W-LAN + Bluetooth Module Data Sheet

Qualcomm Chipset
for 802.11a/b/g/n/ac + Bluetooth 4.2

Tentative P/N : LBEE5U91CQ-TEMP

The revision history of the product specification

Issued Date	Revision Code	Revision Page	Changed Items	Change Reason
8, Apr, 2015	-	-	-	First Issue
27.Jul.2017	A	12	Reference Circuit	Corrected
30.Mar.2018	B	Top page	Bluetooth version from BT4.1 to BT4.2	Updated
		7	6.2 External Sleep clock timing	Added
		11	8.3.2.Tx characteristics	Corrected
		12	8.4 DC/RF Characteristics for Bluetooth LE	Added
14.May.2018	C	3	2. Sample part Number Header	Corrected Corrected

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Please be aware that an important notice concerning availability, standard warranty and use in critical applications of Murata products and disclaimers thereto appears at the end of this specification sheet.

1. Scope

This specification is applied to the W-LAN [IEEE802.11a/b/g/n/ac] + Bluetooth [4.2] module.

- Qualcomm QCA6174A
- Compliant with IEEE802.11a/b/g/n/ac
- Compliant with Bluetooth specification v4.2
- Supports PCIe host interface for W-LAN
- Supports UART interface for Bluetooth
- Surface mount type 11.0 x 8.8mm , H=1.15mm Max
- Weight : TBD
- MSL : 3
- RoHS compliant

2. Part Number

Sample Part Number
LBEE5U91CQ-TEMP

3. Block Diagram
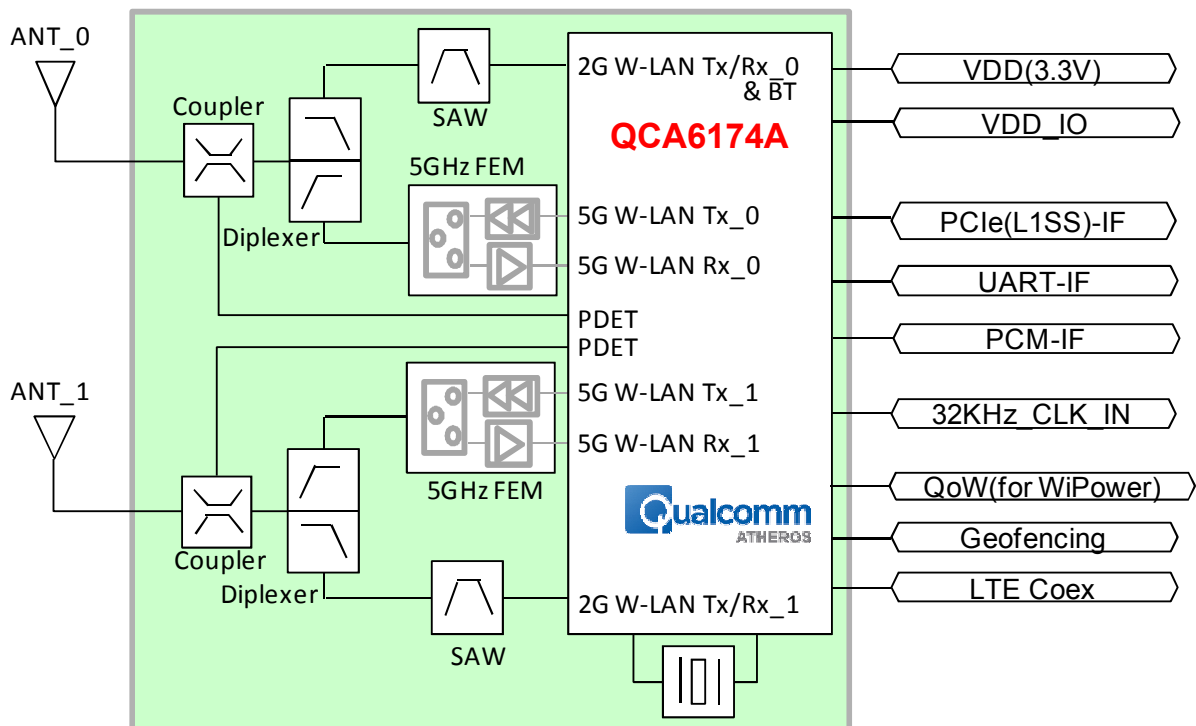
4. Dimensions, Marking and Terminal Configurations

<TOP View>   <Side View>   <Bottom View>
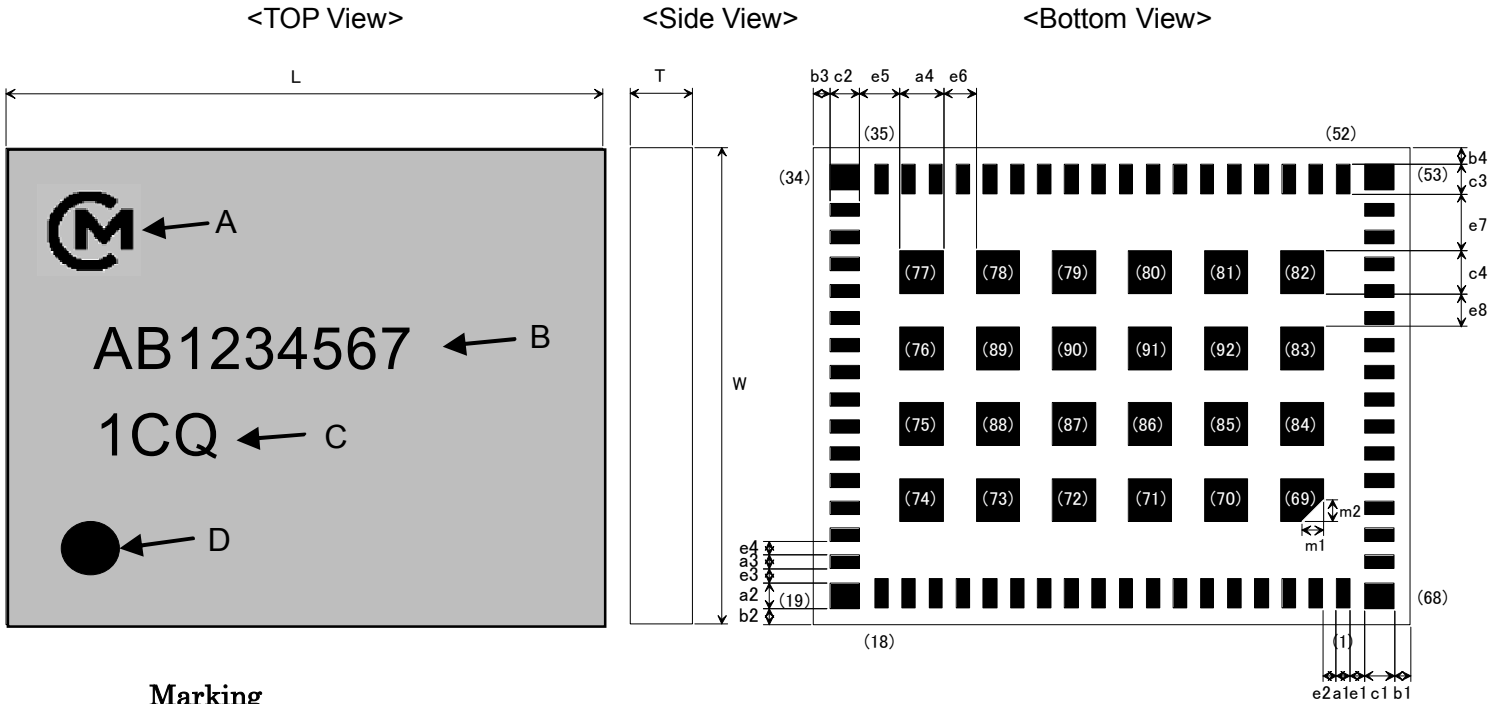
Marking

Marking	Meaning
A	Murata Logo
B	Inspection Number
C	Module Type
D	#1 Pin Marking

Dimensions   (unit : mm)

Mark	Dimensions	Mark	Dimensions	Mark	Dimensions
L	11.0 +/- 0.1	W	8.8 +/- 0.1	T	1.15 max.
a1	0.25 +/- 0.1	a2	0.475 +/- 0.1	a3	0.25 +/- 0.1
a4	0.8 +/- 0.1	b1	0.3 +/- 0.1	b2	0.3 +/- 0.1
b3	0.3 +/- 0.1	b4	0.3 +/- 0.1	c1	0.55 +/- 0.1
c2	0.55 +/- 0.1	c3	0.55 +/- 0.1	c4	0.8 +/- 0.1
e1	0.275 +/- 0.1	e2	0.25 +/- 0.1	e3	0.25 +/- 0.1
e4	0.25 +/- 0.1	e5	0.75 +/- 0.1	e6	0.6 +/- 0.1
e7	1.05 +/- 0.1	e8	0.6 +/- 0.1		
m1	(0.4)	m2	(0.4)		

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Terminal Configurations

< TOP View >
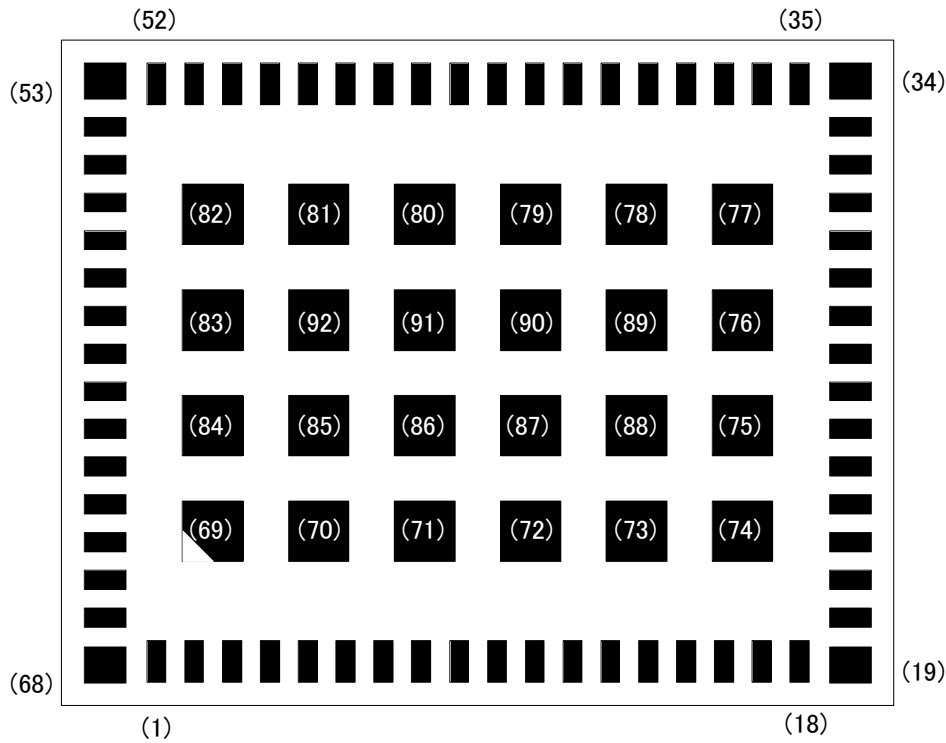
No.	Pin Name	Connection to IC Terminal	Description
1	SWREG_IN	SWREG_IN, REG33_FB	SWREG voltage input
2	SWREG_IN		
3	GND	-	Ground
4	BT_RF_KILL	BT_RF_KILL	Turn-off BT RF analog and front-end. Active low.
5	VDDIO_GPIO1	VDDIO_GPIO1	Voltage supply for IO
6	VDDIO_GPIO0	VDDIO_GPIO0	Voltage supply for IO
7	VDD_3P3	VDD3.3V, VDDIO_GPIO0	Voltage supply (3.3V)
8	VDD_3P3		
9	PCIE_CLKREQ_L	PCIE_CLKREQ_L	Reference clock request for PCIe
10	PCIE_RST_L	PCIE_RST_L	PCI Express reset with weak pulldown
11	PCIE_WAKE_L	PCIE_WAKE_L	Request to service a functioninitiated wake event for PCIe
12	GPS_COEX_WOW	GPS_COEX	This signal can be used to do GPS co- existence signal. Active high means WLAN is TX.
13	QoW	QoW (or GPIO[23])	for WiPower
14	BT_WAKEUP_HOST	BT_WAKEUP_HOST	Bluetooth wakeup the host. Active high.
15	BT_LED	BT_LED	BT_LED
16	GND	-	Ground
17	LF_CLK_IN	32KHz_CLK_IN	Slow-clock (32.768kHz) input
18	GND	-	Ground
19	GND	-	Ground
20	ANT_0	-	RF output of Chain0
21	GND	-	Ground
22	BT_EN	BT_EN	Bluetooth Enable, Active high
23	WL_EN	WL_EN	WLAN ENABLE. Active high
24	GND	-	Ground
25	VDD_FEM	-	Voltage supply for 5GHz FEM
26	VDD_FEM		
27	GND	-	Ground
28	GND	-	Ground
29	ANT_1	-	RF output of Chain1
30	GND	-	Ground

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31	LTE_PRI	LTE_PRI	for LTE co-ex
32	LTE_SYNC	LTE_SYNC	for LTE co-ex
33	LTE_ACTIVE	LTE_ACTIVE	for LTE co-ex
34	GND	-	Ground
35	BT_UART_TXD	UART_TXD	UART TXD signal for Bluetooth
36	BT_UART_RXD	UART_RXD	UART RXD signal for Bluetooth
37	BT_UART_CTS	UART_CTS	UART CTS signal for Bluetooth
38	BT_UART_RTS	UART_RTS	UART RTS signal for Bluetooth
39	PCM_SYNC	PCM_SYNC	Bluetooth PCM_SYNC signal
40	PCM_IN	PCM_IN	Bluetooth PCM_IN signal
41	PCM_CLK	PCM_CLK	Bluetooth PCM_CLK signal
42	PCM_OUT	PCM_OUT	Bluetooth PCM_OUT signal
43	VDDIO_XTAL	VDDIO_XTAL	Voltage supply for XTAL
44	CLK_REQ_OUT	CLK_REQ_OUT	Clock request output.
45	GPIO2	GPIO2	GPIO2
46	GPIO10	GPIO10	GPIO10
47	GND	-	Ground
48	PCIE_TX_P	PCIE_TXP	Differential transmit for PCIe
49	PCIE_TX_N	PCIE_TXN	Differential transmit for PCIe
50	GND	-	Ground
51	PCIE_REFCLK_P	PCIE_REFCLK_P	Differential reference clock for PCIe
52	PCIE_REFCLK_N	PCIE_REFCLK_N	Differential reference clock for PCIe
53	GND	-	Ground
54	PCIE_RX_N	PCIE_RXN	Differential receive for PCIe
55	PCIE_RX_P	PCIE_RXP	Differential receive for PCIe
56	GND	-	Ground
57	GPIO4	GPIO4	GPIO4
58	GPIO3	GPIO3	GPIO3
59	GPIO1	GPIO1	GPIO1
60	GPIO5	GPIO5	GPIO5 (for Geofencing)
61	GPIO6	GPIO6	GPIO6 (for Geofencing)
62	GND	-	Ground
63	SWREG_FB	SWREG_FB, VDD11D, VDD11_PCIE	1.1V voltage feedback to SWREG PMU
64	SWREG_FB		
65	GND	-	Ground
66	SWREG_OUT	SWREG_OUT	SWREG PMU output
67	SWREG_OUT		
68	GND	-	Ground
69	GPIO8	GPIO8	GPIO8
70-81	GND	-	Ground
82	GPIO0	GPIO0	GPIO0
83	GPIO9	GPIO9	GPIO9
84	GPIO7	GPIO7	GPIO7
85-92	GND	-	Ground

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5. Rating

		min.	max.	unit
Storage Temperature		-40	+85	°C
Supply Voltage	VDD_3P3	-0.3	3.63	V
	SWREG_IN	-0.3	3.63	V
	VDD_FEM	-0.5	3.63	V
	VDDIO_GPIO	-0.3	3.63	V
	VDDIO_XTAL	-0.3	3.63	V

* Stresses in excess of the absolute ratings may cause permanent damage. Functional operation is not implied under these conditions. Exposure to absolute ratings for extended periods of time may adversely affect reliability. No damage assuming only one parameter is set at limit at a time with all other parameters are set within operating condition.

6. Operating Condition

6.1 Operationg Conditions

		min.	typ.	max.	unit
Operating Temperature	Ambient	-20	+25	+70	°C
	Top surface			+85	°C
Supply Voltage	VDD_3P3	3.135	3.3	3.46	V
	SWREG_IN	3.135	3.3	3.46	V
	VDD_FEM	3.1	3.3	3.5	V
	VDDIO_GPIO	1.71	1.8 or 3.3	3.46	V
	VDDIO_XTAL	1.71	1.8 or 3.3	3.46	V

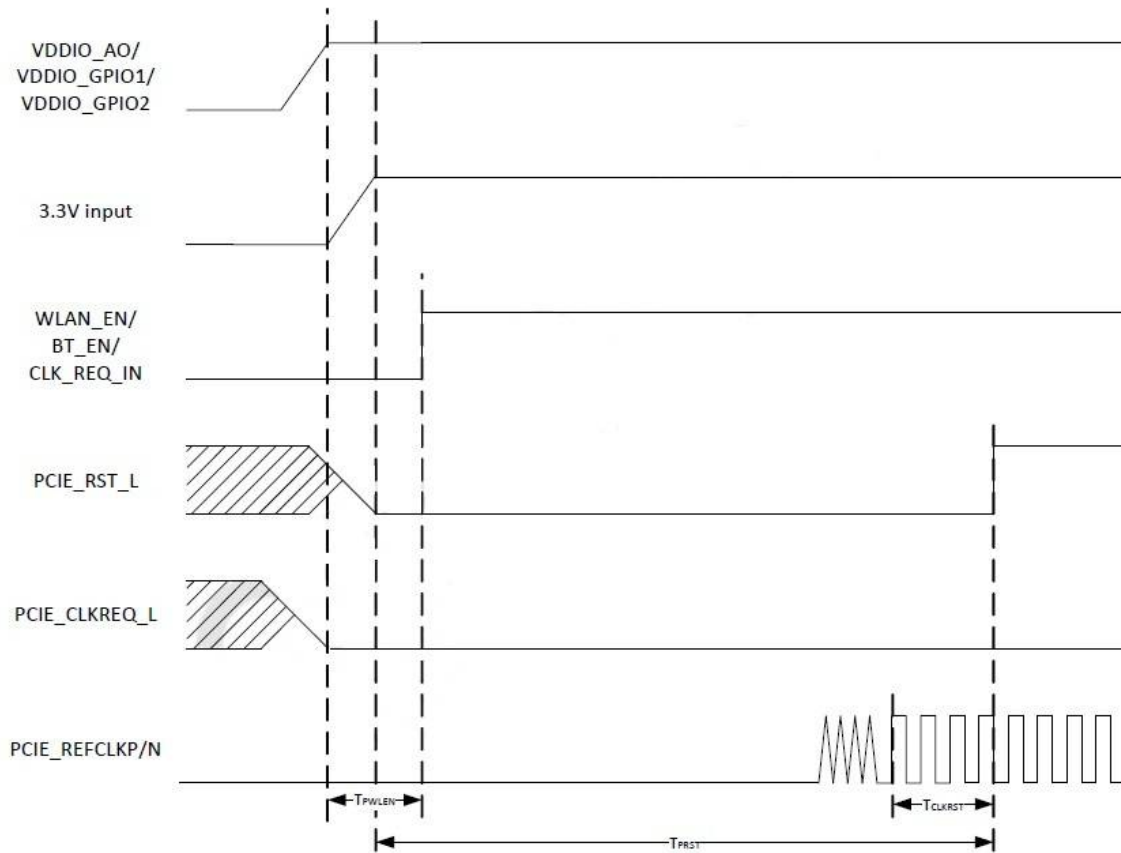* Functionality is guaranteed but specifications require derating at extreme temperatures.

6.2 External Sleep clock (LPO) timing
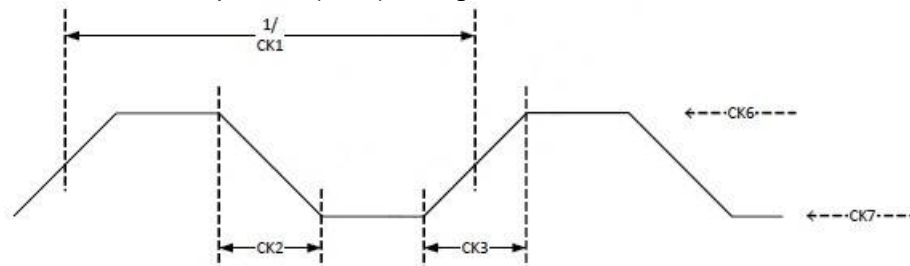
Parameter	Description	Min	Typ	Max	Unit
CK1	Clock rate	–	32.768	–	kHz
CK2	Fall time	1	–	100	ns
CK3	Rise time	1	–	100	ns
CK4	Duty cycle (high to low ratio)	15	–	85	%
CK5	Frequency stability	-200	–	200	PPM
CK6	Input high voltage	0.8 * VDDIO_GPIO2	–	VDDIO_GPIO2 + 0.2	V
CK7	Input low voltage	-0.3	–	0.2 x VDDIO_GPIO2	V

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7. Digital logic characteristics
7.1 PCIe sequence timing

Parameter	Description	Min	Typ	Max	Unit
Tpwlen	Time from power valid to WLAN_EN input active	10	–	–	µs
Tprst	Time from power valid to PCIE_RESET_L assertion	10	–	–	ms
Tclkrst	Time from PCIE_REFCLK stable to PCIE_RESET_L assertion	100	–	–	µs

8. Electrical Characteristics

Normal Condition: 25deg.C, Voltage supplies are typical values.
IEEE802.11b 11Mbps (SISO) mode unless otherwise specified.
IEEE802.11a/g 54Mbps (SISO) mode unless otherwise specified.
IEEE802.11n MCS7 (SISO) mode unless otherwise specified.
IEEE802.11ac MCS9 (SISO) mode unless otherwise specified.

8.1. DC/RF Characteristics for WLAN 2.4GHz

Items	Contents
Specification	IEEE802.11b/g/n
Mode	DSSS / CCK / OFDM
Frequency	2412 to 2472 MHz
Data rate	11b; 1, 2, 5.5, 11Mbps 11g; 6, 9, 12, 18, 24, 36, 48, 54Mbps 11n; MCS0 ~ MCS7

8.1.1. DC Characteristics

Items			min.	typ.	max.	unit
Tx mode	11b	SISO	-	-	580	mA
		Tx diversity	-	-	1000	mA
	11g	SISO	-	-	380	mA
		Tx diversity	-	-	800	mA
	11n	SISO	-	-	370	mA
		MIMO	-	-	800	mA
Rx mode	-		-	-	240	mA

8.1.2. Tx Characteristics

Normal Condition			min.	typ.	max.	unit
Power Levels (ANT0/ANT1)	11b(Target:17dBm)		15	17	19	dBm
	11g(Target:14dBm)		12	14	16	dBm
	11n(Target:13dBm)		11	13	15	dBm
Spectrum Mask	11b	1st Side lobes	-	-	-30	dBr
		2nd Side lobes	-	-	-50	dBr
	11g	fc +/- 11MHz	-	-	-20	dBr
		fc +/- 20MHz	-	-	-28	dBr
		fc +/- 30MHz	-	-	-40	dBr
	11n	fc +/- 11MHz	-	-	-20	dBr
		fc +/- 20MHz	-	-	-28	dBr
		fc +/- 30MHz	-	-	-45	dBr
Modulation Accuracy (EVM)	11b		-	-	35	%
	11g		-	-	-25	dB
	11n		-	-	-27	dB
Frequency Tolerance			-20	-	20	ppm
Spurious Emissions *						
1) 30-1000MHz			-	-	-36	dBm
2) 1000-12750MHz			-	-	-30	dBm
3) 1800-1900MHz			-	-	-47	dBm
4) 5150-5300MHz			-	-	-47	dBm

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8.1.3. Rx Characteristics

Normal Condition		min.	typ.	max.	unit
Minimum Input Level *	11b (FER ≤ 8%) 1Mbps	-	-	-88	dBm
	11b (FER ≤ 8%) 11Mbps	-	-	-78	dBm
	11g (PER ≤ 10%) 54Mbps	-	-	-67	dBm
	11n (PER ≤ 10%) / HT20 /MCS7	-	-	-66	dBm
Maximum Input Level	11b (FER ≤ 8%)	-10	-	-	dBm
	11g/n (PER ≤ 10%)	-20	-	-	dBm

8.2. DC/RF Characteristics for WLAN 5GHz

Items	Contents
Specification	IEEE802.11a/n/ac
Mode	OFDM
Frequency	HT20; 5180 to 5825MHz HT40; 5190 to 5795 MHz HT80; 5210 to 5775 MHz
Data rate	11a; 6, 9, 12, 18, 24, 36, 48, 54Mbps 11n; MCS0 ~ MCS7 11ac; MCS0 ~ MCS9

8.2.1. DC Characteristics

Items			min.	typ.	max.	unit
Tx mode	11a	SISO	-	-	430	mA
		Tx diversity	-	-	800	mA
	11n	SISO	-	-	350	mA
		MIMO	-	-	650	mA
	11ac	SISO	-	-	300	mA
		MIMO	-	-	500	mA
Rx mode	-		-	-	340	mA

8.2.2. Tx Characteristics

Normal Condition			min.	typ.	max.	unit
Power Levels (ANT0/ANT1)	11a(Target:14dBm)		12	14	16	dBm
	11n(Target:13dBm)		11	13	15	dBm
	11ac(Target:11dBm)		9	11	13	dBm
Spectrum Mask	11a	fc +/- 11MHz	-	-	-20	dBr
		fc +/- 20MHz	-	-	-28	dBr
		fc +/- 30MHz	-	-	-40	dBr
	11n	fc +/- 21MHz	-	-	-20	dBr
		fc +/- 40MHz	-	-	-28	dBr
		fc +/- 60MHz	-	-	-40	dBr
	11ac	fc +/- 41MHz	-	-	-20	dBr
		fc +/- 80MHz	-	-	-28	dBr
		fc +/- 120MHz	-	-	-40	dBr
Modulation Accuracy (EVM)	11a(54Mbps)		-	-	-25	dB
	11n(MCS7)		-	-	-27	dB
	11ac(MCS9)		-	-	-32	dB
Frequency Tolerance			-20	-	20	ppm
Spurious Emissions						
1) 30-1000MHz			-	-	-36	dBm
2) 1000-12750MHz			-	-	-30	dBm
3) 1800-1900MHz			-	-	-47	dBm

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8.2.3. Rx Characteristics

Normal Condition		min.	typ.	max.	unit
Minimum Input Level	11a (PER ≤ 10%) / 6Mbps	-	-	-87	dBm
	11a (PER ≤ 10%) / 54Mbps	-	-	-67	dBm
	11n (PER ≤ 10%) / HT40 / MCS7	-	-	-63	dBm
	11ac (PER ≤ 10%) / HT80 / MCS9	-	-	-53	dBm
Maximum Input Level	11a (PER ≤ 10%)	-30	-	-	dBm
	11n (PER ≤ 10%)	-30	-	-	dBm
	11ac (PER ≤ 10%)	-30	-	-	dBm

8.3. DC/RF Characteristics for Bluetooth

Items	Contents
Frequency	2402 to 2480 MHz
Number of RF channel	79
Operation mode (Rx/Tx)	Time division multiplex either transmit or receive Frequency hopping after one Rx/Tx cycle

8.3.1. Power Consumption

Items	min.	Typ	max.	unit
Power consumption	-	-	100	mA

8.3.2. Tx Characteristics

Items		min.	Typ	max.	unit
Output Power (BT power setting = 9)	BR (nomal condition)	4.5	-	11.5	dBm
	EDR	1.5	-	8.5	dBm
-20dB bandwidth		-	-	1	MHz
Modulation characteristics	δf1avg	140	-	175	kHz
	δf2max	115	-	-	kHz
	δf2avg/δf1avg	0.8	-	-	-
Initial Carrier Frequency Tolerance		-75	-	75	kHz
Carrier Frequency Drift	1slot	-25	-	+25	kHz
	3slot	-40	-	+40	kHz
	5slot	-40	-	+40	kHz
	Max drift rate	-20	-	+20	kHz/50µs
Spurious Emissions					
1) 30-1000MHz		-	-	-36	dBm
2) 1000-12750MHz		-	-	-30	dBm
3) 1800-1900MHz		-	-	-47	dBm
4) 5150-5300MHz		-	-	-47	dBm
EDR Relative Power		-4	-	1	dB
EDR Carrier Frequency Stability and Modulation Accuracy	Pi/4-DQPSK & 8DPSK — ωi	-75	-	75	kHz
	Pi/4-DQPSK & 8DPSK — ω0	-10	-	10	kHz
	Pi/4-DQPSK & 8DPSK — ωi+ω0	-75	-	75	kHz
	Pi/4-DQPSK — RMS DEVM	-	-	20	%
	Pi/4-DQPSK — 99% DEVM	-	-	30	%
	Pi/4-DQPSK — Peak DEVM	-	-	35	%
	8DPSK — RMS DEVM	-	-	13	%
	8DPSK — 99% DEVM	-	-	20	%
	8DPSK — Peak DEVM	-	-	25	%

8.3.3. Rx Characteristics

Items		min	Typ	max	unit
Sensitivity (BER ≤ 0.1%)		-	-	-72	dBm
EDR Sensitivity (BER ≤ 0.01%)	8DPSK	-	-	-72	dBm
Maximum Input Level		-20	-	-	dBm

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8.4. DC/RF Characteristics for Bluetooth LE

Items	Contents
Frequency (spacing)	2402 to 2480 MHz (2MHz)
Number of RF channel	40

8.4.1. Tx Characteristics

Items		min	typ	max	unit
Output power *1	Normal Condition	-1	-	6	dBm
Modulation characteristics					
1) $\Delta f1_{avg}$		225	-	275	kHz
2) $\Delta f2_{max}$		185	-	-	kHz
3) $\Delta f2_{avg}$ / $\Delta f1_{avg}$		0.8	-	-	-
Carrier frequency offset and drift					
1) $f_n - f_{TX}$, n=0,1,2,3,…k		-150	-	150	kHz
2) $\| f_0 - f_n \|$, n=2,3,4,…k		-	-	50	kHz
3) $\| f_1 - f_0 \|$		-	-	20	kHz
4) $\| f_n - f_{n-5} \|$, n=6,7,8,…k		-	-	20	kHz

*1: Qualcomm default setting

8.4.2. Rx Characteristics

Items	min	typ	max	unit
Receiver sensitivity (PER < 30.8%)	-	-	-72	dBm
Maximum input signal level (PER < 30.8%)	-10	-	-	dBm
PER Report Integrity (-30dBm input)	50	-	-	%

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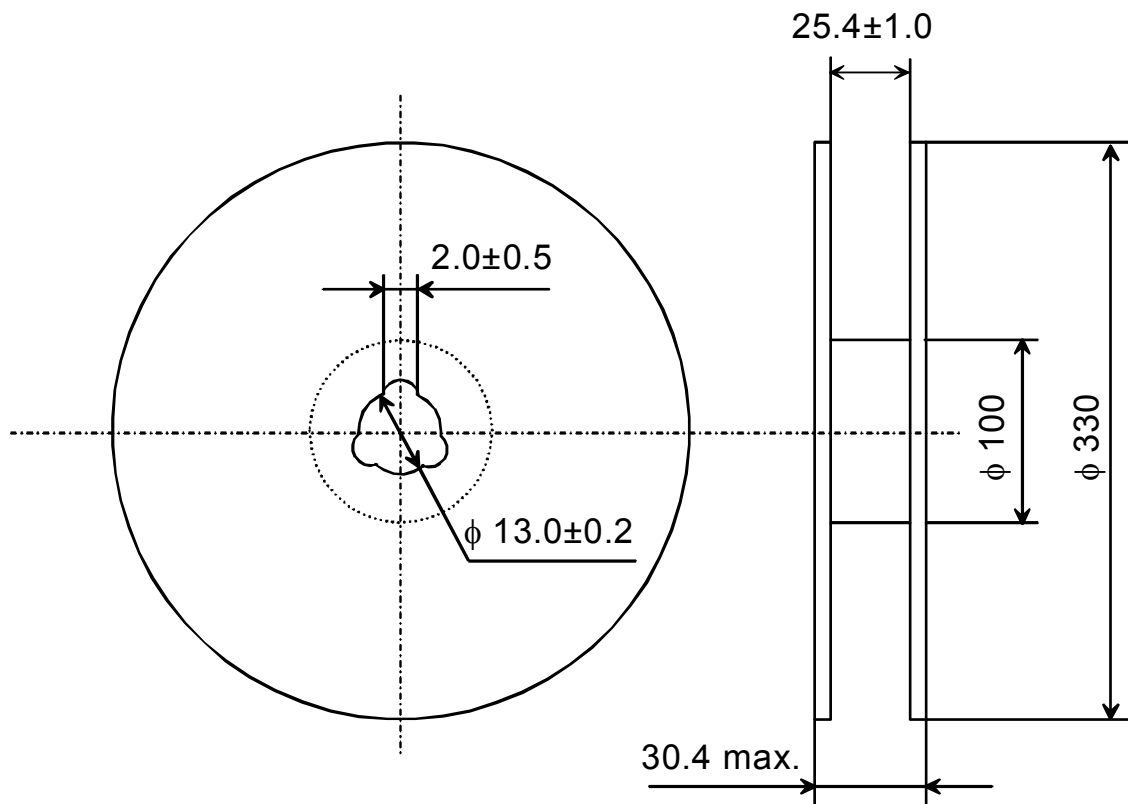## 9. Reference Land pattern

<Top View>
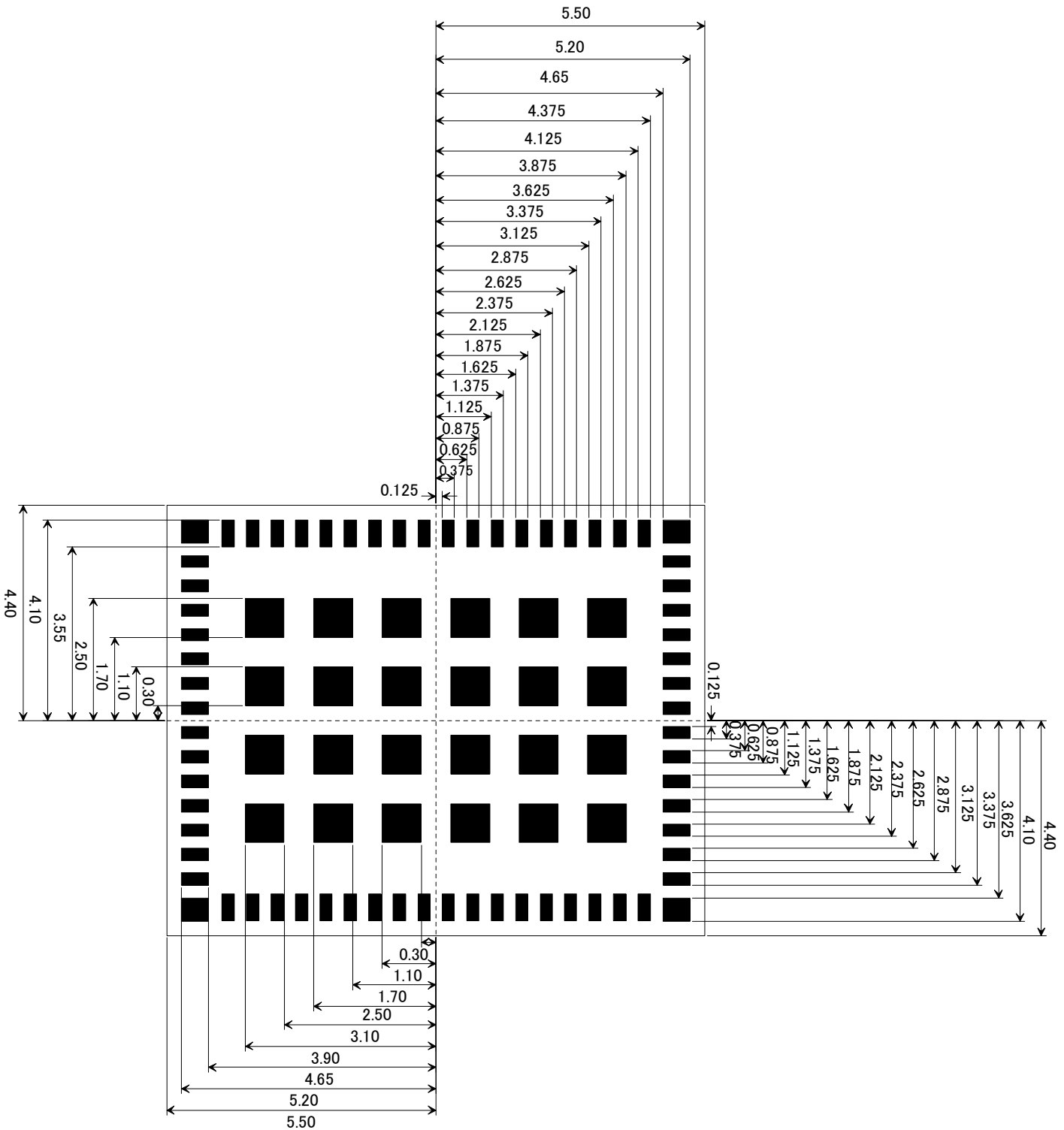
Unit: mm

10. Reference Circuit
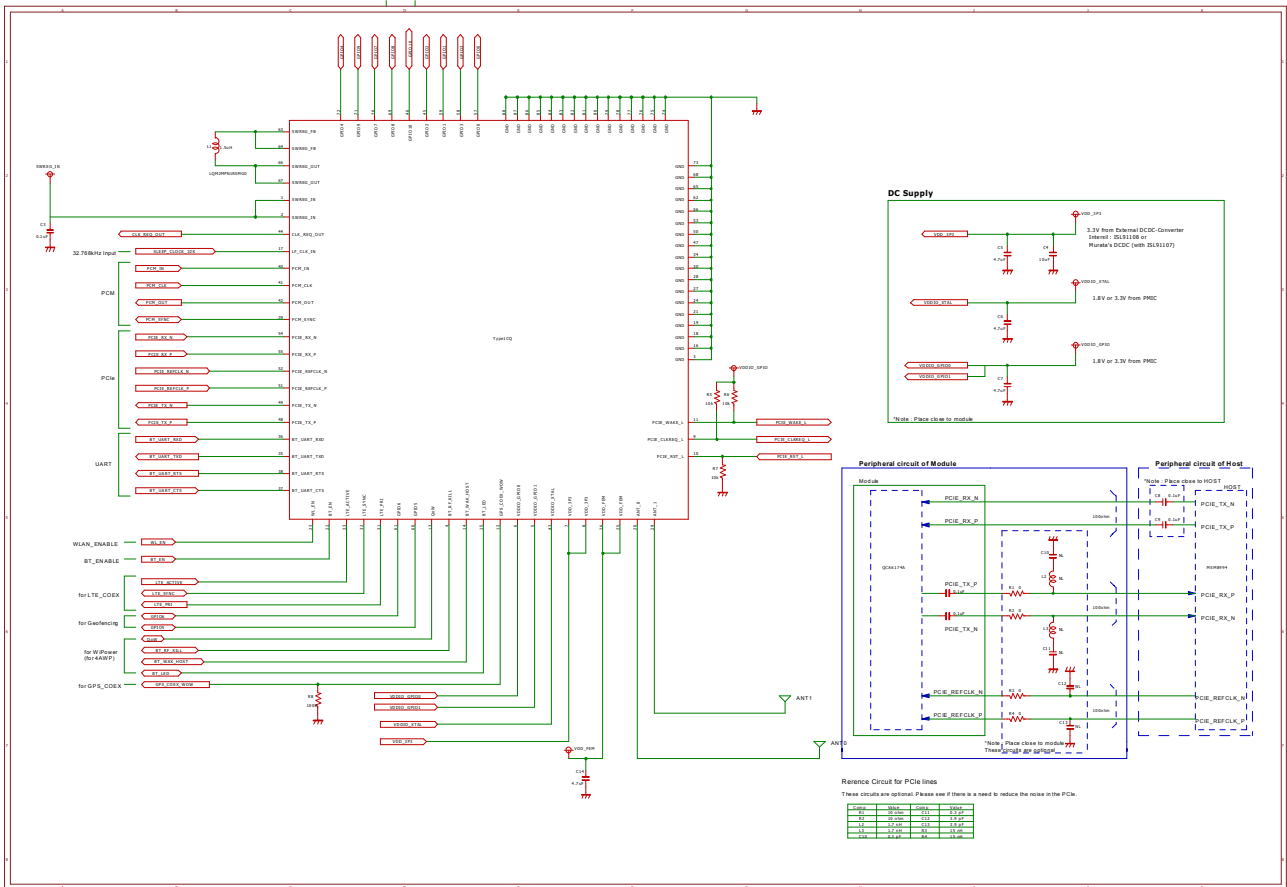
11. **Tape and Reel Packing**

(1) Dimensions of Tape (Plastic tape)

  *1. Cumulative tolerance of max. 40.0 ± 0.15 every 10 pitches

feeding direction
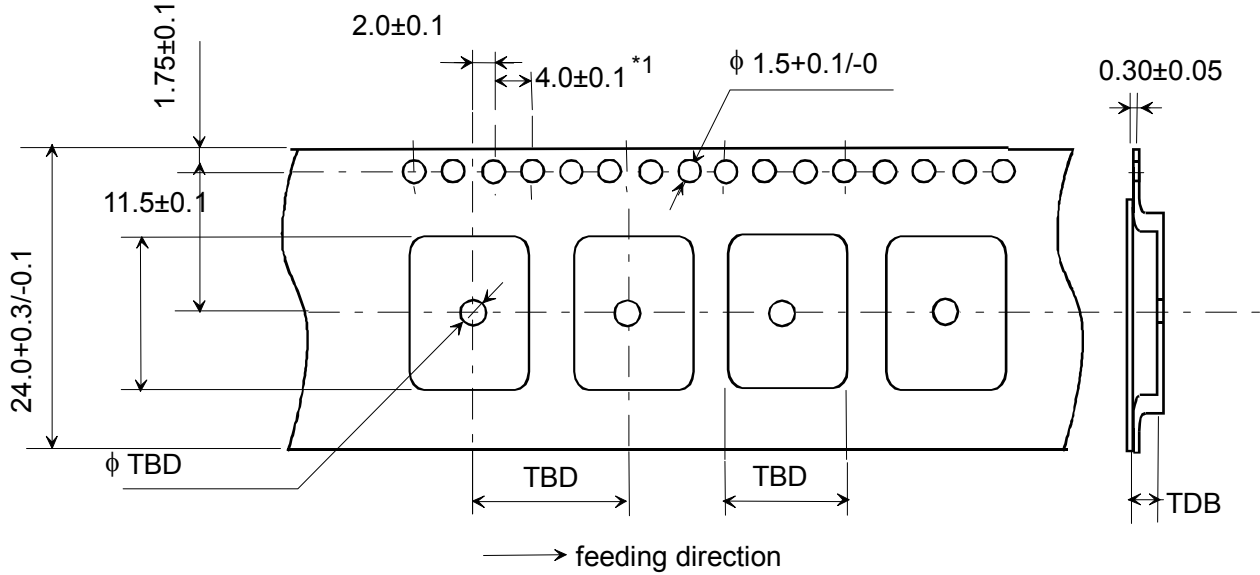
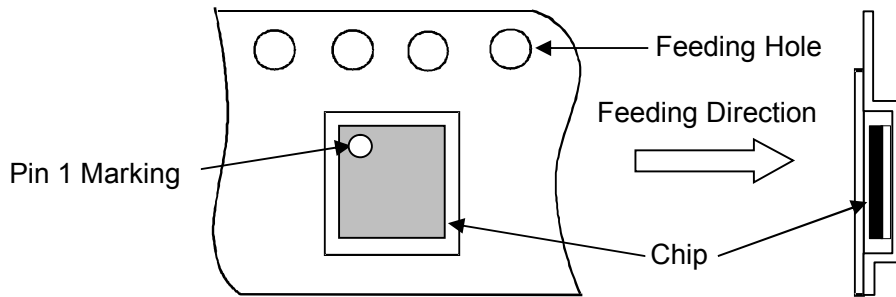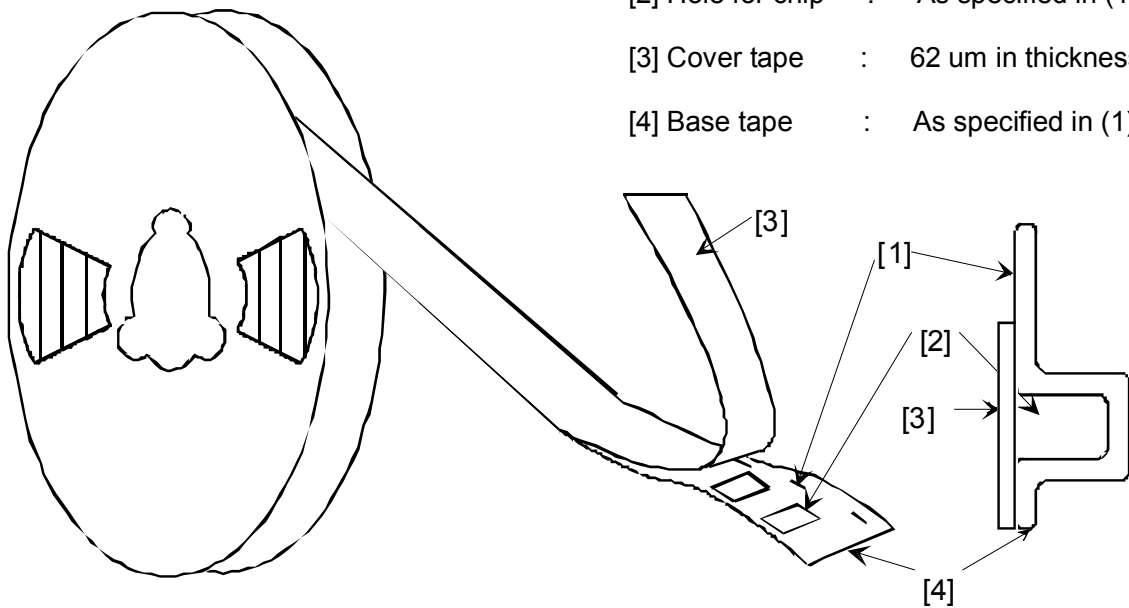(2) Dimensions of Reel

(unit: mm)

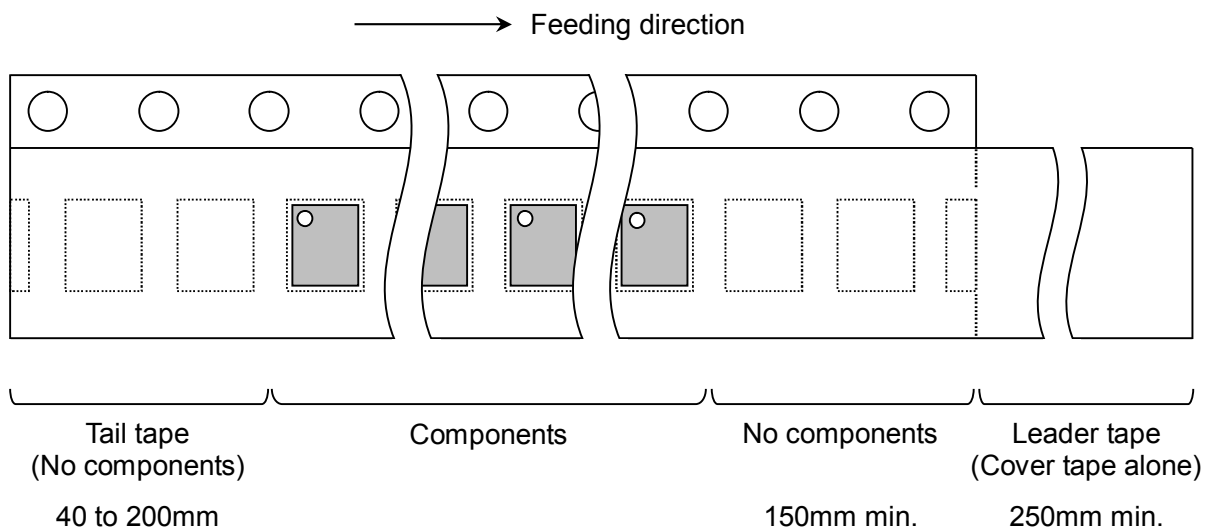(3) Taping Diagrams

[1] Feeding Hole : As specified in (1)

[2] Hole for chip : As specified in (1)

[3] Cover tape : 62 um in thickness

[4] Base tape : As specified in (1)

[3]

[1]

[2]

[3]

[4]

Feeding Hole

Feeding Direction

Pin 1 Marking

Chip

(4) Leader and Tail tape

Feeding direction

Tail tape (No components)	Components	No components	Leader tape (Cover tape alone)
40 to 200mm		150mm min.	250mm min.

(5)   The tape for chips are wound clockwise, the feeding holes to the right side as the tape is pulled toward the user.

(6)   The cover tape and base tape are not adhered at no components area for 250 mm min.

(7)   Tear off strength against pulling of cover tape : 5 N min.

(8)   Packaging unit : 1000 pcs./ reel

(9)   material : Base tape : Plastic
          Reel   : Plastic
          Cover tape , cavity tape and reel are made the anti-static processing.

(10)   Peeling of force : 1.1N max. in the direction of peeling as shown below.
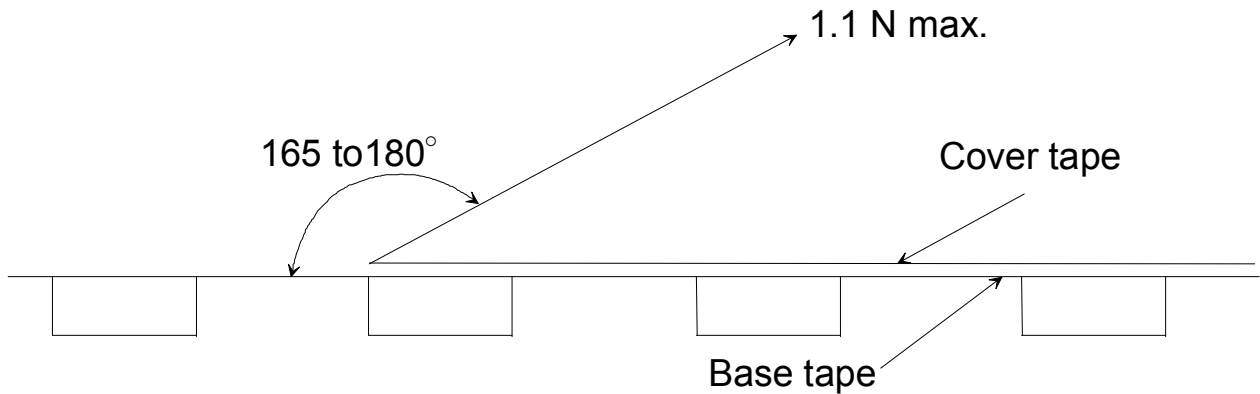
(11) PACKAGE (Humidity proof Packing)
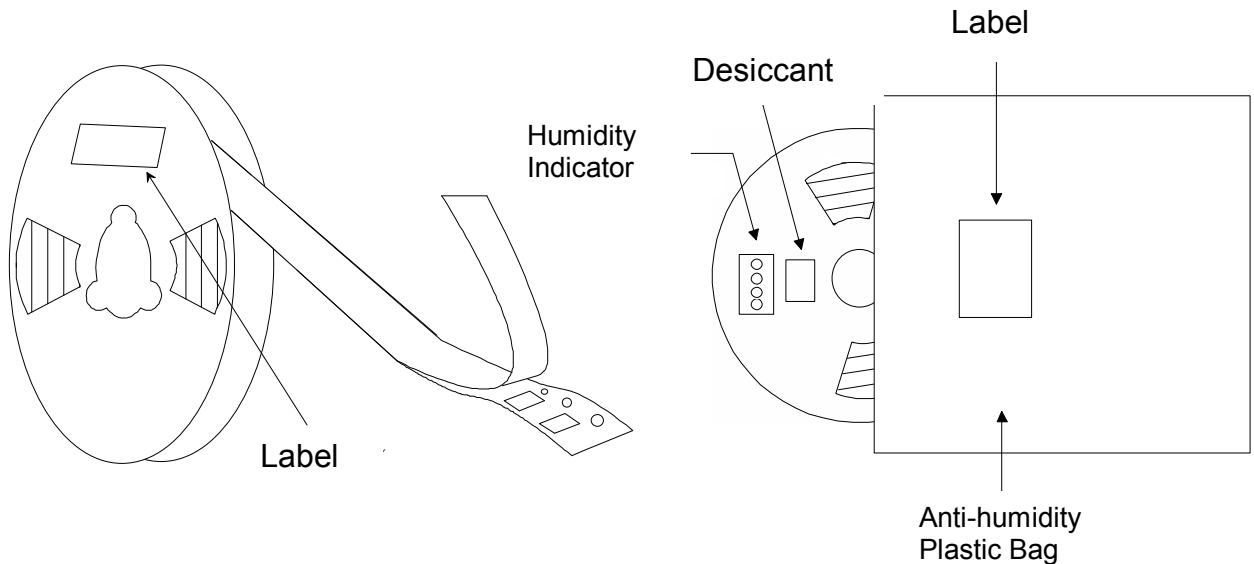
Tape and reel must be sealed with the anti-humidity plastic bag. The bag contains the desiccant and the humidity indicator.

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12. NOTICE

12.1. Storage Conditions:
Please use this product within 6month after receipt.
- The product shall be stored without opening the packing under the ambient temperature from 5 to 35deg.C and humidity from 20 to 70%RH.
(Packing materials, in particular, may be deformed at the temperature over 40deg.C.)
- The product left more than 6months after reception, it needs to be confirmed the solderbility before used.
- The product shall be stored in non corrosive gas (Cl_2, NH_3, SO_2, No_x, etc.).
- Any excess mechanical shock including, but not limited to, sticking the packing materials by sharp object and dropping the product, shall not be applied in order not to damage the packing materials.
This product is applicable to MSL3 (Based on JEDEC Standard J-STD-020)
- After the packing opened, the product shall be stored at $\leq$30deg.C / $\leq$60%RH and the product shall be used within 168hours.
- When the color of the indicator in the packing changed, the product shall be baked before soldering.
    Baking condition: 125+5/-0deg.C, 24hours, 1time
The products shall be baked on the heat-resistant tray because the material (Base Tape, Reel Tape and Cover Tape) are not heat-resistant.

12.2. Handling Conditions:
Be careful in handling or transporting products because excessive stress or mechanical shock may break products.
Handle with care if products may have cracks or damages on their terminals, the characteristics of products may change. Do not touch products with bear hands that may result in poor solder ability and destroy by static electrical charge.

12.3. Standard PCB Design (Land Pattern and Dimensions):
All the ground terminals should be connected to the ground patterns. Furthermore, the ground pattern should be provided between IN and OUT terminals. Please refer to the specifications for the standard land dimensions.
The recommended land pattern and dimensions is as Murata's standard. The characteristics of products may vary depending on the pattern drawing method, grounding method, land dimensions, land forming method of the NC terminals and the PCB material and thickness. Therefore, be sure to verify the characteristics in the actual set. When using non-standard lands, contact Murata beforehand.

12.4. Notice for Chip Placer:
When placing products on the PCB, products may be stressed and broken by uneven forces from a worn-out chucking locating claw or a suction nozzle. To prevent products from damages, be sure to follow the specifications for the maintenance of the chip placer being used. For the positioning of products on the PCB, be aware that mechanical chucking may damage products.

12.5. Soldering Conditions:

The recommendation conditions of soldering are as in the following figure.

When products are immersed in solvent after mounting, pay special attention to maintain the temperature difference within 100 °C. Soldering must be carried out by the above mentioned conditions to prevent products from damage. Set up the highest temperature of reflow within 260 °C. Contact Murata before use if concerning other soldering conditions.

Reflow soldering standard conditions(Example)
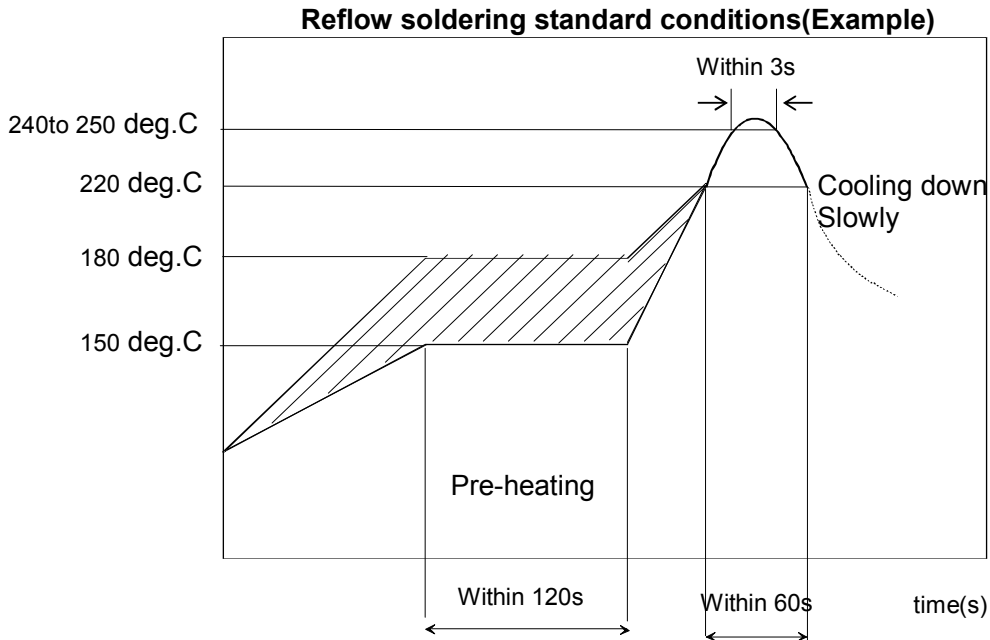
Please use the reflow within 2 times.
Use rosin type flux or weakly active flux with a chlorine content of 0.2 wt % or less.

12.6. Cleaning:

Since this Product is Moisture Sensitive, any cleaning is not permitted.

12.7. Operational Environment Conditions:

Products are designed to work for electronic products under normal environmental conditions (ambient temperature, humidity and pressure). Therefore, products have no problems to be used under the similar conditions to the above-mentioned. However, if products are used under the following circumstances, it may damage products and leakage of electricity and abnormal temperature may occur.

- In an atmosphere containing corrosive gas (Cl_2, NH_3, SO_x, NO_x etc.).
- In an atmosphere containing combustible and volatile gases.
- Dusty place.
- Direct sunlight place.
- Water splashing place.
- Humid place where water condenses.
- Freezing place.

If there are possibilities for products to be used under the preceding clause, consult with Murata before actual use. As it might be a cause of degradation or destruction to apply static electricity to products, do not apply static electricity or excessive voltage while assembling and measuring.

12.8. Input Power Capacity:

Products shall be used in the input power capacity as specified in this specifications.
Inform Murata beforehand, in case that the components are used beyond such input power capacity range.

< Specification may be changed by Murata without notice >
Murata Manufacturing Co., Ltd.

13. <u>PRECONDITION TO USE OUR PRODUCTS</u>

PLEASE READ THIS NOTICE BEFORE USING OUR PRODUCTS.

Please make sure that your product has been evaluated and confirmed from the aspect of the fitness for the specifications of our product when our product is mounted to your product.

All the items and parameters in this product specification/datasheet/catalog have been prescribed on the premise that our product is used for the purpose, under the condition and in the environment specified in this specification. You are requested not to use our product deviating from the condition and the environment specified in this specification.

Please note that the only warranty that we provide regarding the products is its conformance to the specifications provided herein. Accordingly, we shall not be responsible for any defects in products or equipment incorporating such products, which are caused under the conditions other than those specified in this specification.

WE HEREBY DISCLAIMS ALL OTHER WARRANTIES REGARDING THE PRODUCTS, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, THAT THEY ARE DEFECT-FREE, OR AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS.

The product shall not be used in any application listed below which requires especially high reliability for the prevention of such defect as may directly cause damage to the third party's life, body or property. You acknowledge and agree that, if you use our products in such applications, we will not be responsible for any failure to meet such requirements. Furthermore, YOU AGREE TO INDEMNIFY AND DEFEND US AND OUR AFFILIATES AGAINST ALL CLAIMS, DAMAGES, COSTS, AND EXPENSES THAT MAY BE INCURRED, INCLUDING WITHOUT LIMITATION, ATTORNEY FEES AND COSTS, DUE TO THE USE OF OUR PRODUCTS IN SUCH APPLICATIONS.

- Aircraft equipment.   - Aerospace equipment   - Undersea equipment.
- Power plant control equipment   - Medical equipment.
- Transportation equipment (vehicles, trains, ships, elevator, etc.).
- Traffic signal equipment.   - Disaster prevention / crime prevention equipment.
-Burning / explosion control equipment
- Application of similar complexity and/ or reliability requirements to the applications listed in the above.

We expressly prohibit you from analyzing, breaking, reverse-engineering, remodeling altering, and reproducing our product.   Our product cannot be used for the product which is prohibited from being manufactured, used, and sold by the regulations and laws in the world.

We do not warrant or represent that any license, either express or implied, is granted under any our patent right, copyright, mask work right, or our other intellectual property right relating to any combination, machine, or process in which our products or services are used. Information provided by us regarding third-party products or services does not constitute a license from us to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from us under our patents or other intellectual property.

Please do not use our products, our technical information and other data provided by us for the purpose of developing of mass-destruction weapons and the purpose of military use.

Moreover, you must comply with "foreign exchange and foreign trade law", the "U.S. export administration regulations", etc.

Please note that we may discontinue the manufacture of our products, due to reasons such as end of supply of materials and/or components from our suppliers.

By signing on specification sheet or approval sheet, you acknowledge that you are the legal representative for your company and that you understand and accept the validity of the contents herein. When you are not able to return the signed version of specification sheet or approval sheet within 30 days from receiving date of specification sheet or approval sheet, it shall be deemed to be your consent on the content of specification sheet or approval sheet. Customer acknowledges that engineering samples may deviate from specifications and may contain defects due to their development status. We reject any liability or product warranty for engineering samples. In particular we disclaim liability for damages caused by

- the use of the engineering sample other than for evaluation purposes, particularly the installation or integration in the product to be sold by you,
-deviation or lapse in function of engineering sample,
-improper use of engineering samples.

We disclaim any liability for consequential and incidental damages.

If you can't agree the above contents, you should inquire our sales.

< Specification may be changed by Murata without notice >
Murata Manufacturing Co., Ltd.