V>=2.5V.

Figure 13 Application Circuit

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Recommended Reflow Profile

The recommended reflow profile for the module is shown in Figure 14 and Table 3 .
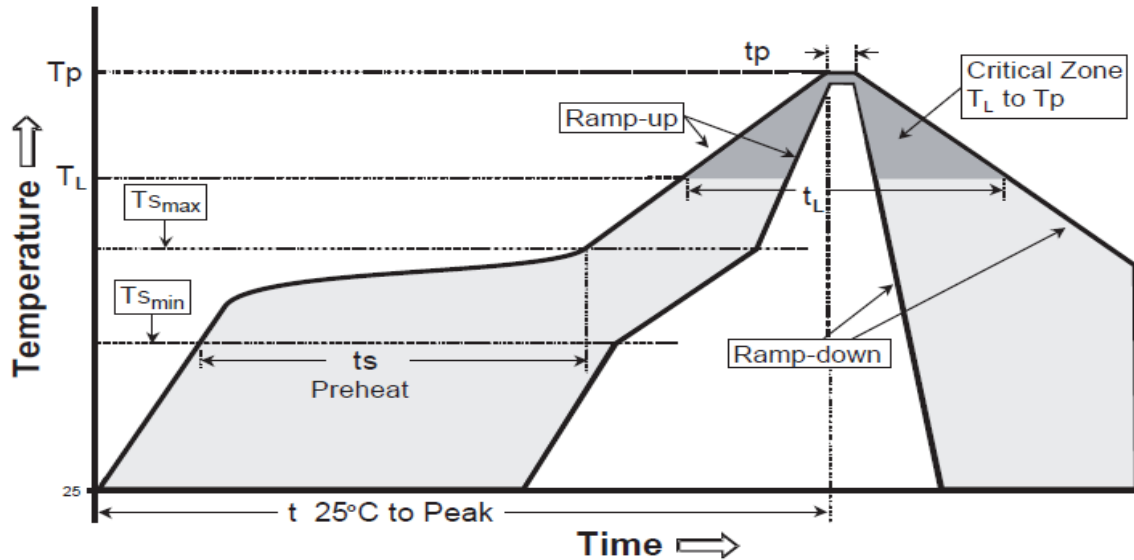
Figure 14 Recommended Reflow Profile

Table 3 Reflow Profile Condition

Profile Feature	Range
Average Ramp-Up Rate (Ts_{max} to Tp)	0.8 ^{o}C/seconds
Preheat:	
-Temperature Min (Ts_{min})	150 ^{o}C
-Temperature Max (Ts_{max})	180 ^{o}C
-Time (ts_{min} to ts_{max})	100 +/-10 seconds
Time maintained above:	
-Temperature (T_L)	220 ^{o}C
-Time (t_L)	50 +/-10 seconds
Peak Temperature (Tp)	250 ^{o}C
Time within 5°C of actual Peak Temperature (tp)	20-40 seconds
Ramp-Down Rate	6 ^{o}C/seconds max.
Time 25°C to Peak Temperature	8 minutes max.

Note:

 Permissible maximum reflow cycle: 2

Tape & Reel Specifications

Reel Diameter: 180 mm
Reel Width   13.0mm
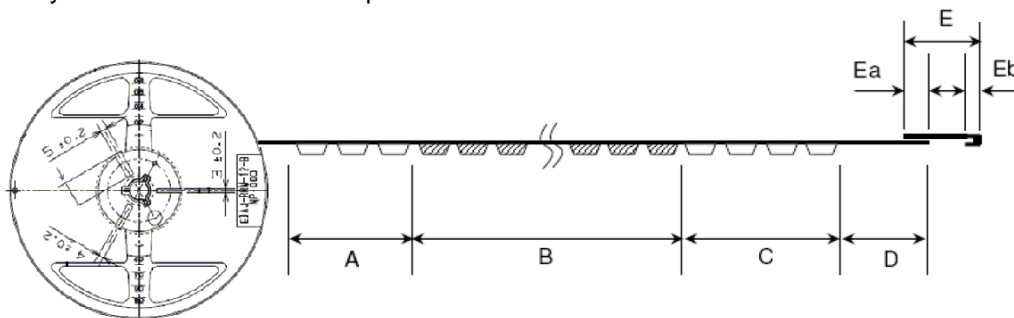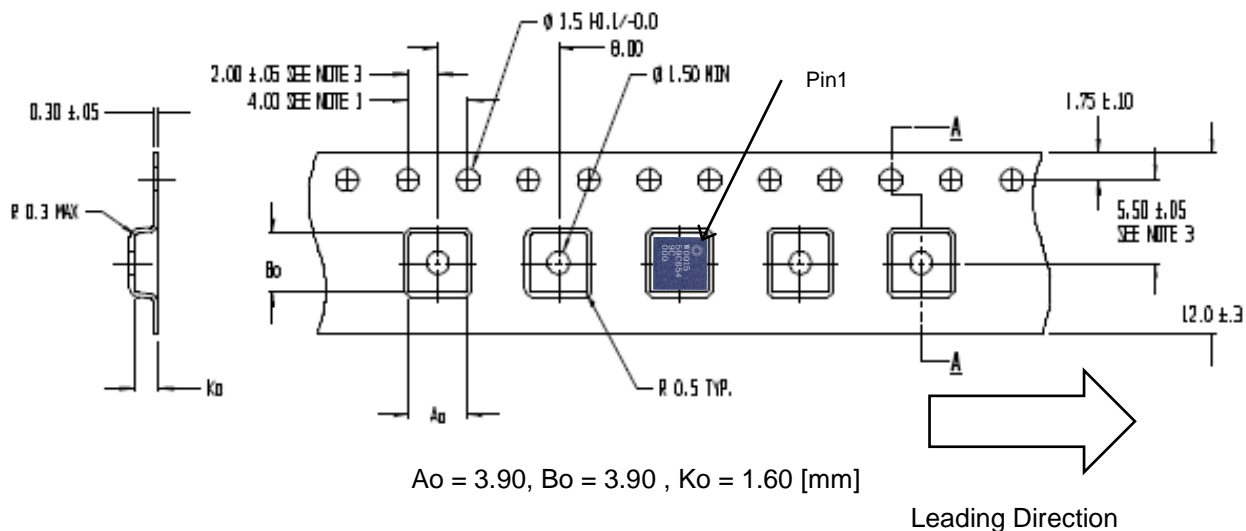Reel Hub Diameter: 21mm
Qty/reel: 1000 pcs

Figure 15 Tape & Reel Definition

Table 4 Taping Length

A	B	C	D	E
Ending pockets	Products pockets	Front pockets	Cover tape	Stop Tape
40mm min	1000pcs	100mm min	250mm min	50mm
		350mm min		70mm

Ea=20mm typ, Eb=10mm typ.

Ao = 3.90, Bo = 3.90 , Ko = 1.60 [mm]

Leading Direction

Figure 16 Carrier Tape Dimension

Notes:

1) 10 Sprocket hole pitches cumulative tolerance +/-0.2.

2) Pocket position relative to sprocket hole measured as true position, not pocket hole

3) Ao and Bo are calculated on a plane at a distance "R" above the bottom of the pocket.

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Figure 17 Reel Dimension

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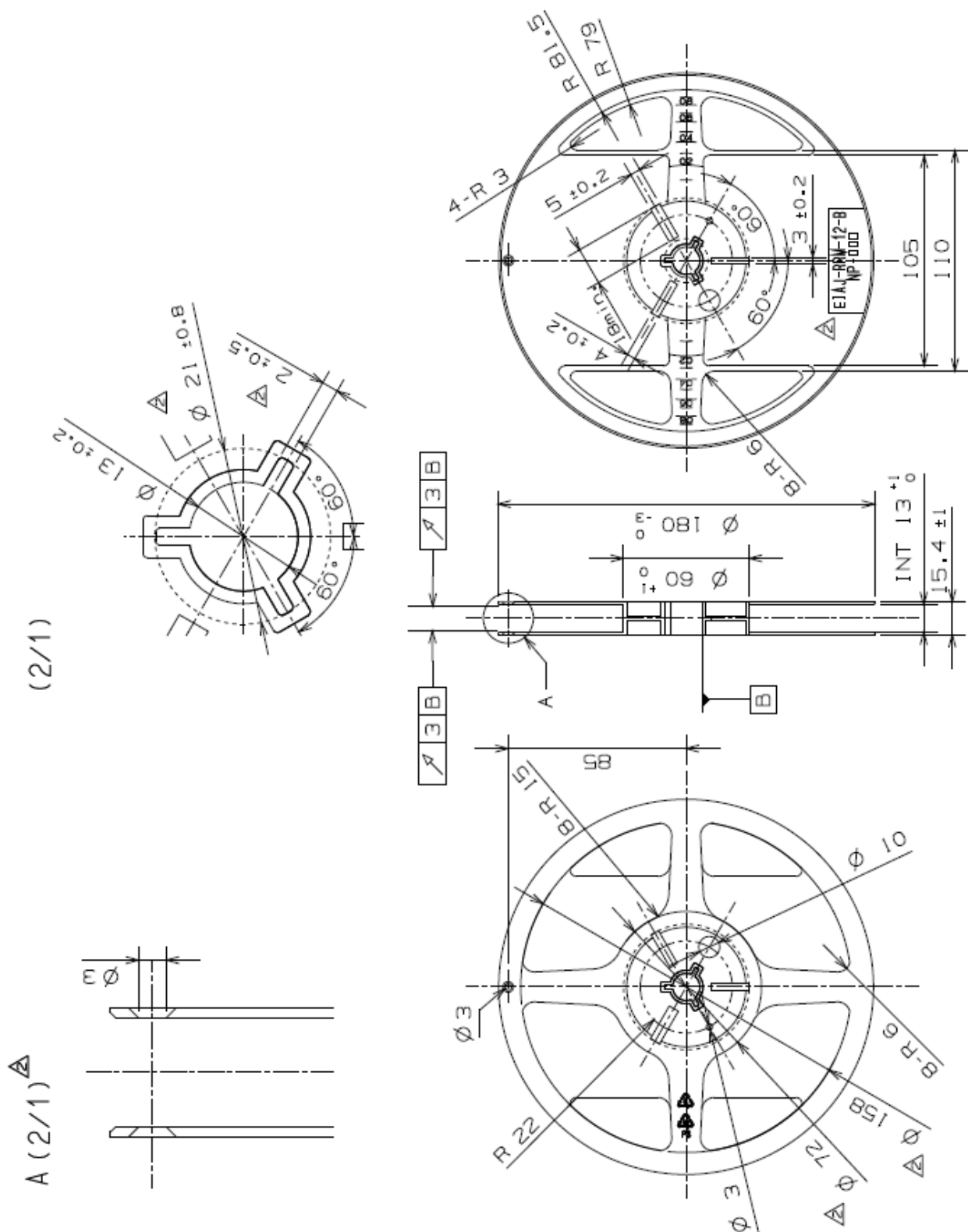
Packing Label Specifications
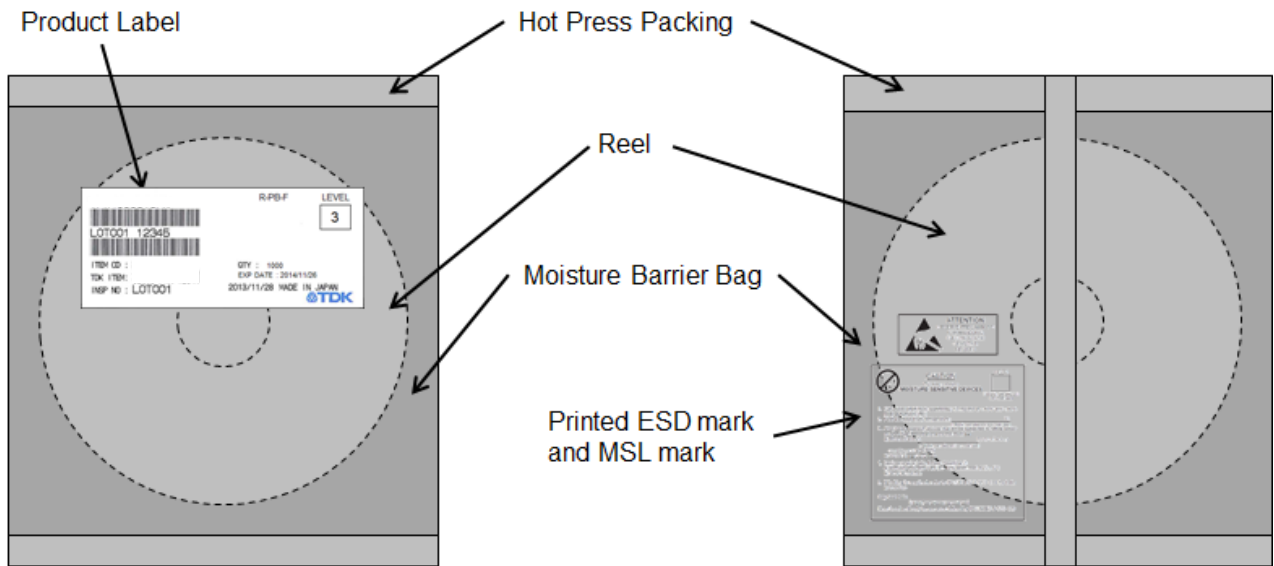
Figure 18 Packing Form

Storage Condition : 5-30℃ / 40-60%RH

The guaranteed term until mounting is 12 months in the above condition.

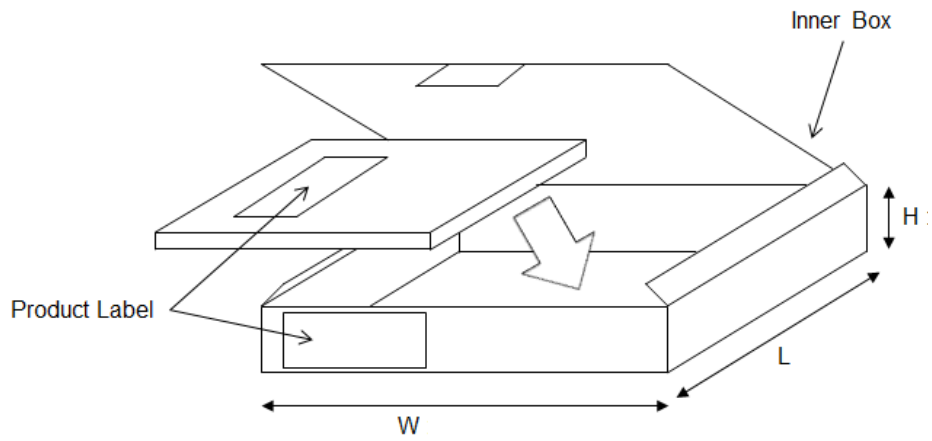| NAME OF DRAWING	DRAWING NO	DATE	REV	PAGE
Preliminary Specification	XL-07-95-SES-1272	2015.10.13	1	21
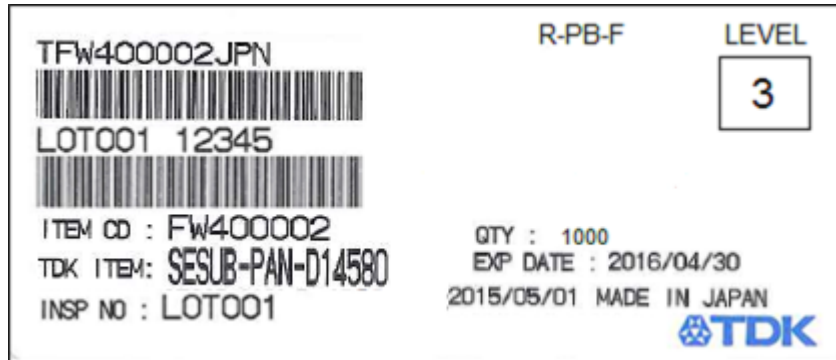
Figure 19 Product Label (Example)
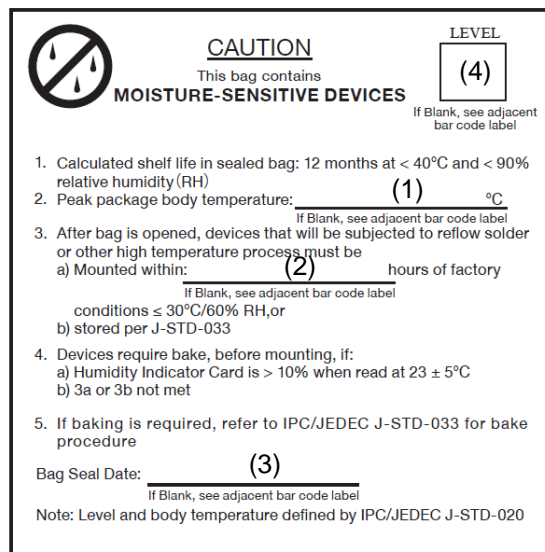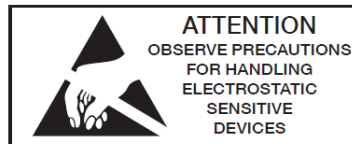
Items	Example
(1) Max Temperature	260
(2) Guarantee time after opening MBB	168
(3) Processing time	2014/06/19
(4) MSL Level	3

Figure 20 Packing Print (Example)

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Figure 21 Inner Box
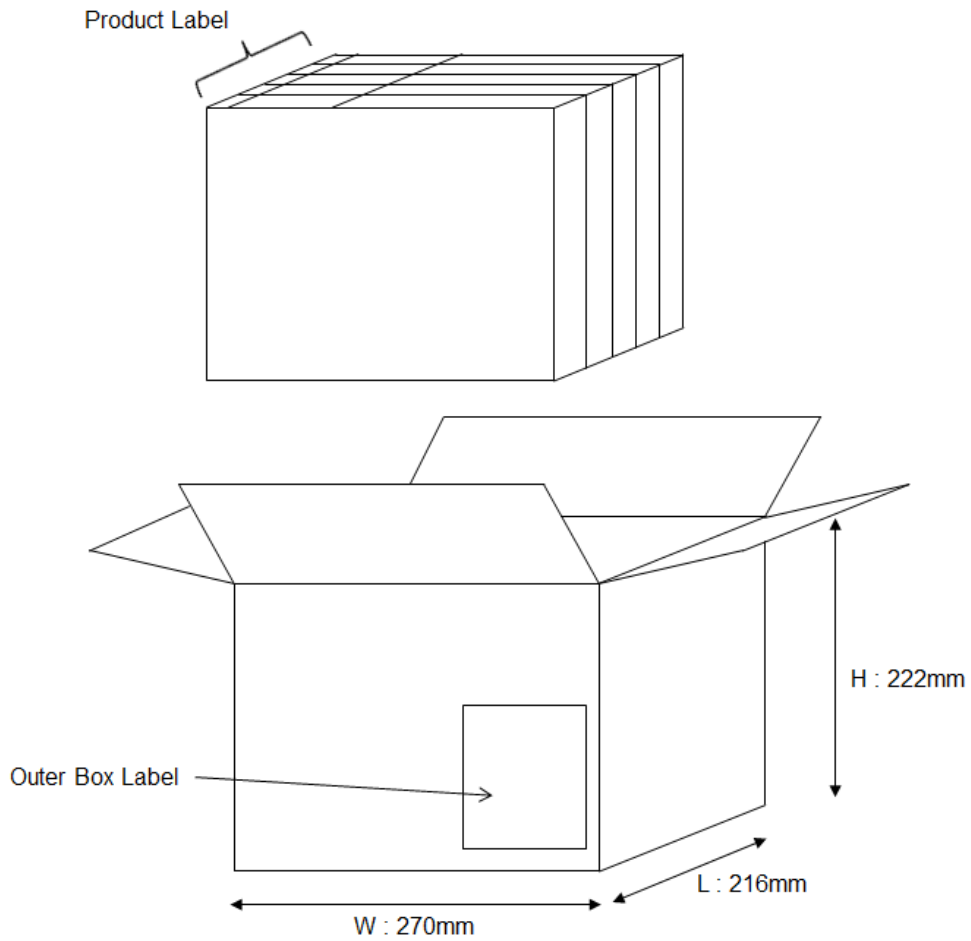
Figure 22 Outer Box

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Figure 23 Outer Box Label (Example)

Reference Information

1. Bluetooth Core Technical Specification document, version 4.1

2. Dialog Semiconductor DA14580 Low Power Bluetooth Smart SoC Datasheet
   Refer DA14580 datasheet for all further technical information unless otherwise described within this specification.

3. Dialog Semiconductor DA14580 Software Development Guide (UM-B-003)
   UM-B-003_DA14580_Software_development_guide.pdf

4. Dialog Semiconductor DA14580 Peripheral Drivers User manual (UM-B-004 / UM-B-005)
   UM-B-004_DA14580_Peripheral_Drivers.pdf
   UM-B-005_DA14580_Peripheral_Examples.pdf

5. DA14580 Product Lifetime Simulation Tool
   DA14580_Product_Lifetime_Simulation.xlsx

6. DA14580 Development Kit User Manual (UM-B-014)
   UM-B-014_DA14580_Development_Kit.pdf

7. DA14580 Booting from Serial Interface (AN-B-001)

8. DA14580-01 Cold boot timing and power details (AN-B-011)

9. Dialog Semiconductor Bluetooth Low Energy Software Development Kit (SDK)
   DA14580_SDK_v_3.x.x.x.zip

10. Dialog Semiconductor Connection Manager
    ConnectionManager_install_sdk3.x.exe_.zip

11. For all other related technical documents, visit Dialog Semiconductor Supporting web site.
    Please check and use the latest materials on Dialog Semiconductor support site.
    http://support.dialog-semiconductor.com/

Lead-free Product Status

Conformity to RoHS Directive: This means that, in conformity with EU Directive 2011/65/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used except for exempted applications.

A comprehensive qualification for these lead-free module packages has been done. The related AQTP documentation is available from TDK on request.

Notice

Please be sure to read the specifications of the module before use.

1) Please pay sufficient attentions to the warnings for safe designing when using the module.
   Incorrect usage may cause smoke or fire.
2) Do not exceed the rated operation voltage range when using the module.
3) Do not exceed the rated operating temperature range when using the module.
4) Do not use the module in the following environments. (Excluding cases in which countermeasures are taken).
   - Corrosive gases (Cl2, NH3, SOx, NOx, etc.).
   - Combustible and volatile gases.
   - Places to be exposed to dust.
   - Places to be exposed to direct sunlight.
   - Places where rain, fog, salt water, and the like will get on the module.
5) Do not use for an extended period at relative humidity in excess of 90%. (maximum wet-bulb temperature of 38° C).
6) After installing the module when designing an apparatus, confirm that there are no abnormalities by performing a reliability evaluation test.
7) If the buzzer is molded or secured by adhesives, thermal expansion stresses from the mold or adhesive agent may cause deterioration in a soldered terminal part.
   Before molding or securing an adhesive, consider the type, amount, hardening conditions, adhesive properties, etc., of the sealing material, and confirm the reliability.
8) Do not apply vibrations or shocks (such as dropping) larger than the specified.
9) Because of deterioration or damage, maintain in rated storage temperature range, avoid environments where there are sudden temperature changes, direct sunlight, corrosive gases and dust, and store wrapped in order to avoid applying stresses.

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