

ULTRA-LOW NOISE, ULTRA-LOW DISTORTION AUDIO VOLUME

■FEATURES

- Operating Voltage Analog: ± 3.0 to ± 5.5 V
Digital: $+1.6$ to $+3.6$ V
- I²C BUS Control
- Volume 0 to -62 dB / 2dB step, Mute
- Input Impedance 1k Ω typ.
- Low Distortion 0.00013% typ.
- High SNR 130dB typ. ($V_O=2$ Vrms, Volume=0dB)
- Zero Cross Detection
- Shutdown Mode
- Package Outline WCSP16

■GENERAL DESCRIPTION

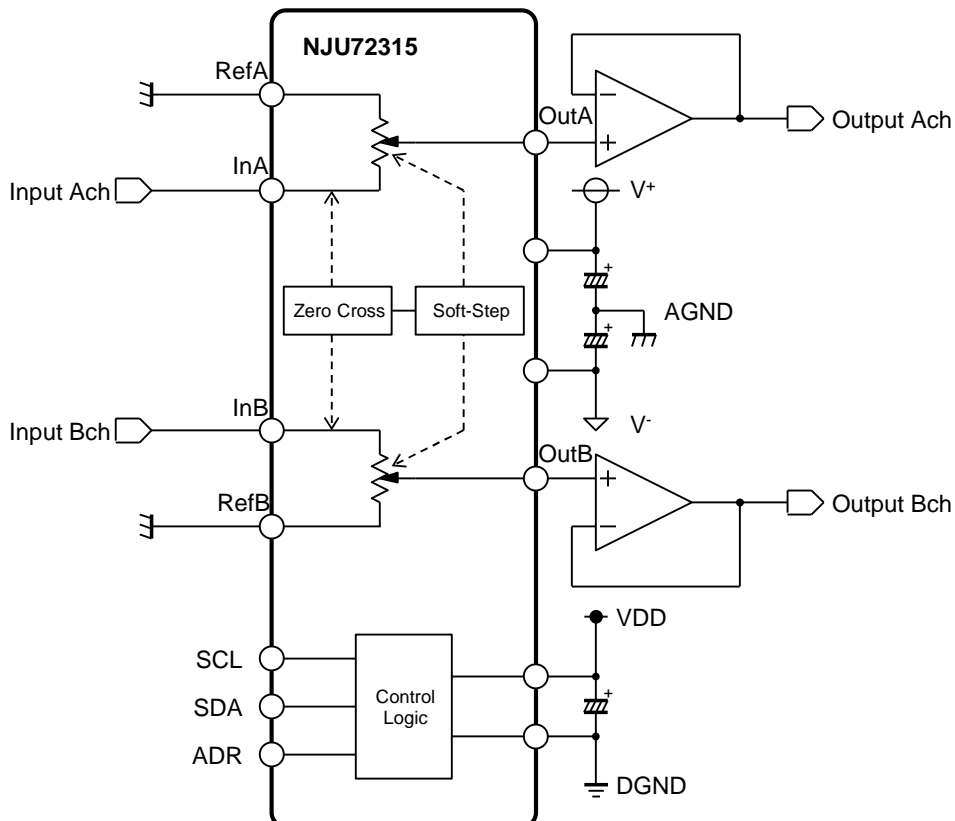
The NJU72315 is a high performance low voltage operation 2-channel audio volume. It provides low noise and low distortion characteristics. In addition, employing external op-amps as output signal buffers, they offer designer's variety of circuit design.

The NJU72315 is suitable for Hi-Fi portable audio systems.

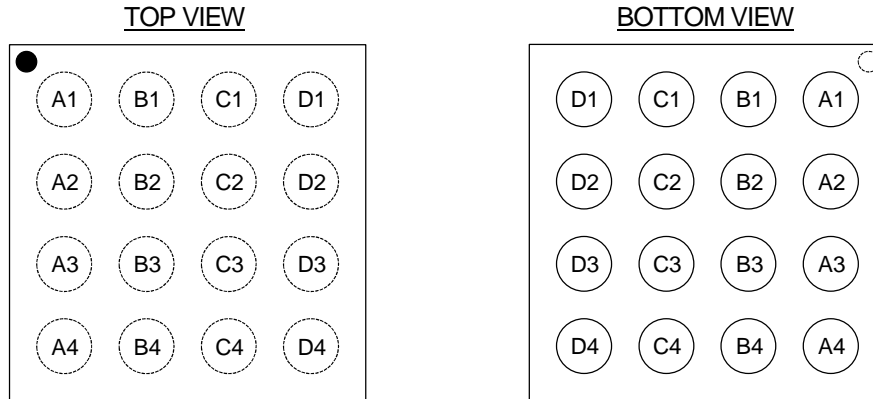
■APPLICATION

- Portable Audio Player
- Portable Audio Amplifier
- Hi-Fi Smartphone/Tablet

■APPLICATION CIRCUIT

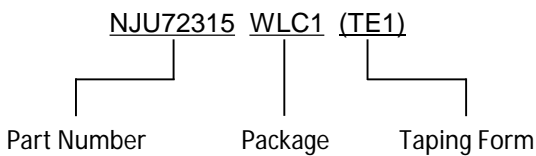


■PIN CONFIGURATION



PIN NO.	SYMBOL	DESCRIPTION
A1	InB	Bch Input
A2	RefB1	Bch Reference Voltage 1
A3	ADR	Chip address setting terminal
A4	OutB	Bch Output
B1	V-	Analog block Power Supply (-)
B2	RefB2	Bch Reference Voltage 2
B3	TEST	TEST terminal
B4	DGND	Digital block Ground
C1	InA	Ach Input
C2	V+	Analog block Power Supply (+)
C3	RefA1	Ach Reference Voltage 1
C4	OutA	Ach Output
D1	RefA2	Ach Reference Voltage 2
D2	SCL	I2C Clock terminal
D3	SDA	I2C Data Input / Acknowledge Output terminal
D4	VDD	Digital block Power Supply

■MARK INFORMATION



■ORDERING INFORMATION

PART NUMBER	PACKAGE	RoHS	HALOGEN-FREE	TERMINAL FINISH	MARKING	WEIGHT (mg)	MOQ (pcs)
NJU72315WLC1 (TE1)	WCSP16	Yes	Yes	SnAnCu	72315	4.6	3,000

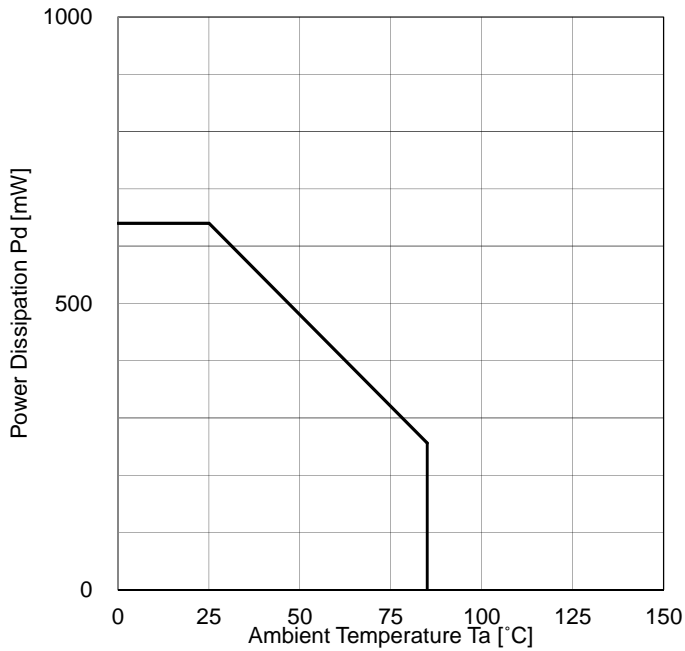
■ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V^+ / V	+6/-6	V
	VDD	+4	V
Maximum Input Voltage	V_{IM}	V^+ / V	V
	V_{ID}	VDD ⁽¹⁾	V
Power Dissipation (Ta=25°C)	P_D	640 ⁽²⁾	mW
Junction Temperature	T_{jmax}	+125	°C
Storage Temperature Range	T_{stg}	-40 to +125	°C

(1): SCL, SDA, ADR, TEST terminal.

(2): Mounted on glass epoxy board. (76.2x114.3x1.6mm:based on EIA/JEDEC standard, 2layers FR-4)

■POWER DISSIPATION vs. AMBIENT TEMPERATURE



RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	VALUE	UNIT
Operating Voltage Range	V^+/V	± 3.0 to ± 5.5 ⁽³⁾	V
Digital block Supply Voltage Range	VDD	+1.6 to +3.6 ⁽³⁾	V
Operating Temperature Range	T_{opr}	-40 to +85	°C

(3): Make sure to operate on the condition of $V^+ > VDD$ when it operates.

ELECTRICAL CHARACTERISTICS
DC CHARACTERISTICS

($T_a=25^\circ\text{C}$, $V^+/V=\pm 5\text{V}$, $VDD=1.8\text{V}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current 1	I_{CC}	No Signal, No Load	-	0.7	2	mA
	I_{CC_SD}	No Signal, No Load, Shutdown	-	-	1	μA
Supply Current 2	I_{EE}	No Signal, No Load	-	0.9	2	mA
	I_{EE_SD}	No Signal, No Load, Shutdown	-	-	1	μA
Supply Current 3	I_{DD}	No Signal, No Load	-	0.4	2	mA
Input Impedance	R_{IN}	InA, InB terminals-	-	1	-	k Ω

AC CHARACTERISTICS

($T_a=25^\circ\text{C}$, $V^+/V=\pm 5\text{V}$, $VDD=1.8\text{V}$, $f=1\text{kHz}$, $V_{IN}=2\text{V}_{rms}$, Volume=0dB, V_{OUT} with Op-Amp, $R_L=10\text{k}\Omega$

unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Voltage Gain Error 1	ΔG_{V1}	-	-1	0	+1	dB
Voltage Gain Error 2	ΔG_{V2}	Volume=-30dB	-1	0	+1	dB
Mute Level	Mute	Volume=Mute, A-weight	-	-100	-	dB
Total Harmonic Distortion	THD	$V_{IN}=1.6\text{V}_{rms}$, BW=10 to 22kHz	-	0.00013	-	%
Output Noise	V_{NO}	$R_g=0\Omega$, A-weight	-	-124 (0.63 μ)	-	dBV (V $_{rms}$)
Channel Separation	CS	$R_g=0\Omega$	-	-120	-80	dB

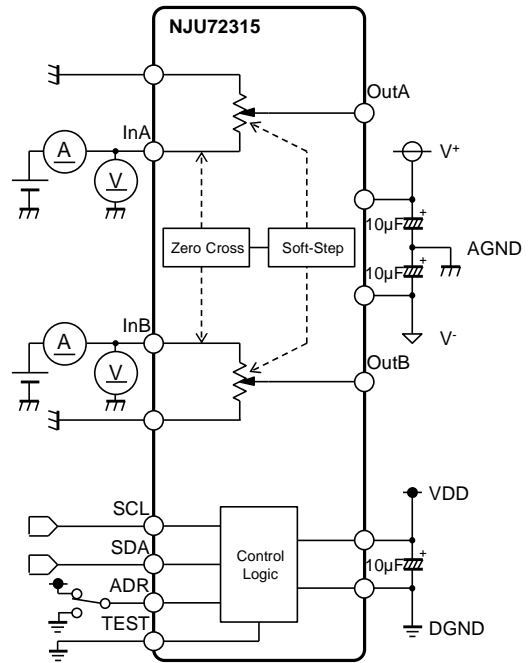
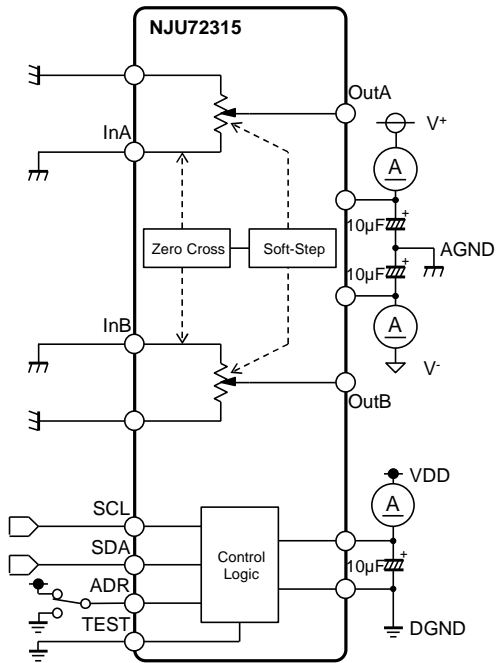
LOGIC CONTROL CHARACTERISTICS ($T_a=25^\circ\text{C}$ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	
High Level Input Voltage	V_{IH}	ADR terminal	$VDD \geq 2\text{V}$	$0.7 * VDD$	-	VDD	V
			$VDD < 2\text{V}$	$0.8 * VDD$	-	VDD	V
Low Level Input Voltage	V_{IL}	ADR terminal	$VDD \geq 2\text{V}$	0	-	$0.3 * VDD$	V
			$VDD < 2\text{V}$	0	-	$0.2 * VDD$	V

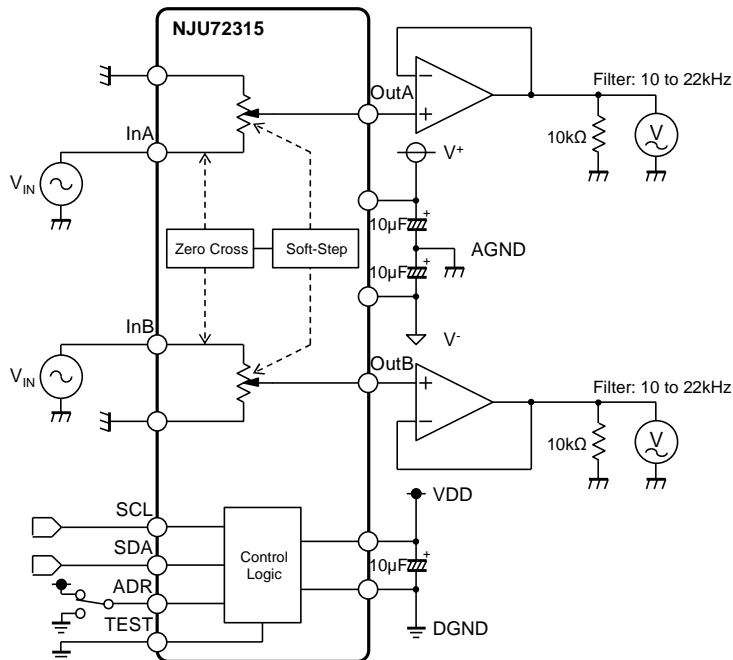
TEST CIRCUIT

◆ I_{CC} , I_{CC_SD} , I_{EE} , I_{EE_SD} , I_{DD}

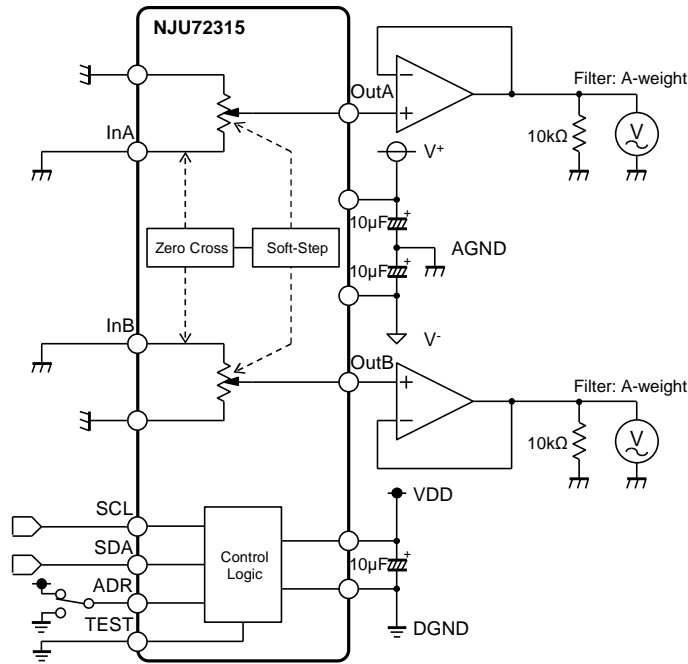
◆ R_{IN}



◆ THD



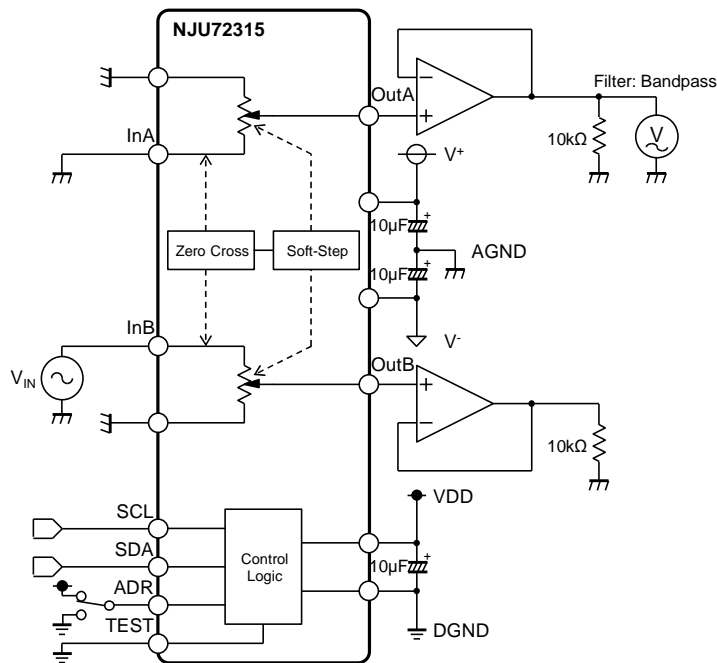
◆ V_{NO}



◆ CS

EX) Input=InB -> Measure=OutA

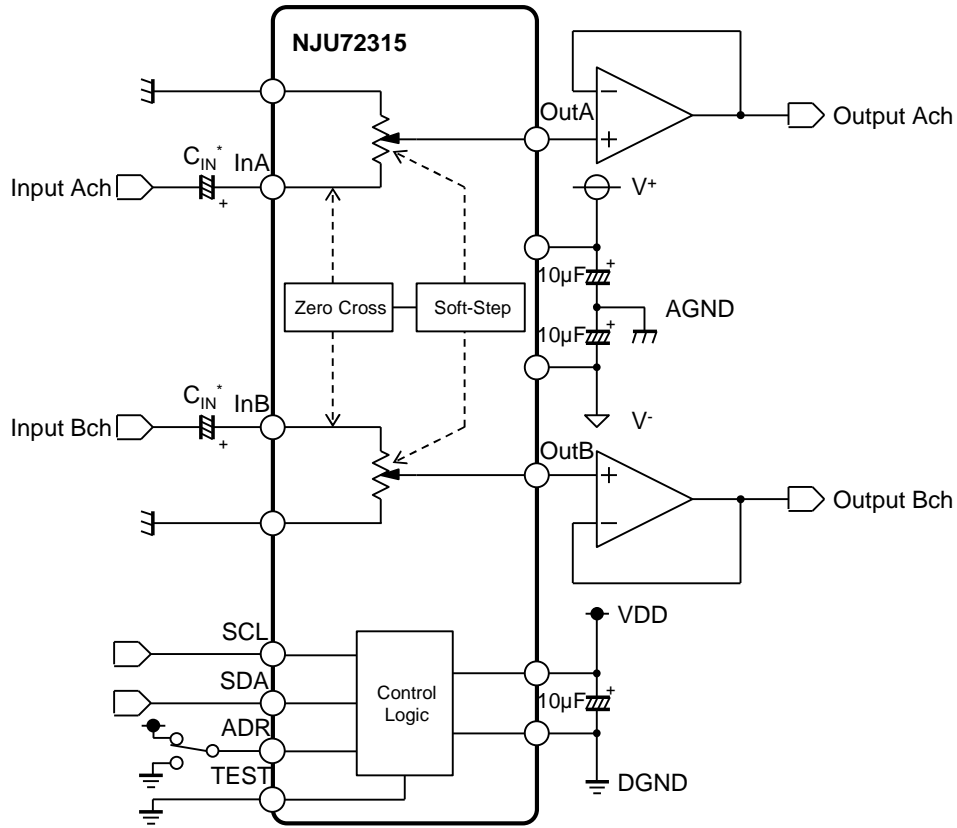
Input=InA -> Measure=OutB



■TERMINAL DESCRIPTION

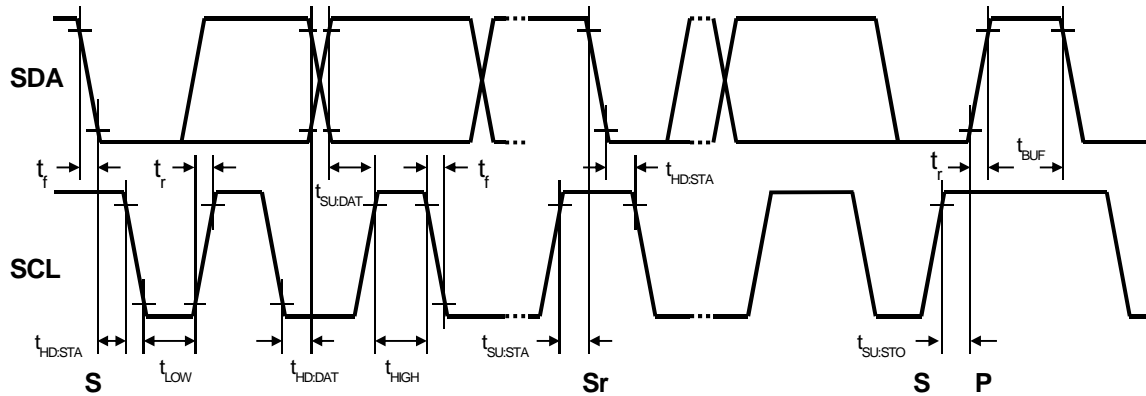
PIN NO.	SYMBOL	FUNCTION	EQUIVALENT CIRCUIT	VOLTAGE
A1 C1	InB InA	Bch Input Ach Input	<p>RefA1, RefA2 RefB1, RefB2</p>	- -
A2 B2 C3 D1	RefB1 RefB2 RefA1 RefA2	Bch Reference Voltage 1 Bch Reference Voltage 2 Ach Reference Voltage 1 Ach Reference Voltage 2		- - - -
A3 B3 D2	ADR TEST SCL	Chip address setting terminal TEST terminal I ² C Clock terminal	<p>DGND</p>	- - -
A4 C4	OutB OutA	Bch Output Ach Output	<p>AREF</p>	- -
D3	SDA	I ² C Data Input / Acknowledge Output terminal	<p>DGND</p>	-

APPLICATION CIRCUIT



* The NJU72315 inputs terminals can be directly connected without input capacitor (C_{IN}) if the output DC offset voltage of the front devices is small.

■TIMING ON THE I²C BUS (SDA, SCL)



■CHARACTERISTICS OF I/O STAGES FOR I²C BUS (SDA, SCL)

I²C BUS Load Conditions

STANDARD MODE: Pull up resistance 3.9kΩ (Connected to +3.3V), Load capacitance 200pF (Connected to GND)

FAST MODE: Pull up resistance 3.9kΩ (Connected to +3.3V), Load capacitance 50pF (Connected to GND)

PARAMETER	SYMBOL	Standard mode		Fast mode		UNIT
		MIN.	MAX.	MIN.	MAX.	
Low Level Input Voltage	VDD ≥ 2V	0	0.3*VDD	0	0.3*VDD	V
	VDD < 2V	0	0.2*VDD	0	0.2*VDD	
High Level Input Voltage	VDD ≥ 2V	0.7*VDD	VDD	0.7*VDD	VDD	V
	VDD < 2V	0.8*VDD	VDD	0.8*VDD	VDD	
Low Level output voltage (3mA at SDA pin)	V _{OL}	0	0.4	0	0.4	V
Input current each I/O pin with an input voltage between 0.1V _{DD} and 0.9V _{DDmax}	I _i	-10	10	-10	10	μA

■CHARACTERISTICS OF BUS LINES (SDA, SCL) FOR I²C BUS DEVICES

PARAMETER	SYMBOL	Standard mode			Fast mode			UNIT
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
SCL clock frequency	f _{SCL}	-	-	100	-	-	400	kHz
Hold time (repeated) START condition.	t _{HD:STA}	4.0	-	-	0.6	-	-	μs
Low period of the SCL clock	t _{LOW}	4.7	-	-	1.3	-	-	μs
High period of the SCL clock	t _{HIGH}	4.0	-	-	0.6	-	-	μs
Set-up time for a repeated START condition	t _{SU:STA}	4.7	-	-	0.6	-	-	μs
Data hold time	t _{HD:DAT}	0	-	-	0	-	-	μs
Data set-up time	t _{SU:DAT}	250	-	-	100	-	-	ns
Rise time of both SDA and SCL signals	t _r	-	-	1000	-	-	300	ns
Fall time of both SDA and SCL signals	t _f	-	-	300	-	-	300	ns
Set-up time for STOP condition	t _{SU:STO}	4.0	-	-	0.6	-	-	μs
Bus free time between a STOP and START condition	t _{BUF}	4.7	-	-	1.3	-	-	μs
Capacitive load for each bus line	C _b	-	-	400	-	-	400	pF
Noise margin at the Low Level	V _{nL}	0.5	-	-	0.5	-	-	V
Noise margin at the High Level	V _{nH}	1	-	-	1	-	-	V

C_b ; total capacitance of one bus line in pF.

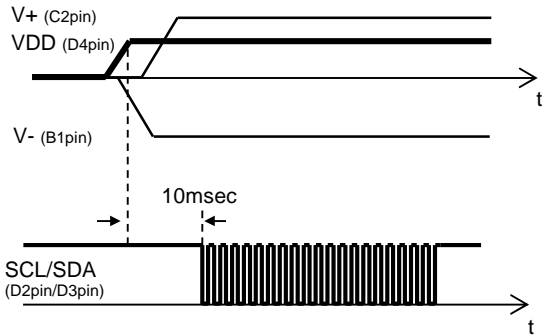
■ RECOMMENDED POWER-UP SEQUENCE

The NJU72315 should be used under the condition that potential V^- terminals are always the lowest potential.

Turn on VDD power supply first.

It is recommended that V^- power supply turns on before or just same time that V^+ power supply turns on.

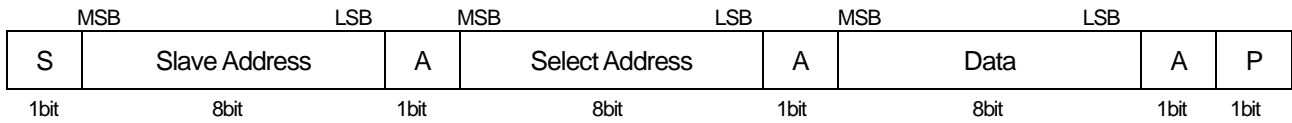
Make sure to operate on the condition of $V^+ > VDD$ when it operates.



■ DEFINITION OF I²C REGISTER

Note) Please don't send except specified data for avoiding an incorrect operation.

◆ I²C BUS FORMAT



S: Starting Term
A: Acknowledge Bit
P: Ending Term

◆ SLAVE ADDRESS

	MSB							LSB	
1	0	0	0	0	0	0	ADR	0	
1	0	0	0	0	0	0	0	0	80H
1	0	0	0	0	0	1	0	0	82H

◆ CONTROL REGISTER TABLE

The select address sets each function.
The auto increment function cycles the select address as follows.
00H→01H→02H→00H

<Write Mode>

	MSB								LSB
Select Address	Data								
	D7	D6	D5	D4	D3	D2	D1	D0	
00H	Ach Volume						Z/C	SS	
01H	Bch Volume						0	0	
02H	Z/C Timer	AB Cont	SD	SS_CLK			TEST		

◆ CONTROL REGISTER DEFAULT VALUE

Control register default value is all "0".

	MSB								LSB
Select Address	Data								
	D7	D6	D5	D4	D3	D2	D1	D0	
00H	0	0	0	0	0	0	0	0	
01H	0	0	0	0	0	0	0	0	
02H	0	0	0	0	0	0	0	0	

■ DEFINITION OF RESISTOR

- ◆ **Volume:** 0 to -62dB / 2dB step. Each volume is controlled independently
- ◆ **Z/C:** Zero Cross Detection circuit ON/OFF setting. Zero-crossing function is to change gain settings on a zero-crossing of the input signal, and provides for reducing audible noise emanating during gain adjustments.
- ◆ **SS:** Soft-Step circuit ON/OFF setting. Soft-step function is to change gain settings step by step, and provides for reducing zipper noise during gain adjustments.

Select Address	Data							D1	D0
	D7	D6	D5	D4	D3	D2			
00H	Ach Volume						Z/C	SS	
01H	Bch Volume						0	0	

< Ach Volume / Bch Volume Setting >

Data						Setting
D7	D6	D5	D4	D3	D2	
0	0	0	0	0	0	Mute ^(*)
0	1	1	0	0	0	0 dB
0	1	1	0	0	1	-2 dB
0	1	1	0	1	0	-4 dB
0	1	1	0	1	1	-6 dB
0	1	1	1	0	0	-8 dB
0	1	1	1	0	1	-10 dB
0	1	1	1	1	0	-12 dB
0	1	1	1	1	1	-14 dB
1	0	0	0	0	0	-16 dB
1	0	0	0	0	1	-18 dB
1	0	0	0	1	0	-20 dB
1	0	0	0	1	1	-22 dB
1	0	0	1	0	0	-24 dB
1	0	0	1	0	1	-26 dB
1	0	0	1	1	0	-28 dB
1	0	0	1	1	1	-30 dB
1	0	1	0	0	0	-32 dB
1	0	1	0	0	1	-34 dB
1	0	1	0	1	0	-36 dB
1	0	1	0	1	1	-38 dB
1	0	1	1	0	0	-40 dB
1	0	1	1	0	1	-42 dB
1	0	1	1	1	0	-44 dB
1	0	1	1	1	1	-46 dB
1	1	0	0	0	0	-48 dB
1	1	0	0	0	1	-50 dB
1	1	0	0	1	0	-52 dB
1	1	0	0	1	1	-54 dB
1	1	0	1	0	0	-56 dB
1	1	0	1	0	1	-58 dB
1	1	0	1	1	0	-60 dB
1	1	0	1	1	1	-62 dB
1	1	1	1	1	1	Mute

^(*)Default Setting

< Z/C Setting >

Data	Setting
D1	
0	Zero Cross Detection Circuit ON ^(*)
1	Zero Cross Detection Circuit OFF

< SS Setting >

Data	Setting
D0	
0	Soft-Step Circuit ON ^(*)
1	Soft-Step Circuit OFF

^(*)Default Setting

Note) Select SS control data setting after power supply just turned ON. Select it when volume setting is "MUTE" except to select it after power supply just turned ON.

- ◆ **Z/C Timer:** Select Zero Cross Timeout setting.
- ◆ **AB Cont:** Select “the independent control” or “the Ach-Bch link control” of volume control method.
- ◆ **SD:** Shut down the analog block ON/OFF setting.
- ◆ **SS_CLK:** Divide the clock frequency setting for Soft-Step.
- ◆ **TEST:** For device check use only.

Select Address	Data							D0
	D7	D6	D5	D4	D3	D2	D1	
02H	Z/C Timer		AB Cont	SD	SS_CLK		TEST	

< Z/C Timer Setting >

Data		Setting
D7	D6	
0	0	OFF ^(*)
0	1	Short
1	0	Middle
1	1	Long

< AB Cont Setting >

Data	Setting
D5	
0	Ach, Bch independent control ^(*)
1	Ach-Bch link control

< SD Setting >

Data	Setting
D4	
0	Shutdown OFF ^(*)
1	Shutdown ON (Note 1)

(Note 1) The Zero Cross function does not operate at shutdown. Other functions operate.

< SS_CLK Setting >

Data			Setting
D3	D2	D1	
0	0	0	Initial ^(*)
0	0	1	Initial / 2
0	1	0	Initial / 4
0	1	1	Initial / 8
1	0	0	Initial / 16
1	0	1	Initial / 32
1	1	0	Initial / 64
1	1	1	Initial / 128

< TEST Setting >

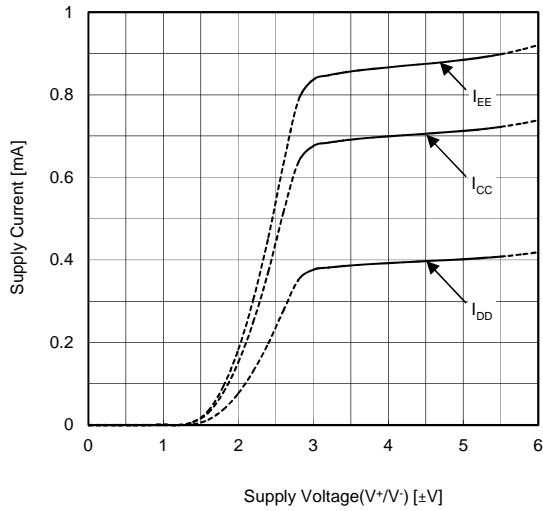
Data	Setting
D0	
0	Test Mode OFF ^(*)
1	Test Mode ON (Note 2)

^(*)Initial Setting

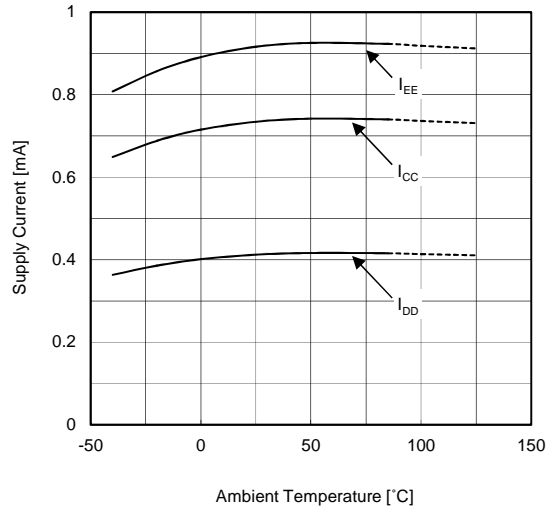
(Note 2) For device check use only. Set “0” in usual.

TYPICAL CHARACTERISTICS

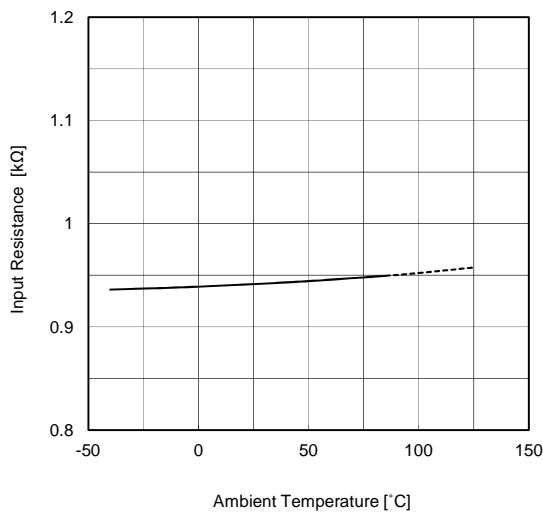
Supply Current vs Supply Voltage
VDD=1.8V, No signal, No load



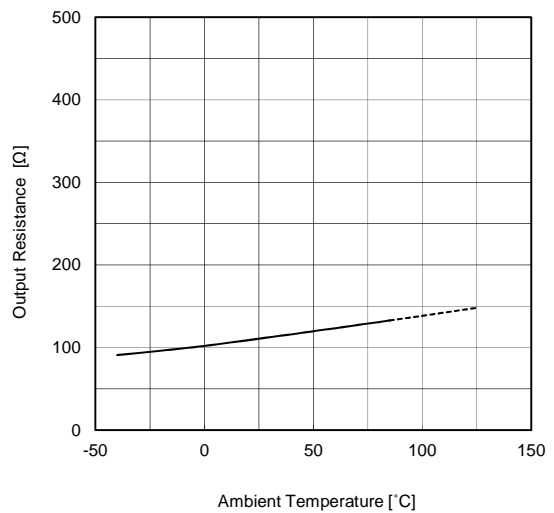
Supply Current vs Temperature
V=±5V, VDD=1.8V, No signal, No load



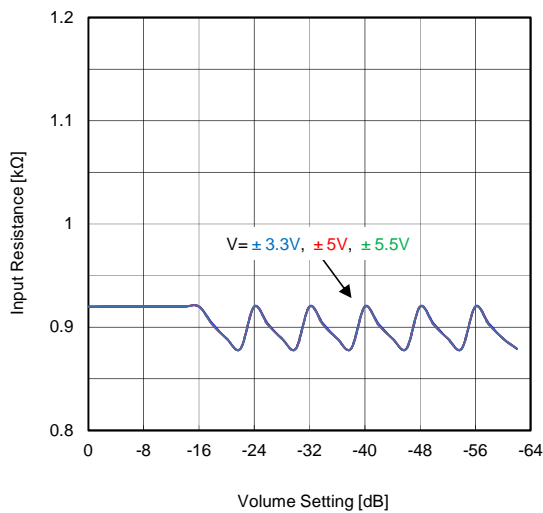
Input Resistance vs Temperature
V=±5V



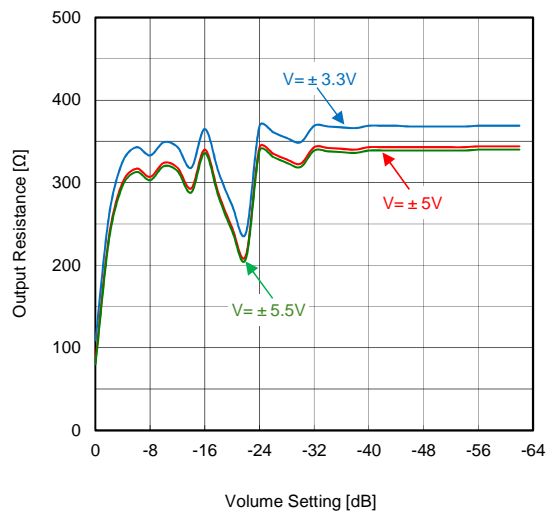
Output Resistance vs Temperature
V=±5V, Rg=0Ω



Input Resistance vs Volume Setting

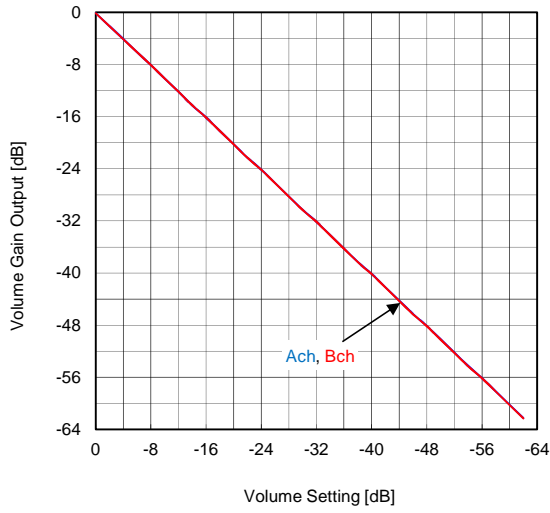


Output Resistance vs Volume Setting
Rg=0Ω

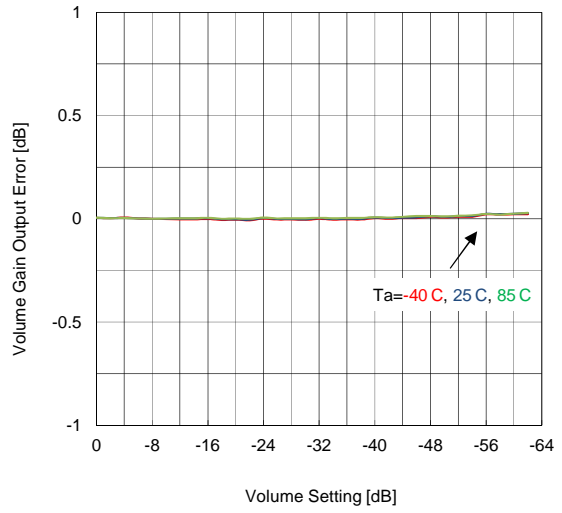


TYPICAL CHARACTERISTICS

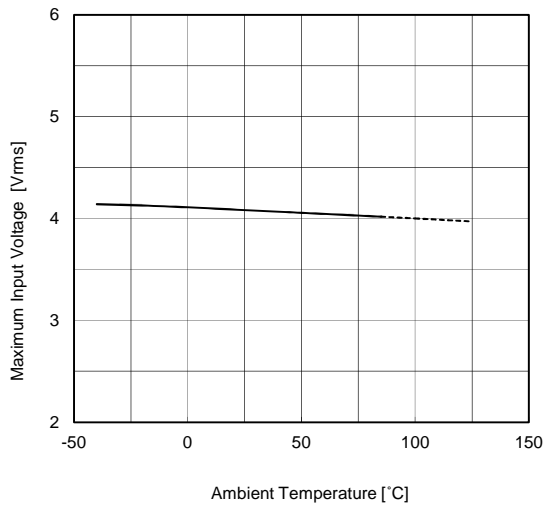
Volume Gain Output vs Volume Setting
 $V=\pm 5V, f=1kHz, V_{in}=2V_{rms}$, Bandpass



Volume Gain Output Error vs Volume Setting
 $V=\pm 5V, f=1kHz, V_{in}=2V_{rms}$, Bandpass



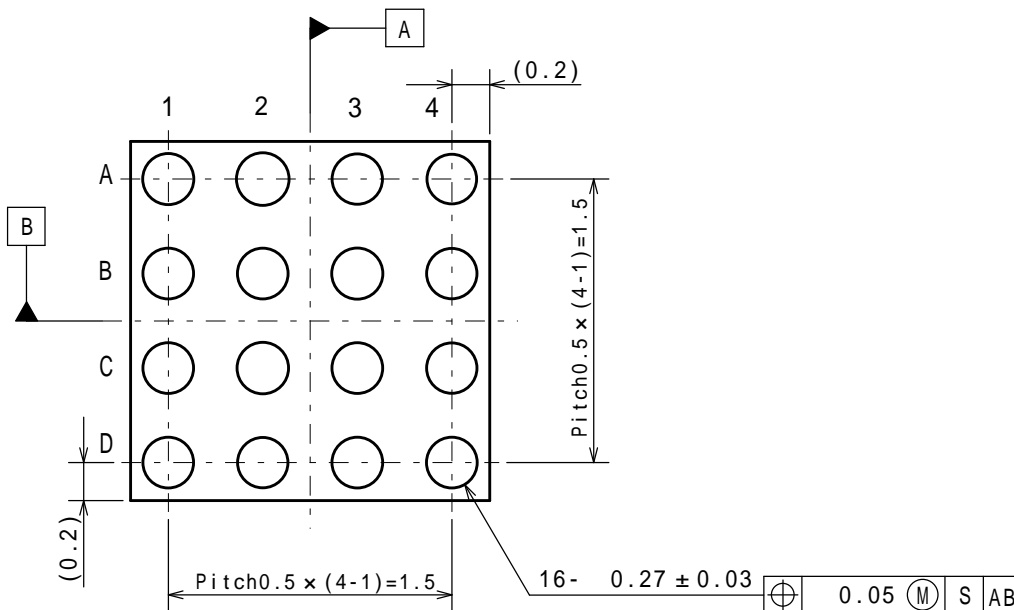
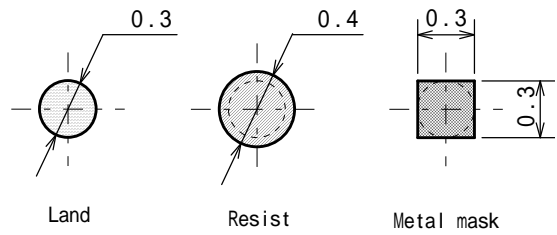
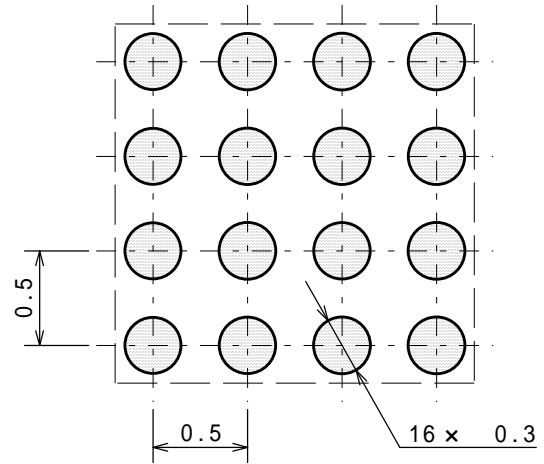
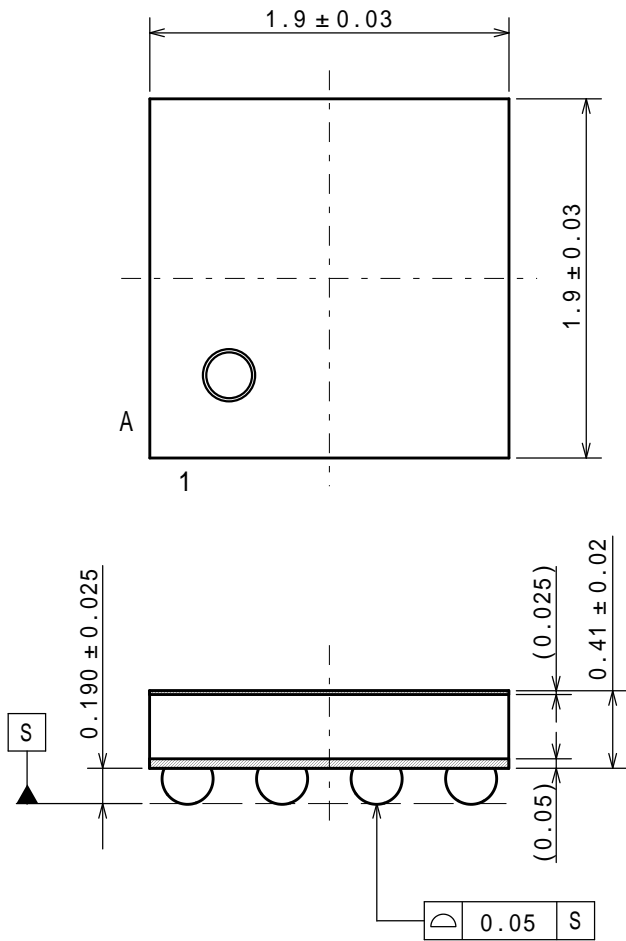
Maximum Input Voltage vs Temperature
 $V=\pm 5V, THD=1\%$, Volume=-20dB



Unit: mm

PACKAGE DIMENSIONS

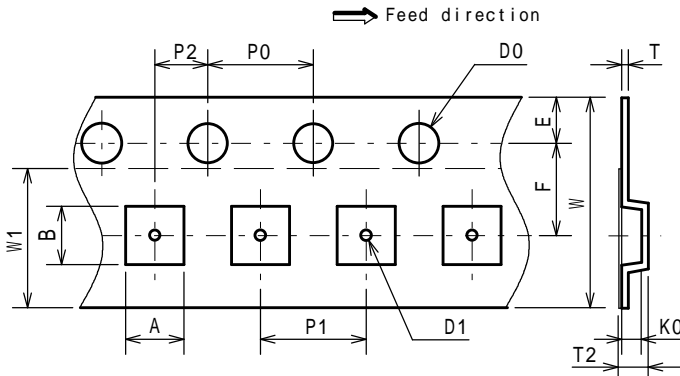
EXAMPLE OF SOLDER PADS DIMENSIONS



PACKING SPEC

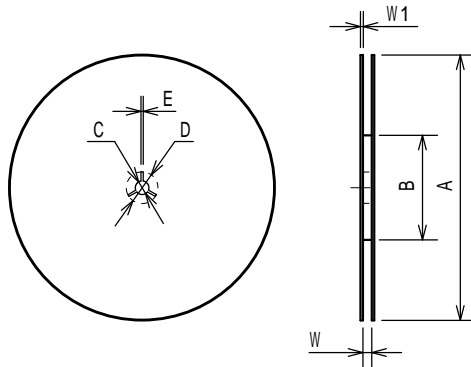
Unit: mm

TAPING DIMENSIONS



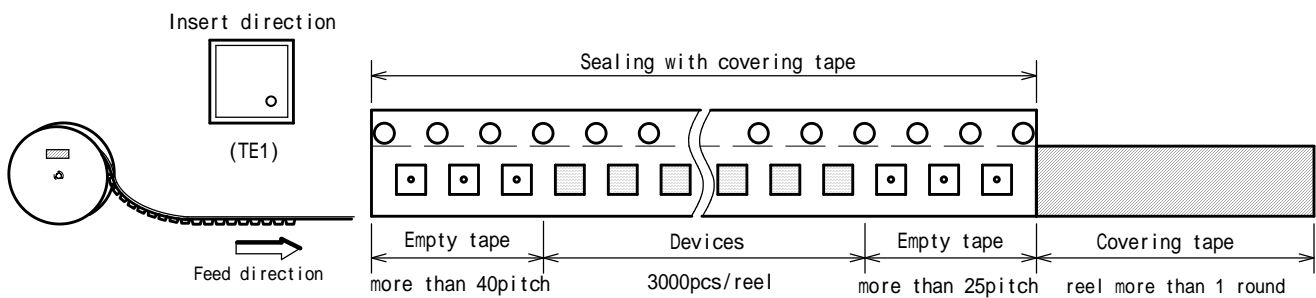
SYMBOL	DIMENSION	REMARKS
A	2.25 ± 0.05	BOTTOM DIMENSION
B	2.25 ± 0.05	BOTTOM DIMENSION
D0	1.5 ^{+0.1} ₀	
D1	0.5 ± 0.1	
E	1.75 ± 0.1	
F	3.5 ± 0.05	
P0	4.0 ± 0.1	
P1	4.0 ± 0.1	
P2	2.0 ± 0.05	
T	0.25 ± 0.05	
K0	1.0 ± 0.07	
W	8.0 ± 0.2	
W1	5.5	THICKNESS 0.1max

REEL DIMENSIONS

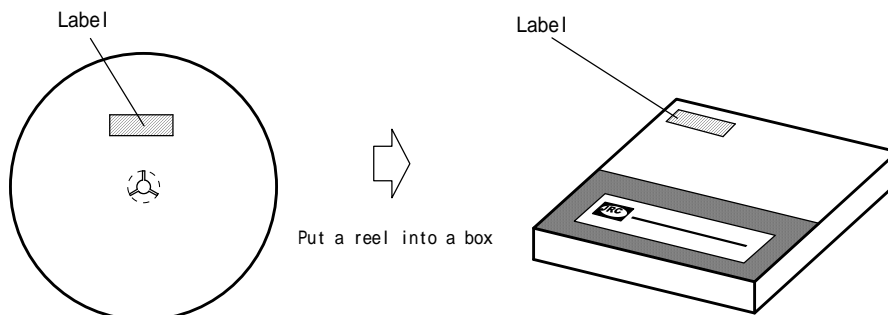


SYMBOL	DIMENSION
A	180 ⁰ _{-1.5}
B	60 ⁺¹ ₀
C	13 ± 0.2
D	21 ± 0.8
E	2 ± 0.5
W	9 ^{+0.3} ₀
W1	1.2

TAPING STATE



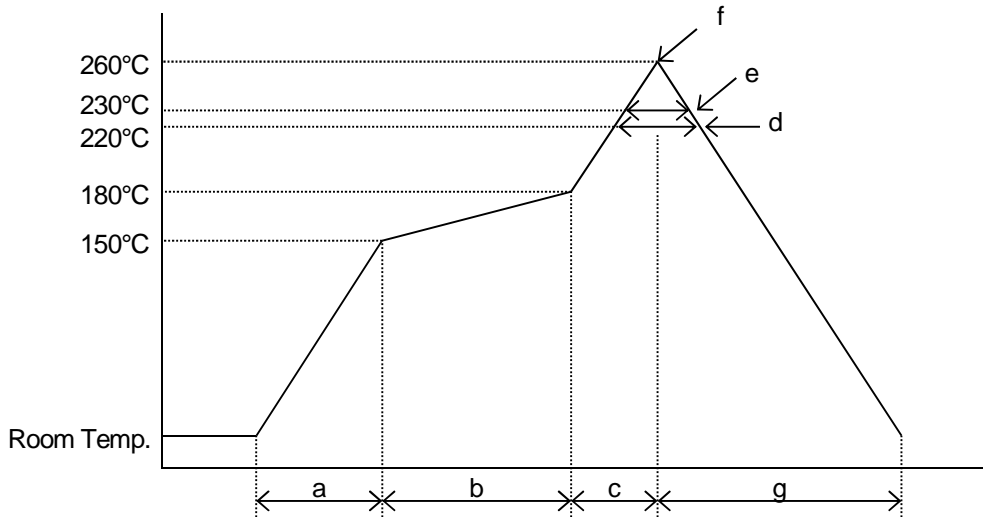
PACKING STATE



■RECOMMENDED MOUNTING METHOD

INFRARED REFLOW SOLDERING METHOD

*Recommended reflow soldering procedure



- | | |
|---------------------------------|--------------------------------|
| a: Temperature ramping rate | : 1 to 4°C/s |
| b: Pre-heating temperature time | : 150 to 180°C
: 60 to 120s |
| c: Temperature ramp rate | : 1 to 4°C/s |
| d: 220°C or higher time | : Shorter than 60s |
| e: 230°C or higher time | : Shorter than 40s |
| f: Peak temperature | : Lower than 260°C |
| g: Temperature ramping rate | : 1 to 6°C/s |

The temperature indicates at the surface of mold package.

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