

LoRa Module User Manual

MP P/N: CMWX1ZZABZ

Sample P/N: CMWX1ZZABZ-TEMP

For LoRa™

Revision History

Revision Code	Date	Description	Comments
A	June 8, 2016	Initial Draft	
B	July 1, 2016	Updated height and package info	
C	July 30, 2016	Revised some formats and ΔRF_OPH_V test condition from 2.4-3.7V to 2.2-3.6V. Updated some electronic Characteristics. Added the recommended land pattern.	
D	Aug 29, 2016	Updated the RF performance, Electrical Characteristics and power up sequence.	
E	Oct 11, 2016	Added FCC and IC statements.	
F	Aug 20, 2018	Added additional antenna info.	
G	Aug 12, 2021	Added additional antenna info.	

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1. Features

Interfaces	: I2C, UART, USB, SPI
Main ICs	: STM32L082, SX1276
Reference Clocks	: Integrated 32MHz clock (TCXO with frequency error= ± 2 ppm) and 32.768KHz clock (frequency error= ± 20 ppm)
Supported Frequencies	: 868 MHz, 915 MHz
Module Size	: 12.5 mm x 11.6 mm x 1.76 mm (Max)
Package	: Metal Shield can
RoHS	: This module is compliant with the RoHS directive

2. Part Number

Ordering Part Number	Description
CMWX1ZZABZ	MP P/N
CMWX1ZZABZ-TEMP	Engineering sample

3. Block Diagram

N/A

4. Dimensions, Marking and Terminal Configurations

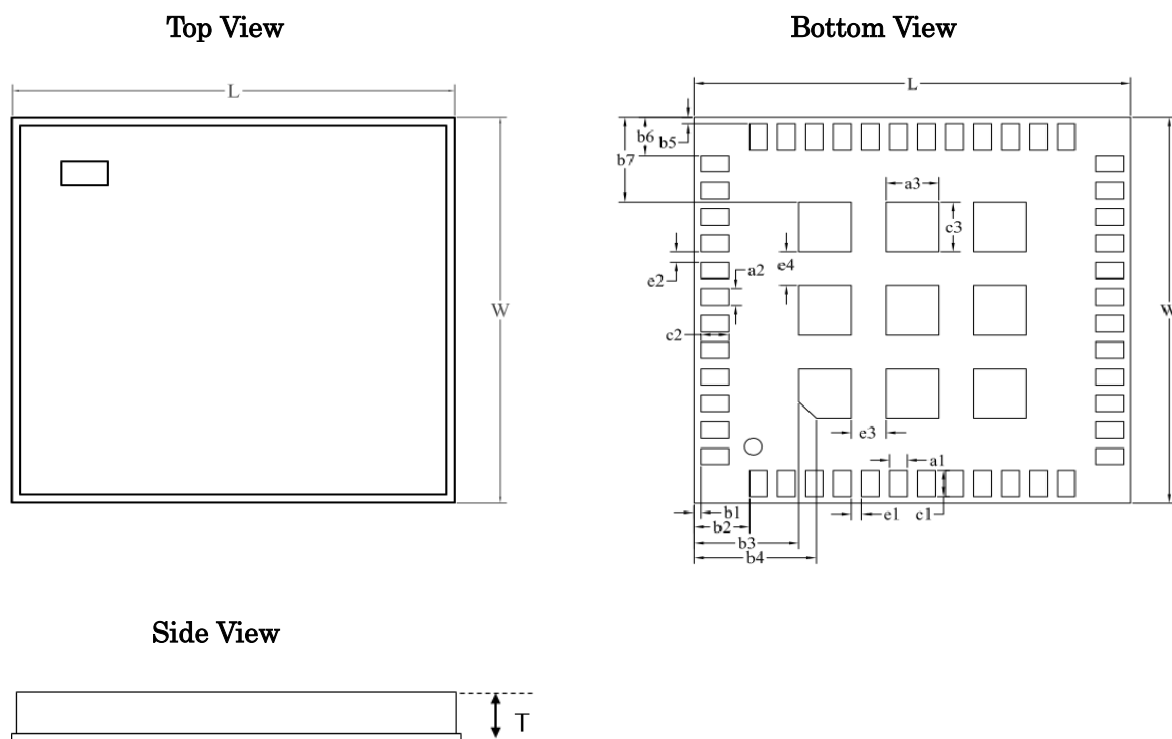


Table 1 Dimension (Unit: mm)

Mark	Dimension	Mark	Dimension	Mark	Dimension
L	12.5 ± 0.20	W	11.6 ± 0.20	T	1.76 max
a1	0.50 ± 0.10	a2	0.50 ± 0.10	a3	1.50 ± 0.10
b1	0.20 ± 0.15	b2	1.60 ± 0.15	b3	3.00 ± 0.15
b4	3.50 ± 0.15	b5	0.20 ± 0.15	b6	1.15 ± 0.15
b7	2.55 ± 0.15	c1	0.80 ± 0.10	c2	0.80 ± 0.10
c3	1.50 ± 0.10	e1	0.30 ± 0.10	e2	0.30 ± 0.10
e3	1.00 ± 0.10	e4	1.00 ± 0.10		

Terminal Configurations

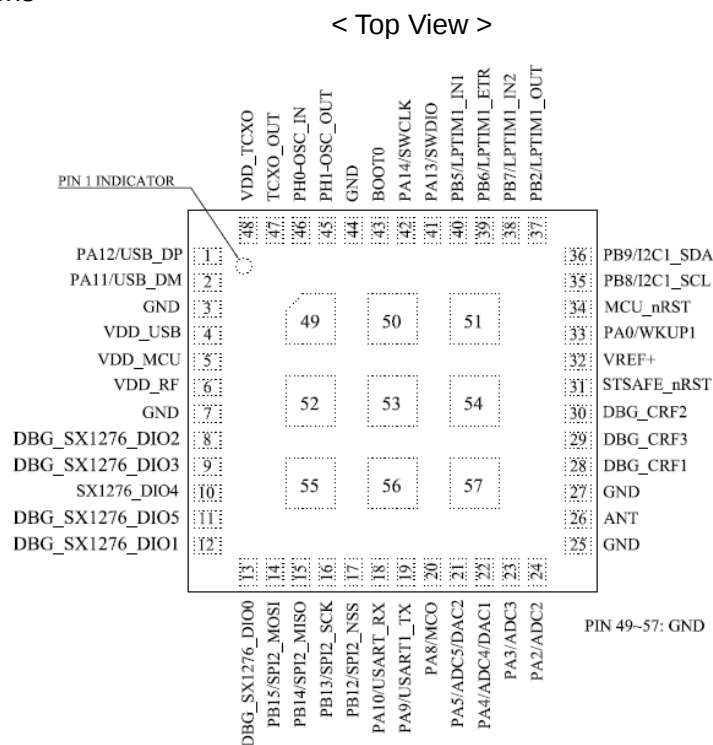


Table 2 Terminal Configurations

Pin NO.	Terminal Name	Type	Connection to IC terminal	Description
1	PA12/USB_DP	I/O	STM32L082_PA12	GPIO Mode:PA12 USB_DP
2	PA11/USB_DM	I/O	STM32L082_PA11	GPIO Mode:PA11 USB_DM
3	GND	Ground	-	Ground
4	VDD_USB	Power	-	Power supply for USB
5	VDD_MCU	Power	-	Power supply for MCU
6	VDD_RF	Power	-	Power supply for RF IC
7	GND	Ground	-	Ground
8	DBG_SX1276_DIO2	I/O	SX1276_DIO2	Debug pin for SX1276
9	DBG_SX1276_DIO3	I/O	SX1276_DIO3	Debug pin for SX1276
10	SX1276_DIO4	I/O	SX1276_DIO4	SX1276 DIO4
11	DBG_SX1276_DIO5	I/O	SX1276_DIO5	Debug pin for SX1276
12	DBG_SX1276_DIO1	I/O	SX1276_DIO1	Debug pin for SX1276
13	DBG_SX1276_DIO0	I/O	SX1276_DIO0	Debug pin for SX1276
14	PB15/SPI2_MOSI	I/O	STM32L082_PB15	GPIO Mode:PB15 SPI2_MOSI
15	PB14/SPI2_MISO	I/O	STM32L082_PB14	GPIO Mode:PB14 SPI2_MISO
16	PB13/SPI2_SCK	I/O	STM32L082_PB13	GPIO Mode:PB13 SPI2_SCK
17	PB12/SPI2_NSS	I/O	STM32L082_PB12	GPIO Mode:PB12 SPI2_NSS
18	PA10/USART1_RX	I/O	STM32L082_PA10	GPIO Mode:PA10 USART1_RX

19	PA9/USART1_TX	I/O	STM32L082_PA9	GPIO Mode:PA9 USART1_TX
20	PA8/MCO	I/O	STM32L082_PA8	GPIO Mode:PA8 MCO
21	PA5/ADC5/DAC2	I/O	STM32L082_PA5	GPIO Mode:PA5 COMP2_INM ADC_IN5 DAC_OUT2
22	PA4/ADC4/DAC1	I/O	STM32L082_PA4	GPIO Mode:PA4 COMP2_INM ADC_IN4 DAC_OUT1
23	PA3/ADC3	I/O	STM32L082_PA3	GPIO Mode:PA3 COMP2_INP ADC_IN3
24	PA2/ADC2	I/O	STM32L082_PA2	GPIO Mode:PA2 COMP2_OUT ADC_IN2
25	GND	Ground	-	Ground
26	ANT	A,I/O	-	Transmit / Receive Antenna
27	GND	Ground	-	Ground
28	DBG_CRF1	I/O	STM32L082_PA1	Debug pin
29	DBG_CRF3	I/O	STM32L082_PC1	Debug pin
30	DBG_CRF2	I/O	STM32L082_PC2	Debug pin
31	STSAFE_nRST	I	-	Reset for Security IC
32	VREF+	Power	-	Reference Voltage For ADC and DAC
33	PA0/WKUP1	I/O	STM32L082_PA0	GPIO Mode:PA0 COMP2_OUT ADC_IN2
34	MCU_nRST	I	STM32L082_PD5	NRST
35	PB8/I2C1_SCL	I/O	STM32L082_PB8	GPIO Mode:PB8 I2C mode: SCL
36	PB9/I2C1_SDA	I/O	STM32L082_PB9	GPIO Mode: PB9 I2C mode: SDA
37	PB2/LPTIM1_OUT	I/O	STM32L082_PB2	GPIO Mode:PB2 LPTIM1_OUT
38	PB7/LPTIM1_IN2	I/O	STM32L082_PB7	GPIO Mode:PB7 LPTIM1_IN2
39	PB6/LPTIM1_ETR	I/O	STM32L082_PB6	GPIO Mode:PB6 LPTIM1_ETR
40	PB5/LPTIM1_IN1	I/O	STM32L082_PB5	GPIO Mode:PB5 LPTIM1_IN1
41	PA13/SWDIO	I/O	STM32L082_PA13	GPIO Mode:PA13 SWDIO LPUART1_RX
42	PA14/SWCLK	I/O	STM32L082_PA14	GPIO Mode:PA14 SWCLK LPUART1_TX
43	BOOT0	I	STM32L082_PA5	Boot Option

44	GND	Ground	-	-
45	PH1-OSC_OUT	I/O	STM32L082_PH1	GPIO Mode:PH1 High-speed external clock OSC output
46	PH0-OSC_IN	I/O	STM32L082_PH0	GPIO Mode:PH0 High-speed external clock OSC input
47	TCXO_OUT	O	-	Internal TCXO output
48	VDD_TCXO	Power	-	Power supply for the TCXO IC
49~57	GND	Ground	-	Ground

Note: GPIO pins are to be left OPEN if not used.

5. Label Information

TBD

6. Absolute Maximum Ratings

Table 3 Maximum ratings

Parameters		Min	Typ	Max	Unit
Storage Temperature		-40	25	+90	degC
Input RF Level		-	-	10	dBm
Supply Voltage	VDD_USB	-0.3	-	3.9	V
	VDD_MCU, VDD_RF, VDD_TCXO	-0.3	-	3.9	V
	VREF+	-0.3	-	VDD_MCU+0.4	V

7. Operating Condition

Table 4 Operating specification

Parameters		Min	Typ	Max	Unit
Operating Temperature		-40	25	+85	degC
Supply Voltage	VDD_USB (USB peripheral used) ⁽¹⁾	3.0	-	3.6	V
	VDD_USB(USB peripheral not used) ⁽¹⁾	VDD_MCU_min	VDD_MCU	VDD_MCU_max	V
	VDD_MCU,VDD_RF,VDD_TCXO	2.2 ⁽³⁾	-	3.6	V
	VREF+ ⁽²⁾	1.8	-	VDD_MCU	V

(1) VDD_USB must respect the following conditions:

- When VDD_MCU is powered on (VDD_MCU < VDD_MCU_min), VDD_USB should be always lower than VDD_MCU.
- When VDD_MCU is powered down (VDD_MCU < VDD_MCU_min), VDD_USB should be always lower than VDD_MCU.
- In operating mode, VDD_USB could be lower or higher than VDD_MCU.
- If the USB is not used, VDD_USB must be tied to VDD_MCU to be able to use PA11 and PA12 as standard I/Os.

(2) VREF+ is used to ensure a better accuracy on low-voltage inputs and outputs of ADC and DAC. Detailed information is on the STM32L082*** datasheet and user guider.

(3) When module is on +20dBm operation, the supply of the voltage should be set from 2.4V to 3.6V.

8. Electrical Characteristics

8.1 FSK/OOK Transceiver Specification

Conditions:

Supply voltage VDD=3.3 V, temperature = 25 °C, FXOSC = 32 MHz, FRF =868/915 MHz , 2-level FSK modulation without pre-filtering, FDA = 5 kHz, Bit Rate = 4.8 kb/s and terminated in a matched 50 Ohm impedance, shared Rx and Tx path matching, unless otherwise specified.

FSK/OOK Receiver Specification

Symbol	Description	Conditions	Min.	Typ	Max	Unit
RFS_F_HF	LnaBoost is turned on	FDA = 5 kHz, BR = 4.8 kb/s		-117.5		dBm
IDDR	Supply current in Receive mode	LnaBoost Off, band 1		22		mA
		LnaBoost On, band 1		23		mA

FSK/OOK Transmitter Specification

Symbol	Description	Conditions	Min.	Typ	Max	Unit
RF_OP	RF output power in 50 ohms on RFO pin (High efficiency PA)	Programmable with steps	Max	14		dBm
			Min	-5		dBm
RF_OPH	RF output power in 50 ohms on PA_BOOST pin(Regulated PA)	Programmable with 1dB steps	Max	18.5		dBm
			Min	2		dBm
Δ RF_OPH_V	RF output power stability on PA_BOOST pin versus voltage supply.	VDD = 2.2 V to 3.6 V		+/-1		dB
Δ RF_T	RF output power stability versus temperature on PA_BOOST pin.	From T = -40 °C to +85 °C		+/-1.5		dB
IDDT	Supply current in Transmit mode with impedance matching	RFOP = +20 dBm, on PA_BOOST		128		mA
		RFOP = +17 dBm, on PA_BOOST		106		mA
		RFOP = +14 dBm, on RFO_HF pin		47		mA
		RFOP = + 7 dBm, on RFO_HF pin		34		mA

8.2 LoRa Transceiver Specification

Conditions:

The table below gives the electrical specifications for the transceiver operating with LoRaTM modulation. Following conditions apply unless otherwise specified: Supply voltage = 3.3 V, Temperature = 25° C, FXOSC = 32 MHz, Error Correction Code (EC) = 4/5, Packet Error Rate (PER)= 1%, CRC on payload enabled, Payload length = 10 bytes.

With matched impedances

LoRa Receiver Specification

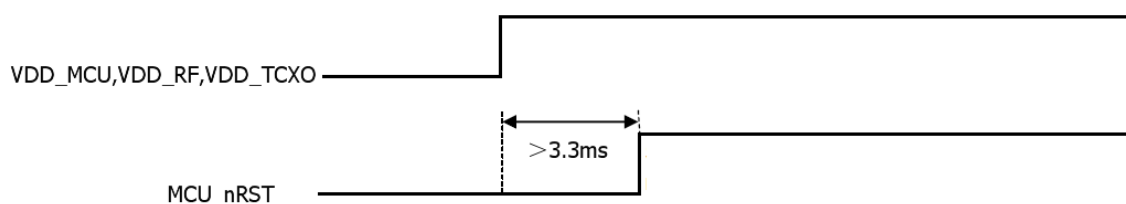
Symbol	Description	Conditions	Min.	Typ	Max	Unit
IDDR_L	Supply current in receiver LoRa mode, LnaBoost off	Band 1, BW = 125 kHz		21.5		mA
		Band 1, BW = 250 kHz		22.2		mA
		Band 1, BW = 500 kHz		23.6		mA
RFS_L125_HF	RF sensitivity, Long-Range Mode, highest LNA gain, LnaBoost for Band1, using split Rx/Tx path 125 kHz bandwidth	SF = 6		-117.5		dBm
		SF = 7		-122.5		dBm
		SF = 8		-125.5		dBm
		SF = 9		-128.5		dBm
		SF = 10		-131.0		dBm
		SF = 11		-133.5		dBm
		SF = 12		-135.5		dBm
RFS_L250_HF	RF sensitivity, Long-Range Mode, highest LNA gain, LnaBoost for Band1, using split Rx/Tx path 250 kHz bandwidth	SF = 6		-114.0		dBm
		SF = 7		-119.0		dBm
		SF = 8		-122.0		dBm
		SF = 9		-125.0		dBm
		SF = 10		-127.5		dBm
		SF = 11		-130.0		dBm
		SF = 12		-133.0		dBm

LoRa Transmitter Specification

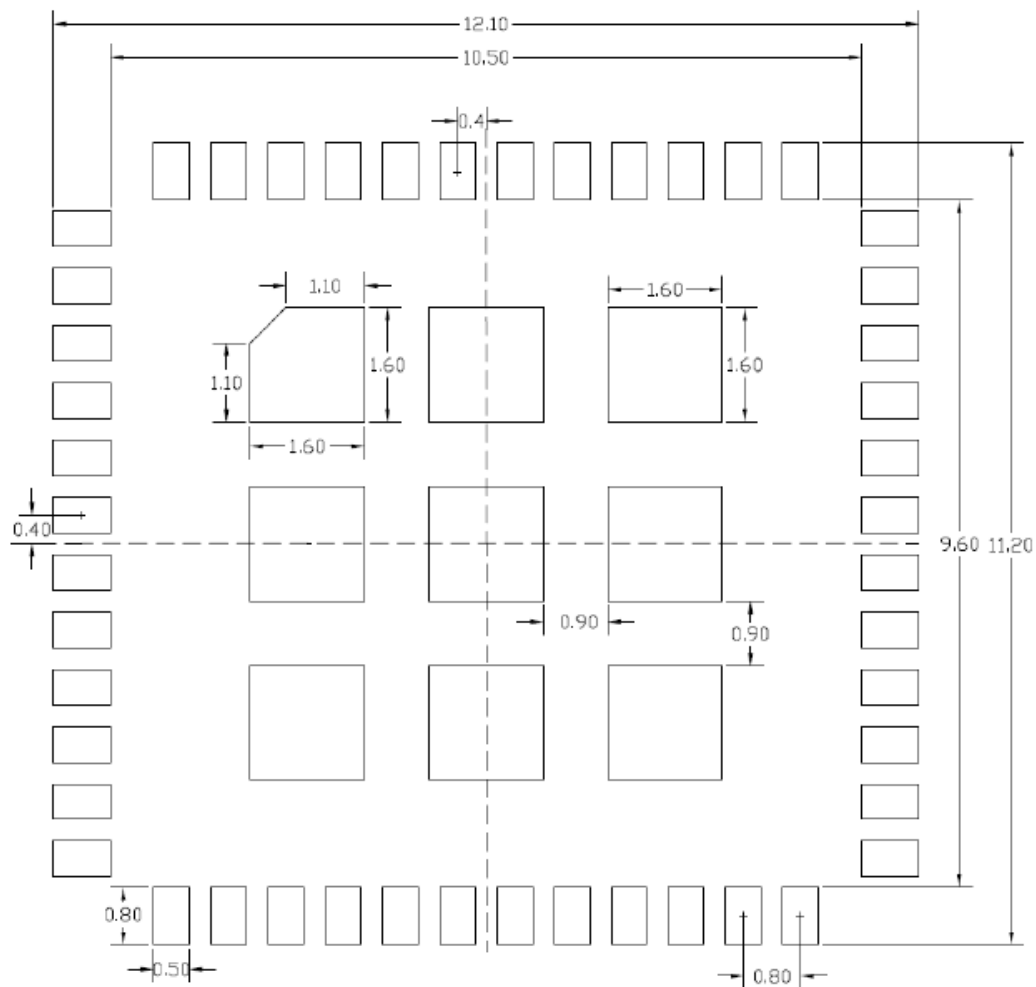
Symbol	Description	Conditions	Min.	Typ	Max	Unit
IDDT_L	Supply current in transmitter mode	RFOP setting = 14 dBm		47		mA
		RFOP setting = 10 dBm		36		mA
IDDT_H_L	Supply current in transmitter mode	Using PA_BOOST pin RFOP setting = 20 dBm		128		mA

9. Power Sequences

9.1 Power Up Sequence



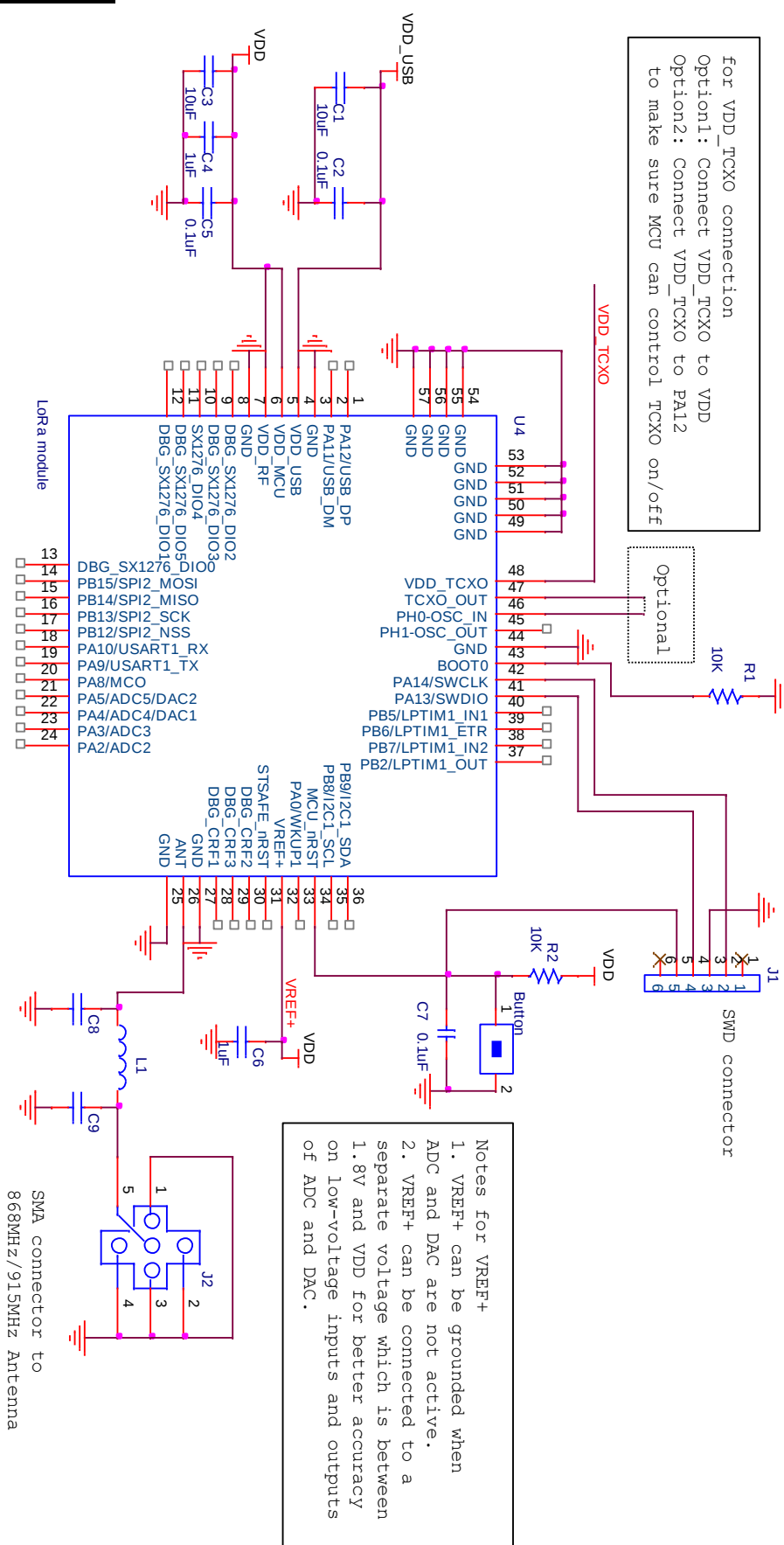
10. Recommend Land Pattern



NOTES:

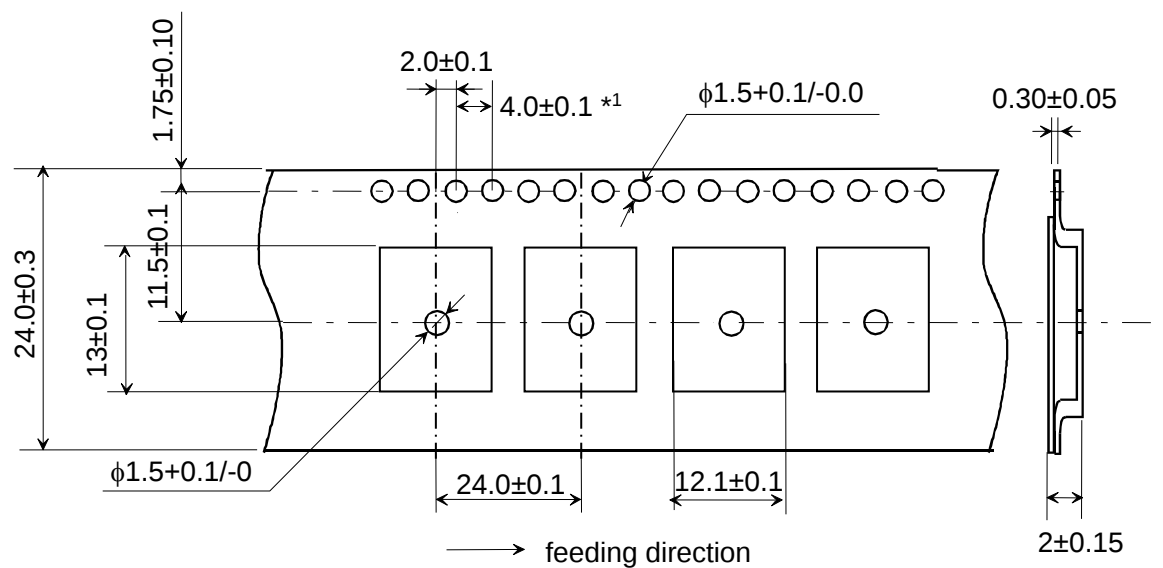
1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. THIS LAND PATTERN IS FOR REFERENCE PURPOSE ONLY.
CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S
MANUFACTURING GUIDELINES ARE MET.
3. THERMAL VIAS IN THE LAND PATTERN OF THE EXPOSED PAD SHALL BE CONNECTED
TO A SYSTEM GROUND PLANE. FAILURE TO DO SO MAY COMPROMISE THE THERMAL
AND/OR FUNCTIONAL PERFORMANCE OF THE DEVICE.
4. SQUARE PACKAGE-DIMENSIONS APPLY IN BOTH "X" AND "Y" DIRECTIONS.

11. Reference circuit



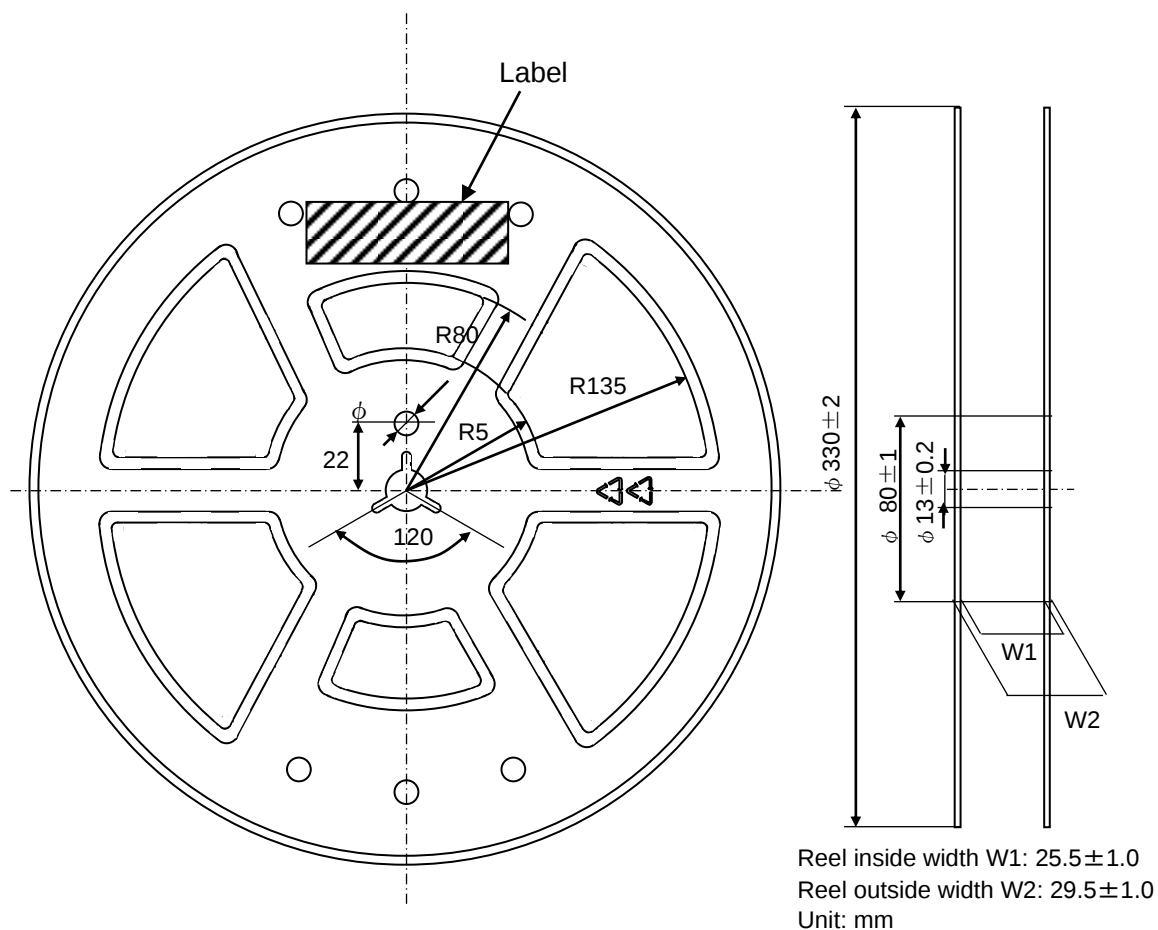
12. Tape and Reel packing

12.1 Dimension of Tape (Plastic tape)

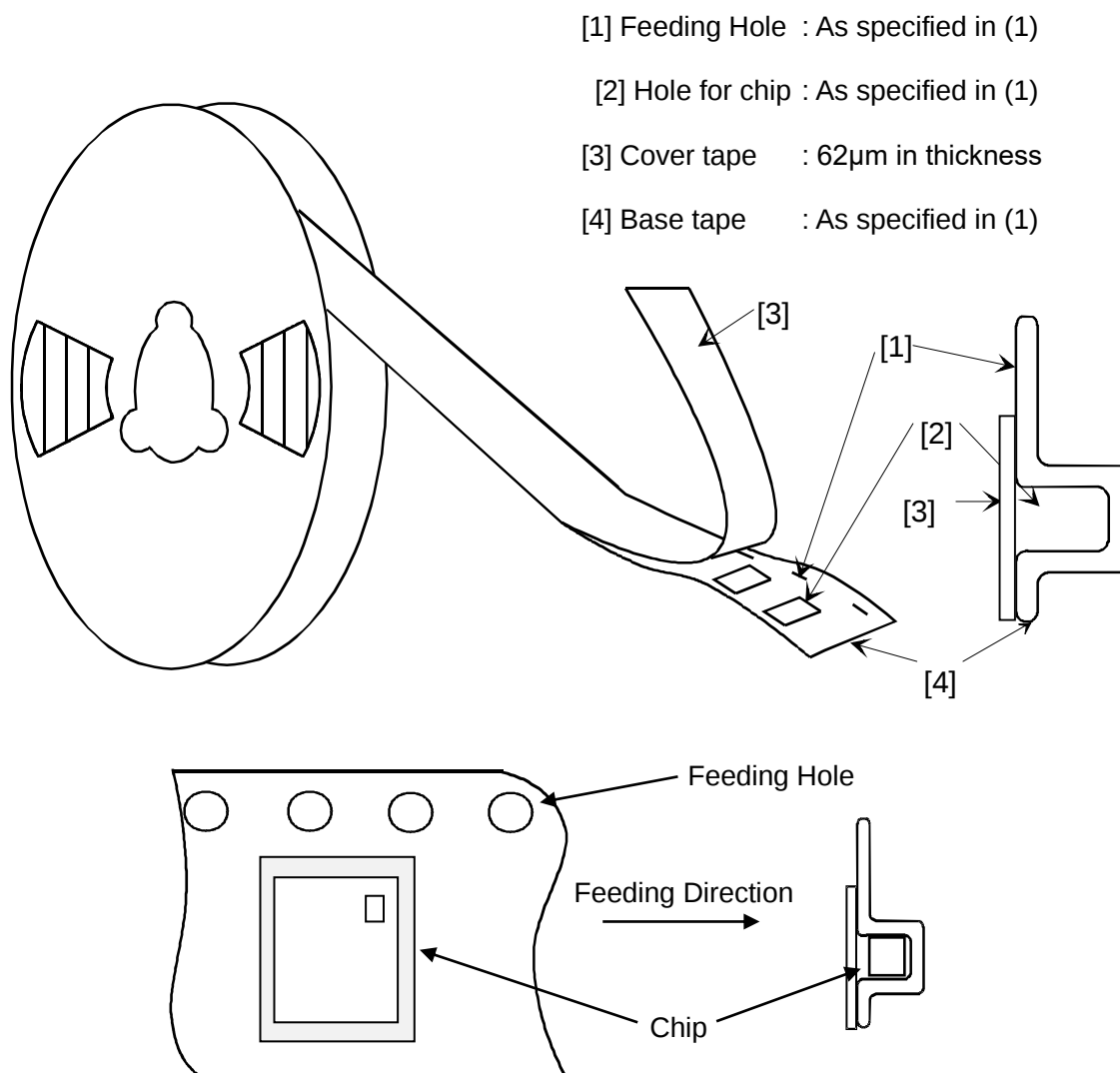


(unit : mm)

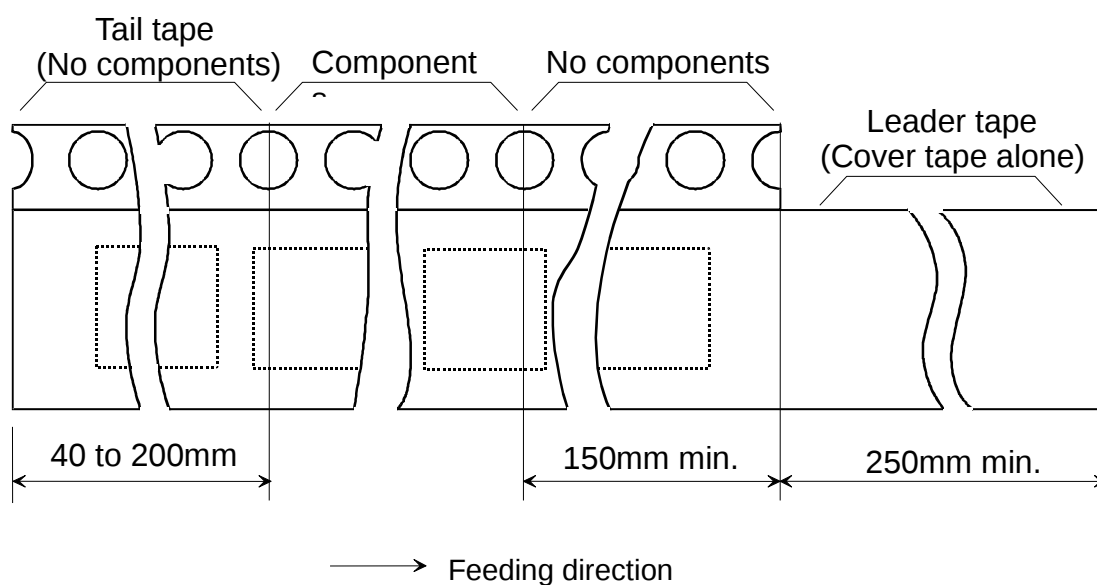
12.2 Dimensions of Reel



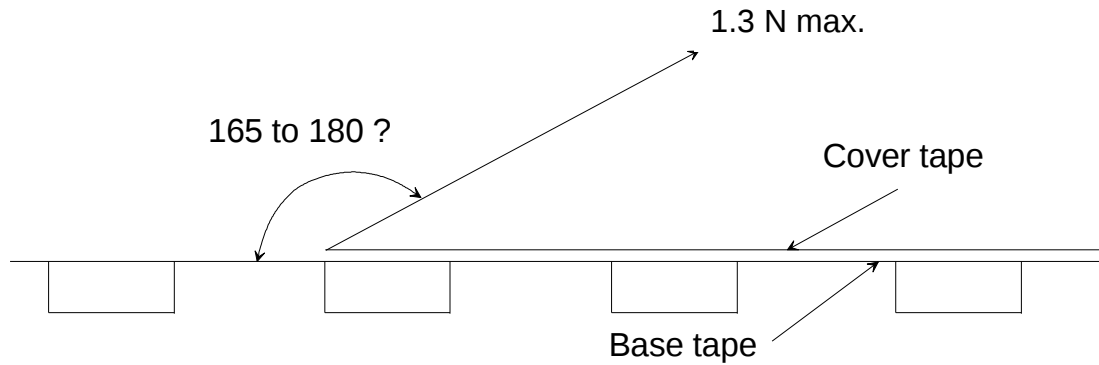
12.3 Taping Diagrams



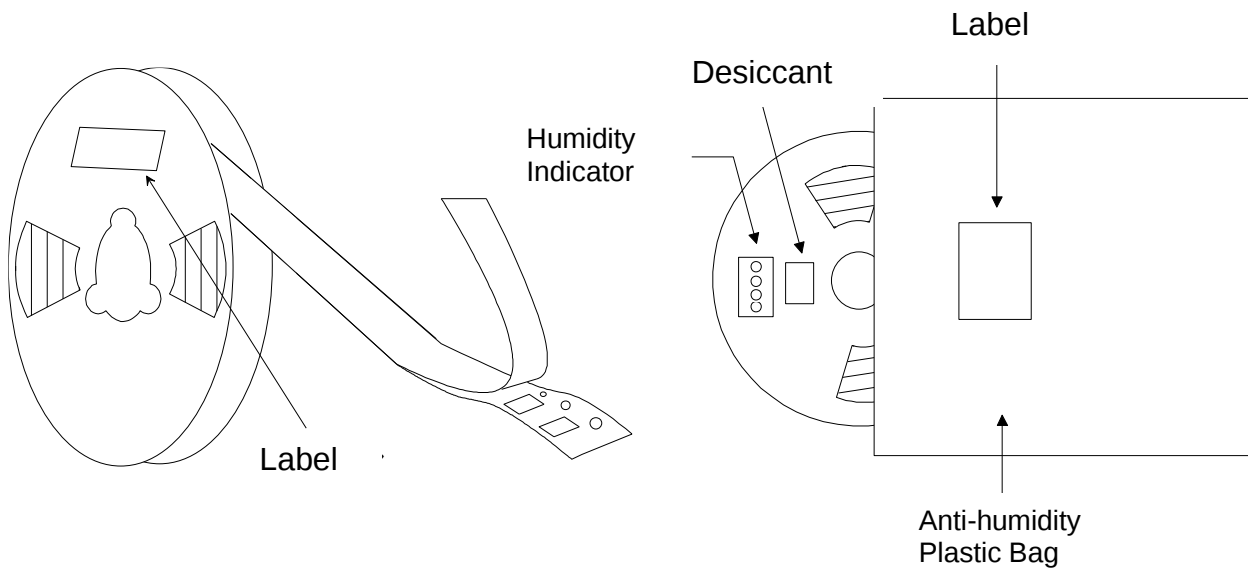
12.4 Leader and Tail tape



- The tape for chips are wound clockwise, the feeding holes to the right side as the tape is pulled toward the user.
- The cover tape and base tape are not adhered at no components area for 250mm min.
- Tear off strength against pulling of cover tape : 5N min.
- Packaging unit : 1000 pcs/ reel
- Material
 - Base tape : Plastic
 - Reel : Plastic
 - Cover tape, cavity tape and reel are made the anti-static processing.
- Peeling of force: 1.3N max. in the direction of peeling as shown below.



- Packaging (Humidity proof Packing)



Tape and reel must be sealed with the anti-humidity plastic bag. The bag contains the desiccant and the humidity indicator.

13. Notice

13.1 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 35 °C and humidity from 20 ~ 70 %RH.

(Packing materials, in particular, may be deformed at the temperature over 40 °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 (Cl₂, NH₃, SO₂, Nox, 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 IPC/JEDEC J-STD-020)

- After the packing opened, the product shall be stored at <30 °C / <60 %RH and the product shall be used within 168 hours.

- When the color of the indicator in the packing changed, the product shall be baked before soldering.

Baking condition: 125 +5/-0 °C, 24 hours, 1 time

The products shall be baked on the heat-resistant tray because the material (Base Tape, Reel Tape and Cover Tape) are not heat-resistant.

13.2 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 solderability.

13.3 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.

13.4 Notice for Chip Placer :

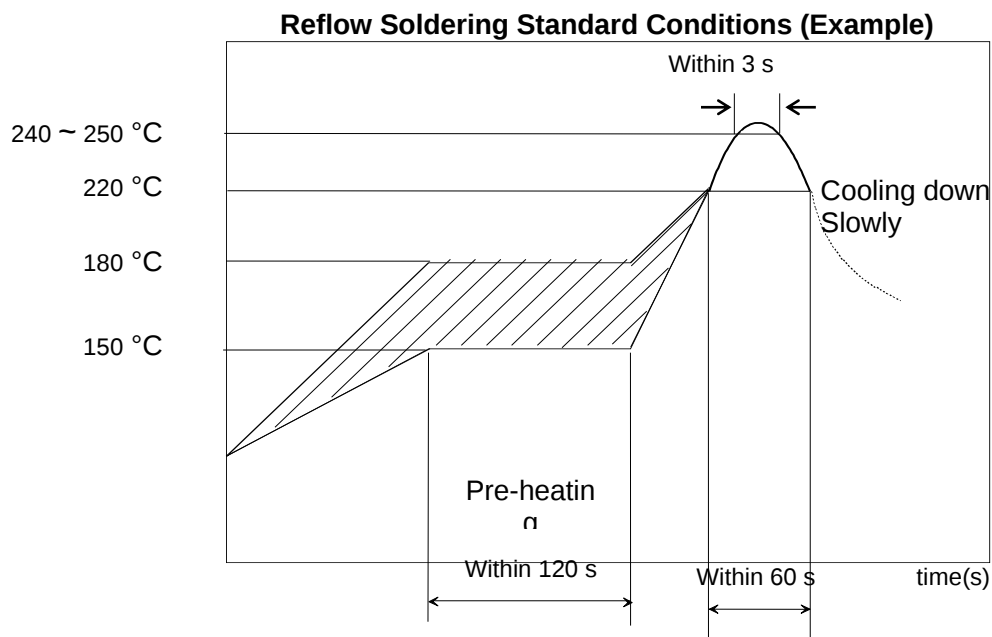
When placing products on the PCB, products may be stressed and broken by uneven forces from a worn-out chucking locating claw or a suction nozzle. To prevent products from damages, be sure to follow the specifications for the maintenance of the chip placer being used. For the positioning of products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

13.5 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.



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.

13.6 Cleaning :

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

13.7 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 (Cl₂, NH₃, 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.

13.8 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.

14. Regulatory Statements

14.1 FCC/IC Statements

Please take attention that changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation.

This equipment complies with FCC/IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

- (1) this device may not cause interference, and
- (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radioexempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- (1) l'appareil ne doit pas produire de brouillage, et
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This equipment complies with FCC/IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

ce matériel est conforme aux limites de dose d'exposition aux rayonnements, FCC / CNR-102 énoncée dans un autre environnement. cette équipement devrait être installé et exploité avec distance minimale de 20 entre le radiateur et votre corps.

(1) Operational use conditions

***if your module has professional users use condition limitations, please keep below sentence here Module has professional users use condition limitations, Host product manufacturer please ensure giving such warning like "Product is limited to professional users use" in your product's instruction.

(2) Antenna used

Antenna Type	Brand/ manufacturer	Model No.	Max. Antenna Gain
PIFA	Murata Manufacturing Co., Ltd.	/	2dBi

(3) Notice to Host Product Manufacturer

Any deviation(s) from the defined parameters of the antenna trace, as described by this instruction, host product manufacturer must notify us that you wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by us, or you (host manufacturer) can take responsibility through the change in FCC ID and IC ID (new application) procedure followed by a Class II permissive change application.

(4) Labelling Instruction for Host Product Integrator

Please notice that if the FCC and IC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following:

"Contains FCC ID: VPYCMABZ " and "Contains IC: 772C-CMABZ " any similar wording that expresses the same meaning may be used.

§15.19 and RSS-Gen Labelling requirements shall be complied on end user device. Labelling rules for special device, please refer to §2.925, § 15.19 (a)(5) and relevant KDB publications. For E-label, please refer to §2.935.

(5) Installation Notice to Host Product Manufacturer

The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.

The module is limited to installation in mobile application, a separate approval is required for all other operating configurations, including portable configurations with respect to §2.1093 and difference antenna configurations.

(6) Antenna Change Notice to Host manufacturer

If you desire to increase antenna gain and either change antenna type or use same antenna type certified, a Class II permissive change application is required to be filed by us, or you (host manufacturer) can take responsibility through the change in FCC ID and IC ID (new application) procedure followed by a Class II permissive change application.

(7) FCC other Parts, Part 15B Compliance Requirements for Host product manufacturer

This modular transmitter is only FCC authorized for the specific rule parts listed on our grant, host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

Host manufacturer in any case shall ensure host product which is installed and operating with the module is in compliant with Part 15B requirements.

Please note that For a Class B or Class A digital device or peripheral, the instructions furnished the user manual of the end-user product shall include statement set out in §15.105 Information to the user or such similar statement and place it in a prominent location in the text of host product manual. Original texts as following:

For Class B

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.*
- Increase the separation between the equipment and receiver.*
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- Consult the dealer or an experienced radio/TV technician for help.*

For Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.



CAUTION

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.

Customer acknowledges that Murata will, if requested by you, conduct a failure analysis for defect or alleged defect of Products only at the level required for consumer grade Products, and thus such analysis may not always be available or be in accordance with your request (for example, in cases where the defect was caused by components in Products supplied to Murata from a third party).

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 90 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 disclaims any liability for consequential and incidental damages.

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